ECONOMIC ANALYSIS

A. Introduction

1. The economic analysis of the Xinjiang Altay Urban Infrastructure and Environment Improvement Project covers five counties and 26 components. The economic analysis evaluates the components through least-cost analysis (LCA) and benefit–cost analysis. Economic analysis was conducted in accordance with the Guidelines for the Economic Analysis of Projects of the Asian Development Bank (ADB).[1]

B. Methods of Economic Analysis

2. **Estimation of costs**. The costs to society are the capital investment and operating costs of the proposed components, and associated costs of environmental and social mitigations, including land acquisition and resettlement. Land acquisition and resettlement costs were estimated based on their opportunity costs—that is, the agricultural output forgone and the re-siting of displaced activities when necessary. Physical contingencies and initial working capital were included. Costs are denominated in domestic price numeraire at constant June 2010 prices. Transfers such as taxes and duties have been excluded. Traded components are converted into economic prices using a shadow exchange rate factor of 1.08. A shadow wage rate factor of 0.67 is used to convert financial into economic wage rates for unskilled labor.

3. **Estimation of benefits**. The net economic benefits in the analysis were derived by comparing the "with-project" and "without-project" scenarios. Under the without-project situation, it is assumed that participating counties would serve demand through existing capacity. Benefits are calculated as the sum of two components: (i) non-incremental benefits, which are estimated as the resource cost savings that result from displacing higher-cost alternatives with water treatment plants (WTPs), under the with-project scenario; and (ii) incremental benefits, which result from reducing unmet demand for water, heating, and solid waste management by adding additional capacity to the system under the with-project scenario. Major economic benefits that were quantified for each component are (i) resource cost savings for heating, water supply, and roads; (ii) increase in land values for solid waste management; and (iii) willingness to pay for water supply and heating components.

4. The economic internal rate of return (EIRR) was calculated for each component by calculating the discount rate at which the total present value of benefits and the total present value of costs are equalized.

C. Demand Analysis

5. Demand forecasts were reviewed for the heating, roads, solid waste, wastewater, and water supply components across counties. For the park infrastructure improvement at the 6.3-square kilometer White Birch Forest, six new wastewater treatment plants,[2] heating, and water

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[1] ADB. 1997. *Guidelines for the Economic Analysis of Projects.* Manila.

[2] David Dole. 2002. Economic Issues in the Design and Analysis of a Wastewater Treatment Project. *Economics and Research Department Technical Note Series*. No. 4. Manila: Asian Development Bank. This has discussed the need for benefit-cost analysis of wastewater treatment plants. It argues that if a wastewater treatment plant is part of a master plan whose aim is to decrease water pollution to national standards and if those standards are rational, there is no need for a separate benefit–cost analysis.

supply pipelines components, LCA was undertaken. For the water supply components, water demand in 2015 was estimated at 16,890 cubic meters per day. Water demand projections are based on projected service area population, existing, and future consumption. Assumptions include (i) consumption range from 130 liters per capita per day (lpcd) to 145 lpcd; (ii) annual population increase; (iii) household size constant; (iv) 80% of households to be connected to water supply in year 1 of operation, increasing to 100% over the next 2 years; (v) nondomestic demand based on actual conditions; and (vi) losses at 10% of water production. For the heating components, the total heating area is projected at 2,443,000 square meters in 2015. The project will increase centralized heating coverage by rehabilitating two central-heating, coal-fired boiler stations. For solid waste management, five new landfills will be constructed with an estimated capacity of 230 tons per day. Total waste generation is projected at 238 tons per day. For the wastewater components, the total volume of wastewater generated is estimated to be 31,200 cubic meters per day in 2015, across counties. This is based on 130–145 lpcd consumption and a return rate of 80% for domestic wastewater. For the road components, about 59 kilometers (km) of roads will be constructed and/or upgraded across the counties. Road improvement is based on annual average daily traffic derived from traffic surveys. Forecast traffic is extrapolated based on traffic trends and/or traffic growth rate based on gross domestic product growth. Generated traffic is assumed to be 10%–20% of total forecast traffic.

D. Least-Cost Analysis

6. LCA of alternative options was carried out to determine whether options specified and included under the project would represent the least-cost means of meeting forecast growth in demand. LCA was carried out in accordance with ADB's Guidelines for the Economic Analysis of Projects. The present value of life-cycle costs of each option, including capital investment, operation, and maintenance, was estimated over the 20-year period of analysis. The capital costs include the cost of resettlement and land acquisition. Taxes, duties, and value-added government sales tax were excluded.

7. The proposed investments are the least-cost solutions to achieve the project development objectives and to meet demand forecast. LCA was conducted throughout component selection and preliminary design to ensure that the selected investments are the most economical interventions. LCA compares economic costs of technically viable project options and selects the one with the lowest present value of economic costs. For the water supply components, the number, location, and size of the WTPs were based on (i) proximity to the water supply source, (ii) absence of any planned settlements in the future, (iii) terrain, and (iv) land availability. Comparison of alternative WTP sites was undertaken from an engineering perspective. The selection of the water treatment process is based on the principle that WTPs must be designed to comply with government national drinking standards, thus, the most common and frequently used process of flocculation, sedimentation, filtration, and disinfection is adopted in water purification, which is more economical than other, more complex processes. Meanwhile, water transmission and distribution pipelines are based on terrain condition and water consumer distribution. Two types of pipes are analyzed and the results show that the polyethylene pipe (CNY1.59/cubic meter) is marginally cheaper than steel pipe (CNY1.60/cubic meter). Cost-effectiveness analysis of new road construction is based on minimizing cost per km or passenger per km to ensure selection of the most efficient alternative for detailed analysis.[3] Two road pavement standards are considered as improvement or construction options in LCA. The results indicate that asphalt pavement has the lowest present value of

[3] Road surface design standards considered: asphalt concrete pavement, cement concrete pavement. Both surface standards have gravel shoulder of 0.5 meter on both sides and concrete stabilization sub-base.

economic cost (PVEC) estimated at CNY74.93 million ($11.35 million) compared with the PVEC of concrete pavement estimated at CNY79.00 million ($11.98 million). Asphalt pavement is cheaper by about 6%. Three wastewater treatment processes were analyzed: (i) aeration basin, (ii) sequencing batch reactors, and (iii) oxidation ditch. Aeration basin showed the lowest PVEC of CNY32.5 million compared with PVEC of CNY35.3 (sequencing batch reactors) and CNY34.8 (oxidation ditch). For the solid waste management, two collection systems were analyzed. The collection system without a transit station was found to be the least-cost option at CNY19.3 million as against the collection system using a transit station at CNY20.6 million.

E. Economic Internal Rate of Return

8. The EIRR was calculated for each component by calculating the discount rate at which the total present value of benefits and the total present value of costs are equalized. The results presented in Table 1 indicate that all components analyzed exceed the proposed EIRR threshold of 12%, and are therefore considered economically viable.

Table 1: Summary of Economic Internal Rate of Return Calculation

Component	**EIRR** (%)	**NPV** (CNY million)
Buerjin		
1. Roads	15.8	19.9
2. Solid waste management	14.8	4.1
3. Water supply	14.8	13.5
Overall	**15.1**	**37.5**
Fuhai		
1. Roads	15.4	17.0
2. Solid waste management	14.9	6.6
Overall	**15.1**	**23.6**
Habahe		
1. Roads	14.5	10.4
2. Solid waste management	15.0	6.1
Overall	**14.8**	**16.5**
Jimunai		
1. Heating	18.0	12.5
2. Roads	17.4	17.2
3. Solid waste management	14.9	3.8
Overall	**16.8**	**33.5**
Qinghe		
1. County seat heating	18.7	12.8
2. County seat solid waste management	15.2	3.8
3. County seat water supply	15.3	4.9
4. Takeshiken roads	14.9	2.9
5. Takeshiken water supply	15.0	2.8
Overall	**15.8**	**27.2**
Overall Project	**15.5**	**138.3**

EIRR = economic internal rate of return; NPV = net present value.
Source: Asian Development Bank estimates.

9. **Sensitivity analysis**. Analysis was undertaken to test the sensitivity of the estimated EIRRs of the proposed components to adverse changes in key variables and to confirm their economic viability under unfavorable conditions. Four major risks were considered: (i) an

increase of 10% in capital and operating costs, (ii) a 10% decrease in benefits, (iii) combination of (i) and (ii), and (iv) a 1-year delay in project implementation. A summary of the results of sensitivity analysis due to changes in the major parameters is included in Table 2. The analysis indicates that the EIRR remains robust under all scenarios.

Table 2: Sensitivity Analysis of Economic Internal Rate of Return
(%)

Component	Case 1: 10% Increase in Costs	Case 2: 10% Reduction in Benefits	Case 3: Cases 1 and 2	Case 4: 1-Year Delay in Implementation
Buerjin				
1. Roads	14.7	14.5	13.4	14.3
2. Solid waste management	13.6	13.5	12.3	13.2
3. Water supply	13.5	13.4	12.1	13.3
Overall	**13.9**	**13.8**	**12.6**	**13.6**
Fuhai				
1. Roads	14.2	14.0	12.9	13.9
2. Solid waste management	13.7	13.5	12.3	13.2
Overall	**14.0**	**13.8**	**12.6**	**13.6**
Habahe				
1. Roads	13.4	13.3	12.1	13.0
2. Solid waste management	13.8	13.7	12.5	13.3
Overall	**13.6**	**13.5**	**12.3**	**13.2**
Jimunai				
1. Heating	16.7	15.0	12.1	15.4
2. Roads	16.2	15.9	14.7	15.4
3. Solid waste management	13.6	13.4	12.2	13.2
Overall	**15.5**	**14.8**	**13.0**	**14.7**
Qinghe				
1. County seat heating	17.4	15.3	12.0	16.1
2. County seat solid waste management	13.8	13.7	12.4	13.4
3. County seat water supply	13.9	13.7	12.3	13.7
4. Takeshiken roads	13.6	13.4	12.1	13.0
5. Takeshiken water supply	13.7	13.5	12.3	13.5
Overall	**14.5**	**13.9**	**12.2**	**13.9**
Overall Project	**14.3**	**14.0**	**12.5**	**13.8**

Source: Asian Development Bank estimates.

10. The economic analysis shows that the components subjected to benefit–cost analysis are economically viable and stand up to sensitivity tests. The overall viability of the project is estimated at 15.5% while the EIRRs of the components, shown in Table 1, are 15.1% for Buerjin, 15.1% for Fuhai, 14.8% for Habahe, 16.8% for Jimunai, and 15.8% for Qinghe. Sensitivity analysis shows that the EIRRs are most sensitive to reduction in benefits and to both decrease in benefits and increase in costs. The results of the economic analysis demonstrate the economic viability of the components. Economic sustainability is nonetheless subject to the managing of risks attendant to the variables to which economic viability is found to be most sensitive.