EXTENDED ECONOMIC ANALYSIS

A. Introduction

1. Economic analysis of the project is conducted in accordance with the ADB's Guidelines for the Economic Analysis of Projects (1997) and the Cost-Benefit Analysis for Development: A Practical Guide (2013), and follows the outline in the ADB's Key Areas of Economic Analysis of Investment Projects - An Overview (2013). The objective of the economic analysis is to demonstrate the economic rationale and viability of the individual subprojects that comprise the two project outputs—integrated urban development and wetlands rehabilitation—as well as economic viability of the two outputs and the overall project. Demand analysis is conducted based on the sector review in line with the urban development plans of Akesu City. Least cost analysis is conducted for those subprojects where technical alternatives have been identified in the feasibility study report prepared by the local design institute (LDI). Project economic costs are derived from the financial costs set out in the detailed financing plans. Economic benefits are quantified based on (i) incremental output in the wetlands restoration; (ii) cost savings in the urban roads and underpass subprojects as well as partly in the improved central heating subproject; (iii) a combination of willingness to pay (WTP) and incremental output in the improvement of public green spaces and provision of plant nurseries subproject; and (iii) WTP in all other subprojects.[1] These are further detailed below. The economic viability of the individual subprojects, the two benefit-generating outputs, and the overall project are assessed through estimation of the economic internal rates of return (EIRRs) and economic net present values (ENPVs). Project management and capacity building costs are allocated across all subprojects based on the subproject investment costs. Land acquisition and resettlement costs are allocated to the two main subprojects—urban road network improvement and wetlands rehabilitation—based on analysis of the land acquisition and resettlement cost provided in the overall cost estimates. Project risks are assessed through sensitivity analysis against various standard risk scenarios.[2]

B. Project Rationale

2. Located in the northwest of the People's Republic of China (PRC), Xinjiang is a border area linking PRC to Central Asia. It covers almost one-sixth of the total area of the country.[3] In 2011, its population was approximately 22.1 million (about 1.5% of the population of the PRC), 60% of which comprised 36 ethnic minority groups, the largest portion of these being Uygur. In 2011, Xinjiang's gross domestic product (GDP) was CNY657 billion (about 1.3% of the total GDP of the PRC). Xinjiang's GDP per capita at CNY30,000 was below the PRC average of CNY35,000.

3. Akesu City is a medium-sized city and capital of Akesu prefecture, home to approximately 620,000 of the prefecture's 2.2 million inhabitants. Located in the mid-section of the south corridor, the city plays a strategic role in facilitating socioeconomic development in southern Xinjiang. In 2011, its GDP was CNY9.8 billion and the per capita GDP was CNY19,950. In addition to the city's significant growth from agricultural development,[4]

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[1] The methodology initially proposed for the contingent valuation studies required the use of five different bid amounts as detailed the ADB Technical Note No. 29, but due to financial restrictions each survey was limited to 150 respondents. Review of the collected data, and an English language version of the final questionnaire, indicates that the survey sought to identify the highest bid amount that each respondent would be willing to pay.

[2] Specific risks of the individual subprojects are not addressed separately since they tend to reflect either a cost increase or a benefit decrease and are considered to be incorporated into the standard tests.

[3] Approximately 1.7 million square kilometers (km^2).

[4] Formed by the confluence between Akesu River and Tarim River, the alluvial plain of Akesu is home to 85% of the prefecture population.

4. Akesu is undergoing further expansion due to the following: (i) exploration and processing of natural resources, such as oil, natural gas, and non-ferrous resources; (ii) regional and intercity transport improvements, such as the 2007 opening of a 424 kilometer (km)-long north-south highway connecting Akesu City to Khotan City; and (iii) construction of an industrial park for natural resources and agricultural products processing.[5]

5. Akesu's existing central urban area is densely populated and many areas suffer from the lack of essential services such as sealed roads and adequate heating. The urban area is becoming increasingly congested with the growth of public and private vehicles and there is a need both to develop new roads in critical areas and to rehabilitate existing roads, in particular to separate motorcycles and bicycles from other motorized traffic to increase speeds and improve safety. This is expected to have a positive impact on the economic development of the city. In addition, the proposed improvements to domestic heating, solid waste collection (in particular road cleaning), park facilities, and stormwater collection are all expected to have a positive impact on the city's environment, which will have an impact on its attractiveness as a place to live and work.

6. The area of wetlands proposed for inclusion in the project is an important habitat for birds and other wildlife as well as a source for agricultural products and Akesu's water supply. The area has suffered from extensive and largely uncontrolled agricultural development in the past and is now becoming increasingly polluted so that its functions are being threatened. If ignored, the functions of the wetlands will deteriorate further and may well present a threat to the city's water supply. Interventions to be supported by the project are expected to return the wetlands to their former condition so as to promote wildlife, protect the water supply, and provide a facility for tourists.

7. ADB has been helping the PRC Government to develop the western regions, including Xinjiang, by providing financial and technical support for government initiatives to stimulate sustainable economic growth and urban development of the project cities. The project will help the municipal government develop and improve urban infrastructure and municipal services and stimulate social and environmental development that will promote economic growth and development in the Akesu City.

C. Least Cost Analysis

8. Least cost options, including for the type of pipelines to be used, were considered by the local design institute during project preparation. For the pipelines, the comparison is between the capital cost of the options, since there is negligible difference in maintenance costs, and the least cost approach was selected.

D. Demand Analysis

9. The level and quality of many urban services in Akesu City are currently inadequate, and a large portion of the population is impacted in their day-to-day life. The condition of roads impacts on the time spent on normal daily activities as well as on the overall city environment. Substandard heating has a negative impact on health both through inadequate heating and pollution caused by localized small-scale facilities. In general the quality of all services has a negative impact on the quality of life in the city and substantially reduces the rate of economic growth.

[5] From 2006 to 2010, the GDP structure of Akesu prefecture rapidly changed from a primary, secondary, and tertiary industries structure proportion of 33:28:40 to 15:28:56. This reflects a shift from agricultural sector to service sector mainly driven by rural labor taking up small business services in the city.

10. In the with-project scenario, significant improvements in local services are expected to achieved including the smoother, more rapid, and safer situation on the roads due to a combination of and increased number of traffic lanes and the construction of separate lanes dedicate to two-wheel traffic. In addition, urban living conditions will be improved by the sealing of community lanes and improvement in water supply, wastewater, central heating and solid waste management. Further the urban environment will be improved by the creation and improvement of public parks and green areas. Future greening will be supported by the establishment of a plant nursery to produce the required for future activities. Estimates of incremental WTP for improved services were undertaken through various contingent valuation surveys undertaken by the consultant during project preparation for the community lanes, public parks, water supply, wastewater collection, improved central heating. While financial and timing constraints limited the number of sample households for each survey, the results clearly demonstrated a demand for the improved services to be provided through the project. The analysis of urban road construction and improvement, as well as the pedestrian underpass, was assessed in terms of savings in time. Reduced vehicle operating costs and accidents, while recognized, were treated as non-quantifiable due to lack of specific data for the subproject roads.

E. Assumptions and Methodology

11. The economic analysis is undertaken on the basis of the difference between without- and with-project scenarios as required in the ADB's Guidelines on Economic Analysis of Projects. For the wetlands restoration and rehabilitation subproject (output) the without-project scenario involves a continuation of the existing situation with a gradual decline in the biodiversity and water quality in the wetlands and an increasing focus on agricultural production. With project, biodiversity and water quality are expected to improve but there will likely be a decline in agricultural production in response to the need to improve the environment. Tourism will also benefit under this scenario. For the numerous subprojects comprising the integrated urban development output the without-project scenario will be a continuation of the existing situation, with a poor urban environment characterized by road congestion, deficient domestic heating, and relatively high pollution levels. With project, road conditions, water supply, wastewater collection, domestic central heating and solid waste management will all be improved in a sustainable manner resulting in improvement in the overall urban environment leading to faster economic growth.

12. The main assumptions to be used in the economic analysis will include:

(i) The project implementation period will be 5 years starting in 2015 and the project life will be 25 years including the 5-year implementation period.

(ii) Financial costs and benefits will be in prevailing mid-2014 prices and are expressed in constant 2014 terms.

(iii) An exchange rate of $1.00 = CNY6.24 will be used for the conversion of US dollar prices to Chinese Yuan.

(iv) Economic prices and benefits will be expressed in Chinese Yuan using the domestic price level numeracies.

(v) Economic costs and benefits will be derived from financial costs and benefits by (a) excluding taxes and duties (as these are transfer payments), (b) applying a shadow exchange rate factor (SERF) of 1.014 to all tradable items (see **Table SA.1** for estimation of the SERF based on 2013 international trade data[6]) ;(c) applying a shadow wage rate factor of 0.8 to all unskilled labor and 1.0 for skilled labor.[7]

[6] Alternative estimates undertaken using data for earlier confirmed that a SERF of 1.014 is appropriate for the current trend.

[7] The conversion factors for skilled and unskilled are the same as used recently in other similar projects in the Western Region of PRC, for example. ADB. 2012. *Report and Recommendation of the President to the Board*

(vi) The economic value of agricultural land to be acquired for project purposes was assessed based on the net economic value of crops currently grown on that land and based on the same project life as used for the overall project. All other costs associated with land acquisition and resettlement was treated as non-tradable and the financial costs converted to economic values accordingly.

(vii) The economic opportunity cost of capital was assumed to be 12%.

Table SA.1: Estimation of Shadow Exchange Rate Factor

Item	Estimated Value ($ x 10^8)	Proportion of Total Trade (%)	Taxes & Duties ($ x 10^8)	Taxes & Duties (% of Value)	Effective Exchange Rate (CNY/$)
Exports	22,096	53	1,698	7.68	5.72
Imports	19,504	47	2,260	11.59	6.91
Total	41,600	100	3,958		6.28
MER	CNY 6.20	per $			
SER	CNY 6.28	per $			
Premium	1.4%				
SCF	0.99				
SERF	1.014				

Source: China Statistical Yearbook, 2014.

F. Economic Cost-Benefit Analysis

1. Economic Costs

13. Costs included in the economic analysis of each subproject include (i) investment costs such as civil works, equipment, equipment installation, and indirect costs of project preparation and implementation (including costs associated with traffic delays during road rehabilitation), and physical contingencies; and (ii) recurrent costs particularly for incremental operation and maintenance (O&M) of subproject investments. The cost of land acquisition and resettlement was allocated between the road subprojects and the wetlands rehabilitation and restoration subprojects based an assessment of the allocation indicated in the detailed cost tables. The cost of project management and capacity building was allocated pro rata across all subprojects. The economic investment costs exclude price contingencies and financing charges during implementation since these are transfer fees.

14. Investment costs are derived from the detailed project investment plan taking into account the distribution of investments by year with individual subprojects commencing in 2015, 2016, and 2017. However all analyses are based on discounting of costs and benefits to a common 2015 base, the first year in which project activities are expected to commence. Financial costs are converted to economic values based on the above assumptions.

15. Recurrent costs are estimated for each subproject based on expected incremental O&M costs provided by the project management office (PMO) and assessed for consistency against the project preparatory technical assistance (PPTA) team's extensive experience with similar facilities. Subproject specific costs were provided for (i) the improvement of public green spaces and provision of plant nurseries subproject, (ii) central heating network improvement, (iii) water supply, (iv) sewage network subprojects, and (v) community lanes. With the exception of the community lanes subprojects, a detailed breakdown into unskilled labor, skilled labor and equipment and material costs was provided (**Table SA.2**), which was used for conversion to economic values.

of Directors. Proposed Loan People's Republic of China: Gansu Urban Infrastructure Development and Wetland Project. Manila.

Table SA.2: Operation and Maintenance Costs for Individual Subprojects including Cost Breakdown

Subproject	Annual O&M Cost	Of which		
		Unskilled Labour (CNY)	Skilled Labour (CNY)	Equipment and Materials (CNY)
Public parks	499,200	350,000	49,360	99,840
Road landscaping (street parks)	654,048	500,000	23,238	130,810
Plant nursery	1,000,000	700,000	100,000	200,000
Central heating network	1,500,000	400,000	100,000	1,000,000
Water supply network	1,200,000	600,000	100,000	200,000
Sewage network	800,000	400,000	100,000	1,300,000
Community lanes	300,000	not available	not available	not available

CNY = Chinese yuan, O&M = operation and maintenance.
Source: Project Management Office

16. Incremental O&M costs for the road construction and upgrading subprojects were provided as individual annual values for each of the new roads—CNY110,000 for Fuqi Road and CNY40,000 for Minzhu Road—and an aggregate value of CNY1.3 million for the road rehabilitation subprojects, reflecting the likely differences in costs for these different types of subprojects.[8] In addition to routine O&M, extensive renovation is expected to be required every 10–15 at a cost of CNY3.3 million for Fuqi Road, CNY1.2 million for Minzhu Road and CNY60.2 million for the upgraded roads. Annualized costs for the renovations are included in the O&M costs for each subproject. The total incremental O&M costs for the upgraded roads were allocated between the individual upgraded road subprojects based on the length of road to be upgraded in each subproject. Detailed annual O&M costs for the pedestrian underpass, which is included as a part of the Nanda Street and Beida Street subprojects, were not available and were assumed to be 1% of the investment cost for the underpass. This seems reasonable given the type of O&M required.

17. Incremental O&M costs for the improved solid waste collection were not available and are therefore assumed to be a percentage of the investment costs. Based on the nature of O&M it seemed reasonable to use a value of 2.5% of the investment costs. The impact of this on the economic viability of the subproject was assessed through the sensitivity tests.

18. Financial O&M costs are converted to their economic values using the same assumptions as for investment costs and, where possible, the breakdown into unskilled labor, skilled labor, and equipment and materials (**Table SA.2)**. Annual O&M for roads, where no detailed information was available, was assumed to be 100% civil works. While some labor costs doubtless are included in the O&M costs, their omission from the analysis would be unlikely to seriously impact on the conclusions. Again, the sensitivity tests included an assessment of the impact of increased O&M costs.

2. Economic Benefits

19. Economic benefits for each subproject comprising the integrated urban development output are estimated separately, including benefits for each of the new and upgraded road subprojects. Economic benefits for the wetland rehabilitation output are estimated for the overall output. Benefits are estimated for the without- and with-project scenarios using a base

[8] Data provided by the PMO related to 2020, 2025, 2030, and 2035 and showed an increasing cost. No indication was provided as to whether the increase is due to use of nominal values or whether there is expected to be an increase in the real cost of O&M. The former was assumed and 2020 values used for O&M estimates.

year of 2015, the first project year, and constant mid-2014 values. In addition, with- and without project benefits are projected beyond 2015 to reflect the likely build-up of benefits following project completion.

20. **Wetland rehabilitation.** Wetland rehabilitation benefits comprise (i) production values including agricultural production, other wetland products, and fish; (ii) regulating services including water supply, water purification, climate regulation, and air regulation; (iii) supporting services including biodiversity maintenance and nutrient cycle; (iv) cultural services such as leisure and recreation; (v) reduction in the sediment levels in the water that will eventually be used for drinking water and other purposes; and (vi) research and education. All of these benefits, other that reduced sedimentation, were previously reported under TA 8303 but the available report contains insufficient information to verify the results.[9] In particular the document (i) does not clearly indicate the subproject area although it seems likely to be significantly larger than the current project area, (ii) uses 2012 as the base without project year; (iii) does not project the without-project scenario to future years, and (iv) does not provide the level of detail necessary to permit checking or modifying of the benefit estimation to reflect the revised project area and to allow updating to constant 2014 values. The analysis was therefore reworked based on the final design of the subproject, available information in particular Luo, et al (2010),[10] and the experience of the wetland rehabilitation and environmental specialists in the PPTA team. In particular, it was indicated that reduced sedimentation would be a major benefit that had not been previously considered. With an average flow of water of 9.95 cubic meters per second (m^3/sec) through the wetlands, the annual flow is estimated at 313.8 million m^3. The economic value of sedimentation reduction in this water is considered to be substantial since it both improves the environment and reduces the cost of subsequent water treatment prior to distribution. Although other sources frequently assume such benefits to be in excess of CNY1.00/m^3, the current analysis uses a conservative assumption of only CNY0.10/m^3. Nevertheless this represents the main subproject benefit.

21. The revised calculations are set out in **Tables SA.3** to **SA.7**. The estimated increase/ decrease in net value in **Table SA.3** and **Table SA.4** assume that input costs represent 50% of the gross value of outputs. The net values are used for the estimates in **Table SA.7**. Since all benefits are assumed to be non-tradable and locally consumed, their economic and financial values are the same.[11] Yields are not expected to increase in the with-project scenario and the yields in the incremental areas are assumed to be the same as in the existing area. This seems reasonable given the experience of the farmers and the available infrastructure. While it is possible that yields might be lower in the initial years and build up to full project development, and that some farmers will switch to organic crops with a higher value, there is no evidence to support such assumptions. Moreover, the difference in incremental value resulting from these alternative assumptions is minor compared to the overall benefits of the subproject.

[9] ADB. Undated. TA-8303 PRC. Xinjiang Akesu Integrated Urban Development and Environment Improvement Project (46049-001). The Ecosystem Services Evaluation for Akesu-Dulong River Wetlands. Contract No.108792-S80863.

[10] Decheng Luo, et al. 2010. *Dynamics of Ecosystem Services Value in Akesu River Watershed in 1960–2008. Chinese Journal of Applied Ecology.* 21(2): 399-408.

[11] Net taxes and duties are assumed to be zero, which is reasonable given the range of commodities considered.

Table SA.3: Changes in Annual Value of Agricultural Production[a]

Crop	Present Area (mu)	Unit Production (kg/mu)	Unit Price (CNY/kg)	Area after Project Implementation (mu)	Increase/ Decrease in Gross Value (CNY/yr.)	Increase/ Decrease in Net Value (CNY/yr.)
Rice	155	720	5	155	0	0
Corn	110	350	2	100	-8,050	-4,025
Vegetable (Celery)	448	700	3	448	0	0
Beets	240	1,000	2	240	0	0
Total	**953**			**943**	**-8,050**	**-4,025**

Source: Feasibility Study Report.

Table SA.4: Change in Annual Value of Fisheries

Item	Area (mu)	Yield (kg/mu)	Unit Price (CNY/kg)	Gross Value (CNY/yr.)
Without project				
Fish Pond	600	85.4	10	512,400
With project				
Traditional fish pond	350	85.4	10	298,900
Organic fish pond	50	65.0	60	195,000
Incremental Gross Margin				**-18,500**

Source: Feasibility Study Report and due diligence by Wetland's Specialist of PPTA.

Table SA.5: Annual Changes in Value of Forest and Water Resources

Item	Present Area (mu)	Area after Project Implementation (mu)
Non-economic forest	5	100
Water surface	800	1,350

Source: Feasibility Study Report.

Table SA.6: Ecosystem Values after Project Completion (CNY/ha/yr.)

	Cropland	Forest	Wetland
Climatic regulation	1,195	5,329	16,245
Water conservation	516	2,750	13,322
Soil conservation	1,255	3,352	1,470
Waste treatment	1,410	1,126	15,626
Biodiversity	610	2,802	2,149
Recreation and culture	9	1,100	4,770
Total	**4,995**	**16,459**	**53,582**
Incremental Area (mu)	**-10**	**95**	**550**

Source: Decheng Luo, et al. 2010. Dynamics of ecosystem services value in Akesu river watershed in 1960-2008. Chinese Journal of Applied Ecology, 21(2): 399-408.

Table SA.7: Changes to Ecosystem Values following Project Completion (CNY/yr.)

Item	Cropland	Forest	Wetland	Total
Provisioning	-4,025	0	90,750	86,725

Item	Cropland	Forest	Wetland	Total
Climatic regulation	-1,195	50,626	2,332,701	942,906
Water conservation	-516	26,125	1,912,973	758,319
Soil conservation	-1,255	31,844	211,085	111,439
Waste treatment	-1,410	10,697	2,243,815	868,717
Biodiversity	-610	26,619	308,586	144,204
Recreation and culture	-9	10,450	684,948	272,791
Tourism				1,658,800
Reduced Sedimentation				31,378,320
Scientific and research value				
Total				**36,222,221**

Note: Includes reed production estimated to have an annual value of CNY100,000
Source: Luo et al, 2010 and Tables 3-6.

22. **Integrated urban development.** Integrated urban development subprojects include: (i) improvement of the urban road network including landscaping through both new road construction and upgrading, and construction of one pedestrian underpass in association with two of the upgraded roads (Nanda Street and Beida Street);[12] (ii) upgrading of community lanes; (iii) improvement of one public park and five street parks (landscaped areas along roads that are not upgraded under the project) together with establishment of one plant nursery; (iv) water supply network improvement; (v) sewerage network improvement; (vi) central heating network improvement; and (vii) solid waste management.

23. **Urban road network improvement.** Urban road network improvement comprises two different types of subproject: (i) new road construction (2 roads with a length of about 1.7 km), and (ii) road upgrading (19 roads with a length of about 30.2 km)[13] including construction of one associated pedestrian underpass with a total length of 392 m and impacting two upgraded roads as noted above. Each of these subprojects is analyzed separately. LDI estimates of the base traffic/pedestrian flows and traffic growth for each of the subprojects are used to estimate the incremental benefits from time savings. These estimates indicate that traffic is currently increasing at 10% per year, will reduce to 8% per year in 2018, to 6% per year in 2023, and to 4% per year in 2028. However, these increases are considered too optimistic and will result in benefit reduction due to congestion. For the purpose of the economic analysis, benefits are therefore assumed to reach a maximum in 2024 and to decline through to 2028, when they are assumed to be only 10% of the unrestricted amount. Reduced vehicle operating costs (VOCs) represent an additional benefit that could be quantified if the required information was available. However, given the lengths of road involved for each subproject, VOC benefits are likely to be relatively insignificant and are treated as non-quantifiable. Similarly no benefits were estimated for accident reduction since separate statistics were available for each of the project roads. However, city-level data provided suggest that the benefits for individual subprojects would not be substantial.

24. Benefit data for each of new and upgraded road subprojects, as well as the pedestrian underpass, were compiled separately and the pedestrian underpass benefits were then added to the benefits for the associated roads. The without-project scenario for new Mingzhu Road required identification of the current route for traffic that would benefit from the new road. This permitted estimation of (i) the distance travelled on the existing, without-project route(s) compared to the proposed, with-project route; (ii) the current traffic volume will be

[12] No information was available to allow for the economic analysis of the proposed bridges, which probably should be combined with certain road sections.
[13] Excluding Fujiu Road Extension for which no data were available.

diverted to the new road; (iii) projections of future traffic flows based on annual percentage increases estimated by the LDI and assuming no incremental traffic flows due to the new road; and (iv) average traffic speed without- and with-project. As noted above, there was assumed to be no change in VOCs. For Mingzhu Road, three existing routes were identified with travel distances of 857 m, 861 m, and 1,535 m. Assuming that 90% of the traffic will be diverted from the two shorter routes, the average distance travelled without-project is 1,013 m compared to a with-project distance of 337 m, a saving of 675 m. Traffic that will be diverted to the new Mingzhu Road is currently flowing along Wenhua Road and Yingbin Road with an estimated combined daily without-project of about 33,000 vehicles in 2016. Assuming that 5% of the flow along all roads will divert to the new road, the daily flow on the new section of Mingzhu Road in 2015 will be 1,650 vehicles. This is projected to increase to about 4,770 vehicles by 2033. The situation for Fuqi Road is somewhat different since there is no existing alternative road and traffic currently has to use the poor-quality route. The format for the analysis therefore uses the same approach as for upgraded road subprojects.

25. Benefit data for each of the upgraded roads were compiled separately. The basic data are the same as used for the new-road analyses, but road length is the same without- and with-project. Benefits therefore are derived from the time savings that can be achieved by higher traffic speeds. To simplify the analysis it was assumed that all traffic travels over the entire distance of the section, which seems reasonable. Data compiled for the without- and with-project scenarios are (i) current traffic volume and projections for the future without- and with-project, which were estimated by the LDI and based on annual percentage increase modified as previously described; and (iii) expected traffic speed without and with project. Traffic projections by year for each new and upgraded road are shown in **Table SA.8**. As with the new road, there was assumed to be no reduction in VOCs.

26. For both the new and upgraded roads, the total number of vehicles was allocated by type based on the distribution of types reported in the FSR and after adjusting for the number of pedestrians. This produced a distribution of 19% buses, 26% cars, 37% non-motorized vehicles and motorcycles, 11% taxis and 7% others. Assuming the number of people carried, including the driver, was 25, 2, 1, 3, and 1 respectively, the average number of persons per vehicle was estimated at 5.94. The value of time for these people was based on average income in Akesu in constant 2014 values and projected out by year based on recent actual increases in real incomes and projected future increases: about CNY58,000/year in 2015 or CNY4,857/month. This translates into a daily wage of CNY220 based on a 22-day month and an hourly rate of CNY28 based on an 8-hour day. For the purpose of translating these financial values into economic values, a labor participation rate of 60% was applied and non-working persons were assumed to have an economic value of 30% of a working person.

27. Increased traffic speed due to road upgrading should be based on the average traffic speed during the whole day or, if traffic flow is disaggregated into peak and non-peak flows on the average speeds during each of these periods. Speeds of different types of vehicle could also be included if they were available. Unfortunately the only information available to the study relates to average peak-hour traffic speed without- and with-project and it is not clear to which year these relate. After undertaking some initial analyses, average traffic speed was assumed to increase by about 4 kilometer per hour (kph) with-project for all arterial roads and by about 3 kph for all secondary roads. While potential increases are much higher it seems unlikely that these can be achieved in an urban environment particularly with significant levels of public transport. While incremental benefits might be expected to reduce as the traffic flow increases, the use of modest incremental speeds is considered to take this into account.

Table SA.8: Estimated Traffic Flow in 2014 and Future Projections by Year

Road Name	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027 & beyond
New Construction														
Fuqi Road	0	0	0	0	15,191	16,406	17,719	19,136	20,667	22,321	23,660	25,079	26,584	28,179
Mingzhu Road	1,667	1,834	2,017	2,219	2,441	2,636	2,847	3,075	3,320	3,586	3,801	4,029	4,271	4,527
Upgrading														
Renmin Road	10,012	11,013	12,115	13,326	14,659	15,832	17,098	18,466	19,943	21,539	22,831	24,201	25,653	27,192
Nanda Street	16,727	18,400	20,240	22,264	24,490	26,449	28,565	30,850	33,318	35,984	38,143	40,431	42,857	45,429
Beida Street	16,752	18,427	20,270	22,297	24,526	26,488	28,607	30,896	33,367	36,037	38,199	40,491	42,920	45,496
Tanan Road	17,503	19,253	21,179	23,296	25,626	27,676	29,890	32,281	34,864	37,653	39,912	42,307	44,845	47,536
Yingbin Road	17,212	18,933	19,785	21,764	25,200	27,216	29,393	31,745	34,284	37,027	39,249	41,604	44,100	46,746
Wangsan Street	9,964	10,960	12,056	13,262	14,588	15,755	17,015	18,377	19,847	21,435	22,721	24,084	25,529	27,061
Jiaoyu Road	9,624	10,586	11,645	12,810	14,091	15,218	16,436	17,751	19,171	20,704	21,947	23,263	24,659	26,139
Jianshe Road	10,642	11,706	12,877	14,165	15,582	16,829	18,175	19,629	21,199	22,895	24,269	25,725	27,268	28,904
Minzhu Road	11,200	12,320	13,552	14,907	16,398	17,710	19,127	20,657	22,309	24,094	25,540	27,072	28,696	30,418
Nanchang Road	10,667	11,734	12,907	14,198	15,617	16,866	18,216	19,673	21,247	22,946	24,323	25,783	27,330	28,969
Huannan Road	9,939	10,933	12,026	13,229	14,552	15,716	16,973	18,331	19,798	21,382	22,665	24,024	25,466	26,994
Jiefang Road	10,958	12,054	13,259	14,585	16,043	17,326	18,713	20,210	21,826	23,572	24,987	26,486	28,075	29,760
Jiaotong Road	16,921	18,613	20,474	22,522	24,774	26,756	28,896	31,208	33,705	36,401	38,585	40,900	43,354	45,956
Wenhua Road	10,036	11,040	11,536	12,690	14,694	15,870	17,139	18,510	19,991	21,590	22,886	24,259	25,714	27,257
Tianshan Road	10,376	11,414	12,555	13,810	15,191	16,406	17,719	19,136	20,667	22,321	23,660	25,079	26,584	28,179
Zhongyuan Road	11,297	12,427	13,669	15,036	16,540	17,863	19,292	20,836	22,502	24,303	25,761	27,306	28,945	30,682
Awen Avenue	16,412	18,053	19,859	21,844	24,029	25,951	28,027	30,270	32,691	35,306	37,425	39,670	42,051	44,574
Tabei Road	10,958	12,054	13,259	14,585	16,044	17,328	18,714	20,211	21,828	23,574	24,988	26,488	28,077	29,762
Ying'awati Dong Road	10,497	11,547	12,701	13,972	15,369	16,599	17,926	19,361	20,909	22,582	23,937	25,373	26,896	28,509
Total	239,364	263,300	287,982	316,780	365,645	394,896	426,488	460,607	497,456	537,252	569,487	603,656	639,876	678,268

Source: Local Design Institute Feasibility Study Report

28. A similar approach was used for the pedestrian underpass using pedestrian counts provided by the PMO. Based on 15-minute counts for each corner, the pedestrian flow for the three peaks - morning, lunch, and evening - was estimated at: (i) 1,300 p/h south-west to south-east over South Avenue; (ii) 1,100 p/h north-west to north-east over North Avenue; (iii) 1,500 p/h north-west to south-west over West Avenue; and (iv) 1,000 p/h north-east to south-east over East Avenue. With three rush hours in the day, this amounts to total pedestrian rush-hour traffic of 14,700 persons per day. Assuming pedestrian traffic during the non-rush-hours is 50% of rush-hour traffic, total estimated daily pedestrian traffic in 2014 was 20,050 persons. The benefits from the pedestrian underpass are identified as: (i) time saving for pedestrians; (ii) reduced accidents; and (iii) improved traffic flow. Time savings are conservatively estimated at 1 minute per pedestrian based on informal observations of delays in crossing roads at current intersections, and valued in the same way as time savings for traffic. Reduced accidents cannot be valued since there are no data on the existing frequency of pedestrian accidents at this junction, and improved traffic flow is included as a road upgrading benefit so that inclusion here would be double counting. The benefits were divided equally between Nanda and Beida Streets, which are alternatively known as North and South Avenue.[14]

29. Community Lane Upgrading. Estimation of benefits from community lane upgrading are more complex since unit costs tend to be low and benefits difficult to quantify either in a traditional market framework or through a contingent valuation survey. The benefits that are expected from the activity are (i) improved and increased traffic flow, but little traffic, (ii) reduced vehicle operating costs, but again few vehicles, (iii) reduced accidents, (iv) improved access, (v) reduced dust and air pollution, which will improve health, (vi) improved safety due to installation of lights, and (vi) improvement in the local aesthetics. Review of related literature suggests four possible approaches: (i) assume the activity is a response to a social issue, since the improvements benefit the poorer members of the community, and that the benefits are non-quantifiable so that no economic analysis is possible or required; (ii) assume that any income differences, improved health, and/or reduced expenditure is due to the road improvement and then try to quantify this through a survey covering both the project area and areas that have already been upgraded; (iii) conduct a contingent valuation survey in which the respondents are requested to rank their preference for a number of alternatives that can be readily valued as well as the road upgrading; and (iv) conduct a contingent valuation survey in which the beneficiaries WTP is directly addressed. The fourth option was selected for the economic analysis and questions were included in the household socioeconomic survey. Data were collected for 150 respondents specifically selected for the component relating to their perception of benefits from community lanes. The average expected value was calculated at CNY156/household/year with a total of 50,000 benefiting households. Regression analysis was undertaken to determine factors that might affect the perceived value including, in particular, household income. However, household income does not appear to have a significant impact on WTP with the result that no increase in benefits per household from increased incomes over the project life could be included in the economic analysis.

30. Improvement of Public Green Spaces and Investment in Plant Nursery Establishment. Benefits for this subproject were estimated separately for public green spaces and plant nursery establishment. Improvement to public green spaces (parks and green areas along roads that are not being upgraded under the project) presents a particularly difficult scenario, which is most appropriately addressed through a contingent valuation survey. Given the constraints of project preparation, a separate contingent valuation survey could not be conducted. Questions were therefore included in the household socioeconomic survey. The sample for this part of the survey was only 100 respondents specifically selected for the

[14] Due to problems in translation it was not possible to identify East and West Avenues, which are included in the analysis but with different names.

component. While the initial design of the questions involved random selection from five bid amounts and a question on WTP for the improved facilities, implementation in the survey sought a bid amount that individual respondents would be willing to pay. Therefore the appropriate value for WTP is the average of the amounts reported, that is CNY177/household/year with a total of 20,000 benefiting households. Regression analysis was undertaken to determine factors that might affect the WTP for the upgraded facilities including, in particular, household income. However, household income did have a significant impact on WTP. Thus no increase in benefits per household from increased incomes over the project life could be included in the economic analysis.

31. While the plant nursery will provide an intermediate output to be used in public parks and green spaces, it is highly unlikely that the nursery will produce any plants for use in the proposed project since the nursery could not be established and in production during the project implementation period. Double-counting of benefits is therefore not an issue. Estimation of the economic benefits of the new plant nursery requires only determination of the level of annual output that will be achieved by the nursery and the unit value of output. Given that the nursery is not a commercial business producing plants for sale to the public, and the quantities to be produced by this single nursery are considered minor in comparison the total output for Akesu and its expected growth, the unit values of output are considered most appropriately quantified as the opportunity costs of the plants: that is the price that would need to be paid if they were purchased from the cheapest alternative source. Annual production costs for the plants are incorporated in the recurrent costs, which are substantial. The PMO provided estimates of the annual outputs from the nursery and their value as follows. In 2020, annual output is estimated at 600,000 trees and shrubs, and 2,000 square meters (m^2) of grass turf with a value of CNY2.0 million if purchased on the open market. Output values were also produced for 2025, 2030, and 2035 but since no estimates were provided on levels of output, these increased values are concluded to be increases in nominal prices. Estimated benefits are therefore based on the 2020 outputs and values.

32. **Water supply network improvement.** The water supply network improvement activity comprises construction of about 40 km of water supply pipelines. The pipeline is a combination of a new main pipeline and distribution pipes to predominantly currently connected households.[15] It is expected that about 35,000 households will directly benefit from the more reliable and improved quality water. A contingent valuation survey of a random sample of 150 households specifically selected for the component was undertaken as a part of the household socioeconomic survey in order to assess the WTP for the improved water supply system. As with the other sections of the survey, the WTP question was posed in such a way as to determine the highest bid amount that a respondent would be willing to pay for the improved service and the result was estimated as the average value per household. The average WTP was estimated at CNY261/household/year. Regression analysis was undertaken to determine factors that might affect WTP for the improved water supply network including, in particular, household income. However, household income does not appear to have a significant impact with the result that no increase in benefits per household from increased incomes over the project life could be included in the economic analysis.

33. **Sewerage network improvement.** Sewerage network improvement comprises construction of about 26 km of combined stormwater-sewage pipes, including manholes. The low rainfall, and rainfall intensity, in the project area suggests that stormwater benefits are likely to be relatively unimportant. Improved wastewater collection and treatment is likely to provide the overwhelming part of the benefits and the analysis is therefore focused on these benefits, including improved health, improved local environment, etc. With respect to improved health substantial research would be required to quantify the current situation

[15] Discussions with the LDI indicated that there are currently very few households that are not connected to the public water supply and these are based in isolated areas that are unlikely to benefit from the project.

and to assess the benefits likely to be achieved by the improvements. Data for such analyses are is typically extremely difficult to obtain with any level of reliability and confidence. The alternative approach of conducting a contingent valuation study was therefore undertaken with the appropriate questions included in the household socioeconomic survey and 150 households specifically selected for the component questioned on their WTP for an improved sewerage network. These households are assumed to be representative of the 40,000 households that are expected to directly benefit from the subproject either through new connections or improvement of their existing service. Although initially specified in the form of a question with five bid amounts from which one would be randomly selected for each respondent, the question was again implemented in such a way as to determine the highest bid amount a respondent would be willing to pay for the improved service. The average WTP for the improved service was estimated at CNY91/household/year for existing users. The results of the survey further indicated that about 89% of the households are currently not connected to the wastewater collection system and should be treated as incremental users. These incremental users would be willing to pay the same amount as the non-incremental users for the current system plus the same incremental amount for an improved service. The total WTP was there estimated at about CNY220/incremental household/year. Combining the two estimates produced a weighted average WTP of CNY205.6/household/year. Regression analysis was undertaken to determine factors that might affect WTP including, in particular, household income. As with the other analyses, household income does not appear to have a significant impact on WTP with the result that no increase in benefits per household from increased incomes over the project life could be included in the economic analysis.

34. **Central heating network improvement.** Central heating improvements, comprising construction of new central heating pipelines (about 43.7 km) and construction of 28 heat exchange units are expected to provide benefits from: (i) reduced O&M costs as the old heat generation plants are decommissioned; and (ii) increased comfort, health, etc. for consumers as a result of the improved heating system. O&M cost savings achieved by decommissioning of 28 old heat generation plants are estimated by the PMO at about CNY2.8 million/year, comprising unskilled labor costs of CNY900,000, skilled labor costs of CNY200,000, and equipment and materials costs (including fuel) of CNY1.7 million per year. Benefits to consumers, which are expected to amount to 30,000 households, are difficult to define precisely and even more difficult to quantify in a traditional market framework. A contingent valuation survey of a random sample of directly benefiting households was therefore included as part of the household socioeconomic survey. This part of the survey was administered to a random sample of 150 households specifically selected for the component with the WTP question again applied in a manner that sought the highest bid amount that a respondent would be willing to pay for the improved service. Analyzed in terms of the average of the amount indicated by each respondent, the benefit per household is estimated at CNY178/ heating season. In addition the results of the household socioeconomic survey indicated that about 87% of the respondents were not connected to the municipal heating system and should therefore be treated as incremental beneficiaries. The incremental beneficiaries indicated a willingness to pay the current fee of about CNY1,627/household/heating season plus the incremental amount for the improved service. Regression analysis was undertaken to determine factors that might affect WTP for the improved central heating network including, in particular, household income. As with the other analyses, household income did not have a significant impact on WTP with the result that no increase in benefits per household from increased incomes over the project life could be included in the economic analysis.

35. **Solid waste management.** Solid waste management comprises the purchase of street cleaning and waste collection vehicles and equipment together with the construction of a waste collection transfer station. The subproject is expected to directly benefit about 75,000 households through reduction of pollution and provision of an improved living environment. A contingent valuation survey of a random sample of 150 directly benefiting households

specifically selected for the component was therefore included as a part of the household socioeconomic survey. The WTP question was applied in a manner that sought the highest bid amount that a respondent would be willing to pay for the improved service. Analyzed in terms of the average amount per benefiting household average WTP was estimated at CNY155/household/year. The survey further revealed that about 89% of the benefiting households do not currently pay a solid waste management fee and should therefore be treated as incremental beneficiaries. The survey further indicated that they would be willing to pay the current fee of about CNY172/household/year for the existing service plus CNY155/household/year for the improved service. Regression analysis was undertaken to determine factors that might affect the WTP for the improved solid waste management including, in particular, household income. As with the other analyses, household income does not appear to have a significant impact on willingness-to-pay with the result that no increase in benefits per household from increased incomes over the project life could be included in the economic analysis.

3. Economic Viability

36. After converting project costs and benefits to economic values based on the domestic price level numeraires, a cost-benefit flow for 25 years has been projected—including the 5-year implementation period—for estimation of the EIRR and economic net present value (ENPV) for each of the subprojects.

G. Wetland Restoration and Rehabilitation

37. Economic analysis of the wetlands restoration and rehabilitation output indicates that the investment is economically viable with an EIRR of less than 13.3% and an ENPV of CNY20.7 million (**Table SA.9**).

Table SA.9: Economic Analysis of Wetlands Restoration and Rehabilitation Output (CNY millions)

Year	Investment Cost	Recurrent Cost	Total Cost	Benefits	Net Benefits
2015	84.6	0.0	84.6	0.0	(84.6)
2016	30.8	0.0	30.8	0.0	(30.8)
2017	140.8	0.0	140.8	0.0	(140.8)
2018		2.6	2.6	42.5	39.9
2019		2.6	2.6	42.5	39.9
2020		2.6	2.6	42.5	39.9
2021		2.6	2.6	42.5	39.9
2022		2.6	2.6	42.5	39.9
2023		2.6	2.6	42.5	39.9
2024		2.6	2.6	42.5	39.9
2025		2.6	2.6	42.5	39.9
2026		2.6	2.6	42.5	39.9
2027		2.6	2.6	42.5	39.9
2028		2.6	2.6	42.5	39.9
2029		2.6	2.6	42.5	39.9
2030		2.6	2.6	42.5	39.9
2031		2.6	2.6	42.5	39.9
2032		2.6	2.6	42.5	39.9
2033		2.6	2.6	42.5	39.9
2034		2.6	2.6	42.5	39.9
2035		2.6	2.6	42.5	39.9
2036		2.6	2.6	42.5	39.9
2037		2.6	2.6	42.5	39.9
2038		2.6	2.6	42.5	39.9
2039		2.6	2.6	42.5	39.9
2040		2.6	2.6	42.5	39.9
2041		2.6	2.6	42.5	39.9
EIRR					13.3%
ENPV	200.3	14.2	214.5	235.2	20.7

Source: Consultant's estimates.

H. Integrated Urban Development

38. **Urban road network improvement.** Economic analysis of individual urban road network improvement subprojects (**Table SA.10**) indicates that the EIRRs for the new roads included in the project are 74.6% for Mingzhu Road and 41.1% for Fuqi Road, which are very high but are justified by the considerable reduction in travel distances for Mingzhu Road users and the major improvement of Fuqi Road, which is currently little more than a dirt track. The EIRRs of the upgraded roads range from 13.8% for Jiefang Road to 42.2% for Renmin Road with an average EIRR for upgraded roads of 28.6% and an ENPV at a 12% discount rate of CNY502.9 million. Combining the new and upgraded roads subprojects into a single subproject yields an EIRR of 29.5% and an ENPV of CNY55.9 million, well above the cut-off point for economic viability (**Table SA.11**).

Table SA.10: Economic Analysis of Urban Road Network Improvement by Subproject

	Net benefits by Year																
Road Name	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029 & beyond**	**EIRR**	**ENPV**
New Construction																	
Fuqi Road	-236	-10,079	-4,734	6,301	7,266	8,206	9,261	10,447	11,662	12,766	12,538	11,375	8,181	3,909	1,347	41.4%	28,362
Mingzhu Road	-4,604	2,706	3,239	3,799	4,368	4,922	5,545	6,244	6,961	7,612	7,477	6,791	4,907	2,488	958	74.6%	24,680
Upgrading																	
Renmin Road	-18,127	5,357	6,410	7,514	8,637	9,730	10,959	12,338	13,752	15,037	14,771	13,418	9,701	4,730	1,748	42.2%	40,173
Nanda Street	-34,868	9,169	10,961	12,860	14,774	16,638	18,732	21,084	23,495	25,685	25,434	23,477	17,796	9,926	5,204	38.3%	68,983
Beida Street	-26,573	5,773	6,966	8,237	9,512	10,754	12,150	13,717	15,323	16,782	16,683	15,496	11,928	6,886	3,861	33.2%	41,869
Tanan Road	-66,052	6,430	7,697	9,026	10,377	11,693	13,172	14,832	16,534	18,080	17,760	16,131	11,658	5,676	2,086	14.4%	8,732
Yingbin Road	-15,855	2,871	3,494	4,390	5,090	5,771	6,537	7,397	8,279	9,080	8,914	8,070	5,753	2,654	795	29.5%	18,615
Wangsan Street	-19,773	4,604	5,508	6,457	7,422	8,362	9,418	10,603	11,819	12,923	12,694	11,531	8,336	4,064	1,501	34.4%	30,776
Jiaoyu Road	-21,475	5,967	7,142	8,374	9,627	10,848	12,218	13,758	15,336	16,769	16,473	14,963	10,815	5,268	1,940	40.1%	43,642
Jianshe Road	-554	-29,249	9,379	10,992	12,631	14,228	16,021	18,036	20,100	21,976	21,588	19,612	14,185	6,927	2,573	42.0%	52,370
Minzhu Road	-434	-21,133	4,778	5,615	6,465	7,294	8,224	9,269	10,340	11,313	11,112	10,087	7,271	3,506	1,247	30.6%	21,740
Nanchang Road	-10,505	2,021	2,427	2,853	3,286	3,708	4,182	4,714	5,260	5,755	5,653	5,131	3,697	1,779	629	29.3%	12,041
Huannan Road	-6,095	1,053	1,266	1,489	1,716	1,937	2,185	2,464	2,749	3,009	2,955	2,682	1,931	926	324	26.6%	5,739
Jiefang Road	-749	-31,524	3,421	4,063	4,716	5,352	6,066	6,868	7,690	8,437	8,283	7,496	5,334	2,444	710	13.8%	2,572
Jiaotong Road	-508	-24,016	4,260	5,018	5,788	6,539	7,382	8,328	9,298	10,180	9,998	9,069	6,519	3,108	1,061	24.2%	15,280
Wenhua Road	-453	0	-26,229	5,222	6,017	6,791	7,661	8,638	9,640	10,549	10,361	9,403	6,770	3,250	1,138	24.6%	14,031
Tianshan Road	-374	0	-18,853	4,463	5,142	5,803	6,545	7,379	8,233	9,010	8,849	8,031	5,785	2,781	979	29.4%	14,538
Zhongyuan Road	-1,248	0	-85,270	12,996	14,986	16,923	19,100	21,545	24,050	26,326	25,856	23,457	16,871	8,064	2,779	18.1%	20,643
Awen Avenue	-928	0	-60,116	11,713	13,489	15,219	17,162	19,345	21,581	23,613	23,193	21,052	15,173	7,310	2,592	24.1%	30,603
Tabei Road	-10,231	2,260	2,713	3,188	3,672	4,143	4,672	5,266	5,874	6,428	6,313	5,730	4,130	1,990	706	33.1%	14,802
Fujiu Road Extension	0	0	-1,573														
Ying'awati Dong Road	-467	-20,160	7,795	9,135	10,498	11,826	13,317	14,992	16,709	18,268	17,946	16,303	11,790	5,756	2,135	49.1%	46,829
Upgraded Roads	**-235,269**	**-80,576**	**-107,824**	**133,602**	**153,843**	**173,559**	**195,703**	**220,575**	**246,062**	**269,219**	**264,837**	**241,138**	**175,443**	**87,045**	**34,006**	**28.6%**	**502,859**

Note: No traffic data were available for Fujiu Road Extension
Source: Consultant's estimates.

Table SA.11: Summary of Economic Analysis for Aggregate of Urban Road Subprojects (CNY000s)

Year	Investment Cost	Recurrent Cost	Total Cost	Benefits	Net Benefits
2015	240,109	0	240,109	0	(240,109)
2016	136,161	2,907	139,068	51,119	(87,949)
2017	196,413	4,887	201,300	91,980	(109,319)
2018		6,676	6,676	150,379	143,702
2019		6,676	6,676	172,153	165,477
2020		6,676	6,676	193,363	186,686
2021		6,676	6,676	217,185	210,509
2022		6,676	6,676	243,942	237,266
2023		6,676	6,676	271,361	264,685
2024		6,676	6,676	296,272	289,596
2025		6,676	6,676	291,528	284,852
2026		6,676	6,676	265,979	259,303
2027		6,676	6,676	195,207	188,531
2028		6,676	6,676	100,119	93,443
2029		6,676	6,676	42,988	36,311
2030		6,676	6,676	43,031	36,355
2031		6,676	6,676	43,077	36,400
2032		6,676	6,676	43,124	36,447
2033		6,676	6,676	43,173	36,496
2034		6,676	6,676	43,173	36,496
2035		6,676	6,676	43,173	36,496
2036		6,676	6,676	43,173	36,496
2037		6,676	6,676	43,173	36,496
2038		6,676	6,676	43,173	36,496
2039		6,676	6,676	43,173	36,496
2040		6,676	6,676	43,173	36,496
2041		6,676	6,676	43,173	36,496
EIRR					29.5%
ENPV	462,733	42,787	505,520	1,061,422	555,902

Source: Consultant's estimates.

39. **Community lane upgrading.** Economic analysis of community lane upgrading indicates that the investment is economically viable (**Table SA.12**). The EIRR is estimated at 12.6% and the ENPV at a 12% discount rate is CNY2.2 million based on 50,000 beneficiary households and an annual benefit of about CNY156/household/year, equivalent to about CNY13/month. The number of beneficiary households is not expected to increase given the current housing density, but willingness-to-pay might increase as households become wealthier although this was not apparent from the economic analysis.

Table SA.12: Economic Analysis of Community Lane Upgrading (CNY000s)

Year	Investment Cost	Recurrent Cost	Total Cost	Benefits	Net Benefits
2015	43,383	0	43,383	0	(43,383)
2016	6,664	189	6,853	5,945	(908)
2017	6,723	218	6,941	6,859	(82)
2018		247	247	7,780	7,533
2019		247	247	7,780	7,533
2020		247	247	7,780	7,533
2021		247	247	7,780	7,533
2022		247	247	7,780	7,533
2023		247	247	7,780	7,533
2024		247	247	7,780	7,533
2025		247	247	7,780	7,533
2026		247	247	7,780	7,533
2027		247	247	7,780	7,533
2028		247	247	7,780	7,533
2029		247	247	7,780	7,533
2030		247	247	7,780	7,533
2031		247	247	7,780	7,533
2032		247	247	7,780	7,533
2033		247	247	7,780	7,533
2034		247	247	7,780	7,533
2035		247	247	7,780	7,533
2036		247	247	7,780	7,533
2037		247	247	7,780	7,533
2038		247	247	7,780	7,533
2039		247	247	7,780	7,533
2040		247	247	7,780	7,533
2041		247	247	7,780	7,533
EIRR					12.6%
ENPV	48,833	1,673	50,505	52,728	2,223

Source: Consultant's estimates.

40. **Improvement of public green spaces and plant nurseries.** Economic analysis of improvement of public green spaces and plant nurseries indicates that the subproject is economically viable with an EIRR of 12.5% and an ENPV at a 12% discount rate of CNY3.3 million (**Table SA.13**). The analysis is based on 50,000 beneficiary households for the public green spaces and an estimated average benefit of CNY177/household/year based on the results of the contingent valuation section of the household socioeconomic survey. The benefits of the plant nurseries are derived from their expected output.

Table SA.13: Economic Analysis of Public Green Spaces and Plant Nurseries (CNY000s)

Year	Investment Cost	Recurrent Cost	Total Cost	Benefits	Net Benefits
2015	63,328	0	63,328	0	(63,328)
2016	17,882	209	18,091	833	(17,258)
2017	2,827	1,479	4,200	10,517	6,316
2018		1,582	1,582	11,439	9,857
2019		1,707	1,707	12,028	10,321
2020		1,791	1,791	12,451	10,661
2021		1,791	1,791	12,943	11,152
2022		1,791	1,791	13,435	11,644
2023		1,791	1,791	13,928	12,137
2024		1,791	1,791	14,422	12,631
2025		1,791	1,791	14,917	13,126
2026		1,791	1,791	15,279	13,488
2027		1,791	1,791	15,643	13,852
2028		1,791	1,791	16,007	14,216
2029		1,791	1,791	16,372	14,582
2030		1,791	1,791	16,739	14,948
2031		1,791	1,791	16,840	15,049
2032		1,791	1,791	16,941	15,150
2033		1,791	1,791	17,044	15,253
2034		1,791	1,791	17,148	15,357
2035		1,791	1,791	17,253	15,462
2036		1,791	1,791	17,358	15,568
2037		1,791	1,791	17,465	15,674
2038		1,791	1,791	17,573	15,782
2039		1,791	1,791	17,682	15,892
2040		1,791	1,791	17,793	16,002
2041		1,791	1,791	17,904	16,113
EIRR					12.5%
ENPV	72,811	10,962	83,697	86,995	3,298

Source: Consultant's estimates.

41. **Water supply network improvement.** Economic analysis of the water supply network improvement subproject indicates that it is economically viable with an EIRR of 14.8% and an ENPV of CNY7.9 million (**Table SA.14**). This is above the cut-off point for economic viability. The estimated EIRR is based on 35,000 beneficiary households and an average benefit of CNY261/household/year.

Table SA.14: Economic Analysis of Water Supply Network Improvement (CNY000s)

Year	Investment Cost	Recurrent Cost	Total Cost	Benefits	Net Benefits
2015	11,877	0	11,877	0	(11,877)
2016	12,939	0	12,939	0	(12,939)
2017	21,736	0	21,736	0	(21,736)
2018		996	996	8,998	8,002
2019		996	996	8,998	8,002
2020		996	996	8,998	8,002
2021		996	996	8,998	8,002
2022		996	996	8,998	8,002
2023		996	996	8,998	8,002
2024		996	996	8,998	8,002
2025		996	996	8,998	8,002
2026		996	996	8,998	8,002
2027		996	996	8,998	8,002
2028		996	996	8,998	8,002
2029		996	996	8,998	8,002
2030		996	996	8,998	8,002
2031		996	996	8,998	8,002
2032		996	996	8,998	8,002
2033		996	996	8,998	8,002
2034		996	996	8,998	8,002
2035		996	996	8,998	8,002
2036		996	996	8,998	8,002
2037		996	996	8,998	8,002
2038		996	996	8,998	8,002
2039		996	996	8,998	8,002
2040		996	996	8,998	8,002
2041		996	996	8,998	8,002
EIRR					14.8%
ENPV	36,391	5,517	41,907	49,853	7,946

Source: Consultant's estimates.

42. **Sewerage network improvement.** Economic analysis of the sewerage network improvement investment indicates that this subproject is not economically viable with an EIRR of 7.6% and an ENPV of negative CNY20.8 million (**Table SA.15**). This is not unexpected since beneficiaries often view wastewater collection and treatment as an essential service that should be provided by the public sector at zero, or very low, cost to the consumer. Moreover wastewater treatment charges are frequently included in the water supply bill so that beneficiaries have little awareness of what they are paying. Given the nature of this essential service and the environmental benefits to the entire community, rather than just the direct beneficiaries, that could not be quantified from the results of the household socioeconomic survey, the low estimated EIRR should not be considered sufficient to exclude it from the proposed project.

Table SA.15: Economic Analysis of Sewerage Network Improvement (CNY000s)

Year	Investment Cost	Recurrent Cost	Total Cost	Benefits	Net Benefits
2015	46,251	0	46,251	0	(46,251)
2016	20,988	0	20,988	4,477	(16,510)
2017	18,775	0	18,775	6,509	(12,266)
2018		684	684	8,327	7,643
2019		684	684	8,327	7,643
2020		684	684	8,327	7,643
2021		684	684	8,327	7,643
2022		684	684	8,327	7,643
2023		684	684	8,327	7,643
2024		684	684	8,327	7,643
2025		684	684	8,327	7,643
2026		684	684	8,327	7,643
2027		684	684	8,327	7,643
2028		684	684	8,327	7,643
2029		684	684	8,327	7,643
2030		684	684	8,327	7,643
2031		684	684	8,327	7,643
2032		684	684	8,327	7,643
2033		684	684	8,327	7,643
2034		684	684	8,327	7,643
2035		684	684	8,327	7,643
2036		684	684	8,327	7,643
2037		684	684	8,327	7,643
2038		684	684	8,327	7,643
2039		684	684	8,327	7,643
2040		684	684	8,327	7,643
2041		684	684	8,327	7,643
EIRR					7.6%
ENPV	71,390	3,787	75,177	54,340	(20,837)

Source: Consultant's estimates.

43. **Central heating network improvement.** Economic analysis of the central heating network improvement investment indicates that the subproject is economically viable with an EIRR of 29.6% and an ENPV at a 12% discount rate of CNY180.2 million (**Table SA.16**). The main benefits will come from the 87% of the benefiting households who are currently not connected to the municipal heating system and rely on numerous local centralized heating systems. Additional benefits will also be received by all benefiting households due to the improved performance of the system, and from the reduced O&M costs resulting from the decommissioning of 28 local heating plants. Due to lack of information, the economic value of the land that can be released for alternative development following decommissioning of these heating plants was treated as non-quantifiable.

Table SA.16: Economic Analysis of Central Heating Network Improvement (CNY000s)

Year	Investment Cost	Recurrent Cost	Total Cost	Willingness-to-pay	Recurrent Cost Savings	Total Benefits	Net Benefits
2015	0	0	0	0	0	0	0
2016	170,151	0	170,151	0	0	0	(170,151)
2017	0	1,298	1,298	47,975	3,843	51,818	50,520
2018		1,298	1,298	47,975	3,843	51,818	50,520
2019		1,298	1,298	47,975	3,843	51,818	50,520
2020		1,298	1,298	47,975	3,843	51,818	50,520
2021		1,298	1,298	47,975	3,843	51,818	50,520
2022		1,298	1,298	47,975	3,843	51,818	50,520
2023		1,298	1,298	47,975	3,843	51,818	50,520
2024		1,298	1,298	47,975	3,843	51,818	50,520
2025		1,298	1,298	47,975	3,843	51,818	50,520
2026		1,298	1,298	47,975	3,843	51,818	50,520
2027		1,298	1,298	47,975	3,843	51,818	50,520
2028		1,298	1,298	47,975	3,843	51,818	50,520
2029		1,298	1,298	47,975	3,843	51,818	50,520
2030		1,298	1,298	47,975	3,843	51,818	50,520
2031		1,298	1,298	47,975	3,843	51,818	50,520
2032		1,298	1,298	47,975	3,843	51,818	50,520
2033		1,298	1,298	47,975	3,843	51,818	50,520
2034		1,298	1,298	47,975	3,843	51,818	50,520
2035		1,298	1,298	47,975	3,843	51,818	50,520
2036		1,298	1,298	47,975	3,843	51,818	50,520
2037		1,298	1,298	47,975	3,843	51,818	50,520
2038		1,298	1,298	47,975	3,843	51,818	50,520
2039		1,298	1,298	47,975	3,843	51,818	50,520
2040		1,298	1,298	47,975	3,843	51,818	50,520
2041		1,298	1,298	47,975	3,843	51,818	50,520
EIRR							29.6%
ENPV	135,644	8,118	143,762	299,962	24,030	299,962	180,231

Source: Consultant's estimates.

44. **Solid waste management.** Economic analysis of the solid waste management investment indicates that the subproject is economically viable with an EIRR of 37.9% and an ENPV at a 12% discount rate of CNY98.4 million (**Table SA.17**).

Table SA.17: Economic Analysis of Solid Waste Management Improvement (CNY000s)

Year	Investment Cost	Recurrent Cost	Total Cost	Benefits	Net Benefits
2015	44,504	0	44,504	0	(44,504)
2016	9,795	0	9,795	17,513	7,718
2017	4,409	0	4,409	21,368	16,959
2018		1,468	1,468	23,103	21,635
2019		1,468	1,468	23,103	21,635
2020		1,468	1,468	23,103	21,635
2021		1,468	1,468	23,103	21,635
2022		1,468	1,468	23,103	21,635
2023		1,468	1,468	23,103	21,635
2024		1,468	1,468	23,103	21,635
2025		1,468	1,468	23,103	21,635
2026		1,468	1,468	23,103	21,635
2027		1,468	1,468	23,103	21,635
2028		1,468	1,468	23,103	21,635
2029		1,468	1,468	23,103	21,635
2030		1,468	1,468	23,103	21,635
2031		1,468	1,468	23,103	21,635
2032		1,468	1,468	23,103	21,635
2033		1,468	1,468	23,103	21,635
2034		1,468	1,468	23,103	21,635
2035		1,468	1,468	23,103	21,635
2036		1,468	1,468	23,103	21,635
2037		1,468	1,468	23,103	21,635
2038		1,468	1,468	23,103	21,635
2039		1,468	1,468	23,103	21,635
2040		1,468	1,468	23,103	21,635
2041		1,468	1,468	23,103	21,635
EIRR					37.9%
ENPV	50,682	8,132	58,814	157,177	98,363

Source: Consultant's estimates.

1. Overall Integrated Urban Development Output

45. Economic evaluation of the overall integrated urban development output is undertaken by combining the investment costs, recurrent costs results, and benefits shown in **Tables SA.11**– **SA.17** into a single simplified table and computing the total cost and net benefits by year (**Table SA.8**).[16] With an EIRR of 26.0% and an ENPV at a 12% discount rate of CNY878.5 million, the overall output is concluded to be economically viable.

[16] Individual households may well benefit from more than one subproject but this is not an issue since the estimates are based on expected benefits from a single subproject. Benefits are aggregated and not beneficiaries. If the benefits for a beneficiary household are more than additive, the economic value of the project will be higher than estimated.

Table SA.18: Economic Analysis Overall Integrated Urban Development Output (CNY millions)

Year	Investment Cost	Recurrent Cost	Total Cost	Benefits	Net Benefits
2015	449.5	0.0	449.5	0.0	(449.5)
2016	374.6	3.3	377.9	81.2	(296.6)
2017	250.9	8.1	259.0	197.0	(62.0)
2018		13.3	13.3	270.0	256.7
2019		13.1	13.1	292.3	279.3
2020		13.2	13.2	314.0	300.8
2021		13.2	13.2	338.3	325.1
2022		13.2	13.2	365.5	352.4
2023		13.2	13.2	393.5	380.3
2024		13.2	13.2	418.9	405.7
2025		13.2	13.2	414.6	401.5
2026		13.2	13.2	389.4	376.3
2027		13.2	13.2	319.0	305.9
2028		13.2	13.2	224.3	211.1
2029		13.2	13.2	167.5	154.4
2030		13.2	13.2	167.9	154.8
2031		13.2	13.2	168.1	154.9
2032		13.2	13.2	168.2	155.1
2033		13.2	13.2	168.4	155.2
2034		13.2	13.2	168.5	155.3
2035		13.2	13.2	168.6	155.4
2036		13.2	13.2	168.7	155.5
2037		13.2	13.2	168.8	155.6
2038		13.2	13.2	168.9	155.8
2039		13.2	13.2	169.0	155.9
2040		13.2	13.2	169.1	156.0
2041		13.2	13.2	169.2	156.1
EIRR					26.0%
ENPV	878.5	81.3	959.8	1,838.3	878.5

Source: Consultant's estimates.

2. Overall Project

46. **Table SA.19** presents the data for the overall project economic analysis, estimated by combining the analyses of the wetlands restoration (**Table SA.9)** and rehabilitation output and the integrated urban development output (**Table SA.18**). This indicates that the overall project is economically viable with an EIRR of 23.6% and an ENPV at a 12% discount rate of CNY899.1 million.

Table SA.19: Summary Economic Analysis of Overall Project (CNY millions)

Year	Investment Cost	Recurrent Cost	Total Cost	Benefits	Net Benefits
2015	534.1	0.0	534.1	0.0	(534.1)
2016	405.4	3.3	408.7	81.2	(327.4)
2017	391.7	8.1	399.8	197.0	(202.8)
2018		16.1	16.1	312.4	296.4
2019		15.6	15.6	334.8	319.2
2020		15.7	15.7	356.4	340.7
2021		15.7	15.7	380.8	365.0
2022		15.7	15.7	408.0	392.3
2023		15.7	15.7	435.9	420.2
2024		15.7	15.7	461.3	445.6
2025		15.7	15.7	457.1	441.3
2026		15.7	15.7	431.9	416.2
2027		15.7	15.7	361.5	345.8
2028		15.7	15.7	266.8	251.0
2029		15.7	15.7	210.0	194.3
2030		15.7	15.7	210.4	194.7
2031		15.7	15.7	210.5	194.8
2032		15.7	15.7	210.7	195.0
2033		15.7	15.7	210.8	195.1
2034		15.7	15.7	210.9	195.2
2035		15.7	15.7	211.0	195.3
2036		15.7	15.7	211.2	195.4
2037		15.7	15.7	211.3	195.5
2038		15.7	15.7	211.4	195.6
2039		15.7	15.7	211.5	195.8
2040		15.7	15.7	211.6	195.9
2041		15.7	15.7	211.7	196.0
EIRR					23.6%
ENPV	1,078.8	95.7	1,174.5	2,073.6	899.1

Source: Consultant's estimates.

3. Sensitivity Analysis

47. Standard sensitivity tests including (i) a 10% cost increase; (ii) a 10% benefit decrease; (iii) a 10% cost increase combined with a 10% benefit decrease; (iv) a 1-year benefit lag; and (v) a 10% increase in recurrent costs have been undertaken. In addition to EIRRs and

ENPVs, the sensitivity analysis includes estimation of switching values for cost increases and benefit decreases. While the tests have not been defined for any specific risks, they cover the main impacts of such risks. The results for each subproject,[17] output, and the overall project (**Table SA.20**) can be readily assessed from the table.

48. Most critically the overall project EIRR of 23.6% is reduced to 21.3% with a 10% cost increase, to 21.1% with a 10% benefit decrease, to 19.0% with a 10% cost increase combined with a 10% benefit decrease, and to 19.5% with a one year lag in benefits. A 10% increase in recurrent costs will reduce the EIRR by 0.1 percentage points, indicating that recurrent costs are not critical to overall project viability. Overall the project is assessed to be highly robust.

Table SA.20: Summary of Results of Sensitivity Tests for Subprojects, Outputs and Overall Project

Item	Indicator	10% Cost Increase	10% Benefit Decrease	10% Cost Increase + 10% Benefit Decrease	1 Year Benefit Lag	10% Increase in Recurrent Costs
Wetlands restoration and rehabilitation output	EIRR (%)	12.0	11.8	10.5	11.6	13.2
	ENPV (CNY millions)	(0.8)	(2.8)	(24.3)	(6.3)	19.1
	SV (%)	10	9			
Urban road subprojects	EIRR (%)	26.9	26.6	24.1	23.7	29.4
	ENPV (CNY millions)	505.3	449.8	399.2	440.4	551.6
	SV (%)	110	52			
Community lane upgrading	EIRR (%)	11.2	11.1	9.8	11.0	12.6
	ENPV (CNY millions)	(2.8)	(3.1)	(8.1)	(3.8)	(2.1)
	SV (%)	4	4			
Public green spaces & plant nurseries	EIRR (%)	11.2	11.1	.9	11.0	12.3
	ENPV (CNY millions)	(5.1)	(5.4)	(13.8)	(6.8)	2.1
	SV (%)	4	4			
Water supply network improvement	EIRR (%)	13.2	13.1	11.6	12.7	14.5
	ENPV (CNY millions)	3.7	3.0	(1.2)	2.2	7.3
	SV (%)	19	16			
Sewerage network improvement	EIRR (%)	6.4	6.3	5.2	6.6	7.5
	ENPV (CNY millions)	(28.4)	(26.3)	(33.8)	(27.0)	(21.3)
	SV (%)	(28)	(38)			
Central heating network improvement	EIRR (%)	26.9	26.6	24.0	23.7	29.5
	ENPV (CNY millions)	165.9	(147.8)	133.5	143.3	179.3
	SV (%)	125	56			
Solid waste management	EIRR (%)	34.3	33.9	30.6	28.9	37.8
	ENPV (CNY millions)	92.5	82.6	76.8	80.6	97.5
	SV (%)	167	63			
Overall integrated urban development	EIRR (%)	23.5	23.3	21.0	21.2	25.9
	ENPV (CNY millions)	782.6	694.7	598.7	674.5	870.4
	SV (%)	92	48			
Overall project	EIRR (%)	21.3	21.1	19.0	19.5	23.5
	ENPV (CNY millions)	781.6	691.7	574.3	668.1	889.5
	SV (%)	77	43			

EIRR = economic internal rate of return; ENPV = economic net present value; SV = switching value.

[17] The numerous new and upgraded roads subprojects are combined into a single roads subproject for the sensitivity analysis since a more detailed presentation would have little meaning.

Note: Values in parentheses are negative. A negative value for the switching value indicates the percentage a cost must be reduced by or a benefit increased by to achieve economic viability.

4. Distribution Analysis

49. A benefit distribution analysis was undertaken in accordance with the methodology outlined in the ADB's Guidelines for the Economic Analysis of Projects (1997) to measure the share of project benefits and costs accrued by the poor. Project costs and quantifiable benefits form the basis for the benefit distribution. Non-quantifiable benefits were not taken into account. Estimation of the project impact ratio for the overall project is shown in **Table SA.21**. The poverty impact ratio is estimated at 0.14, implying that the project will have significant benefits for the poor.

Table SA.22: Estimation of Poverty Impact Ratio

Present Value (@12%) (in CNYmillions, mid-2014 Prices)	**Financial Net Present Value** (1)	**Economic Net Present Value** (2)	**Difference** (1) - (2)	**Distribution of Benefits/Costs**		**Total**
				Subproject Beneficiaries	**Govern-ment**	
Incremental Benefits	**2,155.3**	**2,073.6**	**81.7**			
Wetlands	235.2	235.2	-	-	-	-
Integrated Urban Development	1,920.1	1,838.3	81.7	81.7	-	81.7
Incremental Costs	**1,326.5**	**1,174.3**	**152.2**			
Investment Costs	1,228.2	1,078.8	149.4	(74.7)	(74.7)	(149.4)
Operation and Maintenance	98.3	95.5	2.8	(1.7)	(1.1)	(2.8)
Net Benefits	**828.8**	**899.2**	**(70.4)**	**158.1**	**75.8**	**233.9**
Proportion of Poor				16.8%	8.6%	
Net Benefits to the Poor				26.6	6.5	33.1
Poverty Impact Ratio						**0.14**