ECONOMIC ANALYSIS

1. Huanggang is one of eight prefecture-level cities comprising the Wuhan metropolitan region in Hubei Province, referred to as the Wuhan 1+8 megacity cluster. Huanggang's current urban area is Huangzhou District. The Huanggang municipal government (HMG) intends to expand the urban area eastward by creating the New Eastern District (NED). The first phase of NED development is designed to attract 100,000 residents by 2020, along with commercial businesses and industries. At the center of NED are Baitan and Chiye lakes and seven associated rivers upon which the lakes depend for drainage and water circulation. The lakes are polluted and the seven associated rivers are badly silted with inadequate water-carrying capacity. The project will clean up the lakes and rivers so that NED development can take place.

A. Macroeconomic Context

2. Endorsed by the State Council in 2007, the Wuhan 1+8 megacity cluster plan was intended to anchor balanced economic development along the middle Yangtze River with Nanjing to the east and Chongqing to the west. Of all the urban areas within Hubei Province, Wuhan's urban area has grown the most and its share of gross domestic product (GDP) in the province increased by 6.6% during 2000–2010. However, its growth rate is considerably lower than other cities in the PRC, including Changsha, Hefei, Nanjing, Xian, and Zhengzhou.

3. In addition to anchoring development along the middle Yangtze River, the Wuhan 1+8 megacity cluster policy is one of several policies that promote smaller cities and towns. To date, this policy strand has only been partially successful in terms of population increase and economic growth.

4. In contrast with Jiangxi and Hunan provinces in the south of the Yangtze River, most cities in Hubei Province other than the Wuhan urban area, experienced population decline during 2001–2010. Huanggang's actual population decreased by 13% in all its counties; county-level cities, even in Huangzhou District, had a drop of 2%. Attracting migrants is key to increasing population. The Wuhan urban area outpaced other members of the Wuhan 1+8 megacity cluster. The number of migrants in the cluster grew from 2.8 million in 2000 to 4.8 million in 2010. Wuhan urban area took 83% of this migrant increase, while Huangzhou District took just 2% (increase from 44,000 to 86,000). Among the nine cities in the cluster, Huanggang has the lowest average annual urbanization growth rate of about 0.1% for 2000–2010 and urbanization ratio of 35.7% in 2010.[1]

5. Wuhan urban area's dominance of regional GDP has continued. During 2008–2011, its GDP rose from 31% to 35% of that of Hubei Province, with average growth of 18%, while the provincial economy grew at an average of 13.7%. Huanggang's share also grew slightly from 4.7% to 5.3% with average growth of 19%. However, Huangzhou District's growth rate lagged somewhat at an average of 16%. Unfortunately, Huanggang's improved GDP growth rate has not been translated into a competitive urban employment opportunity needed to induce migration into Huangzhou District.

6. Although Huangzhou District has declined relative to Wuhan's urban area, it has its strengths. Its human capital is comparatively strong within the Wuhan 1+8 megacity cluster. It ranks high in terms of years of formal education and proportion of graduates of senior middle schools, its vocational training and education take a leading position within the PRC. Also, it has

[1] National Bureau of Statistics. Government of the People's Republic of China. 2000. *National Population Census*. Beijing; National Bureau of Statistics. Government of the People's Republic of China. 2010. *National Population Census*. Beijing.

five main industrial parks, approved during 1990–2010. Textiles and clothing remain as the district's dominant industry—the number of firms quadrupled and employment doubled during 2001–2010. Meanwhile, Huangzhou District shifted from some of its traditional lower-value-added industries, such as building materials, machinery, food, and beverages. Two new manufacturing industries have emerged: processing steel from Wuhan, and electronics and telecommunications. Despite these changes, Huangzhou District's economy did not become a new industrial center or a center of producer or consumer services to the Wuhan 1+8 megacity cluster, instead it lagged the achieved growth in other parts of Huanggang.

7. Huanggang has good transport connections by road and rail, and its access to major domestic and international export markets is better than from the western part of Hubei Province. Three railway lines pass through Huanggang, but none connects to Huangzhou District's inland port, which may be a reason for the lack of heavy industry in the urban area. A new high-speed line and road–rail bridge from Huangzhou District to urban areas south of the Yangtze River was completed in June 2014. Travel time from Huangzhou District to Wuhan urban area dropped from 90 to 50 minutes by road and 28 minutes by rail. This will allow improved integration of the two economies, making Huangzhou a better alternative in areas where it has comparative cost advantages to Wuhan urban area.

8. The development of NED as a high-quality livable urban environment is one of the Huanggang government's principal strategies to facilitate local economic growth and urbanization in Huangzhou District, to take advantage of its comparative advantages, and to improve transport links. The basic physical planning principles guiding the NED development are considered sound. NED will integrate well with the existing city. It will (i) incorporate a major green area in the eastern area, (ii) have the rehabilitated Baitan Lake as the unifying element of the district, and (iii) and incorporate new commercial and institutional hubs in the northeastern quadrant and an educational hub in the south. The road network plan integrates well with the existing city and surrounding areas.

B. The Project and its Economic Rationale

9. Currently, the water quality status of Baitan and Chiye lakes and their associated river system is class V or worse and if left untreated, will continue to deteriorate.[2] Eutrophication will increase and the amenity value of the lake environment, already low, will drop further. Thus, the economic rationale for the project rests, first and foremost, on the need to improve the environment through cleanup of local lakes and rivers. The project responds to various environmental initiatives by the Hubei provincial government and HMG intended to redress this situation. At the provincial level, the Chang River Basin Master Plan includes restoration of Yiai and Baitan lakes in Huangzhou District, and sets a water quality target of class IV. At the HMG level, the Huanggang Municipal Urban Master Plan, 2012–2030 sets out to implement these improvements, including improved flood control standards and wastewater separation and treatment standards, while the River and Lake System Rehabilitation Plan for Baitan Lake and its Surrounding Area, 2013 includes many of the project's structural measures.

10. The project supports improvements in water quality and the environment, and NED development by making water quality and other environmental improvements to Baitan and

[2] Class I water has the highest quality and class V+ water is the worst. Class III water is suitable as a supply source for municipal drinking water treatment and for swimming; class IV is suitable for use as a general industrial water supply and for recreational use involving no direct human contact with the water; class V is suitable only for agricultural water supply and general landscaping use; and class V+ is unsuitable for any use (PRC Environmental Water Quality Standard GB 3838-2002).

Chiye lakes and seven associated rivers (component 1), all of which lie in the zone of planned eastward urban expansion and are central to NED development. As a result of the project, water quality will improve to class IV, from class V or worse. Protection from flooding will be increased and public amenities created to result in a livable urban environment.

11. The solid waste management component (component 2) will ensure that waste generated around the lakes is properly disposed of and not discharged into lakes and rivers, and includes a solid waste public awareness campaign. Capacity-building elements (component 3) are designed to support project implementation and the effective management of the water system, thus helping to ensure the environmental sustainability of NED development.

12. The second part of the economic rationale relates to expected urbanization. Acceleration of urban development is a priority under the PRC's Twelfth Five-Year Plan, with government projecting a 4% increase in urbanization. The NED development plan provides for 100,000 new residents (the direct beneficiaries of the project) together with industries and services in NED by 2020. This implies a growth rate of Huangzhou District's population of 2.4% annually. This would be greater than that achieved by Wuhan urban area (18% in total during 2000–2010) and represents a significant break from Huangzhou District's recent past (although Huangzhou District's migrant population grew by 42,000 from 2000–2010, its total actual population fell by 6,800). However, the relatively low cost of housing, the improved transport links with Wuhan, and Huangzhou's comparative industrial cost competiveness make this growth achievable if NED is viewed as an attractive locality in which to reside.

13. The project will learn from the restoration project of Yiai Lake, a broadly similar scheme to that proposed for Baitan and Chiye lakes in NED. Yiai Lake is located in the southern part of Huangzhou District, on the edge of the core urban area. It is a popular recreational venue for local residents. With rapid urbanization of its catchment, its water quality fell to worse than class V by 2009. A restoration project launched in 2009 (budgeted at $140 million) has not improved water quality. Consequently, Huanggang Urban Construction Investment Company launched a new restoration phase in 2013. The reasons for the poor performance of initial restoration efforts include (i) incomplete interception of wastewater discharge into the lake, (ii) intensive fish farming in part of the lake exceeding its self-purification capacity, and (iii) insufficient circulation; all of which will be addressed by the project.

14. The HMG's investment (external to the project) ensures that NED will be socially inclusive by constructing low-rent, affordable, and public rental housing to accommodate 4,500 households in addition to resettlement housing for 6,484 households, and a technical and vocational education and training center that provides students and migrants with skills training to respond to the demands of local industries.

C. Approach

15. The nature of the project is such that the direct and indirect economic benefits are difficult to quantify. The project will improve the environment by cleaning up lakes and rivers, which can lead to development of the NED area. Even if the economic growth of the development could be forecast, those benefits cannot be attributed separately to the lakes and rivers cleanup (i.e., the project) and other interventions planned by HMG. However, the major economic benefits expected to come from the project are the indirect economic regeneration effects that the project and the complementary NED development will have on the local Huangzhou environment and economy. As a result, the economic justification for the project relies primarily on the strength of the project economic rationale, and on cost-effectiveness analyses of alternative approaches to achieve the required water quality improvement.

D. Cost-Effectiveness

16. The analysis focuses on a simulation and least-cost approach to optimize the project design by first simulating the impact of eight scenarios, and then applying least-cost analysis to the three design options that meet the project's objectives and technical requirements.

17. A water quality impact simulation model tests the outcomes of eight alternative dredging and wetland construction scenarios.[3] Table 1 sets out the possible scenarios subjected to simulation. The scenarios vary in terms of the balance and extent of wetland construction and sediment dredging. The model was also subsequently used to optimize the location of dredging and wetland construction for the preferred scenario.

Table 1: Scenarios of Water Quality Simulation

Scenario	Engineering Measures	Pollution Loading (year)	Horizon (year)	Water Quality Prediction (class)	Notes
1.	Do nothing	2013	2013	V	
2.	Do nothing	2020	2020	V	
3.	Sediment dredging only: 539,405 m^3	2020	2020	V	
4.	Sediment dredging only: 915,000 m^3	2020	2020	V	
5.	Sediment dredging 539,405 m^3 Surface-flow constructed wetland 80 ha plus water transfer 1.1 m^3/s Vegetated buffer strips, aquatic plants	2020	2020	IV or V	V in Baitan north area
6.	Sediment dredging 539,405 m^3 Surface-flow constructed wetland 80 ha plus water transfer 1.1 m^3/s Vegetated buffer strips, aquatic plants Subsurface-flow constructed wetlands 3.8 ha plus detention ponds 1.5 ha	2020	2020	IV	Preferred scenario based on least cost
7.	Sediment dredging 915,000 m^3 Surface-flow constructed wetland 80 ha plus water transfer 1.1 m^3/s Vegetated buffer strips, aquatic plants Surface-flow constructed wetland 8.2 ha in Baitan Lake	2020	2020	IV	Viable alternative 1
8.	Sediment dredging 915,000 m^3 Surface-flow constructed wetland 80 ha plus water transfer 1.1 m^3/s Vegetated buffer strips, aquatic plants Subsurface-flow constructed wetlands 3.8 ha plus detention ponds 1.5 ha	2020	2020	IV	Viable alternative 2

ha = hectare, m^3 = cubic meters, m^3/s = cubic meters per second.
Source: Asian Development Bank.

18. With no engineering measures (scenarios 1 and 2), water quality remains at class V and would most likely deteriorate further. If implemented individually, sediment dredging, and surface-flow and subsurface-flow constructed wetlands can improve the water quality in the lakes to some extent (scenarios 3, 4, or 5). However, for sustainable water quality improvement, combinations of sediment dredging, surface-flow constructed wetlands with water transfer, aquatic planting, and subsurface-flow constructed wetlands are required. Of the scenarios examined, only three combinations of engineering measures, scenarios 6, 7, and 8, are

[3] A hydraulic and water quality model was constructed to simulate the water quality variations of Baitan and Chiye lakes and calibrated using actual current data (scenario 1). The potential impact of the do-nothing option and six proposed engineering interventions are evaluated by reference to pollutants removed and sustainable water quality improvements in the lakes.

technically feasible ways of achieving and maintaining the class IV target in the lakes, necessary to comply with the Huanggang Municipal Urban Master Plan. When the present value of the cost of technically suitable scenarios is compared, scenario 6 is the least-cost option. It is, therefore, incorporated in the project design.

Table 2: Least-Cost Analysis of Technically Suitable Options to Achieve Water Quality Target

	Scenario 6		Scenario 7		Scenario 8	
Engineering Measures	**Physical Units**	(CNY million)	**Physical Units**	(CNY million)	**Physical Units**	(CNY million)
Baitan Lake dredging and pretreatment	404,405 m^3	50.6	780,000 m^3	97.5	780,000 m^3	97.5
Transport of the dewatered dredged material	190,070 m^3	4.7	366,600 m^3	9.2	366,600 m^3	9.2
Baitan Lake subsurface-flow constructed wetland for treating urban runoff	33,030 m^2	21.1			33,030 m^2	21.1
Chiye Lake subsurface-flow constructed wetland for treating urban runoff	5,197 m^2	3.6			5,197 m^2	3.6
Baitan Lake surface-flow constructed wetland for treating urban runoff			82,575 m^2	14.0		
Chiye Lake surface-flow constructed wetland for treating urban runoff			13,425 m^2	3.6		
Chiye Lake dredging and pretreatment	135,000 m^3	8.1	135,000 m^3	8.1	135,000 m^3	8.1
Surface-flow constructed wetland and water transfer for treating pollutants from Xingfu river catchment	800,000 m^2	142.3	800,000 m^2	142.3	800,000 m^2	142.3
Vegetated buffer strips and aquatic plants		10.6		10.6		10.6
Other construction costs		971.0		971.0		971.0
Total		**1,212.0**		**1,256.3**		**1,263.4**
Present Value		**897.1**		**927.8**		**934.2**

m^2 = square meters, m^3 = cubic meters.
Note: Present value calculated based on 2013 prices using discount rate of 12%.
Source: Asian Development Bank.

E. Willingness to Pay and Flood Alleviation Benefits

19. The contingent valuation exercise undertaken as part of the project preparatory technical assistance provides evidence to support the value of the improvements, but proved of limited use and inherently uncertain as (i) the survey respondents were generally not those who will reside in NED, and (ii) aggregating willingness to pay benefits over a wide area is difficult—a widely recognized environmental economics problem. The results of contingent valuation questions embedded within a social survey undertaken in May 2013 did, however, provide general support for the lake restoration.

20. In addition to water quality improvements, quantifiable flood alleviation benefits are valued by comparing expected reference and project case average annual damage. This benefit stream is valued at CNY1.15 million per annum.