SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

WUHAN WASTEWATER MANAGEMENT PROJECT

IN THE

PEOPLE’S REPUBLIC OF CHINA

July 2002
CURRENCY EQUIVALENTS
(as of 15 June 2002)

Currency Unit - yuan (CNY)

CNY 1.00 = $0.121
$1.00 = CNY8.27

The exchange rate of the yuan is determined under a floating exchange rate system. In this report a rate of $1.00 = CNY8.27 is used.

ABBREVIATIONS

AAOV average annual output value
A/C anaerobic plus modified carousel oxidation ditch process
ADB Asian Development Bank
A/O anaerobic/oxic
AP affected people
BOD biochemical oxygen demand
COD cr chemical oxygen demand
EIA environmental impact assessment
EIRR economic internal rate of return
HPEPB Hubei Provincial Environmental Protection Bureau
PPTA project preparatory technical assistance
PRC People’s Republic of China
PRO project resettlement office
RAP Resettlement Action Plan
RP Resettlement Plan
SEPA State Environmental Protection Administration
t/yr ton per year
WMEPB Wuhan Municipal Environmental Protection Bureau
WMWC Wuhan Municipal Wastewater Company
WPMO Wuhan Project Management Office
WWTP wastewater treatment plant

WEIGHTS AND MEASURES

ha Hectare
km Kilometer
km² square kilometer
m Meter
m/s meter per second
m³ cubic meter
m³/day cubic meter per day
t/yr ton per year

NOTES:

(i) The fiscal year (FY) of the government coincides with the calendar year.
(ii) In this report, “$” refers to US dollars.
WUHAN WASTEWATER MANAGEMENT PROJECT
IN THE
PEOPLE’S REPUBLIC OF CHINA
I. INTRODUCTION

1. Economic development has degraded the aquatic environmental quality in Wuhan. The surface waters have been seriously polluted: 56% of the rivers and 89% of the lakes in Wuhan have been polluted to different levels with organic materials and nutrients. This situation is worse for urban areas and lakes than for rural areas and rivers. Severe pollution accidents have occurred several times in the Hanjiang River (1992, 1998, and 2000), the largest drinking water source for Wuhan. Moreover, along the Changjiang River, the other major drinking water source, a pollution belt (band of nearshore pollution) has formed, which has led to adverse impacts on the intakes of water treatment plants. Therefore, increased municipal wastewater treatment capacity is necessary for Wuhan.

2. Currently the total wastewater flow generated within Wuhan is 2,050,000 cubic meters per day (m$^3$/day), while the existing wastewater treatment capacity of Wuhan is only 150,000 m$^3$/day. The proposed Wuhan Wastewater Management Project includes construction of three wastewater treatment plants (WWTPs) and associated wastewater collection and pumping systems. The three WWTPs, located in Hankou and Wuchang districts, are the Sanjintan, Huangjiahu, and Luobuzui WWTPs. They will provide wastewater collection and treatment in the urban areas of Wuhan. The Project WWTPs are among 13 WWTPs posited in the Wuhan Wastewater Master Plan. Map 1 shows the location of these as well as other planned WWTPs.

3. This Summary Environmental Impact Assessment for the Project was prepared in accordance with the requirements of the Asian Development Bank (ADB). The summary is based on the environmental impact assessment (EIA) report and additional information prepared by the Wuhan Project Management Office (WPMO). The EIA outline was approved by the State Environmental Protection Administration (SEPA) in October 2001. The full EIA report for the Project was prepared jointly by the Environmental Protection Center of the Military Rear Service Department and the Wuhan Research Institute of Environmental Sciences. As required by the People’s Republic of China (PRC) Government, the EIA report will be submitted to the Ministry of Construction for review and for SEPA approval.

II. PROJECT DESCRIPTION

4. The proposed Project will add wastewater treatment capacity of 520,000 m$^3$/day for Wuhan and will address municipal and industrial water pollution problems in Hankou, Wuchang, and Qingshan districts. Implementation of the Project will protect drinking water sources, improve the aquatic ecological environment in the rivers and lakes, protect and make full use of water resources, improve the urban environment, and have an overall positive impact on the aquatic environment of the Changjiang River. It will also enhance economic development in the region, improve irrigation for agriculture, and accelerate development of the tourism industry. The project is scheduled to be completed by December 2007. Its major elements are listed in Table 1.
### Table 1: Major Elements of the Project

<table>
<thead>
<tr>
<th>Item</th>
<th>Sanjintan</th>
<th>Luobuzui</th>
<th>Huangjiahu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Capacity (m³/day)</td>
<td>300,000</td>
<td>120,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Treatment Process</td>
<td>Anaerobic + Aeration (A/O)</td>
<td>Anaerobic + Oxidation Ditch (A/C)</td>
<td>Anaerobic + Oxidation Ditch (A/C)</td>
</tr>
<tr>
<td>Receiving Water Bodies</td>
<td>Fu River/Changjiang</td>
<td>Shahu Gang/Changjiang</td>
<td>Qingling River/Changjiang</td>
</tr>
<tr>
<td>Sludge Disposal</td>
<td>Sanitary Landfill</td>
<td>Sanitary Landfill</td>
<td>Sanitary Landfill</td>
</tr>
<tr>
<td>Percentage Industrial Wastewater (%)</td>
<td>22.6</td>
<td>17.3</td>
<td>24.1</td>
</tr>
<tr>
<td>Length of Sewers (km)</td>
<td>32.9</td>
<td>24.2</td>
<td>47.9</td>
</tr>
<tr>
<td>Pipe Diameter (mm)</td>
<td>400-2,800</td>
<td>400-1,800</td>
<td>400-2,200</td>
</tr>
<tr>
<td>Pump Stations</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Pump Station Capacity (m³/s)</td>
<td>14.35</td>
<td>3.4</td>
<td>2.88</td>
</tr>
<tr>
<td>Land Requirement (ha)</td>
<td>25.5</td>
<td>11.9</td>
<td>14.7</td>
</tr>
<tr>
<td>Land Use</td>
<td>Agricultural Use</td>
<td>Agricultural Use</td>
<td>Agricultural Use</td>
</tr>
<tr>
<td>Service Population</td>
<td>820,000</td>
<td>400,000</td>
<td>350,000</td>
</tr>
<tr>
<td>Service Area (km²)</td>
<td>61.4</td>
<td>30.1</td>
<td>56.5</td>
</tr>
</tbody>
</table>

*ha=hectares, km=kilometer, km²=square kilometer, m³/s=cubic meter per second, mm=millimeter*

*Source: Draft Feasibility Study, WPMO, March 2002.*

## III. DESCRIPTION OF THE ENVIRONMENT

5. Wuhan is the capital of Hubei Province and one of the largest cities in the PRC (Map 2). It is also the economic, trade, finance, science and technology, culture, and information center of the central PRC. It lies in the middle and downstream portions of the Changjiang River, east of Hubei Province and the Jianghan Plain. The largest river of the PRC, the Changjiang traverses the Wuhan urban area. Its tributary, the Hanjiang River, meets the Changjiang in the Wuhan urban area. Wuhan consists of 13 administrative districts: 11 urban districts (Caidian, Hanyang, Hongshan, Huangpi, Jiang'an, Jianghan, Jiangxia, Qiaokou, Qingshan, Wuchang, Xinzhou,) and 2 rural districts (Dongxihu, Hannan). The city covers a total area of 8,467 square kilometers (km²), of which 2,144 km² is covered by water. The total population was approximately 7,491,000 in 2000.

A. Topography and Geology

6. The topography of Wuhan is characterized by a plain in the middle, hilly areas in the northern and southern portions, and low mountains in the north. There are many lakes and ponds in the project area. The land elevation varies from 21 to 30 meters (m) above sea level, with a natural gradient of approximately 0.1%. The underlying geology is characterized by a new Cathaysian system structure, and the soil is mostly clay and sandy clay. Over the last 100 years, no major earthquakes have been recorded, and the area is classified as 5 to 6 on the PRC earthquake intensity scale. The service area of the Sanjintan WWTP is flat, sloping slightly from south to north. The service area of the Huangjiahu WWTP is a plain. The service area for the Luobuzui WWTP is flat.

B. Climate and Rainfall

7. The project area has a subtropical monsoon climate with distinct seasonal changes and abundant rainfall. The average annual precipitation is approximately 1,285 millimeters, 74% of which falls from May to October. The average annual humidity is approximately 77%, and the average annual temperature is approximately 17 °C. The hottest month is July. In the hottest
months, about 40 days occur with temperature higher than 35°C. The prevailing wind direction through the year is from the north, with the average wind speed ranging 1.6-2.8 meters per second (m/s).

8. Air quality is classified into three levels in China with Level 1 being the best. Recent ambient air monitoring indicates the air quality in the project area can be characterized as Level 2 most of the time. The major air pollutants are total suspended articles and nitrogen dioxide.

C. Hydrology

9. The Project is located in the Changjiang basin and is crisscrossed by rivers, canals, and drainage ditches. Surface waters in the region are characterized as high flow through the year.

10. The project area is composed of weathered rock and alluvial soil. The shallow aquifers are typically 1-2 m below ground. Deep aquifers are typically 10 m or deeper. Surface waters, such as the Changjiang and Hanjiang rivers, are the primary water sources for most residential, commercial, industrial, agricultural, and fishery use. Groundwater is one of the major water sources for industries.

11. Rivers, canals, and open ditches in the project area are used for flood control, irrigation, and domestic water supply. A variety of aquatic products are found in the region; the most famous of which is Wuchang fish. Aquaculture is one of the major activities in the area.

12. The major water bodies impacted by the Project include Changjiang River’s Wuhan section, Fu River’s Wuhan section, East Lake basin, and Tangxun Lake basin.

   (i) Changjiang River, Wuhan section. The Changjiang, the largest river traversing Wuhan, has a length of 60 kilometers (km) within Wuhan and width ranging from 1,000 m to 3,000 m. In Wuhan, the annual runoff is 741.1 billion cubic meters (m$^3$), with average velocity of 1.16 m/s.

   (ii) Fu River, Wuhan section. The Fu River flows into Wuhan from Xiaogan City to the south and has a length of 48 km within Wuhan. The annual runoff is 4.71 billion m$^3$, with average velocity of 0.38 m/s.

   (iii) East Lake basin. East Lake is located south of the Changjiang River and consists of a series of connecting lakes covering an area of 33 km$^2$. The average water depth is 2.18 m, and the catchment area is about 119 km$^2$.

   (iv) Tangxun Lake basin. The Tangxun Lake basin consists of Tangxun Lake, the Qingling River, and South Lake. The controlled water table is at 20.5 m, and the catchment area is about 40 km$^2$.

D. Ecological Resources

13. Wuhan is located in the transitional zone between the middle and north subtropical zones, with the Changjiang River traversing the area. Biological resources are relatively abundant and diverse. Table 2 summarizes the major biota and agricultural resources in the project area.
Table 2: Biota and Agricultural Resources of the Project Area

<table>
<thead>
<tr>
<th>Category</th>
<th>Type</th>
<th>Major Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants (more than 1,000 species)</td>
<td>Trees</td>
<td>Camphor tree, metasequoia, Chinese parasol tree</td>
</tr>
<tr>
<td></td>
<td>Aquatic plants</td>
<td>Lotus, reed</td>
</tr>
<tr>
<td>Animals (more than 130 species)</td>
<td>Fish</td>
<td>Wuchang fish, grass carp, silver carp</td>
</tr>
<tr>
<td></td>
<td>Birds</td>
<td>White crane, wild goose</td>
</tr>
<tr>
<td></td>
<td>Aquatic life</td>
<td>White-flag dolphin, Chinese paddlefish, turtle</td>
</tr>
<tr>
<td></td>
<td>Livestock and poultry</td>
<td>Pig, cow, chicken</td>
</tr>
<tr>
<td>Agricultural Resources</td>
<td>Major crops</td>
<td>Rice, corn</td>
</tr>
<tr>
<td></td>
<td>Cash crops</td>
<td>Tea, rapeseed, vegetables, herb medicines</td>
</tr>
<tr>
<td></td>
<td>Fruits</td>
<td>Orange, grape, peach</td>
</tr>
</tbody>
</table>

14. The Changjiang River originates from the Qingzang Plateau in the western PRC and transverses the country from west to east, flowing into the East China Sea at the border of Shanghai Municipality and Jiangsu Province. Besides its navigation and flood control functions, it is also an abundant ecological system. Its reaches within Wuhan are migration channels for the endangered white-flag dolphin and Chinese paddlefish, which are Class I protection species in the PRC. Various lakes in the project area are local bases for fishery, and the major fish species include Wuchang fish, grass carp, and silver carp.

15. There are two Class I protection species in Wuhan, the white crane and the metasequoia.

E. Water Quality and Pollution

16. The Changjiang River is the ultimate receiving water body for all effluent from the proposed WWTPs. The Changjiang has a sound assimilative capacity, mainly due to the very large flows. Even though it regularly receives significant pollution loads, the Changjiang has been able to maintain a water quality level of Class III. However, the silt loading has increased over the last 10 years due to heavy soil erosion in the upstream area. The silt loading has deteriorated the water quality and is a threat to the ecological system of the Changjiang. Surface waters and shallow groundwater aquifers have been polluted to different levels. The water quality of the receiving water bodies and the major pollution sources for the Project are listed in Table 3.

Table 3: Water Quality of Receiving Water Bodies

<table>
<thead>
<tr>
<th>WWTP</th>
<th>Receiving Water Bodies</th>
<th>Water Quality Requirement</th>
<th>Existing Water Quality</th>
<th>Major Pollution Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanjintan</td>
<td>Fu River</td>
<td>Class IV</td>
<td>Worse than Class V</td>
<td>Domestic and industrial wastewater (shipyard, pulp and paper, chemical and plastic products, food and beverage, hardware and electronics, pharmaceutical, and machinery)</td>
</tr>
<tr>
<td>Huangjiahu</td>
<td>Qingling River</td>
<td>Class IV</td>
<td>Class V</td>
<td>Domestic and industrial wastewater (shipyard, metallurgical, food, machinery, and chemical)</td>
</tr>
<tr>
<td>Luobuzui</td>
<td>Shahu Gang</td>
<td>Class IV</td>
<td>Worse than Class V</td>
<td>Domestic and industrial wastewater (shipyard, chemical products, textile, power, chemical, machinery, and building material)</td>
</tr>
<tr>
<td>Receiving Water Body</td>
<td>Changjiang River</td>
<td>Class II</td>
<td>Class IV</td>
<td>As above directly and indirectly</td>
</tr>
</tbody>
</table>

a PRC water quality classes are I to V, of which I and II are pristine and can be used as a source for potable water, and V is the worst.

F. Social and Economic Conditions

17. The total area of Wuhan is approximately at 8,467 km², with the urban and suburban areas covering 864 km² and 7,603 km², respectively. The developed urban area is about 210 km². Of the resident population of Wuhan Municipality of 7,491,000 at the end of 2000, 7,157,600 lived...
in the urban area and the rest in the suburban area. The gross domestic product of Wuhan in 2000 was CNY120.65 billion, or approximately CNY16,100 per capita. The ratio of primary to secondary to tertiary industries was 6.7:44.3:49.0. The net annual income of the rural population was CNY2,953 per capita. The farmland area of Wuhan was 217,840 hectares (ha) in 2000, with rice fields covering 132,400 ha. The predominant industries in Wuhan include iron and steel, automobile, machinery and electric, high technology, clothing, food, chemical, and building materials. Some of the existing sewers are a separate system, such as the Honggangcheng collection system, and others are combined sewers. Social and economic conditions of Wuhan are summarized in Table 4.

| Table 4: Major Social and Economic Conditions in Wuhan |
|---------------------------------------------|-------------------|
| Urban Population                           | 7,491,900         |
| GDP                                        | CNY120,647,000,000|
| Water Supply                               | 2,750,000 m³/d    |
| Wastewater Treatment                       | 150,000 m³/d      |
| Transportation                             | The roads of Wuhan total at 1,332 km; Wuhan is also a railway hub. The Jingzhu (Beijing-Zhuhai) highway, national highway 107, and the Jingguang railroad traverse the urban area. Also, Wuhan plays a pivotal role in the Changjiang channel. |
| Historical and Tourism                     | Famous historic and cultural city. Four national cultural heritages including Shang Dynasty Relics in Panlong Town. Huanghe Pavilion and East Lake tour sites, and nine forest parks. |

IV. ALTERNATIVES

A. With-Project and Without-Project Alternatives

18. Wuhan is seriously deficient in wastewater treatment facilities, and the water quality of surface waters cannot meet the designated water use. Without the Project, surface water and groundwater will continue being polluted, and the water quality of surface receiving bodies will still deteriorate. With this Project, living conditions in the Wuhan urban area will be improved. The service population of the Project will be 18% of Wuhan, and approximately 26% of the total wastewater discharged will be treated under the Project. Consequently, pollutant loading of the water bodies will be reduced. The water quality of surface waters such as the Fu River, Huangxiao River, Shahu Gang, Luoja Gang, Xuns River, and Qingling River will be improved. This project also will have positive impacts on the South, Tangxun, and East lakes. Meanwhile, drinking water sources will be protected.

B. Alternative Treatment Processes

19. The proposed WWTPs will be secondary biological treatment plants. Several alternative biological processes were considered in the draft feasibility studies including: (i) the conventional activated sludge process; (ii) the anaerobic-aerobic-oxic process with nitrogen and phosphorus removal; (iii) the oxidation ditch process with anaerobic selector (A/C), which has higher nitrogen and phosphorus removal efficiency than conventional processes; (iv) the anaerobic/oxic (A/O) biologic process with anaerobic zone ahead, which also includes removal of nitrogen and phosphorus; and (v) Sequential Batch Reactor (SRB) process. Alternative analysis factors included treatment efficiency in relation to raw wastewater characteristics, environmental aspects,
cost, and sludge handling. Based on various conditions and requirements, the A/O process was proposed for the Sanjintan WWTP and the A/C process for the Huangjiahu and Luobuzui WWTPs.

C. Alternative WWTP Sites

20. Two alternative sites were evaluated for each WWTPs. The sites were selected based on the Wuhan Urban Master Plan requirement, sewer networks and effluent outfalls, site construction, land acquisition and resettlement, and anticipated regular impacts on the surrounding environment.

D. Alternatives for Effluent Outfalls and Reuse

21. Alternative effluent outfall locations were evaluated in the draft feasibility studies. The locations proposed are based on anticipated regular impacts on surface water and cost.

22. Effluent reuse was preliminarily considered for in-plant use for the Sanjintan WWTP, but no specific reuse programs have been developed because no potential users, flows, or applicable standards were identified.

E. Alternatives for Sludge Disposal

23. For each WWTP, a controlled sanitary landfill was selected for sludge disposal. The Wuhan Municipal Urban Management Bureau, which is responsible for garbage disposal, has agreed in principle to receive the excess sludge generated in the WWTPs. In the feasibility studies, other sludge reuse and disposal methods such as sludge cake pelletizing were also considered but were found to be less suitable for technical, financial, and economic reasons.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Impacts during Construction Phase

24. A large area of ponds at the proposed WWTP sites will require grading and earthwork. Consequently, a large amount of sediment will be dredged and excavated from the WWTP construction sites and surrounding areas during the initial phase. Preliminary estimates indicated that the excavated material for the Sanjintan, Huangjiahu and Luobuzui WWTPs will be about at 146,400 m$^3$, 32,000 m$^3$, and 51,000 m$^3$, respectively, and dredged sediment for the Huangjiahu and Luobuzui WWTPs will be about at 17,500 m$^3$ and 8,800 m$^3$, respectively. The major disposal approach is to store and dry the sediment at the WWTP site and then use it for backfill or afforestation. Engineering estimates showed that there will be sufficient land within the proposed WWTP sites for sediment storage and drying. Major impacts on the environment before backfill will involve change of land use and soil erosion control. The following measures are required for the construction contract to follow and to reduce potential adverse impacts: retaining walls will be built during sediment storage; the storage sites will be graded after backfill; and landscaping will be applied to non construction land (generally not less than 40% in the planned WWTP). Additionally, small amounts of dredged sediment will be generated from rehabilitation of open channels, and will be transported to sanitary landfills or farmland for final disposal. These sediments have been sampled and analyzed and found to be non hazardous, nontoxic, and suitable for farmland based on applicable PRC laws and standards. The sediments will be re-sampled prior to dredging and transport, and disposal will be managed accordingly. The transportation vehicles will be enclosed to avoid potential leakage. Transportation schedules will
be arranged at night as much as possible to avoid peak traffic hours. Thus, adverse impacts on
the environment and traffic from transportation of the dried sediments will be minimal.

25. Based on the construction budget, an additional 239,000 m³ of backfill material will be
required for the proposed WWTPs in the initial construction phase in addition to the dredged
sediment. Respective excavation sites in Hankou, Qingshan, and Jiangxia districts are planned
for the backfill material. The ground surfaces at the three sites are primarily wild grasses and
small amounts of planted trees (10 years old). Earthwork will not have significant impacts on local
residents or the local environment. The site will be graded shortly after excavation, and the
vegetation will be replanted. Vehicles should be covered or enclosed to avoid dust. The
transportation schedule will be carefully arranged at nighttime as much as possible to avoid peak
traffic hours. For the Sanjintan and Huangjiahu WWTPs, only short distance transportation is
required, which will not transverse the urban area. Therefore, transport of backfill material will not
create additional urban traffic. The above mitigation measures will be included in the construction
management contracts. Based on the preliminary soil investigation, the backfill material will not
have an adverse impact on the soil at the WWTP sites.

26. Construction activities for the WWTPs, pumping stations, and sewers will use construction
machinery and vehicles. Construction activities will produce short-term noise, vibration, air
pollution, muddy runoff, safety hazards, sewage and solid wastes from construction workers, and
debris, spoils, and traffic congestion. Environmental protection measures in connection with the
construction operations are required as part of the engineering contracts. Good practices such as
dust reduction, provision of storm runoff detention ponds, controlled disposal of spoil material,
and car/truck washing before leaving the construction site are necessary environmental
protection measures to be included in the contract specifications.

27. Noise and vibration will be generated during construction by the large earth-moving
devices including excavators, transportation vehicles, and other heavy construction machinery.
Generally, construction noise exceeding a noise level of 70 decibels has significant impacts on
surrounding sensitive receptors within 50 m of the construction site. For the three WWTPs, there
are residents within 400 m of the construction sites. The noise impact will be significant.
Therefore, the noise level should meet standards within 50 m of the construction site during the
day, and within 100 m of the boundary at night. Major mitigation measures will include (i) no night
construction (from 22:00 to 6:00) using heavy machinery near residential areas, (ii) no
discretionary use of noisy machinery, (iii) good maintenance and proper operation of construction
machinery to minimize noise, (iv) installation of temporary sound barriers if necessary, and (v)
avoidance of large vehicle transport routes near residential areas.

28. Mitigation measures to minimize dust generation during construction will included: (i)
enclosure of demolition sites; (ii) spraying of dusty roads; (iii) maintaining moisture on
construction materials; (iv) covering transportation vehicles, vehicle speed control, and selecting
transportation routes to minimize impact on dust-sensitive receptors; (v) covering or spraying of
exposed soil or storage sites; and (vi) minimizing on-site storage time of construction materials.

29. All vehicles and construction machinery will be operated in compliance with the relevant
vehicle emission standards and with proper maintenance to minimize air pollution.

30. Construction workers will generate small amounts of sewage. To minimize the impact,
interim sewers will be installed to convey the sewage to nearby sewers, or interim holding tanks
will be installed to discharge the sewage to the existing sewers.
31. Refuse generated by construction workers, construction spoils, and other solid wastes could have adverse impacts on the surrounding environment and traffic. The most practical and effective mitigation measure is timely clean-up. All of the on-site refuse should be stored in closed containers.

32. Traffic congestion, air pollution, and inconvenience to pedestrians and shop owners are potential problems in areas of trunk sewer installation. Mitigation measures will include constructing interim roads, selecting transport routes to reduce disturbance to regular traffic, diverting traffic at peak traffic hours, and repairing disturbed roads shortly after the construction. Traffic congestion will occur during construction of the Huangjiahu WWTP because it is near the existing road. The mitigation measure is to make an interim traffic arrangement, which will be one of the major components for construction management.

33. Construction areas for trunk sewers and the WWTPs are not located in forest, grassland, designated natural reserves, or scenic spots. Construction of the three WWTPs and trunk sewers will not change air or aquatic ecological environment within construction areas. There are no important historical and cultural sites, and no rare or endangered species within the project area. Although there are rare white crane and metasequoia in Wuhan, which are Class I protection species in China, their habitats are far from the construction areas and will not be affected by the construction. The WWTP effluent will eventually be discharged to the Changjiang River, but as described in para. 46, its adverse impact on the water quality of the Changjiang will be minimal, and it will not have an adverse impact on the endangered white-flag dolphin and Chinese paddlefish, whose migration channel is far from the riverbanks. Investigation conducted by the Aquatic Life Division of the State Institute of Sciences has confirmed this conclusion.

34. Construction will result in removal or relocation of 614 trees (149 for Sanjintan, 370 for Luobuzui, and 59 for Huangjiahu WWTPs and vegetation along sewer alignments or at WWTP sites. These impacts will be temporary, and original vegetation will be recovered or replanted after construction. Landscaping will generally be applied to more than 40% of the land at the WWTP sites. Thus, no significant adverse impacts will be imposed on the local ecological environment. However, to avoid potential damage to the trunk sewers, some trees will not be replanted after construction.

35. The proposed WWTP sites are within or adjacent to farmlands and/or fishponds, so the construction activities will have short-term adverse impacts on the surrounding crops. Mitigation measures will include construction of containment for controlling muddy runoff and soil erosion.

36. Construction of WWTPs and sewers will interfere with the existing utilities (water, storm and gas pipelines, communication, power cables, etc.) and will result in temporary suspensions of service. Avoidance of and/or clearance with other utilities will be carefully considered in the design and construction of the WWTPS and trunk sewers. Emergency measures will be in place to minimize adverse impacts.

37. Construction of some trunk sewers will involve railway crossing. Coordination will be carried out prior to design in order to avoid adverse impact.

B. Resettlement

38. Full details on the land acquisition and resettlement issues are discussed in the project preparatory technical assistance (PPTA) socioeconomic assessment and the project Resettlement Action Plan (RAP). Appendix 1 provides the project Summary Resettlement Plan.
Impacts relating to resettlement (physical and economic displacement) affect three groups: (i) people affected by the acquisition of land for the WWTPs and pump stations, (ii) people affected by the temporary use of land for installation of the trunk sewers, and (iii) people whose livelihood is impacted. Project components have been planned to avoid residential areas, minimize disruption to villages, and maintain village cohesion.

39. The Project will acquire 52.1 ha of land permanently, and will use 112.1 ha temporarily during construction. Temporary land use and permanent land acquisition will affect 1,253 and 666 persons, respectively. The Project will require the demolition of 70,803 square meters of buildings, which will affect 500 households. The budget for land acquisition and resettlement is CNY244 million ($29.3 million).

40. Short-term severance impacts on land parcels will occur during construction. These will include blockage of public right-of-way and disruption of access to land and commercial, community, and some residential buildings. WPMO and the relevant road construction department will liaise to ensure that access arrangements are made for the local community during construction so that impacts can be minimized. Following construction, road shoulders will be repaired to preproject conditions. Temporarily used land will be returned to the original land user when trunk sewer installation is complete.

41. Mitigation measures and compensation for impacts to the affected population are addressed in the PPTA socioeconomic assessment and draft RAP. There is no presence of indigenous people or ethnic minorities among the affected persons. The project RAP provides the detailed discussions.

42. The socioeconomic benefits of the Project related to improvements in the quality of life, documented in the PPTA socioeconomic assessment, include better wastewater services, a cleaner environment, improved waterborne disease prevention, increased employment opportunities for women and men, social assistance for vulnerable people, and poverty reduction.

C. Impacts during Operational Phase

43. In a WWTP, the bar screens, sedimentation tanks, aeration tanks, and sludge processing units are all potential sources of foul odor, which can produce adverse environmental impacts on the neighboring community.

44. Mitigation measures to minimize the potential odor problem of the WWTPs will include source control, a green belt 6-8 m around the plant, planting trees within the plant, and rational arrangement of the treatment facilities to minimize opportunities for odor to reach receptors. Source control includes the covering of sludge processing facilities and avoidance of storing dewatered sludge within the plant. A 160-350 m buffer strip around the plant with restricted development will ensure no odor impact on future communities near the site.

45. Dewatered sludge from the WWTPs will be placed in a sanitary landfill. The Wuhan Urban Construction Bureau has agreed in principle to receive sludge cakes from the WWTPs. The Wuhan Municipal Wastewater Company (WMWC) has received the signed agreement with the Wuhan Urban Construction Bureau for the final disposal of sludge in the sanitary landfills. Anticipated adverse impacts from sludge disposal will be minimal.

46. WWTP effluents will be discharged into the nearby rivers, which are currently receiving untreated wastewater. All effluents will eventually be discharged into the Changjiang River. With the operation of the WWTPs, effluent quality will meet discharge requirements for irrigation use.
With the treated wastewater meeting discharge standards, effluent discharge to the receiving water bodies such as the Fu, Qingling, and Shahu Gang rivers will produce positive impacts on the water quality. This improved water quality will eventually benefit the Changjiang River’s deteriorated water quality.

47. There is no water quality model available for predicting the impact of the effluent on the quality of the receiving water bodies. According to the process design of the three WWTPs and similar experience in other places, it is estimated that reductions of 16,280 tons per year (t/yr) biochemical oxygen demand (BOD$_5$), 24,380 t/yr chemical oxygen demand (COD$_{cr}$), 23,870 t/yr suspended solids, 620 t/yr total phosphorus, and 2,700 t/yr total nitrogen will be achieved after all of the WWTPs become operational. Preliminary estimates by using simple mass balance from the treated effluent to the receiving water bodies show that water quality improvement can be projected, especially for the near-shore pollution zone.

48. Noise generated in WWTP operation typically comes from the operation of pumps and blowers, and is usually within the plant. Mitigation measures will include (i) selection of low noise machines; (ii) placing high-noise equipment indoors; (iii) installation of noise enclosures or buffers; (iv) semi-underground placement of influent and effluent pump stations; and (v) a greenbelt as a buffer around the plant, and between the office and treatment units.

49. Chlorine leakage could result in serious injury to WWTP staff and in property damage. One of the preventive measures is to install safety detectors such that the chlorine feed system would automatically shut down when a leak is detected. Another measure is to install a chlorine scrubber system. When a large amount of chlorine leaks, the chlorine scrubber system automatically starts to absorb the chlorine and contains the leak within the chlorine building. Other mitigation measures will include (i) minimizing the amount of chlorine stored on-site, (ii) placing a buffer zone around the chlorine room, (iii) providing gas masks and oxygen tanks for workers, and (iv) providing periodic training and practice on safe operational procedures.

50. Corrosive and toxic gases and liquids could accumulate in long-distance trunk sewers, resulting in structural damage, sewer leakage, and threat to life. Mitigation measures will include inspection of potential sources, reasonable spacing between manholes to allow access and sampling to track sources, and implementation of emergency response plans by coordinating associated city agencies.

51. Overflows and bypassing of sewage at pump stations may occur during heavy rains or when the WWTP is out of order, which may flood the surrounding area or discharge untreated wastewater into the receiving water bodies. Preventive measures will include (i) installing standby equipment to avoid overflow during major equipment failure and regular maintenance, (ii) using a dual power source to avoid power failure, (iii) implementing a proper maintenance program for major equipment inspection, (iv) enhancing operational monitoring, and (v) good design with provision of overflows to the receiving water bodies that can handle the overflows.

VI. FINANCIAL AND ECONOMIC ASSESSMENT

52. The estimated project cost is $200.6 million, including the ADB loan of $90 million (45% of the total) and counterpart funding of $110.6 million (55%). The breakdown of estimated project cost is shown in Table 5.
Table 5: Cost Estimates

<table>
<thead>
<tr>
<th>Item</th>
<th>Foreign Exchange</th>
<th>Local Currency</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Wastewater Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Huangjiahu</td>
<td>16.7</td>
<td>24.8</td>
<td>41.5</td>
</tr>
<tr>
<td>2. Luobuzui</td>
<td>12.9</td>
<td>18.3</td>
<td>31.2</td>
</tr>
<tr>
<td>3. Sanjintan</td>
<td>37.7</td>
<td>44.3</td>
<td>82.0</td>
</tr>
<tr>
<td><strong>Subtotal (A)</strong></td>
<td><strong>67.3</strong></td>
<td><strong>87.4</strong></td>
<td><strong>154.6</strong></td>
</tr>
<tr>
<td><strong>B. Capacity Building and Administration</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Water Quality Monitoring</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>2. Project Implementation Assistance</td>
<td>2.2</td>
<td>2.2</td>
<td>4.3</td>
</tr>
<tr>
<td>3. Training</td>
<td>1.6</td>
<td>1.6</td>
<td>3.2</td>
</tr>
<tr>
<td>4. Administration (PMU/PIU)</td>
<td>0.1</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Subtotal (B)</strong></td>
<td><strong>4.8</strong></td>
<td><strong>5.4</strong></td>
<td><strong>10.3</strong></td>
</tr>
<tr>
<td><strong>Subtotal Base Costs</strong></td>
<td><strong>72.1</strong></td>
<td><strong>92.8</strong></td>
<td><strong>164.9</strong></td>
</tr>
<tr>
<td><strong>C. Contingencies</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Physical</td>
<td>7.2</td>
<td>9.3</td>
<td>16.5</td>
</tr>
<tr>
<td>2. Price</td>
<td>4.3</td>
<td>5.8</td>
<td>10.0</td>
</tr>
<tr>
<td><strong>Subtotal (C)</strong></td>
<td><strong>11.5</strong></td>
<td><strong>15.1</strong></td>
<td><strong>26.5</strong></td>
</tr>
<tr>
<td><strong>D. Financial Charges</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>90.0</strong></td>
<td><strong>110.6</strong></td>
<td><strong>200.6</strong></td>
</tr>
</tbody>
</table>

PIU = project implementation unit, PMU = project monitoring unit.

53. The economic analysis was undertaken separately for each of the proposed WWTPs. The analysis assesses the need and demand for the Project and alternatives. Economic costs are calculated and compared to identify benefits that can be valued to determine an economic internal rate of return (EIRR). The calculated EIRRs are 16.2% for the Project as a whole, and for the project components 14.5% for Sanjintan, 18.2% for Huangjiahu, and 18.1% for Luobuzui.

54. The unit wastewater treatment cost for the Project is approximately CNY1,630/m³. A total of 16,280 t/year of BOD₅ and 24,380 t/yr of COD₅ will be removed. Unit capital costs for wastewater treatment in the Sanjintan, Huangjiahu, and Luobuzui WWTPs are CNY1,670, 1,660, and 1,490/m³ wastewater, respectively. In accordance with PRC technical and economic guidelines, unit cost is generally CNY1,600-2,500/m³ for wastewater treatment.

55. The benefits of the Project include (i) substantial environmental improvement of rivers and lakes in Wuhan; (ii) improved urban environment and public health; and (iii) increased asset value, which may be reflected in the willingness to pay for the assets, such as rents and tourism income. With improved quality of groundwater and improved water quality for irrigation and fisheries due to quality improvement of surface water, the Project will improve the quality of agricultural and aquatic products, and generate higher rural incomes.
VII. INSTITUTIONAL REQUIREMENTS AND ENVIRONMENTAL MONITORING

A. Institutional Requirements

56. During project preparation and implementation, various organizations with different environmental management responsibilities have been involved, viz., SEPA, the Hubei Provincial Environmental Protection Bureau (HPEB), WPMO, the Wuhan Municipal Environmental Protection Bureau (WMEPB), WMWC, design institutes, and contractors. Table 6 shows the environmental responsibilities of each organization in the various phases.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Responsible Institutions</th>
<th>Environmental Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>SEPA, HPEPB, WPMO</td>
<td>Review and approval of EIA/environmental programs</td>
</tr>
<tr>
<td>Design</td>
<td>Design Institutes</td>
<td>Incorporation of mitigation measures in engineering designs and contracts</td>
</tr>
<tr>
<td>Design</td>
<td>HPEPB, WMEPB</td>
<td>Review and approval of environmental measures</td>
</tr>
<tr>
<td>Tendering</td>
<td>Contractors</td>
<td>Incorporation of environmental management program into the bids</td>
</tr>
<tr>
<td>Construction</td>
<td>WMEPB, Contractors</td>
<td>Implementation of environmental protection measures</td>
</tr>
<tr>
<td>Construction</td>
<td>WMEPB, WMWC</td>
<td>Environmental monitoring and periodical environmental inspection</td>
</tr>
<tr>
<td>Operational</td>
<td>WMEPB, WMWC</td>
<td>Environmental management and monitoring</td>
</tr>
</tbody>
</table>

57. During construction, WMEPB will be responsible for supervising the implementation of environmental management programs and measures. The WMEPB Environmental Monitoring Department will be responsible for environmental monitoring outside the WWTPs during the construction and operational stages, especially for dust and noise monitoring. If complaints are received from the public, monitoring staff will conduct inspections immediately. The WMEPB Environmental Monitoring Department have qualified engineers with monitoring equipment and the technical capability for monitoring the aquatic environment, air environment, physical environment (noise and vibration), sediment, soil and ecology (including solid waste), and traffic conditions. Laboratories of these departments have obtained certificates issued by the Government, to be renewed periodically (usually every 5 years). These certificates assure the accuracy of the analytical results and their legal standing. During operation, specific divisions of WMWC will be responsible for implementing environmental programs and measures, and for routine monitoring of the effluent and environmental quality within the plant.

58. To conduct routine monitoring, environmental monitoring divisions of WMWC will need to acquire necessary staff and monitoring instruments. Staffing and major monitoring equipment requirements are presented in Table 7.

<table>
<thead>
<tr>
<th>WWTP</th>
<th>Staff Size</th>
<th>Major Instruments</th>
<th>Budget (CNY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanjintan</td>
<td>9</td>
<td>Biological microscope, dissolved oxygen meter, quick chemical oxygen demand meter, noise meter, analytical scales, acidity meter, auto time air sampling device, continuous wastewater sampler, atomic absorption spectrophotometer, ultraviolet spectrophotometer, biological culture box</td>
<td>1,200,000</td>
</tr>
<tr>
<td>Huangjiahu</td>
<td>6</td>
<td>Same as above</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Luobuzui</td>
<td>6</td>
<td>Same as above</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td></td>
<td>3,200,000</td>
</tr>
</tbody>
</table>
59. Management and monitoring staff of WMEPB and WMWC will receive adequate domestic and international training in environmental monitoring, results interpretation, mitigation planning, emergency response, environmental policy making, and other environmental management techniques.

B. Environmental Monitoring

60. Table 8 summarizes the environmental monitoring programs to be conducted. Monitoring frequency will not be less than the numbers specified in the table. The WMEPB Environmental Monitoring Department will be responsible for external environmental monitoring during both the construction and operational phases. The WMWC will be responsible for internal environmental monitoring and routine effluent monitoring during the operational phase. The environmental monitoring results in both the construction and operational phases will be submitted to WMEPB, WPMO, and other responsible agencies. WMEPB and WPMO will be responsible for supervising the implementation of monitoring programs and, if necessary, will determine further mitigation measures during the construction and operational stages. Copies of all results will be sent to HPEPB or SEPA, and to ADB. These agencies/institutions will request that appropriate actions be taken for environmental mitigation, as they deem necessary.

<table>
<thead>
<tr>
<th>Table 8: Summary Environmental Monitoring Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Phase</strong></td>
</tr>
<tr>
<td><strong>Air Monitoring</strong></td>
</tr>
<tr>
<td>Locations</td>
</tr>
<tr>
<td>Parameters</td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Length of monitoring</td>
</tr>
<tr>
<td>Sampling hours</td>
</tr>
<tr>
<td>Implementing agency</td>
</tr>
<tr>
<td>Responsible agency</td>
</tr>
<tr>
<td>Review agency</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
</tr>
<tr>
<td>Locations</td>
</tr>
<tr>
<td>Parameters</td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Length of monitoring</td>
</tr>
<tr>
<td>Sampling hours</td>
</tr>
<tr>
<td>Implementing agency</td>
</tr>
<tr>
<td>Responsible agency</td>
</tr>
<tr>
<td>Review agency</td>
</tr>
<tr>
<td><strong>Water Quality Monitoring</strong></td>
</tr>
<tr>
<td>Locations</td>
</tr>
<tr>
<td>Parameters</td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Monitoring agency</td>
</tr>
<tr>
<td>Responsible agency</td>
</tr>
<tr>
<td>Review agency</td>
</tr>
</tbody>
</table>

HPEPB = Hubei Provincial Environmental Protection Bureau, SEPA = State Environmental Protection Administration, WMEPB = Wuhan Provincial Environmental Protection Bureau, WMWC = Wuhan Municipal Wastewater Company, WPMO = Wuhan Project Management Office.
61. In addition, industrial wastewater discharges will be monitored at least two times a year by WMEPB. A comprehensive monitoring program with higher frequency will be considered, especially for larger dischargers and dischargers with highly polluting wastewater.

VIII. PUBLIC PARTICIPATION

A. Public Participation during Project Preparation

62. Direct public involvement has been conducted as an ongoing element in the planned development of the Project. This was carried out by the agencies that prepared the draft EIA and by WPMO. Public consultation is required by PRC national guidelines (“Environmental Impact Assessment Technical Guideline (HJ/T2.1-2.3-93), the State Technical Supervision Bureau, 1993”).

63. For each WWTP, a representative sample of affected persons was selected to include residents of various age, education, occupation, gender, and distance from the construction sites. The persons surveyed were randomly selected. In September to October 2001, a survey collected information on project priority, project effects, attitudes towards the Project, and suggestions. In total 605 questionnaires were distributed, and 554 returned, a 92% return rate. Of the returned questionnaires, 86-97% expressed support for the Project, and 64-79% were willing to accept the project construction impacts. All the persons surveyed confirmed the environmental and social benefits of the Project, and most of them were concerned about noise, foul odor, and traffic impacts. However, over half of the persons surveyed knew little about the construction contents and potential environmental impacts.

64. A special workshop on project construction was held in September 2001; attendees included representatives of the local people’s congress, political consultative committee, and residents. Project priority, various potential impacts, and mitigation measures were discussed in the workshops. All the attendees expressed their support for the Project.

65. Twenty professionals from the environmental protection, landscaping, and municipal sectors, colleges; and hospitals were interviewed during September and October 2001 regarding the WWTPs’ construction. The consultation covered project priority, benefits, effects, feasibility, etc. The interviewed professionals expressed positive attitude towards the above contents, and presented beneficial prevention and mitigation measures for various impacts that may be created by project construction.

B. Future Plans for Public Participation

66. The project monitoring office has developed plans for public involvement during the design, construction, and operational stages. These plans include public participation in (i) monitoring impacts and mitigation measures during the construction and operational stages; (ii) evaluating environmental, economic, and social impacts; and (iii) interviewing public opinion after the Project is completed. These plans include several types of public involvement, e.g., site visits, workshops, investigation of specific issues, and interviews. All of these will be incorporated into the project construction and operation management plan.
IX. CONCLUSIONS

A. Benefits

67. The Project will improve the aquatic environment and local public health of Wuhan. In addition, environmental improvements from the Project will provide opportunities for local economic and social development, provide improved recreation, promote development of the tourism industry, and promote sustainable urban development.

B. Significant Adverse Impacts and Associated Mitigation Measures

68. The Project’s adverse impacts on ecological and physical environment will be minimal, and will be mitigated. The affected persons will be compensated in terms of cash for loss of houses and ancillary buildings, land, livelihood productivity, and land improvements. If required, livelihood restoration and alternative employment will be provided to minimize potential negative impacts. The mitigation measures for social impacts and the aim of the RAP are to ensure that the affected person’s livelihoods are at least maintained after implementation of the Project. The short-term construction impact will be mitigated by appropriate measures. Potential impacts on the social environment, including noise and odor, will be reduced to acceptable levels through engineering and management measures. Implementation of each project component will concur with planned mitigation measures. Therefore, adverse impacts from the Project, including those on the social environment, will be minimal.

69. Through mitigation measures, monitoring, supervision, and reporting plans, the Project will be able to meet environmental protection requirements.

C. Use of Irreplaceable Resources

70. During project construction and operation, relatively small amounts of irreplaceable resources will be used. On the other hand, one of the purposes of the Project is to increase the potential for full utilization of water resources. Wastewater reuse is a post construction issue that will be explored and will bring potential benefits to the project area.

D. Follow-Up Monitoring and Management Requirements

71. A comprehensive monitoring and environmental management program for the pre-construction, construction and operational phases will be developed to ensure that all mitigation requirements and other environmental protection requirements are met.
SUMMARY RESETTLEMENT ACTION PLAN

A. Introduction

1. This document summarizes the complete Resettlement Action Plan (RAP) for the proposed Wuhan Wastewater Management Project to be funded by the Asian Development Bank (ADB). The RAP was prepared in accordance with (i) the People’s Republic of China (PRC), Land Administration Law 1998 and related laws and regulations, and (ii) ADB’s Involuntary Resettlement policy and its requirements as outlined in its *Handbook on Resettlement*.

2. The Project is located in three urban districts of Wuhan Municipality and will finance construction of three wastewater treatment facilities at Sanjintan, Luobuzui, and Huangjiahu. The Sanjintan wastewater treatment plant (WWTP) is located in Zhangjiadun Company, Dongxiihu District, with 61.4 square kilometers (km²) of service area, 824,000 service population, 5 pumping stations, and 32.9 kilometers (km) of sewers (including 5.4 km of open channel rehabilitation). The Luobuzui WWTP is located in Beiyangqiao Village, Heping Township, Hongshan District, with 30.1 km² of service area, 401,000 service population, 4 pumping stations, and 24.2 km of sewers. The Huangjiahu WWTP is located in Shenli Village, Qinglin Township, Hongshan District, with 56.5 km² of service area, 347,000 service population, 4 pumping stations, and 47.9 km of sewers (including rehabilitation of 7.9 km of open channels).

B. Scope of Land Acquisition and Resettlement

3. The Project will affect 3 districts, 4 townships, 3 subdistricts, and 13 administrative villages. According to the detailed surveys, including a follow-up survey undertaken to provide more information on (i) temporary effects, and (ii) socioeconomic conditions and views of affected persons (APs), the Project will permanently acquire 46.9 hectares (ha) of land, including 35.4 ha of vegetable fields, 11.2 ha fish pond, and 0.3 ha housing plots. Most of the permanent land acquisition (97%) will be used for three WWTPs, and the remaining for the pumping stations. In addition, about 107.2 ha of land will be occupied temporarily for sewer construction, comprising 36% vegetable land, 25% fishpond, and the rest dry land or non-agricultural/urban land. Land acquisition and resettlement will directly affect 500 households and 1,919 APs, including permanent losses and temporary losses as shown in Table 1.

<table>
<thead>
<tr>
<th>Project</th>
<th>Permanent</th>
<th>Demolished</th>
<th>Temporary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acquisition</td>
<td>Structures</td>
<td>Land</td>
</tr>
<tr>
<td></td>
<td>(ha)</td>
<td>M²</td>
<td>Acquisition</td>
</tr>
<tr>
<td>WWTPs</td>
<td>45.6</td>
<td>12,937</td>
<td>109/431</td>
</tr>
<tr>
<td>Pumping Stations</td>
<td>1.3</td>
<td>3,535</td>
<td>12/37</td>
</tr>
<tr>
<td>Sewers</td>
<td>0</td>
<td>54,310</td>
<td>0/0</td>
</tr>
<tr>
<td>Total</td>
<td>46.9</td>
<td>70,803</td>
<td>121/468</td>
</tr>
</tbody>
</table>

Notes:

*Data referenced from Wuhan Project Management Office Resettlement Plan, May 2002.

bDenotes households/persons affected by temporary land occupation due to sewer construction.

4. Along with land acquisition, 70,803 m² of structures will be demolished, including 2% frame structures, 77% brick and concrete, 14% brick and wood, and the rest earth wood or simple structures. A total of 321 households and 1,253 APs will be temporarily affected,
including 238 households (888 persons) from rural areas and 83 households (365 persons) from urban areas. Rural households will need only to be relocated within their own villages to the housing plots provided by the villages. Urban households will be assigned new apartments within the same area. A total of 25 enterprises will be affected by the land acquisition and building demolition, and only 3 of them will be relocated within the existing village.

C. Policy Framework and Compensation Standards

5. For people unavoidably affected by the Project, the resettlement objective is to ensure attainment of equal, or better, livelihoods and living standards than without the Project. The executing agency, the Wuhan Project Management Office (WPMO), will ensure that any people losing land, housing, or other assets due to the Project will be assisted to restore their income and living standards. Following consultation with local governments and general practice in Wuhan, a set of generous compensation standards that are near the top of the 1998 Land Law Range was adopted by WPMO. For permanent land acquisition, a total 21 times average annual output value (AAOV) will be provided, with 10 times AAOV for land compensation, 10 times AAOV for resettlement subsidy, and 1 time AAOV for green crop compensation. Based on average yields, the compensation rates will be set at CNY7,560/ha for vegetable land, dry lands, and other non cultivated land; and CNY4,800/ha for fishponds. For temporary land occupation, 2 times AAOV will be provided, with 1 time AAOV for annual loss and 1 time AAOV for restoring land to original conditions. For lost structures, replacement value will be provided, with CNY1,400/m² for frame structures, CNY900/m² for brick and concrete, CNY600/m² for brick and wood, and CNY400/m² for earth and wood structures. In addition, relocated households will be provided with transfer assistance, including moving allowance, early moving bonus, etc.

D. Rehabilitation Approach and Measures

6. To avoid land acquisition in the most densely populated areas, efforts were made in close consultation with local officials and village committees during the feasibility studies to minimize the resettlement impacts. For APs, the resettlement strategy encompasses the replacement of housing, infrastructure, and income. People losing housing will receive direct compensation based on the replacement value of their lost structures. Due to limited land acquisition, most of these people will be resettled within their own villages, provided with new housing sites free of charge, and connected with essential infrastructure (e.g., water, sewer, road, gas, and electricity). Relocated urban households will be given cash compensation that is sufficient to purchase a replacement apartment in the project area. Affected enterprises will be provided with cash compensation covering lost structures, lost wages, lost profit, and an alternative site for reconstruction.

7. Those affected by permanent land acquisition, who are primarily concentrated at the WWTP site, will receive compensation. Two approaches for economic rehabilitation will be taken based on different village conditions. For Sanjintan, since the affected Zhangjiadun Company will have sufficient farmland left after land acquisition, land redistribution will be carried out to ensure that each individual still has 0.09 ha farmland after land acquisition. In addition, the resettlement subsidy will be distributed equally among all members in the company, and land compensation will be used to improve farm conditions and create nonfarm opportunities for the APs. For the other two affected villages, land redistribution after land acquisition will be difficult due to limited landholdings. Following consultation with affected villages and local government, a full resettlement subsidy equal to 10 times AAOV will be provided to those APs for expanding nonfarm activities. According to the socioeconomic survey, most of the affected villagers are currently engaging in various nonfarm activities, with farming
income accounting less than 20% of their total income. In addition, the affected villages will use
70% of the land compensation (10 times AAOV) to develop a range of employment
opportunities, such as small shops and gas stations, to set up village enterprises, which will
provide about 240 employment opportunities for APs. To facilitate the process, WPMO has
committed to provide up to 77 employment opportunities in these WWTPs. In addition, some
APs will also benefit from temporary employment during project construction, and there are
provisions to pay the resettlement subsidy directly to APs opting for self-employment where
workers obtain enterprise jobs, rather than to the village committee.

E. Institutional Arrangements

8. The Wuhan Municipal Government will assume full responsibility for implementing
resettlement according to the approved RP. Within WPMO under the Wuhan Municipal
Wastewater Company, a project resettlement office (PRO) with 7-8 full-time staff will be set up
to be responsible for coordinating resettlement planning and supervising implementation of the
Project. The PRO will be responsible for monitoring and supervision, coordinating impact
survey, carrying out consultation, contracting with an independent monitor, allocating
resettlement funds, and inspecting the utilization of funds by local government. The township
resettlement officers, together with affected village officials, are responsible for the payment of
entitlements, the selection of new housing sites, the redistribution of remaining farmland, the
development of economic rehabilitation measures, and the provision of livelihood support. Land
compensation will be paid directly to the affected villages, while resettlement subsidy
compensations for housing and young crops will be paid directly to the APs.

F. Vulnerable Groups

9. A sample socioeconomic survey identified vulnerable households, including welfare
households, households headed by women, and households headed by people with disabilities.
From the survey of 272 households, 3 vulnerable households of 5 persons were identified,
accounting for 1.2% of the surveyed population. Any vulnerable households identified during
resettlement implementation will receive CNY5,000 additional financial assistance besides the
provided resettlement compensation. In addition, they will also receive assistance for house
construction and relocation during resettlement implementation. Special measures are also
provided to support creation of new small enterprises by women from affected households.

G. Consultation, Disclosure, and Grievance Redress

10. The PRC 1998 Land Administration Law provides for disclosure to and consultation with
APs. A series of consultation meetings were carried out during the RAP preparation at which
APs were consulted about the key elements of the RAP and rehabilitation measures. Additional
consultations will be made during resettlement implementation to ensure that suitable relocation
sites and proper rehabilitation activities are selected. At least 3 months prior to land acquisition
and relocation, the approved RP will be disclosed to all affected villages and individuals.
Specifically, upon State Development and Planning Comission approval of the Project and prior
to project negotiation, copies of the RP will be placed in the affected village offices and at
WPMO for people to review. A resettlement information booklet including key resettlement
policies and grievance procedures was distributed to all affected townships and villages in May
2002. The PRO will be responsible for receiving the comments of APs and addressing their
concerns.
11. The RP includes grievance redress arrangements. In the case of grievance, AP submits an oral or written complaint first to the village committee. If the complaint cannot be settled within 2 weeks, then the AP can go to the township government for redress. If still unresolved within another 2 weeks, the PRO or Wuhan Municipal Land Administration Bureau will try to achieve a solution directly within 3 weeks. The final redress could be sought in the civil courts in accordance with the PRC Civil Procedure Act, within 15 days from receiving the PRO decision.

H. Monitoring and Evaluation

12. A systematic procedure for internal supervision, reporting, and evaluation of key resettlement activities will be developed. The system will comprise regular reporting from the resettlement staff at the township to the PRO. Monitoring and evaluation include APs feedback, including external monitor access to grievance redress records. A qualified institution will be employed to carry out independent resettlement monitoring and evaluation for the Project. The selected institution, the qualifications of which will be reviewed and confirmed, will conduct an undated baseline survey, carry out semiannual inspections and survey updates during the period of resettlement implementation, prepare reports, and evaluate the resettlement results 2 years after completion. The PRO will report to ADB on progress in land acquisition and resettlement through quarterly progress reports. The independent resettlement monitoring and evaluation reports prepared by the selected institution will also be submitted to ADB by WPMO every 6 months during project implementation.

I. Finance and Implementation Schedule

13. The total cost of land acquisition and resettlement, including contingencies, is estimated at CNY244.1 million ($29.3 million equivalent). This includes the cost of asset compensation, other assistance, income restoration, land occupation taxes, temporary land disturbance, and resettlement supervision, management, monitoring, and evaluation. Annual adjustment in the cost estimates, including compensation rates, will be made based on the inflation rate for the previous year. The land acquisition and resettlement cost are included in the Project cost estimates. The Project will be implemented between 2003 and 2007. Land acquisition and resettlement activities will need to be complete prior to the end of 2004 for the construction of wastewater collection and treatment facilities. Three months prior to the construction, the APs will be officially informed of the effects on them and compensation entitlements; the compensation agreement will be signed between WPMO and the affected villages and individuals; and compensation funds will be paid to the affected villages, enterprises, and individuals. The new housing construction, the acquisition and handover of land for construction purposes, and the demolition and ground leveling will proceed sequentially in sections, and will precede the commencement of construction work involving acquisition. Supervision, auditing, monitoring, and evaluation will be continuous throughout the Project.

14. The source of funding for resettlement will be $29.3 million, with WMG to make up any shortfalls as agreed in loan assurances. Section 10 of the RAP provides detailed flow of funds information.