SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

JILIN WATER SUPPLY AND

SEWERAGE DEVELOPMENT PROJECT

IN THE

PEOPLE'S REPUBLIC OF CHINA

December 2004

CURRENCY EQUIVALENTS
(as of 01 December 2004)

Currency Unit	–	yuan (CNY)
CNY1.00	=	$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

ADB	–	Asian Development Bank
BAF	–	biological aerated filter
BOD_5	–	5-day biochemical oxygen demand
COD_{Cr}	–	chemical oxygen demand using the dichromate reflux method
DO	–	dissolved oxygen
EIA	–	environmental impact assessment
EIRR	–	economic internal rate of return
EMP	–	environmental management plan
GDP	–	gross domestic product
H_2S	–	hydrogen sulfide
IA	–	Implementing Agency
JPG	–	Jilin Provincial Government
MSBR	–	modified sequential bio-reactor
NH_3	–	Ammonia
NH_3-N	–	ammonia nitrogen
NO_x	–	nitrogen oxides
PME	–	powered mechanical equipment
PMO	–	project management office
RP	–	resettlement plan
SEIA	–	summary environmental impact assessment
SIA	–	social impact assessment
SO_2	–	sulfur dioxide
SR	–	sensitive receiver
SRB	–	Songhua River Basin
SS	–	suspended solids
TP	–	total phosphorus
TSP	–	total suspended particulates
WTW	–	water treatment works
WWTW	–	wastewater treatment works

NOTE

In this report, "$" refers to US dollars.

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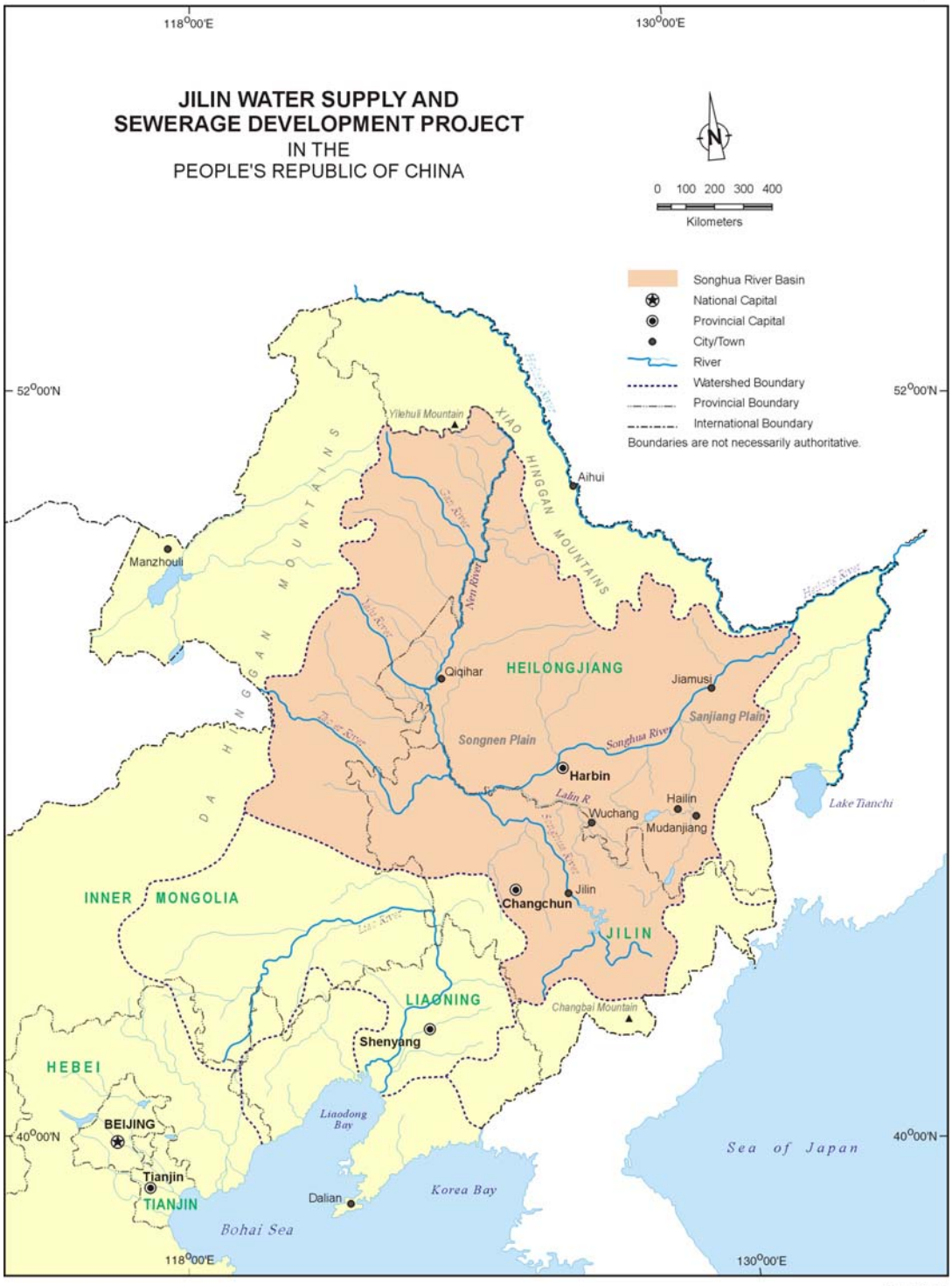
Map 1


JILIN WATER SUPPLY AND
SEWERAGE DEVELOPMENT PROJECT
IN THE
PEOPLE'S REPUBLIC OF CHINA
118°00'E
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0 100 200 300 400
Kilometers
Songhua River Basin
National Capital
Provincial Capital
City/Town
River
Watershed Boundary
Provincial Boundary
International Boundary
Boundaries are not necessarily authoritative.
Yilehuli Mountain
XIAO HINGGAN MOUNTAINS
Aihui
Manzhouli
DA HINGGAN MOUNTAINS
Nen River
Qiqihar
HEILONGJIANG
Jiamusi
Songnen Plain
Sanjiang Plain
Songhua River
Harbin
Lalin R.
Hailin
Wuchang
Mudanjiang
Lake Tianchi
INNER MONGOLIA
Changchun
Jilin
JILIN
LIAONING
Changbai Mountain
Shenyang
HEBEI
Liaodong Bay
BEIJING
Tianjin
TIANJIN
Dalian
Korea Bay
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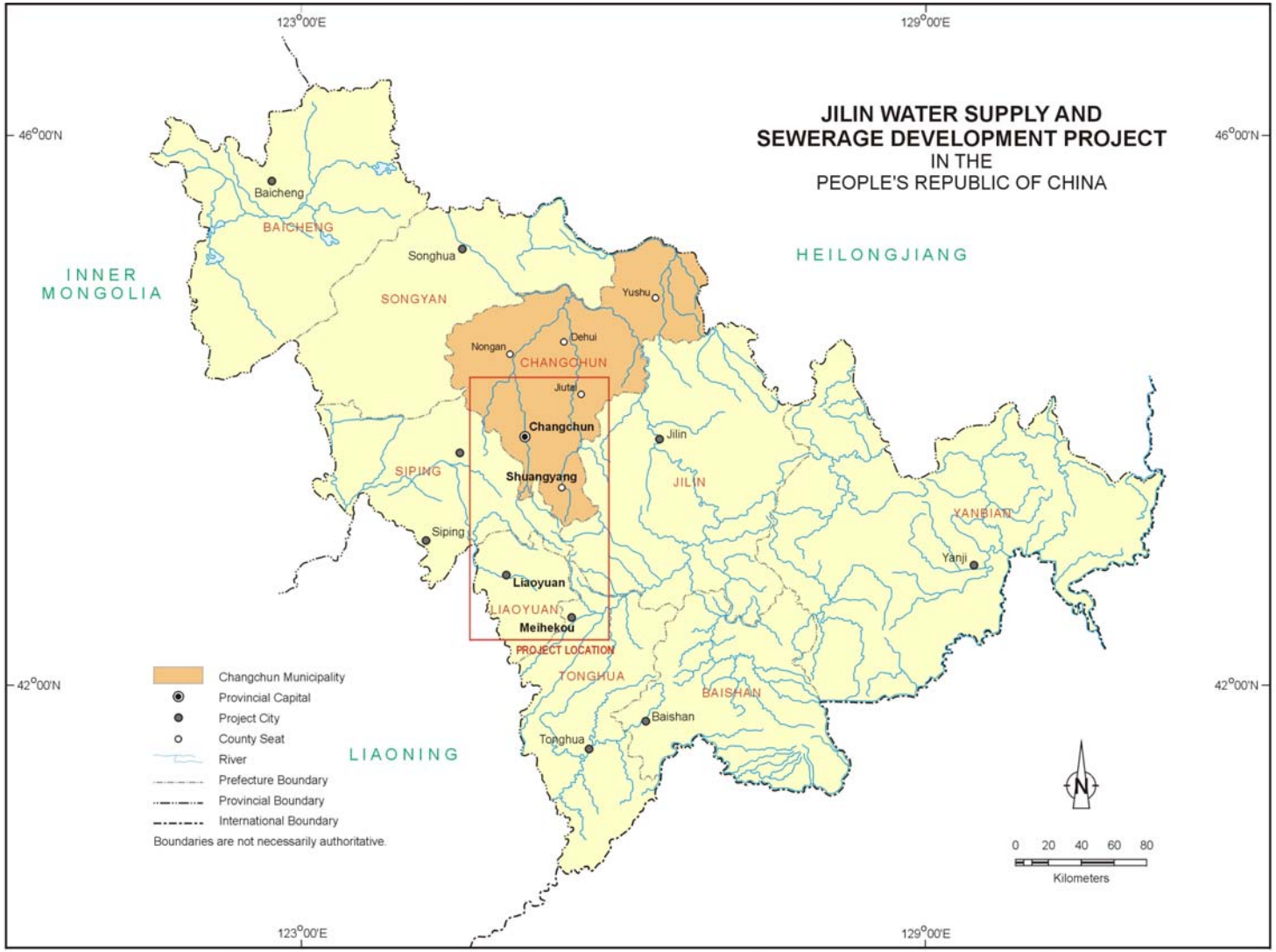
JILIN WATER SUPPLY AND SEWERAGE DEVELOPMENT PROJECT
IN THE
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123°00'E
129°00'E
46°00'N
42°00'N
INNER MONGOLIA
HEILONGJIANG
LIAONING
BAICHENG
SONGYAN
CHANGCHUN
JILIN
SIPING
LIAOYUAN
TONGHUA
BAISHAN
YANBIAN
Baicheng
Songhua
Yushu
Nongan
Dehui
Jiutai
Changchun
Jilin
Shuangyang
Siping
Liaoyuan
Meihekou
Yanji
Tonghua
Baishan
PROJECT LOCATION
Changchun Municipality
Provincial Capital
Project City
County Seat
River
Prefecture Boundary
Provincial Boundary
International Boundary
Boundaries are not necessarily authoritative.
N
0 20 40 60 80
Kilometers
04-47786 HR
Map 2

I. INTRODUCTION

1. This summary environmental impact assessment (SEIA) was prepared for the Jilin Water Supply and Sewerage Development Project, in the People's Republic of China (PRC), under technical assistance (TA)[1] from the Asian Development Bank (ADB). The full environmental impact assessment (EIA) reports were prepared by the Northeast Municipal Engineering Design and Research Institute of China, the Songliao Institute of Water Environmental Science, and the Jilin Environmental Protection Research Institute. The Project involves three cities in Jilin Province; Changchun, Liaoyuan, and Meihekou, located in the upper Songhua River Basin (SRB).

2. The SRB is the third largest river basin in the PRC after those of the Changjiang and Yellow Rivers. Located in Jilin and Heilongjiang provinces and in the Autonomous Region of Inner Mongolia, the SRB has a catchment area of 557,000 square kilometers ($km^{2)}$ with a population of 62 million. The Songhua River, one of the most polluted of the PRC's 47 major rivers, is contaminated with a number of organic chemicals, heavy metals, and conventional pollutants. Water pollution has been identified as a major constraint to the sustainable development of the PRC's economy. To help address the pollution of the SRB, ADB provided the Songhua River Basin Water Quality and Pollution Control Management TA.[2] The TA will (i) address technical knowledge gaps; (ii) strengthen the capacity of the Water Resources Protection Bureau; and (iii) help the Government develop a long-term water pollution control plan for the SRB beyond 2010. The Project would be the first major ADB investment directly contributing to the cleanup of the SRB.

3. Changchun city is located in the upper reaches of the SRB, between the provinces of Heilongjiang and Liaoning in northeastern part of the PRC. The rivers in Changchun (Yitong and Yongchun rivers), which flow into the Songhua River, are highly polluted due to inadequate treatment of wastewater discharge. Jilin Province, therefore, has a critical role to play in wastewater management upstream of the SRB. The current water quality in the Yitong and Yongchun rivers do not meet class V of the national water quality standards,[3] which has caused severe pollution of the Songhua River, and poses a threat to public health of the urban population and downstream users. Changchun has inadequate water supply and wastewater treatment. Water shortage is expected to reach 360,000 cubic meters (m^3)/day by 2010 and water rationing is being implemented occasionally. Changchun's current wastewater treatment capacity of 565,000 m^3/day is inadequate and has already resulted in heavy pollution of the Yitong and Yongchun rivers. To meet future demands, this capacity needs to be increased to 803,000 m^3/day by 2010 and 1,700,000 m^3/day by 2020.

4. The Government recognizes that adequate environmental protection and pollution controls are required for sustainable economic growth. The sewer network and wastewater treatment capacity in Changchun must be expanded to improve water quality in the Yitong and Yongchun rivers. State guidelines require that major cities have a wastewater treatment rate of 70% by 2010.[4] Through the proposed Project, the discharge of untreated wastewater in the

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[1] ADB. 2003. *Technical Assistance to the People's Republic of China for Preparing the Jilin Water Supply and Sewerage Development Project.* Manila.

[2] ADB. 2002. *Technical Assistance to the People's Republic of China for Songhua River Water Quality and Pollution Control Management.* Manila.

[3] The PRC water quality standards have five levels of quality where level I is pristine and level V is very polluted. level III is considered the lowest level suitable as a raw water source for municipal systems.

[4] China State Department Notice 2000 (36) requires at least 60% by 2005 and 70% by 2010 for all major cities.

upstream of the SRB will be significantly reduced. The Project will also contribute to the goal of the Changchun Municipal Government of achieving a wastewater treatment rate of 70% by 2010. The rationale of the proposed Project is consistent with the ADB Water Policy, which aims to foster integrated management of water resources from a river basin perspective.

5. The Project represents the first major step in meeting the environmental goals set by the cities of Changchun, Meihekou and Liaoyuan for their 2020 planning horizon. The components include wastewater treatment with effluent reuse, drainage and sewerage networks, water supply and distribution networks, and flood mitigation.

6. This SEIA is based on information from seven EIA reports (five for the Changchun component and one each for the Liaoyuan and Meihekou components). Three institutes were involved in preparing these seven EIA reports (para. 1). The reports have been submitted to the provincial Environmental Protection Bureau for approval. The SEIA will be appropriately updated should the Government's review of the Project EIAs identify further issues to be addressed. The detailed environmental management plan (EMP) to be prepared under project implementation will follow ADB requirements.

7. The SEIA concludes that the Project will have substantial positive environmental benfits. The adverse impacts on the physical and natural environment during both construction and operational stages of the Project will be largely insignificant with the implementation of the recommended mitigation measures. The most serious impact will be the need to resettle people affected; this is addressed by the resettlement plan (RP) prepared in accordance with ADB's policy on involuntary resettlement.

II. DESCRIPTION OF THE PROJECT

8. The project objectives are to enhance the urban environment and public health through better wastewater management and increased supply of high-quality water, and to improve the quality of surface- and groundwater resources in and downstream of the project cities. Related objectives include (i) contributing to reducing the discharge of untreated wastewater upstream of the SRB, and achieving the goal of 70% wastewater treatment rate by 2010; (ii) addressing water shortage through effluent reuse; (iii) controlling floods; (iv) increasing water supply reliability and meeting water demand through 2010; (v) establishing water supply companies, and making them efficient and commercially managed; (vi) supporting integrated approaches to basin-wide pollution prevention and control; and (vii) improving cost recovery from users through an improved tariff structure, with gradual increases to achieve full cost recovery.

9. The Project will benefit more than 4 million urban residents. The Changchun subcomponents include (i) upgrading the existing Beijiao primary wastewater treatment works (WWTW) to secondary treatment with a capacity of 130,000 m^3/day including recycling 100,000 m^3/day of treated wastewater; (ii) constructing sewerage pipelines of 216 km, three pumping stations and six maintenance and management stations to improve the sewerage network of the Beijiao WWTW; (iii) constructing a 150,000 m^3/day WWTW including 50,000 m^3/day tertiary treatment to recycle the treated wastewater; (iv) improving the drainage and preventing flooding to the Changchun National Hi-Tech Industries Development Zone by widening 4.8 km of the Yongchun River together with improvements to the dam and spillway of the Sanjia Reservoir on the river, and constructing 7 new box culverts; and (v) constructing a water treatment work (WTW) with a capacity of 36,000 m^3/day in the Shuanyang District, with a related water pumping station to extract surface water from the Shuanyang Reservoir, and two 2.4 km of pipelines to convey treated water from the WTW to the district's distribution network.

10. The Liaoyuan subcomponents include (i) upgrading the existing Longshan and Hebing WTWs to enable full utilization of their design capacity of 30,000 m^3/day and 80,000 m^3/day, respectively; (ii) improving the water distribution network by constructing 17 booster pumping stations, rehabilitating 2.0 km of existing water supply networks and laying 53.1 km of new water supply pipelines; (iii) upgrading the drainage-sewerage network to separate the drainage and sewerage systems, including constructing 12 km of sewerage pipelines and three wastewater pumping stations; and (iv) constructing 4.0 km of storm-water open channels and 4.3 km of box culverts to collect mountain terrain runoff for flood mitigation.

11. The Meihekou subcomponents include (i) constructing a WTW with a capacity of 100,000 m^3/day; (ii) constructing a 40 km raw-water transmission pipeline to convey surface water from the Hailong Reservoir to the WTW; and (iii) upgrading 55.5 km of existing water distribution network.

III. DESCRIPTION OF THE ENVIRONMENT

12. The project area is in south-central Jilin Province encompassing the cities of Changchun, Liaoyuan, and Meihekou. Changchun is the provincial capital with an area of 20,220 km^2 and an urban and rural population of 7.31 million. The Changchun Municipal Government administers an area of 3,563 km^2 with an urban population of 2.98 million. Liaoyuan is 120 km south of Changchun with a population of 1.28 million and covering an area of 5,140 km^2. Meihekou, with a population of 0.62 million, is 160 km to the south-southeast of Changchun and covers an area of 2,175 km^2 (see Map).

13. Two of the Changchun subcomponents are in the Changchun National High-Tech Industries Development Zone and the Shuanyang District respectively. The Changchun National High-Tech Industries Development Zone commenced development in 1988, covers an area of 49 km^2, and houses more than 1,750 enterprises. Shuanyang, with a population of 85,000, is a district under Changchun Municipal Government administration and covers an area of 10 km^2.

A. Topography and Geology

14. The project area lies in a transitional zone between the Changbaishan mountain ranges to the east and the Songliao plains to the west. The terrain is characterized by gently sloping hilly plains going east to west. Typical topographic features include low hills and valleys, mesa plains, alluvial plains, and volcanic cones.

15. The underlying geology is characterized by alluvial structure over a granite layer. The geological formation becomes increasingly complicated toward the south, and the southern part of the project area lies within the transitional zone between the East and West Structural System.

B. Climate and Rainfall

16. The project area is in the northern temperate continental climate zone. Seasonal changes are distinct: the long winter is cold and dry, the short summer is hot and rainy, spring is dry and windy, and fall is cool. The annual average temperature is about 4.3 to 4.9^oC. January

is the coldest month: average temperature is –16.9 to –18.9°C; the minimum is –40.7°C. July is the hottest month: average temperature of 22.4 to 22.7°C; the maximum is 38°C.

17. The average humidity is 65%, with annual average rainfall of 572 to 708 millimeters (mm), mainly in July and August. These two months usually account for over half of the annual rainfall. In winter, snow can accumulate to 30 cm with ground frozen to a depth of 1.7 meters (m).

18. The prevailing wind is from the southwest, with a frequency of 24.5% to 32%. This is followed by winds from the south, with a frequency of 9.4%. Windless conditions occur at a frequency of 9.8%. The annual average wind speed is 3.7 meters per second (m/s).

19. Recent ambient air quality monitoring indicates that the air quality in the project area can be characterized as class II. Air quality is classified into five classes in the PRC; class V represents the poorest air quality. Total suspended particulates (TSP) are the major air pollutant, particularly in Changchun where the TSP background levels are approaching the class II limit.

C. Hydrology

20. The project area is in the SRB, with part of Liaoyuan in the Liao River Basin as well. In the northern part of the project area, three rivers pass through Changchun. The Yongchun River flows into the Xinkai River, which flows into the Yitong River. The Yongchun River is usually dry during the dry season. It receives wastewater from the Changchun National High-Tech Industries Development Zone. The Xinkai River is one of the larger tributaries of the Yitong River. It is 127 km long with a catchment of 2,419 km^2. The Yitong River is 382.5 km long with a catchment area of 8,714 km^2. It belongs to the Yinma River system and is a secondary tributary of the Songhua River. The Changchun section of the Yitong River is approximately 5–30 m wide, with an annual average flow of 3.63 m^3/s.

21. The Dongliao River, which flows through Liaoyuan in the southern part of the project area, is one of the large tributaries of the Liao River system. It supplies water to Liaoyuan and receives wastewater from Liaoyuan. The annual average flow is approximately 4.98 m^3/s.

22. Huifa River of the Songhua River system is the main river flowing through Meihekou. It is approximately 784 km long with a catchment of 2,175 km^2. Its annual average flow is 1.29 m^3/s. However, because Hailong Reservoir controls the flow upstream of Meihekou, the flow through the city only averages 0.5–0.8 m^3/s. Hailong Reservoir will become the source water for Meihekou after the Project is implemented.

23. Groundwater resources in the project area are mostly contained in the Quaternary Fluvial Valley Aquifer. In the Changchun area, this layer is approximately 3 m underground with a thickness of approximately 10–20 m, and is in an equilibrium state between extraction and replenishment in recent years. In the southern part of the project area, the depth (5–20 m below ground) and thickness (4–16 m) of this aquifer layer vary considerably due to extraction for potable, industrial, and irrigation water use.

D. Ecological Resources

24. In the northern project area, Changchun is rich in secondary forest resources. Forest coverage is approximately 14.4%. Major species include *Pinus tabuliformis mukdensis*, *Populus pseudosimonii,* and *Cinnamomum camphora*. In urban Changchun, most vegetation is planted, which includes protective woodland consisting of coniferous and broad leaf trees. Another vegetation type is the landscaped woodland consisting of trees, shrubs, and herbaceous plants. The third type is agricultural land dominated by dry farming of vegetables.

25. Due to human disturbance, farmland inhabitants and grassland inhabitants typify wildlife in Changchun. Common farmland avifauna include sparrow, sand martin, red-rumped swallow, magpie, and crow. Common farmland mammals include various species of mice such as *Cricetulus barabensis*, *Mcromys minutus*, and *Apodemus agrarius*. Common species that inhabit grassland and riparian habitats include different species of frogs and toads such as *Rana temporaria* and *R. nigromacula*.

26. Aquatic life in Changchun includes plankton and annelids. Phytoplankton includes blue algae, green algae, dinoflagellates, and diatoms. Because Yitong River is seriously polluted, biodiversity in the river is low and fish species are rarely found.

27. In the southern project area (Liaoyuan and Meihekou), forest resources are either natural secondary forests or farmed forests. Major species include broad-leaf woodland forms such as *Quercus mongolica* and *Juglans madshurica*. Understory shrubs and herbaceous plants are also abundant, plus a few *Pinus sylvestris*, *mongolica*, *Larix gmelinii,* and fir. Wild plants include fern and evening primrose, some of which are edible and have medicinal value.

28. Human activities have disturbed the wildlife in the southern part of the project area. Large wildlife no longer inhabits this area. Only a few Roe deer can still be found occasionally in woodlands far away from human habitation. Common wildlife includes Manchurian hare, squirrel, yellow-throated marten, Himalayan weasel, mountain weasel, badger, fox, raccoon dog, muskrat, and pheasant. The avifauna composition is similar to that in the northern project area. No threatened or endangered species has been recorded in the project sites.

E. Water Quality and Pollution

29. The Yitong River receives Changchun's domestic and industrial wastewater. The water quality of the section of the Yitong River downstream of Changchun is characterized as class V, based on water quality monitoring data for this project. Major pollutants are chemical oxygen demand (COD), biochemical oxygen demand (BOD), ammonia nitrogen (NH_3-N), and petroleum hydrocarbon.

30. The Dongliao River supplies water to and also receives wastewater from Liaoyuan. Assessments of water quality monitoring data at the WTW intake locations against the Water Quality Standards for Drinking Water Sources [CJ3020-1993] indicate that most parameters would meet class I standards except turbidity, phenols, surfactants, and oxygen demand; particularly turbidity during the rainy season. To use the Dongliao River water for potable water supply, protection of the section of the river upstream of the WTWs as a potable water source and suitable treatment processes at the WTWs are necessary. Assessments of water quality monitoring data downstream of Liaoyuan's WWTW discharge point against the Surface Water

Quality Standards [GB3838-2002] show that the water quality no longer meets class IV standards. Major pollutants are COD, BOD, suspended solids (SS) and NH_3-N.

31. The Huifa River, which belongs to the Songhua River system, receives wastewater from Meihekou. Assessments of water quality monitoring data against the Surface Water Quality Standards [GB3838-2002] show that the water quality no longer meets class IV standards. The major pollutant is SS, and occasionally NH_3-N.

32. The Hailong Reservoir will become the source of potable water to Meihekou from the Project. Presently it is not used as a potable water source and commercial activities occur in and around the reservoir, including restaurants, a deer farm, water recreational activities, and aquaculture. Assessments of water quality monitoring data from Hailong Reservoir against the Water Quality Standards for Drinking Water Sources [CJ3020-1993] show that the water quality no longer satisfies class II standards for drinking water due to high levels of SS, COD, iron, and BOD. Protection of Hailong Reservoir as a potable water source and installation of suitable treatment processes at the WTW are necessary and will follow the PRC regulations for protecting water quality of drinking water sources.

F. Social and Economic Conditions

1. Changchun

33. Changchun, the capital of Jilin Province, administers six districts, three towns, and one county. It has a population of 7.31 million, of which approximately 50% is urban and 50% is rural. It is an important industrial as well as agricultural city in the northeastern region of the PRC. Key industries include automobile manufacturing, food processing, electronics, and pharmaceuticals. These four key sectors accounted for a gross value of CNY135.5 billion in 2003, which was approximately 90% of the total gross industrial value of Changchun. Key agricultural products are food crops such as corn, rice, beans, barley, wheat, and sorghum, which accounted for 6.7 million tons in 2003. The total value of all agricultural products was approximately CNY26 billion, with approximately 54% from livestock farming.

34. Changchun has been experiencing fast economic growth in recent years. In 2003, the gross domestic product (GDP) was CNY133.8 billion representing a 14.2% increase from 2002. Of the total GDP, 12% was from the primary sectors (agriculture, mining), 47% from the secondary sectors (manufacturing, heavy industries), and 41% from the tertiary sectors (service and small industries).

35. Changchun is a major transportation hub in the northeastern region of the PRC, with roads, railways, and airline services to other cities within and outside the province. The highways in the city totaled 1,255 km by the end of 2003. Of the total goods throughput of 36.45 billion ton-km in 2003, 91% was by rail, 9% by roads, and a minute percentage by air. Of the 2003 total passenger throughput of 12.2 billion person-km, 66% was by railway, 20% by road, and 14% by air. The passenger throughput by air grew almost 11% compared with the year before.

36. Community services in Changchun are also growing. In 2003, the urban area had 1,554 health and medical institutions and 35,000 people in the medical profession. Of the institutions, 298 were hospitals with 23,000 beds. The rural area had 1,982 medical clinics, with 4,243 medical practitioners. Private medical clinics totaled 2,965. There were 2.12 licensed medical

professionals per 1,000 population. In recent years, community health services have been growing, with the establishment of 140 community health services centers.

37. In 2003, Changchun had 1,814 primary schools with 515,000 students and 389 secondary schools with 442,000 students. Higher education consisted of 28 tertiary institutions and universities, 10 tertiary schools for adults, and 52 technical institutes, with a combined population of 13,570 teachers and over 300,000 students.

2. Liaoyuan

38. Liaoyuan administers two districts and two counties. It has a population of 1.28 million. The 2002 GDP was CNY 7.022 billion, representing a growth of 10.62% over 2001. The 2002 GDP per capita was CNY5,672, which was about 30% of that of Changchun. The mining of coal has been an important industry in Liaoyuan, but recently the city has diversified into light industries for clothing, machinery, pharmaceuticals, petrochemicals, construction materials, electronics, food processing, and metallurgical business. Liaoyuan is known for production of corn, rice, and soybean. Deer farming is also important.

39. Liaoyuan has 88 medical and health organizations, including 71 hospitals with 4,287 beds, and approximately 5,400 medical practitioners. The two tertiary institutions, four technical institutes, 83 secondary schools, and 522 primary schools have a student population of approximately 166,500.

3. Meihekou

40. Meihekou administers two counties and two districts. It has a population of approximately 620,000, with 36% urban and 64% rural. Agricultural land accounts for 40% of the area, producing rice, corn, soybean, sorghum, barley, wheat, buckwheat, peanut, sesame seed, and sunflower seed. The per capita GDP was approximately CNY 5,500 for the urban population but only CNY2,655 for the farmers. Historically, Meihekou has been an important trading center in the northeastern region of the PRC for commercial products, particularly markets for trading rice and nuts. The nuts market is the biggest in Asia. The city has seven class II trading stations, where the buying, selling, and transporting of merchandize among a dozen nearby towns and counties take place. Industries in Meihekou include coal mining, paper manufacturing, food processing, petrochemical, pharmaceutical, metallurgical, and the processing of secondary farm products.

41. Meihekou has 67 medical and health organizations, with 1,008 hospitals, and a population of approximately 20,000 medical professionals. There are one tertiary institution, five technical institutes, and 359 primary and secondary schools.

IV. ALTERNATIVES

A. With Project and Without Project Alternatives

42. The Project will secure clean and reliable drinking water for the people of Changchun, Liaoyuan, and Mehekou. Without the Project, these people will continue to suffer from water shortages and increasing rationing.

43. The Project will secure drinking water from rivers and reservoirs, instead of from groundwater that has already been overexploited and reached unsustainable levels. The Project will allow the groundwater aquifiers the much-needed time to recharge. Without the Project, overextraction of groundwater will continue and the problem of land subsidence will become more serious.

44. The Project improves wastewater treatment and provides effluent reuse by industries. As a result, the amount of pollutants (COD, BOD, SS, NH_3-N, and total phosphorus [TP]) entering the Songhua River system will be reduced, benefiting the people living in the SRB. Without the Project, large amounts of wastewater will be continuously discharged into the Changchun inland rivers, which flow into the SRB, resulting in continued severe pollution of the SRB.

45. This Project provides drainage systems for flood mitigation. Without the Project, flooding and water-logging will continue during the storm season due to extremely poor flood control and drainage capabilities, causing public health problems and economic losses.

B. Alternative Drinking Water Sources

46. Various water sources such as groundwater, rivers, and reservoirs have been considered from the water quality, engineering, and socioeconomic aspects. Bottled water has also been considered. Groundwater has already been overextracted and therefore was ruled out as a viable water source. Bottled water was ruled out based on its high costs. The Shuanyang Reservoir, the Dongliao River, and the Hailong Reservoir have been selected to be the water supply sources for Shuangyuan, Liaoyuan, and Meihekou based on technical, environmental, least resettlement impact, and least-cost considerations.

C. Alternative Treatment Plant Sites

47. Alternative sites for the new WTWs in Shuanyang and Meihekou have been considered. In Shuanyang, a site close to the water source (Shuanyang Reservoir) was selected over an agricultural site closer to the urban area. The selection was based on the ease of operation and maintenance considerations due to its proximity to the intake pumping station, availability of access road, and close proximity to a power supply. The selected site also has lower land compensation cost and fewer resettlement impacts.

48. In Meihekou, the water source (Hailong Reservoir) is approximately 40 km from the urban area. The options of siting the WTW near the water source and near the urban area were evaluated. Siting the WTW near the water source would require conveying treated water for 40 km to the urban area for distribution, along which the water quality could deteriorate. Siting the WTW near the urban area would require conveying raw water for 40 km to the WTW, but the treated water is much nearer to the distribution network. The latter option of siting the WTW closer to the users was selected.

D. Water Transmission Options

49. Various water transmission options have been evaluated. These include the sizes of pipes and the piping materials. For Shuanyang, twin pressure mains instead of a single main with larger diameter are adopted to enhance the reliability of water supply and ease of

maintenance. For Meihekou, three raw water transmission options (from Hailong Reservoir to WTW, a distance of 40 km) were evaluated: pipeline, combination of pipes and open channels, and river channel. The pipeline option was selected for reasons of feasibility, environmental impact, cost, maintenance, and operation reliability and costs.

50. The technical and cost aspects of various piping materials including ductile iron pipes, precast concrete pipes, glass-reinforced plastic pipes, and steel pipes were evaluated. Glass-reinforced plastic pipes have been chosen due to their light weight, long lifespan, high corrosion resistance, convenience for construction, and good hydraulic performance.

E. Water Treatment Options

1. New WTWs in Shuanyang and Meihekou

51. Different options of treatment processes for coagulation, flocculation, sedimentation, and filtration were identified and evaluated for the new Shuanyang and Meihekou WTWs from the water supply quality, technical, operation, maintenance, and cost aspects.

52. For coagulation and flocculation, a number of static, mechanical, and hydraulic-mixing technologies were evaluated. The inline static mixer and the grid-type flocculation tank have been chosen for the Shuanyang WTW. The inline static mixer is suitable for use in water treatment with relatively small flow fluctuation, and has the advantage of low capital cost, easy installation, a low space requirement, and good mixing performance. The grid-type flocculation tank has good performance in treating the low temperature and low turbidity raw water in the northeastern region of the PRC. For the Meihekou WTW, high efficiency turbulent mixing was selected, which would provide a high velocity gradient that greatly increases the treatment capacity and reduces the chemical dosage, as well as have a stable flocculation performance under a wide range of flow and raw water quality conditions.

53. The rectangular tank, tubes settler, lamella plate settler, and high efficiency tilted plate clarifier were evaluated for sedimentation. An inclined tube sedimentation tank was adopted for the Shuanyang WTW, which has the advantage of simple construction, a short retention time, high sedimentation rate, small space requirement, and ease of sludge removal. A high efficiency tilted plate clarifier was chosen for the Meihekou WTW, which has a smaller footprint and low construction cost, while achieving good settled water quality.

54. Up to six different types of filtration were evaluated. Rapid sand filtration was selected for the Shuanyang WTW for its high stability, reliability, proven operation experiences, ease of automated control, and good performance. The V-type filtration process was chosen for the Meihekou WTW, which has the advantages of stable and reliable operation, high solid holding capacity, long filtration cycle, ease of backwash, and good quality of filtered water.

2. Existing WTWs in Liaoyuan

55. Two upgrading options are available for the Longshan and Hebing WTWs. Option 1 keeps the existing treatment processes, but upgrades/replaces the equipment in reaction tanks and filtration tanks. Option 2 replaces the mechanical mixing reaction tanks in the Longshan WTW and the grid reaction tanks in the Hebing WTW by baffle reaction tanks, or replaces the tube settlers in the existing settling tanks. Cost comparison of the two options shows that option 2 would cost less. Option 2 was therefore selected for upgrading these two existing WTWs.

F. Alternative Wastewater Treatment Levels

56. The treatment levels at the Beijiao WWTW were discussed. The Project will upgrade 130,000 m^3/day of the existing primarily treated 390,000 m^3/day to secondary treatment. Of the, 130,000 m^3/day, 100,000 m^3/day will be upgraded for effluent reuse by nearby industries. This leaves 260,000 m^3/day to receive only primary treatment. The question was raised whether the cost of upgrading the 100,000 m^3/day for effluent reuse should be spent on upgrading more of the remaining primarily treated 260,000 m^3/day to secondary treatment, which would potentially remove more pollutants from the SRB.

57. However, Changchun was projected to have a short fall in water supply of approximately 40,000 m^3/day in 2005, reaching 360,000 m^3/day in 2010. Water reuse will help to alleviate the water shortage problem. This will address the water shortage problem and result in pollutant reduction. The decision has been made that the Project should achieve both pollutant reduction and water shortage alleviation.

G. Alternative Wastewater Treatment Processes

58. Two treatment options were evaluated for the Beijiao WWTW: A^2/O Reaction Tank and Orbal Oxidation Ditch. Each has advantages and disadvantages, but the main disadvantage of the Orbal Oxidation Ditch is the lack of local operation and management experience. The A^2/O method costs less and was recommended.

59. Two treatment options were also evaluated for the Nanjiao WWTW. Option 1 includes biological aerated filter (BAF) followed by coagulation, settling, then filtration. Option 2 includes the modified sequential bio-reactor (MSBR) system followed by BAF. On the basis of technical and economic comparisons, option 1 was selected due to its smaller footprint, ease in operation, better effluent quality, and lower cost.

H. Alternative Effluent Reuse Networks

60. Two options on the networks to reuse the Beijiao WWTW effluent were identified and evaluated. Option 1 is a loop system with one end of the main pipeline running eastward and the other running westward to serve the consumers. Option 2 is a branch system with secondary pipelines branching out to the west from the main pipeline. The cost difference between the two options was found to be small. The loop system was selected because it would offer greater reliability, a better pressure head, and in case of emergency the affected area could be isolated and the impact confined.

I. Alternative Drainage System Planning

61. The drainage systems of Changchun comprise sewerage and storm-water systems. Currently they are divided into separate and combined systems. There are plans to progressively separate the combined systems to suit the overall urban planning requirements of Changchun. This Project evaluated the different drainage regions served by the Beijiao WWTW,

and selected to improve the drainage network covered by the drainage systems of western Chuan Kuo and Yitong River.

62. The design flood protection standard of Yongchun River is 1 in 20 years. Different configurations of the drainage channel have been examined, including trapezoidal and rectangular channels. Rectangular cross-section channel was chosen because although construction cost is relatively higher, rectangular channel has the advantages of smaller land requirement and lower total capital cost.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Impacts Associated with the Project Location, Planning, and Design

63. Building the Nanjiao WWTW will involve land acquisition and resettlement. Mitigation measures and compensation for impacts on the population are addressed in the RP.

64. The use of the Shuanyang and Hailong reservoirs for water supply to Shuanyang and Meihekou will restrict future recreational and aquaculture activities in these reservoirs. To ensure protection of the water quality in these reservoirs, the reservoirs and adjacent land will be protected in accordance with the PRC laws and regulations. Impacts on the commercial premises and fish farmers are addressed in the social impact assessment. Mitigation measures and compensation for impacts on the population have been addressed, including compensation and livelihood restoration measures.

65. Adequate technical design of the WWTWs will be required, providing for the desired treatment to meet discharge standards and safety of plant operations. Adequate technical design of the WTWs will be required to provide the desired water quality and waste treatment/disposal that meet existing government regulations, and safety of plant operations.

66. Wastewater flow will increase after the increase of potable water supply to Shuanyang, Liaoyuan, and Meihekou. New WWTWs have been planned to provide for full wastewater treatment capacities, including wastewater to be generated from the Project.

B. Impacts Associated with the Construction Phase

67. Construction impacts are common to all the components and subcomponents. These include the permanent and temporary loss of land and habitats, dust and noise from construction activities, wastewater generated by the workers and activities, sanitation of the construction workforce, construction and demolition waste, and traffic congestion. Mitigation measures are necessary to reduce adverse construction phase impacts to acceptable levels.

1. Resettlement

68. Impacts related to resettlement (physical and economic displacement) include (i) people affected by the permanent acquisition of land for the WWTW and pump stations, (ii) people affected by the temporary use of land for installation of the trunk sewers and water pipelines, and (iii) people whose livelihood is impacted by delmolition of houses and shops. All project components were planned to minimize disruption of residential areas and villages and maintain

village cohesion. The Project will require the permanent acquisition of 77 hectares (ha) of land, the temporary acquisition of 201 ha, and the dismantling of 62,700 m^2 of residential houses and 2077 m^2 of commercial buildings. In total, 700 households with 2500 people will be permanently affected by land acquisition and 502 households with 1800 people by the dismantling of houses. In addition 2 enterprises and 18 shops will be affected.

69. The total cost for both land acquisition and resettlement is estimated to be CNY153.75 million or $18.57 million. Resettlement impacts have been identified and six RPs are being prepared in accordance with PRC laws and ADB's *Policy on Involuntary Resettlement*. The RPs provide a socioeconomic profile of those affected and the scope of the impacts, and addresses issues related to entitlements for compensation, legal framework, public consultations, grievance procedures, rehabilitation measures, budget, and monitoring and implementation milestones. Resettlement requirements have been carefully considered and incorporated into the project design.

70. The Jilin Provincial Government (JPG), the Executing Agency and the concerned local government's will implement ADB's full disclosure policy for the resettlement activities, including: (i) summary resettlement plan to be attached to the SEIA; (ii) distribution of the Resettlement Information Booklet to affected households and village offices; and, (iii) posting of the RPs in village offices and resident committees, and on the ADB website upon its approval/endorsement from JPG. The project management office (PMO) will establish sub-project resettlement units for supervision and monitoring..

71. All those affected will be compensated and resettled in a timely and adequate manner in accordance with the RPs so that they will at least be as well off as they would have been without the Project. To ensure that they have been adequately compensated and rehabilitated, the JPG and the Implementing Agencies (IAs) will (i) keep ADB informed of the progress of implementing the RPs through the quarterly progress reports until the resettlement is completed and (ii) prepare a resettlement completion report. JPG and the IAs will engage an independent agency for semiannual monitoring and annual evaluation of land acquisition and resettlement until two years after the completion of land acquisition and resettlement. The summary RP is provided in Appendix 1.

72. There are no important heritage and archaeological sites, or threatened or endangered species on the land that would be temporarily or permanently lost. These construction areas are not in designated natural reserves or scenic spots.

2. Air Quality

73. Dust would come from the construction vehicles traveling on unpaved haul roads, site formation works including excavation and backfilling, uncovered stockpiles, and concrete batching. The proposed construction sites are within or adjacent to farmlands, rivers, and residential and commercial areas. Dust generated could have short-term adverse impacts.

74. Mitigation measures include paving frequently used haul roads, frequently watering unpaved areas and haul roads, minimizing on-site storage time of construction and demolition wastes, covering stockpiles, using tarpaulins to cover trucks carrying dusty materials, controlling vehicle speeds on construction sites, and quickly restoring disturbed land to minimize adverse impacts on humans and crops.

3. Noise and Vibration

75. The use of powered mechanical equipment during construction could cause adverse noise and vibration impacts to nearby residents. This equipment would have sound power levels ranging from 95 decibels (dB) to 135 dB. Noise levels were predicted to range from 85 to 95 dB at the construction site boundaries, and that sensitive receivers within 60 m from the site boundary could be adversely affected.

76. Construction noise impact is a common environmental issue in water supply and sewerage projects, as the nature of these projects is to connect the pipes to the households, requiring working very close to these households. Fortunately, pipe laying is a linear activity. Once the connection to or near a household is completed, the noise source moves away. Noise impact at each household is therefore of a short duration of only a few weeks.

77. Mitigation measures include the use of quiet equipment, good maintenance and operation of machinery, the use of temporary hoardings or noise barriers to screen off noise sources, and no nighttime construction from 2200 to 0600 hours near residential areas.

4. Water Quality

78. Uncontrolled wastewater and muddy runoff from construction sites could potentially pollute nearby water bodies and clog up drains. Portable toilets and small package wastewater treatment plants should be provided for the workers and canteens. If sewers are nearby, interim holding tanks and pipelines could be installed to convey the wastewater to them. To control process wastewater and muddy runoff, sedimentation tanks could be installed on-site to treat wastewater with high concentrations of suspended solids. If necessary, flocculants could be used to facilitate sedimentation.

79. Sanitation is a key public health issue during construction. The majority of the large workforce will be from outside the immediate neighborhood, living in temporary quarters. Such conditions create a suitable environment for the propagation of diseases. Efficient sanitation must be maintained and monitored, with the provision of health services.

5. Wastes

80. Refuse generated by the workers and construction and demolition wastes could have adverse impacts on the surrounding environment. Refuse should be stored in closed containers and transported off-site for disposal regularly. Considerable quantities of construction and demolition wastes (excavated materials) will be generated from the Yongchun River Improvement and Beijiao Sewerage Networks Improvement subcomponents. The former involves excavating 4.8 km of the Yong Chun River to a width of 35 m and depth of 3 m, plus the dredging and disposal of bottom mud from the Sanjiazi Reservoir. The latter involves excavation and backfilling of over 216 km of trenches for laying sewer pipes in urban Changchun, where temporary stockpiling of such large quantities of soil and backfilling materials would be problematic.

81. The most practical and effective mitigation measure is timely cleanup and removal of construction and demolition wastes. Opportunities to reuse the excavated materials for backfilling should also be explored.

6. Traffic

82. Increase in construction traffic could cause traffic congestion and inconvenience to other drivers, pedestrians, and shop owners, particularly during pipe laying. Temporary traffic management is needed to mitigate these conditions. It would include diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at the road crossings, building interim roads, selecting transport routes to reduce disturbance to regular traffic, and reinstating the roads as soon as possible.

C. Impacts Associated with the Operational Phase

1. Impacts from Operating the WWTW and WTW

a. Air Quality

83. Emissions from boilers would have adverse impact on air quality. All these facilities would install boilers for heating, except the Nanjiao WWTW in Changchun and the Hebing WTW in Liaoyuan, which will use electricity for heating. The amount of coal used per year ranges from 130 to 800 tons. Burning of coal would emit TSP, sulfur dioxide (SO_2), and nitrogen oxides (NO_x). These boilers will be equipped with air pollution control systems, with removal efficiencies of 96% for TSP and 40–60% for SO_2. Dispersion modeling results show that both TSP and SO_2 concentrations at ground level would comply with the class II standards in GB3095-1996: Air Quality Standards.

84. Odor emission from the Beijiao and Nanjiao WWTWs will also have adverse impact on air quality. Odor mainly comes from sulfur and nitrogen in the organic matters of sewage, forming odorous gases such as hydrogen sulfide (H_2S), ammonia (NH_3) and mercaptan. Major odor sources in these WWTWs include the pretreatment tanks, the primary and secondary aerated biofilters, and the sludge storage tanks. Assessments indicate that odor would be noticeable within 100 m downwind of these sources. Mitigation measures include the planting of a 50 m wide green belt at the site boundary, with species such as Canadian poplar, Lombardy poplar, dwarf elm and acacia, plus another protective buffer of 200 m for the Beijiao WWTW and 70 m for the Nanjiao WWTW.

b. Noise

85. Operation of the aerators and various types of pumps could generate noise levels ranging from 85 to 90 dB. These fixed noise sources could be contained in buildings with sound-proof doors and double-glazed windows. With these mitigations, assessment results show that the noise level at the boundary of these plants would comply with class II standards (for residential, commercial, and industrial mixed uses) of GB12348-90: Noise Standards at the Site Boundary of Industrial Enterprises.

c. Chlorine Hazard

86. All the WWTWs and WTWs will use chlorine for disinfection. The dosage would range from 1–3 milligram per liter (mg/l). Hence, bottles of chlorine gas would be stored on-site. Chlorine gas is heavier than air and tends to disperse at ground level, where human activities occur. At low concentrations of 0.02–0.05 parts per million (ppm) in the air, it is an irritant to the respiratory system. At concentrations of 2 ppm and above, chlorine gives a burning sensation to

the eyes and the respiratory system. Inhalation of chlorine gas at concentrations of 50–100 ppm could result in death. Hence, chlorine poses a potential public health risk if there is accidental spillage.

87. Among the WWTWs and WTWs in this project, the Longshan and Hebing WTWs in Liaoyuan pose the highest risk due to their close proximity to residential areas. Both WTWs are existing plants and are already using chlorine for disinfection. Both plants have not reported any accidental spillage of chlorine gas. Inspection of the existing chlorine storage facilities at these plants revealed the lack of containment and treatment measures to handle chlorine leakage or spillage. The Project, which will upgrade these two WTWs, provides an opportunity to install safety features to reduce the risk to public health if there is an accidental spillage of chlorine.

88. For chlorine storage at all the WWTWs and WTWs in the Project, the following mitigation measures have been recommended to reduce chlorine hazards. During the detailed design stage, the chlorine storage facility should be sited, as far as practicable, downwind and farthest from residential areas outside the plant and the administrative buildings and offices inside the plant. Automatic chlorine-dosing equipment is preferred over manual dosing. The chlorine storage facility must be equipped with a chlorine gas detector, an alarm system, and an automatic chlorine gas collection system that will collect as well as neutralize the chlorine gas. When the chlorine level in the storage facility reaches a predetermined level, the alarm will go off to alert the workers, and the chlorine gas collection system will be automatically activated to collect and neutralize the chlorine, thus preventing it from leaking into the outside atmosphere.

89. To minimize the magnitude of each potential spillage, only 500-kg bottles of chlorine are recommended to be stored on-site, and the quantity of chlorine stored on-site should not be more than a 20-day supply. This usually means less than 10 bottles (500 kg) of chlorine are stored on-site at any given time. Each WWTW and WTW should prepare a safety plan and an emergency response plan and regularly train the workers on the proper and safe handling of chlorine, and on emergency response procedures.

d. Wastes

90. The operation of WWTWs and WTWs will produce solid wastes that need proper disposal so as not to generate secondary pollution. The types of solid waste include refuse from the workforce, boiler ash, and sludge.

91. Refuse from the work force at these facilities will be relatively small in quantity, generally less than 50 kg/day per facility, and can be properly disposed of at sanitary landfills.

92. The quantities of boiler ash produced will range from 53 ton per annum (t/a) at the Shuanyang WTW to 216 t/a at the Beijiao WWTW (the Nanjiao WWTW will use electricity for heating and therefore will not produce any boiler ash). Boiler ash could be sold to brick manufacturers.

93. WTWs produce backwashing sludge. This quantity varies from plant to plant depending on the turbidity of the intake water. The Shuanyang WTW estimated that approximately 644 t/a of backwashing sludge would be produced. The Meihekou WTWs estimate was 2,727 t/a. The Longshan and Hebing WTWs in Liaoyuan were estimated to produce 5,475 t/a and 14,600 t/a of backwashing sludge respectively, due to the highly turbid intake water. Backwashing sludge is mainly made up of suspended solids. The material can be used for composting or as a substrate for horticulture. However, composting or planting sites should be identified early, and

plans made, in advance, including the logistics of transporting the sludge on a timely basis to these sites. Otherwise, the sludge would have to be disposed of at landfills.

94. WWTWs also produce sludge. Sludge quantities estimated for Beijiao and Nanjiao WWTWs are approximately 38,500 t/a and 18,250 t/a respectively. One potential means is to transport the sludge to a composting facility for producing fertilizer. However, a key issue is the heavy metal contents in the sludge. Of the wastewater generated in Changchun, approximately 52–54% is from industrial sources. The Nanjiao WWTW estimated that approximately 70% of its future wastewater would be from industrial sources. Heavy metals in the industrial wastewater would be concentrated in the sludge during the treatment process. It is recommended that the heavy metal concentrations in the sludge from these two WWTWs be determined first. If such concentrations were found to be safe for agricultural use, it is recommended that a composting facility be built at the Beijiao site, where space is available, for treating the sludge generated by both Beijiao and Nanjiao WWTWs. If the sludge is found to be unsafe for agricultural use, then disposal at landfills or by incineration are alternative options.

e. Water Quality

95. Impact from wastewater generated during the operation of the WWTWs and WTWs would be minimal. For the WWTWs, the quantities of wastewater generated by the work force will be small, and be discharged back to the WWTWs for treatment. For the WTWs, the wastewater will come from the work force and from backwashing. A portion of the backwash wastewater will go through filtration and sedimentation for reuse (50–85%), and the rest will be discharged. For Shuanyang and Liaoyuan, wastewater generated will range from 250–350 m^3/day, which will be discharged into public sewers for treatment at the municipal WWTWs. These quantities are small and the WWTWs could accommodate their treatment. The Meihekou WTW will generate approximately 760 m^3/day of wastewater during operation. This will be treated by septic tanks at the WTW before discharging to the municipal drainage network going into the Huifa River. Assessments show that downstream of the discharge, COD_{Cr} and BOD_5 concentrations would increase by approximately 0.1% and 0.5% respectively. Such increases are deemed minimal.

f. Positive Impacts

96. This Project will have a positive impact on the water quality of the Songhua River, because of the treatment upgrade and effluent reuse at the Beijiao and Nanjiao WWTWs.

97. The Beijiao WWTW presently discharges 390,000 m^3/day of primarily treated effluent into the Yitong River. This Project will reuse 100,000 m^3/day, reducing the discharge to 290,000 m^3/day. Of this volume, 30,000 m^3/day will receive secondary treatment, while 160,000 m^3/d will receive primary treatment. Project implementation will achieve the following reductions in pollutant loads into the Yitong River: 6,424 t/a (32.2%) BOD_5, 11,205.5 t/a (31.5%) COD_{Cr}, 5,475 t/a (32.1%) SS, 1,022 t/a (28.7%) NH_3-N, and 149.65 t/a (30%) TP.

98. The Nanjiao WWTW will treat 150,000 m^3/day of raw sewage that is now discharging into the Yongchun River, also a tributary in the Songhua River system. Of this quantity, 50,000 m^3/day will receive treatment for reuse. The remaining 100,000 m^3/day will receive secondary treatment before being discharged into the Yongchun River. Project implementation will achieve the following reductions in pollutant loads into the Yongchun River, compared with the present situation: 9,125 t/a (92.6%) BOD_5, 16,425 t/a (88.2%) COD_{Cr}, 12,410 t/a (94.4%) SS, 547.5 t/a (50%) NH_3-N, and 118.6 t/a (86.7%) TP.

99. This Project will have a positive impact on the groundwater in Shuanyang and Meihekou, where groundwater resources have already been overexploited. In Shuanyang, such overexploitation still cannot satisfy the need of this district for potable water and water rationing is increasingly needed. In Meihekou, overexploitation of groundwater has resulted in land subsidence in several areas of the city. On completion of the Shuanyang and Meihekou WTWs, potable water will be supplied by surface water from reservoirs. This will not only provide a dependable source for satisfying potable water needs, but will also allow the aquifers to recharge. In Meihekou, such recharge will elevate the groundwater levels, thus reducing the loss of irrigation water due to ground seepage. As a result, the farmers in Meihekou will use less water for irrigation, further saving valuable water resources.

2. Impacts from Operating the Pipelines and Pumping Stations

a. Pipe Burst

100. The Project involves networks of pipelines and pumping stations for conveying water or sewage. The Beijiao and Nanjiao WWTWs will have 30.4 km and 15.9 km of pipelines respectively for conveying the treated effluent for reuse. The Beijiao WWTW will also include sewerage pipeworks of 210 km and three pumping stations. Shuanyang will have one water intake pumping station at the reservoir connected to the WTW with a 250 m pipeline, and another 2.4 km of pipeline to convey the treated water to the district households. Liaoyuan will have 55.1 km of water pipes with 17 pumping stations, and 12 km of sewer pipes. Meihekou will have a 40 km water intake pipeline to convey raw water from the reservoir to the WTW, and another 55.5 km of water pipes to convey treated water to the households.

101. One potential impact during the operational stage is leaking or bursting of pipes. This would cause loss of valuable resources in the case of water pipes, and environmental pollution and public health hazards in the case of sewer lines. Such events would also cause flooding of streets and nearby premises, resulting in nuisance to the residents and economic losses to the commercial premises. Adequate design of the pipes, choice of proper piping materials, and proper supervision during construction are essential to preventing these potential impacts.

b. Pump Noise

102. The operation of the pumping stations will have noise impact on nearby residents, particularly the 17 pumping stations in Liaoyuan and the three pumping stations in the Beijiao sewerage network, which are located in the urban areas. These pumping stations will be designed with adequate acoustic mitigation measures such as soundproof doors, double-glazed windows and adequate wall thickness to contain the pump noise. The pumping stations will be designed to fit in with the nearby environ and buildings, with proper landscaping around to provide aesthetics to nearby residents.

3. Impacts from Operating the Flood Control Drainage Channels

103. The Project includes the construction and operation of flood control drainage channels in Changchun (drainage improvement of the Yongchun River) and Liaoyuan.

104. The Yongchun River presently receives domestic and industrial wastewater from the Changchun National Hi-Tech Industries Development Zone. The Yongchun River improvement and the construction and operation of the Nanjiao WWTW are parts of a plan to improve the

water quality of the Yongchun River by alleviating flooding problems and by intercepting the domestic and industrial wastewater for treatment at the Nanjiao WWTW.

105. Construction and operation of the flood control drainage channels in Liaoyuan is also part of a plan to improve the environmental and public health conditions of the city, together with the upgrading of two WTWs and the building of water supply, drainage and sewage collection networks.

106. Operation of these flood control drainage channels would have minimal environmental impact. The key operational issue is to clean these channels regularly, so that rubbish, undesirable growth, and other foreign objects would not compromise their flood control functions. Regular maintenance would generate refuse and solid wastes that would be properly disposed of at sanitary landfills.

VI. ECONOMIC ASSESSMENT

107. The total project cost is estimated at $229.2 million equivalent, including a foreign exchange cost of $106.0 million (46%) and local currency cost of $123.2 million equivalent (54%). The estimated ADB loan is $100 million to finance 94% of the foreign exchange cost.

108. The economic analysis provides a rationale and justification for the Project based on policy, sector, and local area analysis. It considers the Project, not as a stand-alone investment, but as an integrated part of the ongoing city, municipal, and basin-wide environmental programs directly contributing to the clean-up of the SRB. The economic analysis assesses the need and demand for the Project and assesses the alternatives. Economic costs are calculated and compared to identify benefits that could be valued to determine an economic internal rate of return (EIRR). The EIRRs are (i) Changchun Wastewater Component, 17.5%; (ii) Shuangyuang Water Supply Component, 51.6%; (iii) Liaoyuan Water Supply Component, 45.9%; (iv) Meiekou Water Supply Component, 19.2%; (v) Yongchun River Component, 26.1%; and Liaoyuan Drainage Component, 33%. The EIRR for the whole Project is estimated at 23.6%, which exceeds the economic opportunity cost of capital, assumed to be no less than 12%.

VII. ENVIRONMENTAL MANAGEMENT PLAN

A. Environmental Management

109. The EMP is an important tool to ensure that the Project will be implemented in an environmentally acceptable manner. The EMP describes the procedures and plans to ensure that the mitigation measures and monitoring requirements will actually be carried out during subsequent stages of the Project.

110. At the project preparation stage of the project cycle, specific construction and operational activities cannot be well defined. Preliminary EMPs have been developed in the EIAs for the Project, but details are still lacking, particularly on the number of contract packages and the construction sequences, which would dictate the number and location of concurrent construction activities and therefore the extent of environmental monitoring required. These preliminary EMPs, however, have identified the environmental impacts and measures required to mitigate these impacts, institutional arrangements to oversee as well as to implement these measures, environmental monitoring requirements, and public participation. As the project progresses, the project design institutes will develop these EMPs including the public

consultation-participation plans based on the final design. The EMP requirements will be clearly indicated in the bidding documents and contract-level EMP will be developed to specify contractors' EMP responsibilities.

111. These preliminary EMPs estimate that the implementation of environmental mitigation measures will cost approximately $1.8 million equivalent, and the environmental monitoring during the construction stage approximately $0.12 million equivalent. Major costs for mitigation are odor control and sludge disposal at the WWTWs. The total is only about 1% of the project cost. However, these estimates do not include the resettlement costs, as well as the long-term environmental monitoring during the operational stage, which will likely be taken by the IAs' own environmental staff. The IAs have adequate staff, budget, and capacity to conduct environmental monitoring during the operational phase.

112. The PMO will ensure that the Project's progress and impacts are monitored and reported in line with ADB requirements. The PMO, assisted by the consultants, will monitor and assess overall project activities under the project performance management system, including environmental targets and will submit to ADB the EMP progress reports and information including project implementation and environmental performance of the contractors, IAs, and environmental project management consultants. These reports will include (i) semiannual progress reports on project implementation, (ii) annual reports, and (iii) a project completion report no later than three months after completion of the Project. The progress reports will emphasize progress made in the areas of water quality improvements, monitoring results, implementation of mitigation measures, environmental compliance, training, and capacity-building progress.

113. Environmental management is a process that should evolve and interact with the Project as it progresses. As such, the EMP should be a dynamic document that should be reviewed periodically to take account of changes occurring during project implementation.

B. Institutional Arrangement and Enhancement

114. The Jilin PMO is led by the Jilin Provincial Construction Bureau. Since this Project involves the cities of Changchun, Liaoyuan, and Meihekou, each city has established its own PMO.

115. The Changchun PMO is led by the Changchun Planning Commission, with three IAs for the subcomponents in Changchun. These IAs include the Changchun Drainage Company (for Beijiao and Nanjiao subcomponents), the Shuanyang Water Supply Company (for the Shuanyang subcomponents), and the Changchun National High-Tech Industries Development Zone (for the Yongchun River subcomponent).

116. The Liaoyuan PMO is led by the Liaoyuan Planning Commission and the Water Conservancy Bureau. The IA for the Liaoyuan component is the Liaoyuan Water Group.

117. The Meihekou PMO is led by the Meihekou Construction Bureau. The IA for the Meihekou component is the Meihekou Water Supply Company.

118. The IAs are utimately responsible for ensuring EMP implementation during project preparation, construction, and operational stages. The IAs are recommended to enhance their institutional arrangements by hiring environmental specialists to oversee EMP implementation

and to undertake long-term monitoring during the operational stage. Training should be provided to the staff regularly to enhance their environmental awareness.

119. During project preparation, construction, and operation, various parties with different environmental management responsibilities have been and will be involved. The environmental responsibilities of each party in the successive phases of the Project are indicated in Appendix 2. These include the design institutes; contractors; environmental protection authorities at the state, provincial, and local levels; and environmental monitoring stations at the local levels.

120. The EIA reports recommend mitigation measures for construction and operation of the project (Appendix 3). The relevant design institutes, during detailed design, will be responsible for incorporating these measures into the design and the environmental management requirements into the tender documents. The contractors, when tendering, must demonstrate their abilities and commitment to implement the environmental management program.

121. The environmental monitoring stations of the city/district environmental protection bureaus are responsible for conducting environmental monitoring during construction. They will also prepare monthly environmental monitoring reports for submission to the provincial Jilin Environmental Protection Bureau. The reports will present all environmental monitoring results and indicate whether these results comply with the environmental standards, unanticipated issues encountered, and the implementation status of the mitigation measures.

C. Environmental Monitoring

122. The environmental monitoring program is indicated in Appendix 4. During construction, the environmental monitoring stations of the city/district environmental protection bureaus are responsible for carrying out the environmental monitoring. During operation, the monitoring stations and the IAs will carry out the environmental monitoring.

123. During construction, environmental monitoring will focus on dust and noise on construction sites and from the construction equipment. During the operational stage, environmental monitoring will focus on noise from plant rooms and pumping stations, and for WWTWs, odor from the sludge and other sources.

VIII. PUBLIC INVOLVEMENT AND DISCLOSURE

A. Public Participation during Project Preparation

124. Ten public consultations were conducted during project preparation. Two rounds of public consultations were carried out in each of Changchun (for the Beijiao and Nanjiao subcomponents), the Changchun National Hi-Tech Industries Development Zone (for the Yongchun River Improvement subcomponent), Shuanyang (for the Shuanyang subcomponent), Liaoyuan, and Meihekou.

125. The first round of five public consultations was conducted shortly after the commencement of the EIAs. The purpose was to introduce the Project and the relevant components and subcomponents to the stakeholders; and to solicit ideas, suggestions, comments, concerns and critiques on the potential environmental implications of the Project, so that the EIAs could take these into account during impact assessment.

126. The stakeholders were identified with the help of the IAs and the research institutes doing the EIAs. These stakeholders included relevant government officials, nongovernment representative from nearby schools and hospitals, and residents who could be affected by the Project. Invitation letters and an information paper on the Project were sent to the stakeholders approximately 10 days before the public consultation was to take place. This was followed up by telephone calls to the stakeholders as a reminder about 2 days before the public consultation was to take place.

127. The second round of five public consultations was conducted after the draft EIA reports were completed. The same invitation process was repeated. The same stakeholders were invited. At this meeting, the information paper presented the findings of the EIA, summarizing potential environmental impacts and mitigation measures, and answered the comments and concerns raised by the participants in the first round.

128. The public consultations were chaired by the local PMO or IA, and the institutes doing the EIAs described the Project, explained the environmental impacts and mitigation measures, and answered queries raised by the participants.

129. Approximately 35 to 40 stakeholders were invited to each public consultation. Attendance rates averaged approximately 50%. Each public consultation lasted approximately 1 to 1.5 hours. Venues included hotel conference rooms or IAs' offices.

130. Most of the participants supported the project and showed appreciation to ADB for providing funding to the Project. Some raised concerns on noise during construction and from the operation of pumping stations. The fact that there are technical remedies to mitigate such noise was explained, and the concerns resolved.

131. Concerns were raised on the Meihekou component regarding the use of Hailong Reservoir as a potable water source and whether this would deplete the supply of irrigation water to the farmers. Calculations showed that the reservoir would have sufficient water to serve both purposes. Besides, by switching to surface water, the overextraction of groundwater for potable uses would cease and the aquifers would eventually recharge, raising the groundwater level. This would reduce the loss of irrigation water due to ground seepage, resulting in reduced consumption of irrigation water. These concerns were resolved and information will be provided to all affected communities.

132. For the Shuangyang Reservoir, the water will be exclusively allocated to urban water supply. In 2002 and 2003, the local government installed a total of 211 tubewells to meet the irrigation demands. To date, the farmers have been satisfied with this arrangement, since the groundwater supply is more reliable.

133. Both, Shuanyang and Meihekou would extract water from the reservoirs for potable use. Once the decision is made to use the reservoirs as potable water sources, PRC regulations on protecting these water sources would become effective, and other uses not related to water extraction would be restricted.

B. Future Public Participation Plans

134. Plans for public involvement during the design and construction stages of the Project will be developed, once the construction program is better defined. These plans will provide forums for updating stakeholders periodically on project progress and mitigation measure implementation. These plans will be incorporated into the revised EMP.

IX. CONCLUSIONS

A. Benefits

135. The Project will benefit Jilin Province by increasing wastewater treatment and potable water supply capacity, hence improving the population's public health and living conditions.

136. The Project will secure the provision of reliable drinking water to Changchun, Liaoyuan, and Meihekou. The recycling of wastewater of 150,000 m^3/day will have two significant benefits: reducing water pollution and addressing the water shortage problem. This would also have a catalytic effect on encouraging the replication of similar optimal and cost-effective approaches to addressing water pollution and water shortage. By switching the supply from groundwater to surface water, overextraction of groundwater will cease, thus preventing further subsidence and allowing the aquifers to recharge.

137. The Project will reduce transboundary pollution, by reducing pollutant input into the tributaries of the Songhua River. Upon project implementation, the following quantities of pollutants are expected to be removed from the SRB: 15,549 t/a of BOD_5, 27,631 t/a of COD_{Cr}, 17,885 t/a of SS, 1,570 t/a of NH_3-N, and 268 t/a of TP.

138. The Project will provide flood relief, thus minimizing loss of life and damage to property, agriculture, and infrastructure. Flood control achieved by the Project will contribute to the overall well-being of the population residing in the project area.

139. The Project will improve the drainage-sewerage network by separating storm-water and sewage flows into different systems. This will improve the treatment capacities of the WWTWs, resulting in better protection of Yitong River, Songhua River's tributary. Changchun's water quality target for Yitong River in the urban area is to restore it to class III by 2010, thus significantly contributing to improving the water quality of the Songhua River.

B. Significant Adverse Impacts and Associated Mitigation Measures

140. A negative unavoidable impact will be the need to relocate 500 households, primarily for the construction of the Nanjiao WWTW, and compensate 700 households for permenant loss of farmland. Temporary impacts will also be compensated. Six sub-project RPs are being prepared and the resettlement will be carried out to satisfy both the PRC and ADB requirements.

141. During construction, dust from construction sites, noise from powered mechanical equipment, wastewater, solid wastes, and construction traffic are the major adverse impacts.

Effective mitigation measures have been recommended. With the implementation of these recommendations, these impacts will largely be insignificant.

142. During operation, boiler emissions, odor, noise from pumping stations and plant machinery, chlorine hazard, solid wastes, and wastewater are the major adverse impacts. Effective mitigation measures have also been recommended (Table 2). With the implementation of these recommendations, these impacts will largely be insignificant.

C. Use of Irreplaceable Resources

143. The Project will result in the permanent loss of approximately 63 ha of land and associated habitats. The land is mostly agricultural land and existing riverbed.

D. Follow-Up Monitoring and Environmental Management Requirements

144. Preliminary EMPs have been developed for the design, tendering, construction, and operational phases of the Project. These plans include the institutional arrangement and enhancement for implementing the mitigation measures and undertaking the monitoring requirements. They will be developed as the project progresses, to provide more details to ensure that all mitigation requirements are met. A separate monitoring requirement is included in each RP.

SUMMARY RESETTLEMENT PLAN

1. The Project is composed of six subprojects in Changchun, Liaoyuan, and Meihekou cities, all of which will require some land acquisition and population resettlement. The resettlement planning and implementation is designed to ensure that the affected persons will be better-off or at least not worse-off as a result of the Project.

2. The impacts of the Project are summarized in Table A1. In total, 28 villages will be affected by land acquisition and resettlement. About 77 hectares (ha) of land will be permanently acquired by the Project, of which 22% is farmland. Permanent land acquisition will affect about 700 households or 2,500 people. The Project will also require the temporary acquisition of 201 ha of land, which will affect another 2,300 households or 8,100 persons. About 500 households with 1,800 people will be relocated and about 62,700 m^2 of houses will be demolished. Two small enterprises and 18 shops with a total of 81 employees will be affected by the demolition of 2,077 m^2 of commercial structures. In addition, some public infrastructure and facilities will be affected, including gravel roads, culverts, fiber cables, electric poles, transformers, and machine-operated wells. The 10,800 people affected by the Project components include urban and rural residents, legal and nonlegal owners of structures, private business owners, and permanent and temporary employees.

3 In order to avoid or minimize land acquisition and resettlement, there was close consultation with the local officials and village committees/street committees during the preliminary and final Feasibility Study stages.

3 The compensation of the permanent land loss is based on the Land Administration Law of the PRC in 1998, and the house demolishment is based on the Provincial and Municipal Urban Housing Demolishment Administration Regulations. Six Resettlement Plans (RPs) were prepared to comply with ADB*'s Policy on Involuntary Resettlement.*[1] Based on consultations with local governments and those affected, and general practice in Changchun, Liaoyuan, and Meihekou cities, a set of compensation standards was adopted by the respective city project management offices (PMOs) and implementing agencies (IAs). The resettlement principles established for the Project are (i) land acquisition and involuntary resettlement should be avoided or minimized where feasible by developing and comparing a series of design alternatives; (ii) compensation and entitlements provided must be adequate to allow those affected to at least maintain their preproject standard of living, with the prospect of improvement; (iii) land temporarily occupied and the period for disruption are to be kept to a minimum; (iv) all the people affected, legal and illegal, are to be taken into consideration and accounted for; (v) the per capita landholding after land acquisition will be sufficient to maintain the previous livelihood standard; (vi) where land allocation per capita is not sufficient to maintain the previous livelihood standards, other income-generating activities will be provided for; (vii) a preferential policy will be provided to vulnerable groups in such things as compensation, housing assignment, transfer, and employment; (viii) all those affected will be adequately informed about eligibility, compensation rates and standards, livelihood and income restoration plans, and project timing; and (ix) close monitoring and timely actions will be carried out to identify and resolve any problems.

4. The people affected will be notified about the key elements of the RP prior to ADB loan appraisal. On various occasions during meetings, interviews, focus group discussions, public

[1] The Long Shan Water Treatment Works Improvement and He Bing WTW Improvement under the Liaoyuan Component will not involve any land acquisition and resettlement as the two projects involve rehabilitation of water treatment works.

consultation workshops, and community consultation meetings, local representatives have participated in the planning and concerns have been integrated into the RPs. The resettlement information booklet will be distributed to affected villages and households between December 2004 and January 2005. Once finalized, the RPs will be provided to village offices and resident committees and posted on the ADB website. The respective project IAs will establish project resettlement units for supervising implementation, continuing public consultation, monitoring progress and responding to grievances. The grievance address procedures are well established and explanations are included in the resettlement information booklets.

5. For land acquisition, part of the compensation will be paid to the affected village and the resettlement subsidy will be paid to the affected households. For residential houses, enterprises and commercial shops to be demolished, compensation will be paid to owners, including those without house registration. The payment will be made in cash according to the appraised value of the property. The households that have to relocate will also receive a transfer and transportation allowance. Compensation for standing crops, auxiliaries and other assets will also be paid directly to affected farmers. Income losses resulting from reduced production/sales and wages caused by the Project will be compensated in cash.

6. The resettlement strategy encompasses (i) the replacement of housing, and (ii) the restoration of livelihoods and income. For people losing housing in urban areas, there are two resettlement options -- to receive cash compensation or property exchange. Assistance will be provided to find available housing close to their original homes, if that is their preference. People will be relocated to apartment housing which have better infrastructure, e.g., water, sewer, road, gas, and electricity. The respective subproject PMOs and local government will provide necessary assistance for house construction and relocation during resettlement implementation.

7. The measures for economic rehabilitation include: (i) provision of employment opportunities during the project construction and operational phases; (ii) arrangement of those affected to be employed in the local enterprises and businesses; (iii) land redistribution where possible; (iv) intensify and diversify farm operations to raise the value of production and income per unit of land; (v) training on scientific and diversified agricultural business to assist the affected people increase their income, such as court-yard economic activities, technology on animal husbandry and economic crops planting, and technology on planting vegetables in greenhouses; and promotion and development of tertiary business (e.g., transportation and catering services). The compensation paid to village committees will be used to improve village production and infrastructure (e.g., road construction, clinics, etc.). Relocated enterprises and shops will be provided with the options of compensation and resettlement. The same enterprises and shops will either reemploy affected employees, or they will be provided assistance to secure other jobs.

8. Vulnerable persons affected by the Projects will identified, such as poverty households, those losing a lot of farmland, temporary employees of relocated businesses and occupants of unregistered structures. Special measures will be taken to ensure these vulnerable persons receive adequate compensation and assistance to restore their living conditions and incomes.

9. The staff from each sub-project resettlement unit will take the lead responsibility for coordinating the planning, implementation, financing, and monitoring of land acquisition and resettlement. Each PMO will have two full-time staff responsible for land acquisition and resettlement. They will work closely with relevant village/street officials, land administration bureaus and house demolishment offices, and will be responsible for supervision and

monitoring of resettlement (e.g., delivery of entitlements, selection of new housing sites, restoration of incomes, provision of replacement land and other economic measures). A training program will be organized for the PMO resettlement units.

10. The cost estimate for land acquisition and resettlement is $18.57 million, equivalent to CNY153.75 million in 2004 prices, including contingencies. Resettlement implementation will be scheduled to precede the sub-project construction schedules. Most resettlement activities will occur between April 2005 and December 2006.Construction will not take place before the affected people are fully compensated and relocated to new housing. Detailed measurement surveys will be conducted in each village, neighborhood, and enterprise, and the compensation contracts will be negotiated and signed with village committees, households and enterprises. Based on these surveys, the RPs will be updated and submitted to ADB for concurrence.

11. Internal and external monitoring of RP implementation will be conducted. Monitoring methodologies are specified in the RPs. Internal supervision and monitoring will be done by the PMO of each IA. External monitoring and evaluation will be carried out by an independent agency under contract to the IAs.

Table A1: Summary of Land Acquisition and Resettlement Impacts and Costs

Project Components	Engineering Works			Permanent Land Acquisition				Temporary Land Acquisition				Residential House Demolition		
	Project Activities	Quantity	Units	Total Area (ha)	Of which Farmland (ha)	Affected House-Holds	Affected People	Total Area (ha)	Of which Farnland (ha)	Affected House-holds	Affected People	Total Area (m^3)	Affected House-holds	Affected People
Changchun City														
1) Nanjiao WWTP	New WWTP	150,000	m^3/day	20.88	6.5	450	1,687	0	0	0	0	55,354	450	1,687
2a) Beijiao WWTP	Upgrade to secondary WWT	130,000	m^3/day	0	0	0	0	5.83	0	0	0	0	0	0
2b) Beijiao Sewer Network	Pipelines, 3 PS, 7 maintenance stations	216	km	4.7	2.9	12	43	21.8	18.8	29	106	7,182	50	107
3) Shuangyang Water Supply	Pumping Stations & WTP Transmission Pipeline	36,000 2.4	m^3/day km	3.15	1.26	13	48	7.59	7.04	90	448	193	2	5
4) Yongchunhe Improvement	Flood Canal	4.8	km	28.08	0	84	252	16.09	4.8	198	595	0	0	0
Subtotal				56.81	10.66	559	2,030	51.31	30.64	317	1,149	62,729	502	1,799
Meihekou City														
5a) WS Pipeline and WTP	Transmission Pipeline	40	km	0.56	0.56	6	36	98.5	98.5	1,988	6,964	0	0	0
	WTP	100,000	m^3/day	5.6	5.41	31	110	0	0	0	0	0	0	0
5b) Water Distribution Network	Pipelines	55.5	km			0	0	11.41				0	0	0
Subtotal				6.16	5.97	37	146	109.91	98.50	1,988	6,964	0	0	0
Liaoyuan City														
6a) Water Treatment Plants	Upgrading two WTP	110,000	m^3/day	0	0	0	0	0	0	0	0	0	0	0
6b) Water Distribution Network	Pipelines, 17 PS	53.1	km	1.046	0	42	136	16.24	0	0	0	0	0	0
6c) Drainage & Sewerage Network	Upgrading drainage pipelines			0	0	12	36		0	0	0	0	0	0
	New sewer pipes & 3 PS	12	km	0	0	0	0	11.03	0	0	0	0	0	0
6d) Flood Canals	Open channels & box culverts	8.3	km	13.15	0	46	138	12.34	0	0	0	0	0	0
Subtotal				14.20	0	100	310	39.61	0	0	0	0	0	0
TOTAL				77.17	16.63	696	2,486	200.83	129.14	2,305	8,113	62,729	502	1,799

Project Components	Enterprises & Shops			Total Affected People			Affected Villages	Resettlement Costs	
	Total Area (m^3)	Number	Affected Workers	Total	Urban	Rural		10,000 CNY	$ million
Changchun City									
1) Nanjiao WWTP	1,887	19	106	1,793	106	1687	2	5,083.50	6.14
2a) Beijiao WWTP	0	0	0	0	0	0	-	0	0.00
2b) Beijiao Sewer Network	0	0	0	256	0	256	3	1,581.74	1.91
3) Shuanyang Water Supply	190	1	6	507	8	507	4	314.1	0.38
4) Yongchunhe Improvement	0	0	0	847	0	847	3	5,128.44	6.19
Subtotal	2,077	20	112	3,403	114	3,297	12	12,107.78	14.62
Meihekou City									
5a) WS Pipeline and WTP	0	0	0	7,000	0	7,000	14		
	0	0	0	110	0	110		3,131.29	3.78
5b) Water Distribution Network	0	0	0	0	0	0			
Subtotal	0	0	0	7,110	0	7,110	14	3,131.29	3.78
Liaoyuan City									
6a) Water Treatment Plants	0	0	0	0	0	0			
6b) Water Distribution Network	0	0	0	136	136	0			
6c) Drainage & Sewerage Network	0	0	0	36	36	0	2	136	0.16
	0	0	0	0	0	0			
6d) Flood Canals	0	0	0	138	138	0			
Subtotal	0	0	0	310	310	0	2	136	0.16
TOTAL	2,077	20	112	10,823	424	10,407	28	15,375	18.57

WWTP= Wastewater Treatment Plant; WTP= Water Treatment Plant; PS= Pumping Station.

Notes: 1. Households affected by land loss will also need to relocate. Two enterprises and 18 shops will be demolished.

ENVIRONMENTAL RESPONSIBILITIES

Phase	Responsible Institutions	Environmental Responsibilities
Feasibility Study	SEPA, JPEPB	Review and approve EIA reports and environmental protection measures
Sign	Design Institutes	Incorporate mitigation measures in engineering designs and tender documents
Tendering	Contractors	Incorporate the environmental management program into the bids
Construction	Contractors	Implement environmental protection measures
	CDC, CNHTIDZ, SWSC, LWG, MWSC	Ensure the implementation of the environmental management plan
	CEMS, SEMS, HTZEMS, LEMS, MEMS	Conduct environmental monitoring and periodic site inspections
	JPEPB	Review and approve environmental monitoring reports
Operation	CDC, CNHTIDZ, SWSC, LWG, MWSC	Implement environmental management plan and conduct operational phase environmental monitoring
	CEMS, SEMS, HTZEMS, LEMS, MEMS	Alternate conduct of operational phase environmental monitoring
	JPEPB, CEPB, HTZEPB, SEPB, LEPB, MEPB	Review and approve environmental monitoring reports

CDC = Changchun Drainage Company, CEMS = Changchun Environmental Monitoring Station, CEPB = Changchun Environmental Protection Bureau, CNHTIDZ = Changchun National Hi-Tech Industries Development Zone, HTZEMS = Hi-Tech Zone Environmental Monitoring Station, HTZEPB = Hi-Tech Zone Environmental Protection Bureau, JPEPB = Jilin Province Environmental Protection Bureau, LEMS = Liaoyuan Environmental Monitoring Station, LEPB = Liaoyuan Environmental Protection Bureau, LWG = Liaoyuan Water Group, MEMS = Meihekou Environmental Monitoring Station, MEPB = Meihekou Environmental Protection Bureau, MWSC = Meihekou Water Supply Company, SEMS = Shuanyang Environmental Monitoring Station, SEPA = State Environmental Protection Administration, SEPB = Shuanyang Environmental Protection Bureau, SWSC = Shuanyang Water Supply Company.
Source: Government.

ENVIRONMENTAL MITIGATION MEASURES

Parameter	Environmental Impacts	Mitigation Measures
	Construction Stage	
Air	Dust from construction sites due to stockpiles, construction vehicles traveling on unpaved haul roads, etc.	• Pave frequently used haul roads • Water unpaved areas and haul roads frequently • Control vehicle speeds on construction sites • Cover stockpiles and trucks carrying dusty materials • Minimize on-site storage time of construction and demolition wastes • Restore disturbed land timely
Noise	Noise from powered mechanical equipment	• Use quiet equipment • Maintain construction machinery regularly • Use temporary hoarding/screen to shield off noise source • Stop work from 2200 hr to 0600 hr when near residential areas
Water	Wastewater from the work force and uncontrolled muddy water runoff from construction site	• Provide portable chemical toilets or small package wastewater treatment plants on-site • Install interim holding tanks and pipelines to convey sewage to nearby sewers if sewers are nearby • Install sedimentation tanks to treat process wastewater with high concentrations of SS • Maintain and monitor efficient sanitation • Provide health services on-site
Solid Wastes	Refuse from the work force and construction and demolition wastes	• Provide closed containers for storing on-site refuse • Transport refuse for proper off-site disposal regularly • Clean up and remove construction and demolition wastes regularly to prevent buildup on-site • Explore opportunities to reuse excavated soil for backfilling
Traffic	Construction traffic may cause traffic congestion on nearby roads	• Design temporary traffic management schemes and carry out these schemes during construction • Divert or schedule construction traffic to avoid morning and afternoon peak traffic hours • Build interim roads if necessary • Select alternative transport routes to reduce disturbance to regular traffic
	Operational Stage	
Air	Emissions from boilers	• Design and install air pollution control systems with TSP removal efficiency of 96% and SO_2 removal efficiency of 40–60%
	Odor from WWTWs	• Plant a 50 m wide green belt at the site boundaries of the WWTWs, with species such as Canadian poplar, Lombardy poplar, dwarf elm, and acacia • Set another 200 m wide protective buffer outside the

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Parameter	Environmental Impacts	Mitigation Measures
		green belt at the Beijiao WWTW • Set another 70 m wide protective buffer outside the green belt at the Nanjiao WWTW
Noise	Noise from fixed sources such as machineries and pumping stations	• Design the buildings that house these fixed noise sources properly, with adequate wall thicknesses, double-glazed windows and soundproof doors, etc. • Provide landscape to these buildings for aesthetics
Chlorine	Accidental spillage could pose health risks to workers and nearby residents	• Design the chlorine storage buildings properly, and equip them with chlorine gas detector, alarm system, and automatic chlorine gas collection system that will collect as well as neutralize the chlorine gas • Regularly inspect and maintain the above equipment • Store only 500 kg chlorine bottles • Limit the quantity of chlorine stored on-site to no more than a 20-day supply • Prepare a safety plan and an emergency response plan • Train workers regularly on the proper and safe handling of chlorine and on response procedures during an emergency
Solid Wastes	Refuse from the workforce, boiler ash and sludge	• Dispose of refuse properly at sanitary landfills • Explore the opportunity of selling the boiler ash to brick manufacturers • Explore and plan various means of disposing of the sludge, including composting, landfilling, etc.
Water	Wastewater from the workforce and the treatment process	• Discharge wastewater to public sewers • If there is no public sewer nearby, install septic tanks to treat the wastewater before disposal • Explore opportunities to reuse wastewater from backwashing

Source: Environment Protection Bureau.

SUMMARY ENVIRONMENTAL MONITORING PROGRAMS

Item	Location	Parameters	Time And Frequency
Beijiao WWTW—Construction Phase (by CEMS)			
Air	Construction site and nearby SRs	TSP	Once per season for 3 consecutive days
Noise	Construction site and nearby SRs	Noise	Once per month for 2 consecutive days, including once during day time and once at night
Water Quality	Yitong River	pH, SS	Once per month when sewerage pipeworks pass through Yitong River
Beijiao WWTW—Operational Phase (by CDC or CEMS)			
Air	Sludge dewatering, 1^o and 2^o aerated biofilter, plant boundary.	H_2S, NH_3, mercaptan, odor	Once per year in the summer for 2 consecutive days
	Stack	TSP, SO_2, NO_2	Once per heating season for 2 consecutive days
Noise	Plant boundary	Noise	Once per year for 2 consecutive days, including once during day time and once at night
Water	Plant outfall	COD, BOD, NH_3-N, TP	Once per season for 2 consecutive days
Sludge	Sludge storage tank	As, Pb, Cd, Cr, Hg, Zn, Cu	Twice per year
Nanjiao WWTW—Construction Phase (by CEMS)			
Air	Construction site and nearby SRs	TSP	Once per month for 3 consecutive days
Noise	Construction site and nearby SRs	Noise	Once per month for 2 consecutive days, including once during day time and once at night
Nanjiao WWTW—Operational Phase (by CDC or CEMS)			
Air	Plant boundary	H_2S, NH_3, mercaptan, odor	Once per season for 2 consecutive days
Noise	Plant boundary at N, S, E, W directions	Noise	Twice per year for 2 consecutive days, including once during day time and once at night
Water	Plant outfall	COD, BOD, NH_3-N, TP	Once per season for 2 consecutive days
Sludge	Sludge storage tank	As, Pb, Cd, Cr, Hg, Zn, Cu	Twice per year
Yongchun River Improvement—Construction Phase (HTZEMS)			
Air	4 stations in the Hi-Tech Zone and nearby village	TSP, SO_2, NO_2	3 times (in Apr, Jul, and Oct) per year for 3 consecutive days.
Noise	16 stations with 14 on construction site and 2 in nearby SR	Noise	One day each in Mar, Apr, May, Jun, Sep, Oct, Nov, including once during day time and once at night.

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Item	Location	Parameters	Time And Frequency
Water	3 stations: 2 at each of the 2 reservoirs and one control at the railway bridge	PH, SS, COD, BOD, phenols, petroleum hydrocarbon, DO, E. coli	Baseline monitoring before construction starts, and once per month from Apr to Nov during construction
Shuanyang WTW and PipelinesConstruction (SEMS)			
Air	Construction site and nearby SR	TSP	Once per month for 3 consecutive days
Noise	Construction site and nearby SR	Noise	Once per month for 2 consecutive days, including once during day time and once at night
Shuanyang WTW and Pipelines—Operation (SWSC or SEMS)			
Air	Stack	TSP, SO_2, NO_2	Once per year
Noise	1 m outside plant boundary	Noise	Once per year
Water	One station at intake pumping station	All parameters in [CJ3020-1993]	Once per month
	WTWs wastewater discharge point	COD, BOD, SS	Once per year
Liaoyuan WTW, Pumping Stations, Sewerage Network and Flood Control—Construction Phase (LEMS)			
Air	Construction site and	TSP	Two times per month
Noise	nearby SR	Noise	Two times per month
Water	At the barrage intake	COD, BOD, SS	Once per season
Liaoyuan WTW, Pumping Stations, Sewerage Network and Flood Control—Operational Phase (LWG or LEMS)			
Air	Stacks at the Longshan and Hebing WTWs	TSP, SO_2, NO_2	Two times per year
Noise	Plant boundaries of the Longshan and Hebing WTWs, and each of the 17 pumping stations	Noise	Two times per year
Chlorine	Chlorine storage buildings of the Longshan and Hebing WTWs	Inspection	Two times per year
Water	Wastewater from the Longshan and Hebing WTWs	COD, BOD, SS	Two times per year
Meihekou WTW and Pipelines—Construction Stage (MEMS)			
Air	Construction site and concrete batching site	TSP	Once per month for 3 consecutive days
Noise	Residents near the pipeline construction route	Noise	Once per season
Water	One station upstream of intake and one station downstream of intake	SS, COD, total coliform bacteria	Once per month for 3 consecutive days
Ecology	Construction site	Inspection for loss of soil and habitat	Every time on-site doing air monitoring

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Item	Location	Parameters	Time And Frequency
Meihekou WTW and Pipelines—Operational Stage (MWSC)			
Water	One station at intake in Hailong Reservoir	All parameters in [CJ3020-1993]	Once per wet, dry, and transitional seasons
	WTWs wastewater discharge point	SS, COD	Once in Jan and once in Jul
Noise	Noise sources inside plant	Noise	Once per year
	Plant boundary	Noise	Once per year in the summer season

CDC = Changchun Drainage Company, CEMS = Changchun Environmental Monitoring Station, HTZEMS = Hi-Tech Zone Environmental Monitoring Station, LEMS = Liaoyuan Environmental Monitoring Station, LWG = Liaoyuan Water Group, MEMS = Meihekou Environmental Monitoring Station, MWSC = Meihekou Water Supply Company, SEMS = Shuanyang Environmental Monitoring Station, SWSC = Shuanyang Water Supply Company.INCLUDE SS, COD, ETC.

Source: Government, Environment Protection Bureau.