Environmental Impact Assessment (Draft)

Project Number: 47069-001
August 2015

People's Republic of China: Henan Hebi Qi River Environmental Improvement and Ecological Conservation Project

Prepared by the Hebi City Government for the Asian Development Bank

CURRENCY EQUIVALENTS

(As of 31st July 2015)
Currency Unit – yuan (CNY)
CNY 1.00 = $ 0.1611
$ 1.00 = CNY 6.21

ABBREVIATIONS

ADB	Asian Development Bank
BOD_5	5-day biochemical oxygen demand
CNY	Chinese Yuan
COD	Chemical oxygen demand
DO	Dissolved oxygen
EA	Executing Agency
EIA	Environmental impact assessment
EIR	Environmental Impact Report
EIT	Environmental Impact Table
EMP	Environmental Management Plan
EMS	Environment monitoring station
EPB	Environmental Protection Bureau
FSR	Feasibility Study Report
FYP	Five Year Plan
GDP	Gross domestic product
GHG	Greenhouse gas
GRM	Grievance redress mechanism
HCG	Hebi City Government
HPG	Henan Provincial Government
IA	Implementing Agency
I_{Mn}	Permanganate index
LIEC	Loan implementation environmental consultant
MEP	Ministry of Environment Protection
MIS	Management Information System
NWP	National Wetland Park
PEP	Precipitation
$PM_{2.5}$	Particulate matter with diameter<2.5μ
PM_{10}	Particulate matter with diameter<10μ
PMO	project management office
PRC	People's Republic of China
RP	Resettlement Plan
SFA	State Forestry Administration
SWCR	Soil and Water Conservation Report
SOE	State Owned Enterprise
SPS	Safeguard Policy Statement
TN	Total Nitrogen
TP	Total Phosphorus
TSP	Total Suspended Particulates
WHO	World Health Organization
WRB	Water Resources Bureau
WWTP	Wastewater Treatment Plant

WEIGHTS AND MEASURES

^oC	degree centigrade
dB	decibel
ha	hectare (10,000 m^2)
kg	kilogram
km	kilometer
km^2	square kilometer
kW	kilowatt
L	liter
m	meter
m^2	square meter
m^3	cubic meter
m^3/a	cubic meter per annum
m^3/d	cubic meter per day
mg/kg	milligram per kilogram
mg/l	milligram per liter
mg/m^3	milligram per cubic meter
mu	Chinese land unit (1 ha=15 mu)
MW	megawatt (1 million watts)
t	metric ton (1,000 kg)
t/a	ton per annum

NOTE

(i) In the report, "$" refers to US dollars.

Contents

I. EXECUTIVE SUMMARY

A. Background

1. This project environmental impact assessment (EIA) is for the Henan Hebi Qi River Environmental Improvement and Ecological Conservation Project (the project). It is based on: (i) the findings of seven domestic environmental assessments (one Environmental Impact Report and six Tabular Environmental Impact Assessments) prepared by the Beijing Zhonghuan Guohong Environment and Resources Technology Limited Company; (ii) the domestic Soil and Water Conservation Report (SWCR) for the project; (iii) seven feasibility study reports (FSRs) prepared for the project components; and (iv) field surveys between August 2014 and June 2015 conducted by a team of consultants for the project preparatory technical assistance (PPTA). These include assessments on climate risk vulnerability, wetland design, water resources, and biodiversity. The EIA includes an Environmental Management Plan (EMP), and has been prepared in compliance with ADB's Safeguard Policy Statement (SPS, 2009).

2. The project area encompasses an 83-km section of the Qi River, in Qibin District and Qi County of Hebi City, located in the north of Henan Province, People's Republic of China (PRC). The project area represents half (51%) of the Qi River (162 km). Environmental conditions along the river have deteriorated due to intensive economic development and increasing human populations. Vegetation, wetlands, and water quality along the Qi River have declined due to urbanization, modification of the river hydrology (in-channel barrages and embankments along the river, and a large dam, Panshitou, in the upper section), habitat loss and deforestation, livestock grazing, agriculture, over-extraction of water, and non-point source pollution. The variety and quantity of flora and fauna have decreased and the ecological functions of the forest and wetland have been affected. A protected area covers part of the upper Qi, the pilot Qi River National Wetland Park (NWP), but requires habitat restoration and improved facilities and management to provide more effective function for conservation and sustainable use for tourism and education. Flood control capacity of the main stream and tributaries of the lower Qi is insufficient due to siltation and the poor condition of old embankments. The flood control capacity of the lower Qi mainstream is only for a 1 in 5 year flood, and for 1 in 3 year flood in four tributaries of the lower Qi River.

3. Water quality in the lower Qi River has also declined due to inadequate management of wastewater and solid waste. Two wastewater treatment plants (WWTPs) serve the urban areas in Qibin District and Qi County. The WWTP in Qibin District has a treatment capacity of 50,000 m^3/d, is currently treating 20,000 m^3/d of wastewater, and has adequate treatment capacity for higher volumes of wastewater. The WWTP in Qi County has a treatment capacity of 30,000 m^3/d and is currently treating 29,000 m^3/d; its treatment capacity is not adequate to accommodate the increasing volumes of wastewater as the population increases. The sewage pipeline collection network currently covers about 40% of Qibin District and Qi County. Untreated wastewater discharges directly to the lower Qi main stream and tributaries, causing the deterioration of water quality. The Hebi City Government (HCG) has been making various efforts on environmental improvement and ecological conservation in the Qi River basin, including afforestation, WWTP construction, solid waste management, and public awareness education. Although a certain level of improvement has been achieved, the City of Hebi still has significant environmental problems and issues to address as described above.

B. The Project

4. The impact of the project will be sustainable economic development of the Qihe River Basin in Hebi City achieved. The outcome of the project will be integrated environmental and ecological protection of the Qihe River basin improved. The project has four outputs: 1–

ecological conservation and environmental management of upper Qihe River and its watershed enhanced; 2–lower Qihe River mainstream and tributaries improved; 3–wastewater and solid waste management in the Qihe River Basin improved; and 4–institutional and technical support system for integrated management of the Qihe River Basin improved. Output 1 comprises: (i) re-vegetation on hill slopes in the upper and middle sections of the Qi; and (ii) wetland restoration and protection in the NWP. Output 2 comprises: embankment of selected sections of the lower Qi, four tributaries, and five canals, dredging of the canals (not mainstream), and riverside greening (38 km from Panshitou reservoir to Liuzhuang barrage and along the canals), for improved river bank erosion control and water environment. Output 3 comprises wastewater and solid waste management in riverside areas in Qibin District and Qi County, to reduce pollution load to the lower Qi. Output 4 will support the development and implementation of: (i) Qi River ecological monitoring program; (ii) Qi River Management Information System (MIS), to support integrated water resources management (IWRM); and (iii) associated project training. Works are summarized in Table ES-1; locations are shown in Figure IV-1.

Table ES-1: Summary of Project Outputs and Subcomponents

Output	Activity
1	**Ecological conservation and environmental management of upper Qihe River and its watershed enhanced [Qibin District]**
1.1	**Qihe River Upstream Ecological Protection**
1.1.1	Barren hill greening (1,346 ha; 19 hills)
1.1.2	Barren hill community maintenance (irrigation, pest control, patrol)
1.1.3	Barren hill monitoring of planted vegetation
1.2	**Restoration and management of pilot Qihe River National Wetland Park**
1.2.1	Habitat restoration and creation (marsh land restoration 36.3 ha; (habitat creation:12.3 ha)
1.2.2	Protection of flagship species (fencing 1,589 m; signage: 300)
1.2.3	Re-vegetation and restoration of riverbanks (3.9 km)
1.2.4	Re-vegetation (49.2 ha)
1.2.5	Infrastructure: (i) upgrade existing public access road (3.2 km) and patrol road (6.3 km); construct new patrol road (2.5 km) and walking paths (4.4 km); (ii) research and monitoring center (500m2), field stations (160m2), bird hides, ecological monitoring equipment; (iii) management and service facilities (management office, public toilets, power and water supply, drainage)
1.2.6	Establishment of park management agency and first five-year management plan
1.2.7	Park monitoring program
1.2.8	Community participation in park monitoring (local river guards)
2	**Lower Qihe River Mainstream and tributaries improved [Qibin District, Qi County, Xun County]**
2.1	**Qihe Mainstream Watercourse Improvement in Qi County (21 km)**
2.1.1	Mainstream bank stabilization (Gabion works – 14 locations along both banks; total works about 4.08 km)
2.1.2	Crest road paving (42 km; 21 km along each bank)
2.2	**Four Tributary Watercourse Improvement in Qi County**
2.2.1	Channel widening, dredging, bank protection (Side River 9.5 km, Zhaojia Canal 9.8 km, Zhejing River 6.62 km, Hucheng River, including Longxui ditch with a length 5.92; total 31.84 km)
2.2.2	Riverside greening (Side River, Zhaojia Canal; total 11.5 km)
2.3	**Five Canal Watercourse Improvement in Qibin District**
2.3.1	Canal widening, dredging, bank protection (Tianlai 5.15 km, Mianfeng 0.97 km, Erzhi 0.73 km; total 6.852 km)
2.3.2	Canal repair (Sanzhi 2.84 km, Sizhi 1.6 km; total 4.44 km)
2.3.3	Riverside greening at a total length of 11.3km along Tianlai, Mianfeng, Erzhi Canals and Sanzhi and Sizhi Canals (up to 15 m width on each river side along Tianlai, Mianfeng, and Erzhi Canals, and up to 10 m width along Shanzhi and Sizhi Canals)
2.3.4	Supporting facilities (irrigation, bank-side walkways, landscaping)

Output	Activity
3	**Wastewater and Solid Waste Management in the Qihe River Basin improved**
3.1	**Qibin District Wastewater Management**
3.1.1	Stormwater pipeline construction (Dalaidian 7.76 km; Juqiao 73.77 km; total 81.53 km)
3.1.2	Sanitary sewer installation (Dalaidian 21.48 km; Juqiao 68.85 km; total 90.33 km. Includes connection to Qibin WWTP + planned Qishuiwan WWTP
3.2	**Qi County Wastewater Management**
3.2.1	Qi County WWTP expansion (30,000 tons/d to 60,000 tons/d)
3.2.2	Stormwater pipeline construction (132.49 km)
3.2.3	Sanitary sewer installation (69.12 km)
3.3	**Solid Waste Management [Qi County, Qibin District]**
3.3.1	Urban–15 domestic waste transfer stations (capacity 20 t/d) including equipment for compaction, odor removal, 44 transport vehicles (Qi County)
3.3.2	Rural–upper Qihe: install litter bins, waste transport vehicles in 13 villages (Qibin District–6; Qi County–7)
3.3.3	Rural–lower Qihe: install litter bins, waste transport vehicles in 20 villages (Qi County)
3.3.4	Pilot community-led waste management system – awareness raising and waste collection (Qi County and Qibin District)
3.3.5	Domestic study tours for capacity building of relevant agencies and support the development of a better solid waste management system
4	**Institutional and technical support system for integrated management of the Qihe River Basin improved [Qi County, Qibin District]**
4.1	Qihe River Ecological Monitoring Program (ecology and hydrology)
4.2	Qihe River Basin Management Information System
4.1	Project start-up support consulting services
4.2	Loan implementation consulting services
4.3	External resettlement monitoring and evaluation
4.5	Training for project management and other training costs

C. Project Benefits and Features

5. The project will implement an integrated and holistic approach to water resources management for the most flood-prone, and ecologically sensitive, sections of an inland river system, within the most populated province in the PRC. The project area encompasses half of the total length of the Qi, including part of its upper section and all of its middle and lower sections. Project components are tailored to the different management, hydrological, and topographic conditions of each river section, and comprise a range of structural and non-structural measures as follows: wetland protection and control of soil erosion in the upper section; reduction of pollution loads by sewage and solid waste management in the upper and middle sections; flood control measures in the middle and lower sections; capacity building for IWRM; and, implementation of a Qi River MIS to support flood warning, ecological monitoring, and other measures. The project's IWRM approach, which increases efficiency and separation of wastewater and storm water, improves the capacity for water retention in wetlands along the Qi, and strengthens water resource monitoring, supports the PRC concepts for "sponge city" [1] and "ecological civilization", which promote sustainable development, water resources management, and the need to provide demonstration models for river governance.

6. Specific project benefits include: (i) soil erosion in the Qi catchment reduced by 11,000 tons per year, due to the re-vegetation of barren hills (forest cover in Hebi City increased by 7%, from 53% to 60%; output 1.1.1); (ii) carbon sink established due to the re-vegetation activities, which will sequester approximately 16,000 tons CO_{2e} per year and reduce net greenhouse gas emissions during project construction and operation by 26% (Section VI.G);

[1] Hebi City is in the first batch of 16 pilot cities in the PRC to trial the "sponge city" concept, which emphasizes the importance of water resources management.

(iii) flood control capacity improved from a 1 in 5-year to 1 in 20-year flood recurrence interval for the lower Qi River, <1 in 5 to 1 in 20-year interval for three main tributaries (Side and Zheijang Rivers; Zhaojia Canal), and drainage capacity strengthened for six minor waterways (Tianlai, Mianfeng, Second Branch, Third Branch, and Fourth Branch Canals; Hucheng channel) (output 2); (iv) the volume of untreated wastewater discharged into the Qi River and canals will be reduced by 20%, from 57,200 m^3/d in 2015 to 45,840 m^3/d in 2022; (v) the pollutant loads being discharged from the Qi County WWTP will be reduced by 70–97%, due to improved treatment levels; and (vi) IWRM for the Qi River improved, through training of city bureaus and adoption of the MIS for water and land resource management, including flood warning. The ecological services of the Qi will also be strengthened through these measures, including improved water retention and filtration on hill slopes and along riverbanks.

D. Baseline Environment

7. The project area comprises an 83-km section of the Qi River. A large dam, Panshitou, is situated along the Qi River immediately upstream of the project area. The project area begins downstream of the dam and extends to the confluence of the Qi and Wei Rivers. The river within the project area can be broadly divided into three sections: the upper section (23.7 km), middle section (14.3 km) and lower section (45 km). The upstream section comprises a shallow, swift-flowing river less than 80 m wide, with rocky substrate, interspersed with slower-flowing sections with deeper pools. River banks are rocky and vegetated or support villages and associated agricultural land. The pilot NWP encompasses 7.5 km of the Qi (representing 32% of the upper section and 9% of the total Qi length in the project area; and 5% of the total length of the Qi). The middle section of the Qi is urbanized and highly populated. The mainstream is over 100 m wideand almost entirely embanked. Large towns occur along the riverbanks and tributaries. Most tributaries have been converted to artificial canals and are dredged and embanked. The lower section supports few settlements and flows through agricultural land. Here the river is slow-flowing and banks are partly vegetated. All surface water flow in the Qi is heavily regulated, by Panshitou Reservoir in the headwaters, and approximately nine barrages along the mainstream.

8. Project sampling of environmental parameters indicated the following. For surface water quality, the mainstream Qi and canals were confirmed to be highly polluted. Samples exceeded Grade III of the PRC standard GB 3838-2002 and for some canals, exceeded Category V standards for COD, BOD_5, TN, TP and NH_3-N. Pollution is caused by discharge of untreated domestic sewage from residential areas and industrial wastewater from Heqi Industrial Cluster Zone. For ambient air quality, samples complied with Class II air quality standards and the World Bank Group's (EBG) Environmental Health and Safety (EHS) interim targets, except at five locations, where values exceeded Class II for total suspended particulates (TSP) and PM_{10} (reflecting dust dispersion due to seasonal strong wind and potentially, emissions from nearby industrial complexes). For in-channel sediment quality, sampling was restricted to tributaries of the Qi River in Qi County and Qibin District (no project dredging will be conducted in the mainstream Qi) and supplemented by data in the *Environment Quality Bulletin of Hebi* (2012). Sediment quality complied with *Control Standards for Pollutants in Sludge from Agricultural Use* (GB 4284-84). For ecology, the pilot NWP supports significant biodiversity conservation values, including a threatened fish (Qi River Crucian Carp *Carassius auratus*), plant (Wild Soya *Glycine soja*) and at least 45 bird species of conservation interest (Section V.C).

E. Potential Environmental Impacts and Mitigation Measures

9. **Construction phase.** Project works in the pilot NWP will cause temporary noise and visual disturbance which may result in disturbance to migratory and/or nesting waterbird communities, including storks, ducks and geese, minor damage to aquatic habitats, fish, and aquatic invertebrates due to elevated sediment levels, and small-scale flow diversions during

works. The river rehabilitation works will involve the dredging of about 4.18 million m^3 of excavation (excluding dredged sediments) from the project canals and tributaries (widening and blockage removal along the channels) and embankments along the lower Qi. After use for back-fill, about 3.66 million m^3 of spoil will require disposal. This will be disposed in 26 disposal sites, which comprise trenches, farmland, uncultivated land and shrubbery areas of low ecological value, and are described in Section VI.

10. Dredging of waterways will produce about 85,232 m^3 dredged sediments from the four tributaries in Qi County and 18,050 m^3 from the five canals in Qibin District. The canals in Qibin District are small and narrow, and in the dry season, flows are minimal and slow (<1 m^3/s). Flow will be controlled by existing upstream sluice gates during dredging. Dredged sediment will be drained and used as soil supply for project component 1.1 (re-greening of barren hills). Solid waste (litter) will be transported to Caizhuang Landfill Site. Caizhuang Landfill is 10 km from the canals and has receiving capacity of 530 t/d, total capacity of 2.79 million m^3, and remaining operational lifetime (at current rates of landfill) of about 13 years. For the four canals in Qi County, the estimated daily dredged amount will be 2,500 m^3. This will be dried by belt dewatering machine then transported to Huangzhuang Quarry, east of Huangzhuang Village, Qi County. The quarry was formed in the 1990s to supply earth and gravel for road construction and is no longer used. The quarry comprises a large, deep pit. The dredged sediment will be disposed in this pit. The sediment quality is suitable for agriculture, and the site will be used by residents for agriculture after project completion.

11. For construction of the Qi County WWTP, soild waste transter stations and installation of sewer and storm collection pipelines in Qi County and Qibin District, construction will result in temporary dust and noise disturbance to residents.

12. Mitigation measures have been developed for all potential construction-related impacts and are included in the EMP. Overall the potential impacts are to be considered relatively low and manageable.

13. **Operation phase.** Potential operational risks include: (i) impact of odor emissions from the Qi County WWTP to residents; (ii) cumulative effect on water quality in Zhejing canal due to the discharge of the treated wastewater; and (iii) inadequate maintenance of project facilities, including river embankments, due to insufficient capacity and/or operating budget. For odor impacts, a buffer zone distance of 100 m from the WWTP to the nearest residents has been established and complies with the PRC standard. For effluent quality, the Qi County WWTP will treat wastewater to Class 1A of the PRC's *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant*, the highest possible standard, before discharge to Zhejing River. Effluent and surface water quality monitoring will be conducted by the local environment protection bureaus (EPBs). For maintenance of project facilities, roles and responsibilities for operation and maintenance have been largely defined. Embankments will be maintained by the river course management stations of the county/district Water Resources Bureaus, supported by river guards, and the barren hills will be managed by the Qibin District Forestry Bureau. For the pilot NWP, the need to establish a management agency and management plan was identified during project preparation and has been included in the design. The project will provide training for agencies in the management and maintenance for all activities, especially wetland management in the NWP.

F. Climate Change

14. A climate risk vulnerability assessment was conducted to identify the threat that climate change presents to project viability, assuming a design life of 40–50 years. Modeling indicates that between 2020 and 2070, mean annual temperatures will rise, the risk of extreme climate events (including severe storms, floods, and drought) will increase, and that variability in precipitation will increase, causing more rainy days and dry days. Such events

could cause: flood volumes which exceed the capacity of the project embankments, channels, and pipelines; increases sediment deposition in the lower Qi and canals due to more flooding, requiring more frequent maintenance and cleaning of excess sediments to maintain the flood control standards achieved; and, changes in temperature or water availability which affect the growth and survival of the planted vegetation.

15. The project includes the following measures to accommodate these risks: (i) the embankments, channels and pipelines have been designed to PRC flood protection standards, taking into account local topography and climate; (ii) in accordance with the PRC's Embankment Projects Design Specification (GB50286-98), an additional height is included between the top of channel embankments and the maximum design water level. This additional height is to provide protection for (1) wave action; (2) wind action; and (3) inaccuracies in design and construction workmanships; (iii) porous embankment designs have been selected for the lower Qi River, for improved infiltration; (iv) development of the Qi River MIS. This will focus on water resources management, including flood warning; (v) canals and embankments will be regularly maintained for operational effectiveness; and (vi) plant species selected for revegetation of the barren hills will comprise species suited to the seasonally dry climate, harsh winters, and shallow, rocky soils of the area. Overall, the existing project design is oriented to achieve resilience to climate impacts. Improved capacity to manage floods and wastewater are integrated in the project design as specific outputs, while improved management of wetlands in the upper Qi River, and re-vegetation of surrounding hillsides, will improve water retention and filtration. Non-structural measures will supplement these measures, including training in wetland and water resources management.

G. Information Disclosure and Public Consultation

16. Information disclosure of project information and related environmental issues was conducted twice and published on the website of the Hebi EPB (http://www.hbhb.gov.cn/) in December 2014 and May 2015. The first time was at the commencement of preparing the domestic environmental reports; the second was when the draft reports were completed. The duration of each website disclosure was 10 working days. No objections to the project were received. A questionnaire survey by the EIA institute was conducted in May-June 2015 of potential affected residents and groups in Qibin District, Qi County, and Xun County. Meetings with 81 (Qibin District) and 83 (Qi County) staff of local government departments and village representatives were held on 26-27 May 2015. Staff from the EIA institute introduced the project and presented the EIA findings on potential environmental impacts and mitigation. The PPTA national environment specialist participated and introduced the project EMP and grievance redress mechanism. Concerns expressed by residents included the risk of potential construction delays and need for clarification of resettlement issues. Measures to address these concerns have been incorporated in the mitigation measures (EMP; Attachment 1) and resettlement plans respectively.

H. Grievance Redress Mechanism

17. A project-specific grievance redress mechanism (GRM) has been prepared for the project. The GRM provides people affected by the project with a channel to register their grievance. The GRM comprises a series of time-based steps to ensure any concerns are quickly and effectively addressed. The GRM will be coordinated by the Hebi Project Management Office (PMO). It will include a complaint center with hotline for receiving environmental and resettlement grievances and will be accessible to diverse members of the community. Multiple points of entry, including face-to-face meetings, written complaints, telephone conversations, or e-mail, are included in the GRM. The GRM is included in the EMP.

I. Environmental Management Plan

18. As part of this EIA, a project environmental management plan (EMP) has been developed (Attachment 1). This describes the project requirements for environmental mitigation measures, monitoring, reporting, roles and responsibilities, budget, and the project GRM. The EMP will be the key guiding document for environmental-related issues for project construction and operation. It will be included as an annex in all bidding and contract documents. The contractors will be made aware of their obligations to implement the EMP and to budget EMP implementation costs in their proposals. HCG (through the PMO) and the implementing agencies (through the project implementing units; PIUs) will assume overall responsibility for implementing, supervising, monitoring and reporting on the EMP. PMO and PIU capacity to implement the EMP will be strengthened through capacity building and training activities defined in the EMP. The PMO and PIUs will appoint qualified environmental staff to coordinate and monitor EMP implementation. A loan implementation environmental consultant (LIEC) will be funded under the ADB loan to assist the PMO and PIU's in EMP implementation, environmental training and semi-annual environmental monitoring report preparation.

J. Risks and Assurances

19. The project agencies have no previous experience in ADB safeguard procedures and have low institutional capacity for environmental management. This may result in limited implementation of the project EMP and inadequate operation of the project facilities, especially the pilot NWP. These risks have been minimized as follows: (i) appointment of full-time environment officers in the PMO and PIUs; (ii) the inclusion of a LIEC, wetland specialist, and ecological monitoring specialist in the loan consultant services; (iii) close coordination with the local environmental protection bureaus and monitoring stations to support EMP implementation; (iv) defined roles and responsibilities of all relevant agencies, including contractors and construction supervision companies; and (v) capacity building for EMP implementation. Environmental assurances (Section XI) have been agreed upon and are included in the loan and project agreements.

K. Conclusion

20. It is concluded that full and effective implementation of the project EMP (Attachment 1), together with the training and project assurances, will minimize the environmental risks of the project and achieve compliance with the policy and regulatory standards applied in this EIA.

II. INTRODUCTION

21. The Qi River originates from the Qizi Mountain in Shanxi Province and drains into the Wei River, flowing through Hui County, Linzhou City and Hebi City in Henan Province, with a total length of 162 km. Half of the Qi (83 km of 162 km; 51%) is in Hebi City, running through Qibin District, Qi County and Xun County of Hebi City. The Qi River basin is a target for intensive economic development with rapidly expanding residential and industrial estates. However, there are many issues in the basin such as deteriorating vegetation and wetlands in the river reaches and their watersheds causing changes in original and natural ecological functions of forests and wetlands. Flood control capacity of the main stream and tributaries of the lower Qi is insufficient. The wastewater collection system coverage is inadequate in Qibin District and Qi County, leading much of wastewater directly into the main stream and tributaries of the lower Qi River reach.

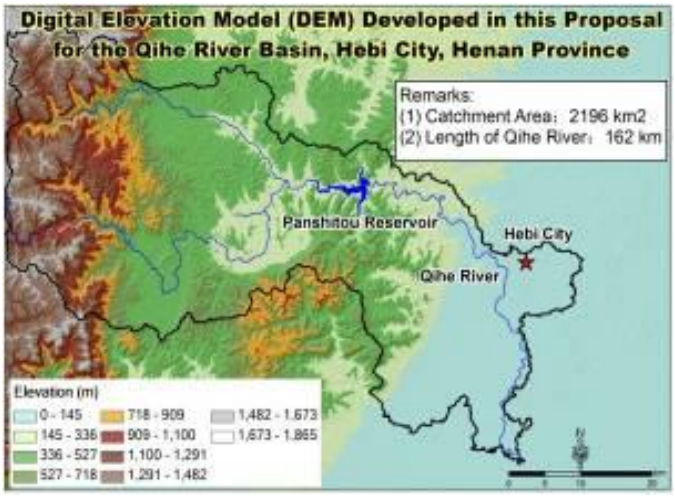


Figure II-1: Location Map of Qi River Basin

22. The Hebi City Government (HCG) has requested the Asian Development (ADB) to provide lending support to implement the Henan Hebi Qi River Environmental Improvement and Ecological Conservation Project (the Project). The proposed project is included in ADB's country operations business plan, 2014–2016 and the ensuing loan in ADB's 2016 lending pipeline for the PRC. The project was classified as environment Category A by ADB, requiring preparation of environmental impact assessment (EIA). This project EIA, including Environmental Management Plan (EMP) has been prepared in compliance with ADB's Safeguard Policy Statement (SPS, 2009). The EMP (Attachment 1) is the key guiding document for environmental-related issues in the construction and operational phases of the project.

23. The EIA was based on: (i) information in the seven Feasibility Study Reports (FSR) and Soil and Water Conservation Report (SWCR) prepared by Henan Water and Power Engineering Consulting Company Limited and seven domestic EIA documents prepared by the Beijing Zhonghuan Guohong Environment and Resources Technology Limited Company; (ii) fieldwork conducted between September 2014 and June 2015 by a consultant team for the project preparatory technical assistance (PPTA); and (iii) other sector studies by the PPTA team, including water resources, wetlands, climate change and biodiversity assessment. The data presented in tables and figures in this EIA are from the FSR and domestic EIAs unless stated otherwise.

III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Policy and Planning Context

24. The project is conducted within the framework of, and contributes to implementation of, the following plans:

- *12th Five Year Plan for Environment Protection in Hebi City (2011-2015).* This requires improvements of rivers flowing through the city and increasing investments in construction of supporting sewage pipe network.
- *Master Plan for Hebi City Qi River Ecological Areas (2010–2020)*. This divides the Qi River into three functional areas: ecosystem protection area in upstream; rehabilitation and utilization in midstream; and, utilization with protective measures in downstream.
- *Hebi Urban Master Plan (2007-2020).* This defines objectives to strengthen the protection of biological resources, rehabilitate wetlands, and increase the forest coverage up to 45%. The Qi River is listed as a priority for ecological protection.
- *River Rehabilitation Planning for Major Rivers in Hai River Basin in Hebi City of Henan Province (2013-2015)*. Under this plan, the upper Qi is required to meet the 50 year flood standard; and the lower section, Side River and Zhaojia Canal the 20 year standard.
- *Management Methods for Development and Protection of Qi River (2002).* This requires the development of the Qi River to follow the principle of "coordinated development and environment protection".
- *Measures for Qi River Protection (2011).* Defines three protection zones (Grades I–III) for the river.
- *Master Plan for the pilot Qi River National Wetland Park (2010–2020*). The plan identifies the need for wetland restoration and management, yet provides few quantitative targets. The project directly contributes to the plan and refines the objectives for habitat restoration into measurable targets (Section V.E).

B. Legislative Framework for Environment Impact Assessment in the PRC

25. The domestic environment impact assessments (DEIAs) conducted for the project were prepared under the EIA Law of 2003, Management Guideline on EIA Categories of construction Projects (2015), and other relevant laws and regulations (Tables III-1 and III-2).

Table III-1: Applicable Environmental Laws

Title	Year
Environmental Protection Law	2014
Environmental Impact Assessment Law	2003
Water Law	2002
Water Pollution Prevention and Control Law	2008
Air Pollution Prevention and Control Law	2000
Noise Pollution Control Law	1997
Solid Waste Pollution Prevention and Control Law	2005
Water and Soil Conservation Law	2011
Forest Law	1998
Wild Fauna Protection Law	2004
Cleaner Production Promotion Law	2002
Urban and Rural Planning Law	2008
Land Administration Law	2004
Circular Economy Promotion Law	2009
Fishery Law	2000
Flood Control Law	1998
Protection of Cultural Relics Law	2013

Table III-2: Applicable Administrative Regulations

Regulation	Year
National	
Regulation on EIA of Plans and Programs	2009
Regulation on Environmental Protection Management for Construction Projects	1998
Directive on Wetland Protection and Management	2013
Environmental Protection Supervision Rules for Construction Projects	1998
Regulation on Culture Heritage Protection	2003
Regulation on River Course Management	1988
Requirements for the EIA Summary of Construction Project	2010
Classification of Construction Project Environmental Protection Management (MEP)	2009
National Biodiversity Strategy and Action Plan (2011-2030)	2010
Requirement for Social Risk Assessment of Large Investment Projects	2012
National Biodiversity Strategy and Action Plan (2011-2030)	2010
National regulation for public disclosure of EIAs (NDRC)	2012
Regulations on Scenic and Historic Areas	2006
Regulation on Hazardous Chemicals Safety Management	2011
Regulation on Wild Flora Protection	1996
Regulation on Wild Fauna Protection	1992
Regulation on Aquatic Wildlife Protection	1993
Regulation on Urban Water Supply	1994
Management of National Wetland Park (trial)	2010
Local	
Qi River Protection Implementation Measures in Henan Province	2011

26. Implementation of the environmental laws and regulations is supported by a series of associated management and technical guidelines (Table III-3).

Table III-3: Applicable Environmental Impact Assessment Guidelines

Guideline	Year/Code
Jurisdictional Division of Review and Approval of EIAs for Construction Projects	2009
Guideline on EIA Categories of Construction Projects	2015
Interim Guideline on Public Consultation for EIA	2006
Technical Guideline on EIA: Outline	HJ2.1-2011
Technical Guideline on EIA Regarding Surface Water	HJ/T 2.3-1993
Technical Guideline on EIA Regarding Atmospheric Environment	HJ 2.2-2008
Technical Guideline on EIA Regarding Acoustic Environment	HJ 2.4-2009
Technical Guideline on EIA Regarding Ecological Impact	HJ 19-2011
Technical Specification on Water and Soil Conservation Plan	GB50433-2008
Technical Guideline on Environmental Risk Assessment for Construction Project	HJ/T 169-2004
Industrial Restructuring Directory (2011)	Revised in 2013

27. The PRC environmental quality standard system that supports the environmental laws and regulations is classified into two categories by function: pollutant emission/discharge standards; and, ambient environmental standards (Table III-4).

Table III-4: Applicable Environmental Standards

Standard	Code
Surface Water Quality Standard	GB 3838-2002
Urban Ambient Acoustic Quality Standard	GB 3096-2008
Ambient Air Quality Standard	GB 3095-1996/2012
Integrated Emission Standard of Air Pollutants	GB 16297-1996
Integrated Wastewater Discharge Standard	GB 8978-1996
Underground Water Quality Standard	GB/T 14848-93
Domestic Drinking Water Quality Standard	GB 5749-2006
Emission Standards of Environment Noise for Boundary of Site Noise	GB 12523-2011
Noise Limit of Industrial Enterprises	GB 12348-2008

Standard for pollution control on hazardous waste storage	GB 18597-2001
Pollution control for storage and disposal site for industrial solid wastes	GB18599-2001
Emission Standards for Odor Pollutants	GB 14554-93

C. International Agreements

28. The PRC is a signatory to international agreements relevant to environment protection. Those relevant to the project, along with the date of signing by the PRC, include:

- *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, 23 February 2005. To reduce greenhouse gas emissions (GHGs) by enhancing the national programs of developed countries aimed at this goal and by establishing percentage reduction targets for the developed countries;
- *Montreal Protocol on Substances That Deplete the Ozone Layer*, 1 January 1989. To protect the ozone layer by controlling emissions of substances that depletes it; and,
- *United Nations Framework Convention on Climate Change*, 21 March 1994. To stabilize GHG levels sufficient to prevent dangerous human interference with the climate.

D. Applicable PRC and ADB Policies and Assessment Categories

29. Under PRC legislation, the proposed project activities are classified as "Significant Impact" (requiring a full Environmental Impact Statement; EIS) or "Medium Impact" (requiring a Tabular EIA; TEIA). Based on the PRC Guideline on EIA Categories of Construction Projects (MEP, 2015), one EIS studies and six TEIA are required (Table III-5). The seven assessments will be approved by the Hebi Municipal Environment Protection Bureau.

Table III-5: Domestic EIA Institute for Each Component

Component	Sub Component	Report
1. Ecological Conservation	Qi River Upstream Ecological Protection	TEIA
	Qi River Wetland Conservation and Rehabilitation	EIS
2. Qi River Mainstream and Tributary Watercourse Improvement	Qi River Mainstream Watercourse Improvement in Qi County (21km)	TEIA
	Four Tributary Watercourse Improvement in Qi County	TEIA
	Five Canal Watercourse Improvement in Qibin District	TEIA
3. Watercourse and Solid Waste management	Qibin District Wastewater Management	TEIA
	Qi County Wastewater Management	TEIA

30. ADB's Safeguard Policy Statement (SPS, 2009) provides the basis for this project EIA. Projects funded by ADB must comply with the SPS. The purpose of the SPS is to establish an environmental review process to ensure that projects funded under ADB loans are environmentally sound, comply with domestic laws, and are not likely to cause significant environment, health, or safety hazards. The project is classified as Category A by ADB, requiring the preparation of an EIA, including EMP.

E. Assessment Standards

31. The environmental standard system that supports the implementation of the environmental protection laws and regulations in the PRC can be classified by function-ambient environmental quality standards, and by pollutant emission and/or discharge standards. ADB's SPS requires projects to apply pollution prevention and control technologies and practices consistent with international good practices such as the World Bank Group's Environmental, Health and Safety Guidelines (EHS).[2] For this assessment, where EHS standards exist for parameters and are relevant, they are used in parallel with PRC standards in this assessment.

[2] World Bank Group. 2007. *Environmental, Health and Safety Guidelines General EHS Guidelines.* Washington: World Bank.

1. Evaluation against Ambient Standards

32. The Hebi Municipal Environmental Protection Bureau has nominated the environmental quality classes for each component of the proposed Project (Table III-6).

Table III-6: Environmental Quality Classes in the Project Area

Variable	Function Classes
Air Quality	Class II of GB3095-1996 before 1st January 2016; Class II of GB3095-2012 after 1st January 2016.
Acoustic Environment	Class II of GB3096-2008
Surface water	Mainstream of Qi River and Side River: Class III of GB3096-2008. Zhaojia and other canals, and Zhejing and Hucheng Rivers-Class V of GB3096-2008
Groundwater	Class III of GB/T 14848-93
Soil	Class II of GB15618-1995

33. **Air quality.** The PRC ranks air quality into three classes according to *Ambient Air Quality Standard* (GB3095-1996; amended in 2000). Class I is highest air quality and Class III the worst. A new standard was issued in 2012 (GB 3095-2012), replacing GB3095-1996, and will become effective in all municipal level city in 2015 and nation-wide on 1 January 2016. The new standard combines Classes II and III, introduces $PM_{2.5}$ standards, and makes more stringent NO_2 standards. Currently, the applicable standard is GB3095-1996. The World Health Organization (WHO) has set up air quality guideline (AQG) standards for various air quality parameters for the protection of public health. Recognizing that progressive actions are needed to achieve these standards and the financial and technological limitations of some countries or localities especially in developing countries, the WHO also established interim targets as intermediate milestones towards achieving the AQG (Table III-7).

Table III-7: Comparison of PRC and WBG Ambient Air Quality Standards. n/a=not applicable

Variable	Averaging period	PRC Class I (μg/m³)		PRC Class II (μg/m³)		World Bank Group EHS[1] (μg/m³)	
		GB3095-1996	GB3095-2012	GB3095-1996	GB3095-2012	Interim target	AQG
SO_2	1-year	20	20	60	60	n/a	n/a
	24-hour	50	50	150	150	50-125	20
	1-hour	150	150	500	500	n/a	n/a
NO_2	1-year	40	40	80	40	n/a	40
	24-hour	80	80	120	80	n/a	n/a
	1-hour	120	120	240	200	n/a	200
CO	24-hour	4,000	4,000	4,000	4,000	n/a	n/a
	1-hour	10,000	10,000	10,000	10,000	n/a	n/a
TSP	1-year	80	80	200	200	n/a	n/a
	24-hour	120	120	300	300	n/a	n/a
PM_{10}	1-year	40	40	100	70	30-70	20
	24-hour	50	50	150	150	75-150	50
$PM_{2.5}$	1-year		15	N/A	35	15-35	10
	24-hour		35	150	75	37.5-75	25

34. **Acoustic quality**. Noise environment for the project's settings will be evaluated against Class II standards of the Ambient Acoustic Quality Standard (GB3096-2008) (Table III-8). The PRC standards are more stringent than those of EHS.

Table III-8: Ambient Acoustic Quality Standards (unit: dB (A))

Applicable Class	Standard Value	
	Day-Time	Night-Time
Class I (residential, hospital, education, research, administrative area)	55	45
Class II (residential, commercial and industrial mixed area)	60	50

Class 4a (along roads – within 35 m measured from the mid-line)	70	55
World Bank EHS	70	70

35. **Surface water quality**. The ambient environmental standard applied in this EIA is Surface Water Ambient Quality Standard (GB3838—2002) Classes III for mainstream of Qi River and Side River, Class V for Zhaojia Canal, Zhejing River, Huancheng River and other canals (Table III-9). There is no EHS guideline or target for water quality in this context.

Table III-9: Surface Water Ambient Quality Standards (Unit: mg/L)

Standard	DO	BOD	COD	NH_3-N	pH	TP	TN
(GB3838-2002) – Class II	6	3	15	0.5	6-9	≤0.1	≤0.5
(GB3838-2002) – Class III	≥5	≤4	≤20	≤1.0	6-9	≤0.2	≤1.0
(GB3838-2002) – Class V	≥5	≤10	≤40	≤2.0	6-9	≤0.4	≤2.0

36. **Groundwater quality**. Groundwater quality will be assessed against Class III standards according to Quality Standards for Groundwater (GB/T14848-1993) (Table III-10). There are no equivalent EHS targets.

Table III-10: Quality Standards for Groundwater

Item	pH	Permanganate Index	Total	Nitrate Nitrogen	Fluoride	Total E.coli
Class III	6.5-8.5	≤3.0 mg/L	≤450 mg/L	≤20 mg/L	≤1.0 mg/L	≤3.0x10^3/L

37. **Soil.** Soil quality in the PRC is divided into three classes according to the Environmental Quality Standard for Soils (GB 15618-1995). Class I represents the best and Class III the worst. Class II is applicable for the proposed project area (Table III-11).

Table III-11: Environmental Quality Standard for Soils (Class II)

Parameter	Maximum Allowable Concentration (mg/kg dry weight)		
pH	<6.5	6.5-7.5	>7.5
Cadmium (Cd)	0.30	0.30	0.60
Mercury (Hg)	0.30	0.50	1.0
Arsenic (As) paddy / dry land	30 / 40	25 / 30	20 / 25
Copper (Cu) farmland / orchard	50 / 150	100 / 200	100 / 200
Lead (Pb)	250	300	350
Chromium (Cr) paddy / Dry land	250 / 150	300 / 200	350 / 250
Zinc (Zn)	200	250	300
Nickel (Ni)	40	50	60

2. Emission Standards for Construction and Operation Activities

38. **Air quality.** Fugitive emission of particulate matter (such as dust from construction sites) is regulated under PRC's Air Pollutant Integrated Emission Standard (GB 16297-1996), which sets 120 mg/m^3 as the maximum allowable emission concentration and ≤1.0 mg/m^3 as the concentration limit at the boundary of construction sites, with no specification on the particle diameter. Odor from the wastewater treatment stations and solid waste transfer stations should follow the Malodorous Pollutant Emission Standard (GB 14554-93). The maximum allowable concentrations at the boundary of the sites for NH_3, H_2S and odor are 1.5 mg/m^3, 0.06 mg/m^3, and "20" (dimensionless).

39. **Wastewater.** Discharge of wastewater from construction sites is regulated under PRC's Integrated Wastewater Discharge Standard (GB 8978-1996). Class I standards apply to discharges into Category III water bodies under GB 3838-2002. Class II standards apply to discharges into Categories IV and V water bodies. Class III standards apply to discharges into municipal sewers going to municipal WWTPs with secondary treatment. Wastewater generated during construction will be discharged into Category III and V water body. Class I and Class II of GB 8978-1996 applies for construction sites under this project (Table III-12).

Table III-12: Integrated Wastewater Discharge

Parameter	Class I	Class II	Class III
	For discharge into Category III water body	For discharge into Category IV and V water bodies	For discharge into municipal sewer
pH	6–9	6–9	6–9
SS mg/L	70	150	400
BOD_5 mg/L	20	30	300
COD mg/L	100	150	500
TPH mg/L	5	10	20
Volatile phenol mg/L	0.5	0.5	2.0
NH_3-N mg/L	15	25	---
PO_4^{2-} (as P) mg/L	0.5	1.0	---
LAS (= anionic surfactant) mg/L	5.0	10	20

40. The proposed WWTP in Qi County designed based on Class 1A of Urban Sewage Treatment Plant Pollutant Discharge Standards (GB18918-2002) (Table III-13).

Table III-13: Discharge Standards for urban WWTP

Parameter	Unit	Class 1A
COD	mg/L	50
BOD_5	mg/L	10
SS	mg/L	10
Ammonia	mg/L	5(8)
TN	mg/L	15
TP	mg/L	0.5

41. **Sludge disposal.** The quality of sludge going to landfill disposal should meet the Standard for Pollution Control on the Landfill Site of Municipal Solid Waste (GB 16889-2008). This requires the water content of sludge not to exceed 60%, and meet standards for reuse including as soil conditioner (GB15618-1995), afforestation in gardens and windbreak plantation (GB23468-2009), fertilizer for agricultural use (GB4284-84), land improvement (CJ/T 291-2008), brick building (CJ/T 289-2008) and other land applications

42. **Noise.** Construction noise will be assessed against the PRC Emission Standards of Ambient Noise for Boundary of Site Noise (GB 12523-2011) and Class II of Emission Standard for Industrial Enterprises Noise at Boundary (GB 12348-2008) (Table III-16).

Table III-16: Construction Site Noise Limits. Unit: Leq [dB (A)]

Period	Major Noise Source	Noise Limit	
		Day	Night
Construction	Bulldozer, excavators and loader; pile driving machines; concrete mixer, vibrator and electric saw; hoist and lifter	70	55
Operation	Pumps	60	50

43. **Vibration.** Construction activities will cause vibration impact, and should comply with the Standard for Urban Area Environmental Vibration (GB10070-88) (Table III-17).

Table III-17: Vertical Vibration Standard Value for Various Urban Areas (Unit: dB)

Scope of applicable area	Day	Night
Special residential area	65	65
Residential, cultural and educational area	70	67
Mixed area and commercial center	75	72
Industrial centralized area	75	72
Both sides of traffic trunk line	75	72
Both sides of railway main line	80	80

IV. DESCRIPTION OF THE PROJECT

A. Project Rationale

44. As a result of intensive economic development, environmental conditions in the Qi River basin have deteriorated rapidly in recent years. Vegetation and wetland conditions in the upper and middle reaches and catchment areas of Qi River have deteriorated due to deforestation, livestock operations, agricultural activities, over water exploitations, and non-point source pollution. The variety and quantity of flora and fauna have decreased and the ecological functions of the forest and wetland have been affected. Flood control capacity of the main stream and tributaries of the lower Qi River is insufficient due to siltation and damages on embankment. The flood control capacity is only for a 1 in 5 year flood in the lower Qi main stream and for 1 in 3 year flood in four tributaries of the lower Qi River.

45. Two wastewater treatment plants (WWTPs) serve the areas in Qibin District and Qi County. The WWTP in Qibin District has a treatment capacity of 50,000 m^3/d and is currently treating 20,000 m^3/d of wastewater. This WWTP has an adequate treatment capacity for increasing volumes of wastewater. However the WWTP in Qi County has a treatment capacity of 30,000 m^3/d and is currently treating 29,000 m^3/d; so its treatment capacity is not adequate to accommodate the increasing volume of wastewater. The sewage collection currently covers about 40% of the area in Qibin District and Qi County. Untreated wastewater is discharged directly to the main stream and tributaries of the lower Qi. The HCG has been making various efforts on environmental improvement and ecological conservation in the Qi River basin, including afforestation, WWTP construction, solid waste management, and public awareness education. Although some improvement has been achieved, key environmental issues remain, as described above.

B. Project Impacts, Outcome and Outputs

46. The impact of the project will be sustainable economic development of the Qihe River Basin in Hebi City achieved. The outcome of the project will be integrated environmental and ecological protection of the Qihe River basin improved. The project has four outputs: 1–ecological conservation and environmental management of upper Qihe River and its watershed enhanced; 2–lower Qihe River mainstream and tributaries improved; 3–wastewater and solid waste management in the Qihe River Basin improved; and 4–institutional and technical support system for integrated management of the Qihe River Basin improved. Output 1 comprises: (i) re-vegetation on hill slopes in the upper and middle sections of the Qi; and (ii) wetland restoration and protection in the NWP. Output 2 comprises: embankment of selected sections of the lower Qi, four tributaries, and five canals, dredging of the canals (not mainstream), and riverside greening (38 km from Panshitou reservoir to Liuzhuang barrage and along the canals), for improved river bank erosion control and water environment. Output 3 comprises wastewater and solid waste management in riverside areas in Qibin District and Qi County, to reduce pollution load to the lower Qi. Output 4 will support the development and implementation of: (i) Qi River ecological monitoring program; (ii) Qi River Management Information System (MIS), to support integrated water resources management (IWRM); and (iii) associated project training. Works are summarized in Table ES-1; locations are shown in Figure IV-1.

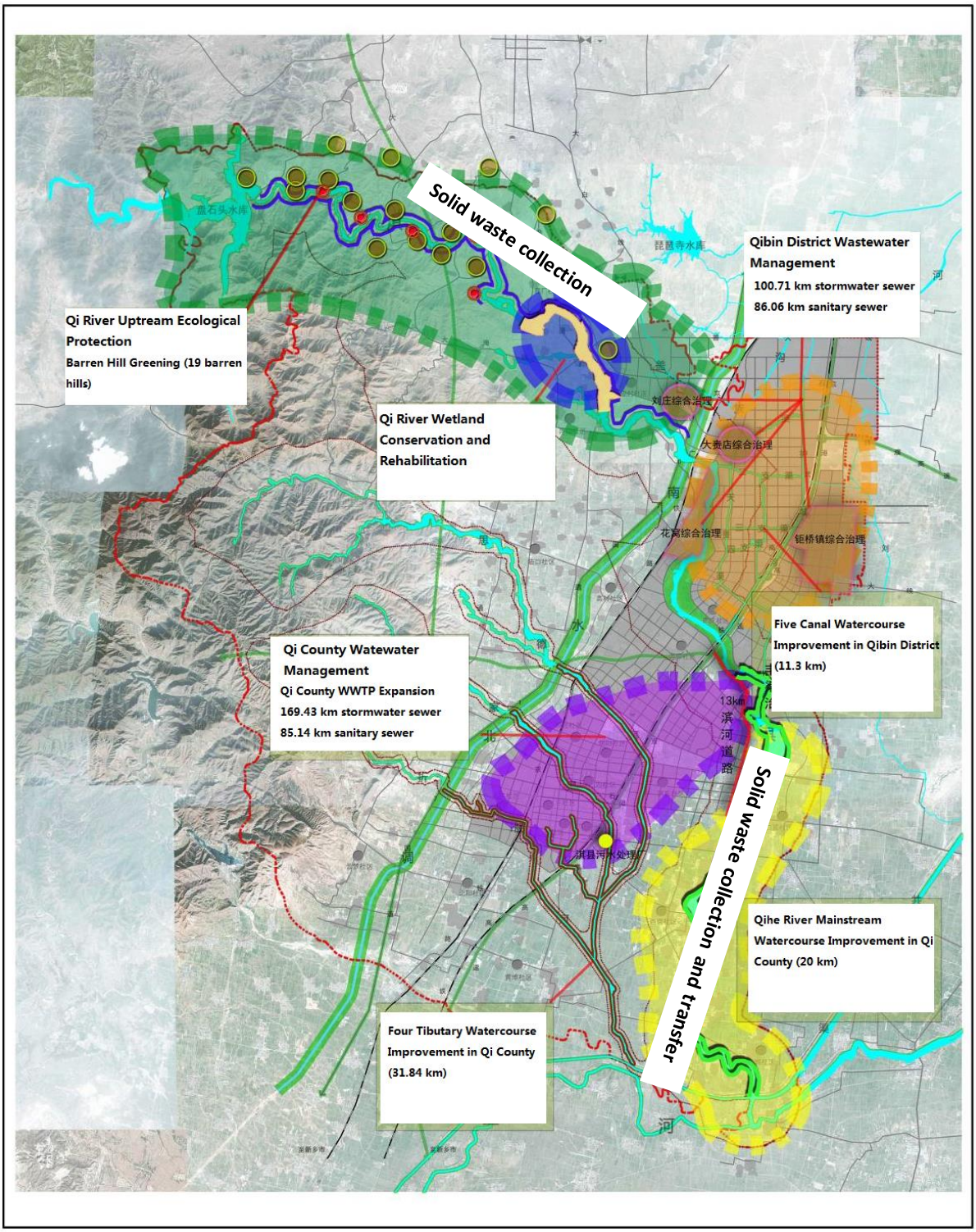


Figure IV-1: Location of Project Components

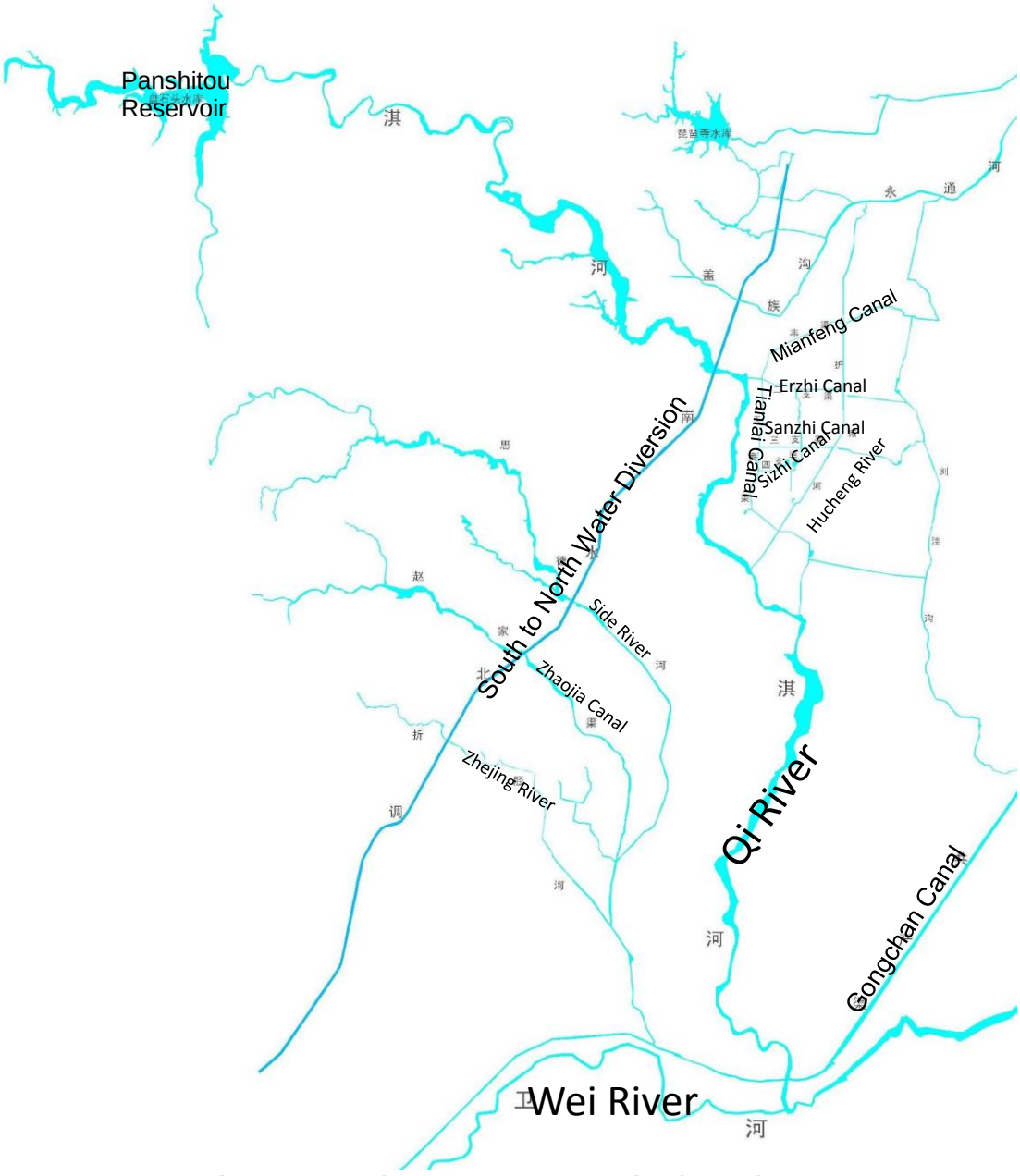


Figure IV-2: Major water systems under the Project

C. Project Design

Output 1. Ecological Conservation

1.1 Qihe River Upstream Ecological Protection – Barren Hill Greening

47. This component will comprise barren hill greening, community maintenance, and monitoring of the planted vegetation. The Qihe is located in the transition zone between Taihang Mountain and North China Plain. Flowing from west to east, there are erosion hills and deposited landforms. Soil erosion is serious due to steep hillside slope and rare vegetation cover. The water intake for Hebi urban area is located in the upstream of Qi River as indicated in Figure IV-3. The Baoshan Industrial Cluster Zone is at the north of Qi River upstream, which focuses on development of coal chemical industry. The dominant wind direction is north with maximum wind speed of 24 m/s, and nitrogen and sulphur oxides discharged from the zone has threatened the air quality of Qi River Basin. The nearest part of

the industrial zone is 2.5 km from Qi River. Partly to offset these air impacts, and partly to improve re-vegetation near the Qi, 19 barren hills with total area of 1,346 ha along the upper Qi River (Figure IV-2) will be reforested. The proposed greening works includes plantings (Table IV-1) and supported irrigation facilities, including storage ponds, pumps and plastic pipes.

Figure IV-3: Location indication of 19 selected barren hills

Table IV-1: Barren hill greening works

No.	Hill Name	Greening Area (ha)	Planting	No.	Hill Name	Greening Area (ha)	Planting
1	Panshitou	4.9	8096	11	Nanshan	88.9	125784
2	Gongjiazhuang	98.0	131952	12	Luchang	89.9	130133
3	Hekou Village	61.7	82758	13	Xugou	20.0	27672
4	Majialing	125.7	153550	14	Niuhengling	140.9	190000
5	Bojianshan	65.5	92248	15	Hongyu	100.2	136309
6	Laowangyan Village	72.3	103451	16	Xiaohejian	148.7	190518
7	Sangyuan Village	28.7	36120	17	Xiekuang	86.0	112897
8	Zhifang	64.1	80871	18	Shangyu	76.6	95146
9	Bailongmiao	21.3	28466	19	Basalt stone pit	9.7	26031
10	Anledong	42.9	55342	Total		1345.9	1807344

48. Species resistant to drought and air pollution have been selected for planting (Table IV-2). There are a number of nurseries in Qibin District and local species will be sourced from these. The average distance from two largest nurseries (1600-1800 mu growing areas) to the selected barren hills are 16-18 km.

Table IV-2: Plant species selected for greening and restoration under the project

Type	Chinese Name	Scientific Name	Barren hill greening	Wetland restoration in QNWP	River bank and canal greening
Evergreen Trees	大叶女贞	*Ligustrum lucidum*		×	×
	雪松	*Cedrus deodara*		×	×
	油松	*Pinus tabulaeformis*		×	
	枇杷	*Eriobotrya japonica*		×	×
	侧柏	*Platycladus orientalis*	×	×	
	圆柏	*Sabina chinensis*			×
	白皮松	*Pinus bungeana*			×
	广玉兰	*Magnolia grandiflora*			×

Type	Chinese Name	Scientific Name	Barren hill greening	Wetland restoration in QNWP	River bank and canal greening
Deciduous Trees	垂柳	*Salix babylonica*		×	×
	悬铃木	*Platanus orientalis*		×	×
	香椿	*Toona sinensis*		×	
	国槐	*Sophora japonica*		×	×
	银杏	*Ginkgo biloba*		×	×
	皂角	*Gleditsia sinensis*		×	
	柽柳	*Tamarix chinensis*		×	
	黄连木	*Pistacia chinensis*	×	×	
	独杆五角枫	*Acer mono*	×	×	×
	从生三角枫	*Acer buergerianum*		×	
	黄栌	*Cotinus coggygria*	×	×	
	三角枫	*Acer buergerianum*		×	
	鹅掌楸	*Liriodendron chinensis*		×	×
	桑树	*Morus alba*		×	
	楸树	*Catalpa bungei*		×	×
	梨树	*Pyrus ussuriensis*		×	
	白蜡	*Fraxinus chinensis*	×	×	
	刺槐	*Robinia pseudoacacia*	×	×	×
	元宝枫	*Acer truncatum*	×	×	
	柿树	*Diospyros kaki*		×	
	乌桕	*Sapium sebiferum*		×	
	水杉	*Metasequoia glyptostroboides*		×	×
	重阳木	*Bischofia polycarpa*		×	
	白玉兰	*magnolia denudate*		×	×
	红玉兰	*Mchella liliflora*		×	
	枫杨	*Pterocarya stenoptera*		×	×
	加杨	*Populus X Canadensis*			×
	馒头柳	*Salix matsudana*		×	
	毛白杨	*populus tomentosa*		×	
	红叶杨	*Populus deltoids*			×
	旱柳	*Salix matsudana*		×	
	合欢	*Albizia julibrissin*		×	×
	泡桐	*Paulownia fortunei*		×	
Shrubs	榆树	*Ulmus pumila*	×		×
	臭椿	*Ailanthus altissima*	×		
	黄山栾	*Koelreuteria bipinnata*			×
	辛夷	*Magnolia liliflora*		×	
	紫叶李	*Prunus cerasifera*		×	×
	木瓜	*Chaenomeles sinensis*		×	
	山楂	*Crataegus pinnatifida*		×	
	紫荆	*Cercis chinensis*		×	×
	文冠果	*Xanthoceras sorbifolia*		×	
	海棠	*Malus spectabilis*		×	×
	紫薇	*Lagerstroemia indica*		×	×
	金银木	*Lonicera maackii*		×	
	石楠	*Photinia serrulata*		×	×
	樱花	*Prunus serrulata*		×	×
	日本晚樱	*Prunus yerrulata*		×	
	李树	*Prunus salicina*		×	
	山茱萸	*Cornus officinalis*		×	
	鸡爪槭	*Acer palmatum*		×	
	紫荆	*Cercis chinensis*		×	
	木槿	*Hibiscus syriacus*		×	
	丝兰	*Yucca smalliana*		×	
	桃	*Prunus persica*		×	×
	海州常山	*Clerodendrum trichotomum*		×	
	大叶黄杨	*Euonymus japonicas*		×	×
	连翘	*Forsythia suspensa*	×	×	×
	凤尾兰	*Yucca gloriosa*		×	
	阔叶箬竹	*Indocalamus latifolius*		×	
	月季	*Rosa chinenisis*		×	×
	绣线菊	*Spiraea salicifolia*		×	
	紫穗槐	*Amorpha fruticosa*	×	×	
	火棘	*Pyracantha fortuneana*		×	

Type	Chinese Name	Scientific Name	Barren hill greening	Wetland restoration in QNWP	River bank and canal greening
	南天竹	*Nandina domestica*		×	×
	淡竹	*Phyllostachys glauca*			×
	刚竹	*Phyllostachys viridis*			×
	红瑞木	*Swida alba*		×	×
	小龙柏	*Sabina chinensis*		×	
	瓜子黄杨	*Buxus sinica*		×	
	卫矛	*Euonymus alatus*		×	
	铺地柏	*Sabina procumbens*		×	×
	棣棠	*Kerria japonica*		×	×
	迎春	*Jasminum nudiflorum*			×
	珍珠梅	*Sorbaria sorbifolia*			×
	丁香	*Syringa Linn*			×
	碧桃	*Amygdalus persica*			×
	小叶女贞	*Ligustrum quihoui Carr*			×
	蜡梅	*Chimonanthus praecox*			×
	花石榴	*Punica granatum*		×	×
Grass	石菖蒲	*Acorus tatarinowii*		×	
	美人蕉	*Canna indica*		×	×
	黄花鸢尾	*Iris wilsonii*		×	
	沿阶草	*Ophiopogon bodinieri*		×	
	阔叶麦冬	*Liriope platyphylla*		×	
	金边麦冬	*Liriope spicata*		×	
	五叶地锦	*Parthenocissus quinquefolia*		×	×
	紫玉簪	*Hosta albo-marginata*		×	
	白玉簪	*Hosta plantaginea*		×	×
	马蔺	*Iris lactea*		×	
	枸杞	*lycium chinense*		×	
	麦冬	*Ophiopogon japonicus*		×	×
	二月兰	*Orychophragmus violaceus*			×
Aquatic Plants	香蒲	*Typha orientalis*		×	×
	黄菖蒲	*Iris pseudocorus*		×	×
	黑藻	*Hydrilla verticillata*		×	
	野慈姑	*Sagittaria trifolia*		×	
	茭白	*Zizania caduciflora*		×	
	浮萍	*Lemna minor*		×	
	狐尾藻	*Myriophyllum verticillatum*		×	
	苦草	*Vallisneria natans*		×	
	金鱼藻	*Ceratophyllum demersum*		×	
	千屈菜	*Lythrum salicaria*		×	
	芦苇	*Phragmites communis*		×	
	泽泻	*Alisma plantago-aquatica*		×	
	荷花	*Nelumbo nucifera*		×	×

QNWP = pilot Qihe River National Wetland Park.

1.2 Restoration and management of the pilot Qihe River National Wetland Park

49. This project component focuses on activities within the pilot NWP. The project will support habitat restoration, small infrastructure development, and improved park management and monitoring, to strengthen the conservation and sustainable use functions (recreation, education) of the park. The NWP is described in Section V.D. This sub-section describes the project works to be undertaken in the NWP. For habitat creation and restoration for each of the seven habitat categories listed below, the species to be planted are listed in Table IV-2.

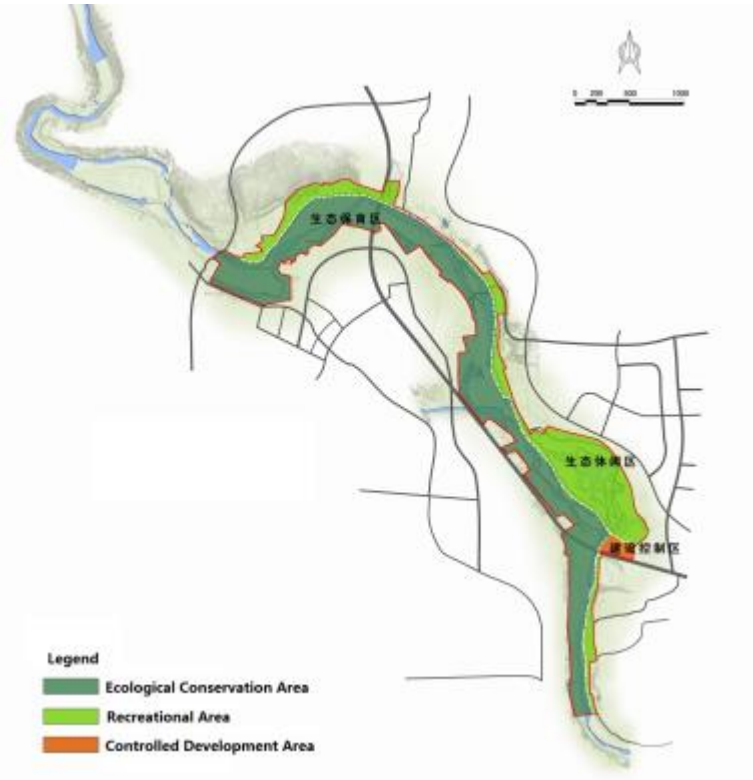


Figure IV-4a: Function zones of the Qi River wetland

50. In the ecological conservation area, activities that are not aligned with wetland ecosystem protection are prohibited. Riverside wetlands in the NWP comprise 95.22 ha, flood plain wetlands 169.51 ha, geothermal wetland 1.20 ha, and the fish raising tanks and artificial wetland 4.83 ha. Water in the NWP originates from the Qi flow, precipitation, and minor in-flows from a small spring, Xugou. Flow in the NWP, as along the entire Qi, is regulated by Panshitou Reservoir upstream. The allocated ecological flow is 0.5 m^3/s. Spring flows are regulated to about 1.01 m^3/s, with annual average water supplement of 32 million m^3. In the flood season, flow reaches 80–300 m^3/s.

51. **Habitat creation.** This project activity aims to: (i) restore and expand wetland habitats; (ii) provide habitats for wetland flora and fauna in the NWP; and (iii) protect the river banks from erosion. Existing habitats in the NWP comprise seven categories, which will be expanded by the project: riparian forest, mudflat, backwater pond, shallow water, deep water, islands, and instream in the main river course (Figure IV-4b).

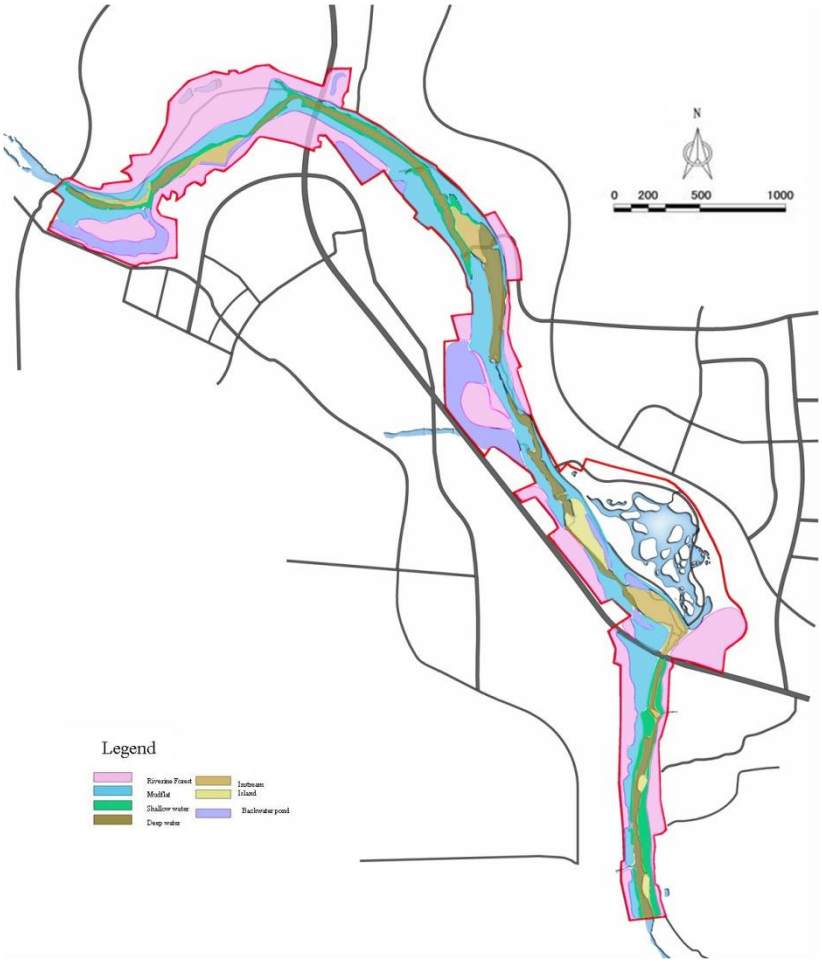


Figure IV-4b: Wetland habitat categories in the pilot Qi River National Wetland Park

52. **Riparian forest** (comprising 85.5 ha of the NWP). This will provide habitats for birds, amphibians, mammals and strengthen a natural buffer between the river and human activities. Most river sections in the NWP support monoculture stands of poplars and willows, which are fast growing, but provide low ecological value. These stands will be enriched with native trees, shrubs and grasses.

53. **Backwater ponds** (21 ha of the NWP). These include three existing fish ponds and 3.5 ha of new ponds will be created to link with the main river. These will provide open water surfaces for waterbirds and function as a buffer zone to absorb high water flows.

54. **Mudflat** (55.86 ha of the NWP). Located at the river banks, this is the transitional zone between the water and river banks. Former farmland along the river will be restored to mudflats. Some remnant fields will be retained to supplement food for waterbirds which graze in shallow flooded fields.

55. **Shallow water zone** (14.6 ha of the NWP). Surrounded by some aquatic plants with water flow all the year around. This area will provide habitats for waterbirds or shorebirds. Big cobbles will be paved to create open space. The existing aquatic plant will be reserved

56. **Deep water zone** (21.2 ha of the NWP). This zone comprises most of the mainstream channel of the Qi. The project will support the removal of small blockages (e.g. rock obstructions) in and alongside the river, to improve flow.

57. **Islands** (4.1 ha of the NWP). Several small natural islands occur in the mainstream. Habitats will be enhanced and the islands maintained free of human activity, as waterbird

resting sites.

58. **Instream zone** (10.2 ha of the NWP). These are areas located along the main river channel. Flows in this zone are seasonal (Figure IV-4c). These areas are isolated from human disturbances with dense vegetation.

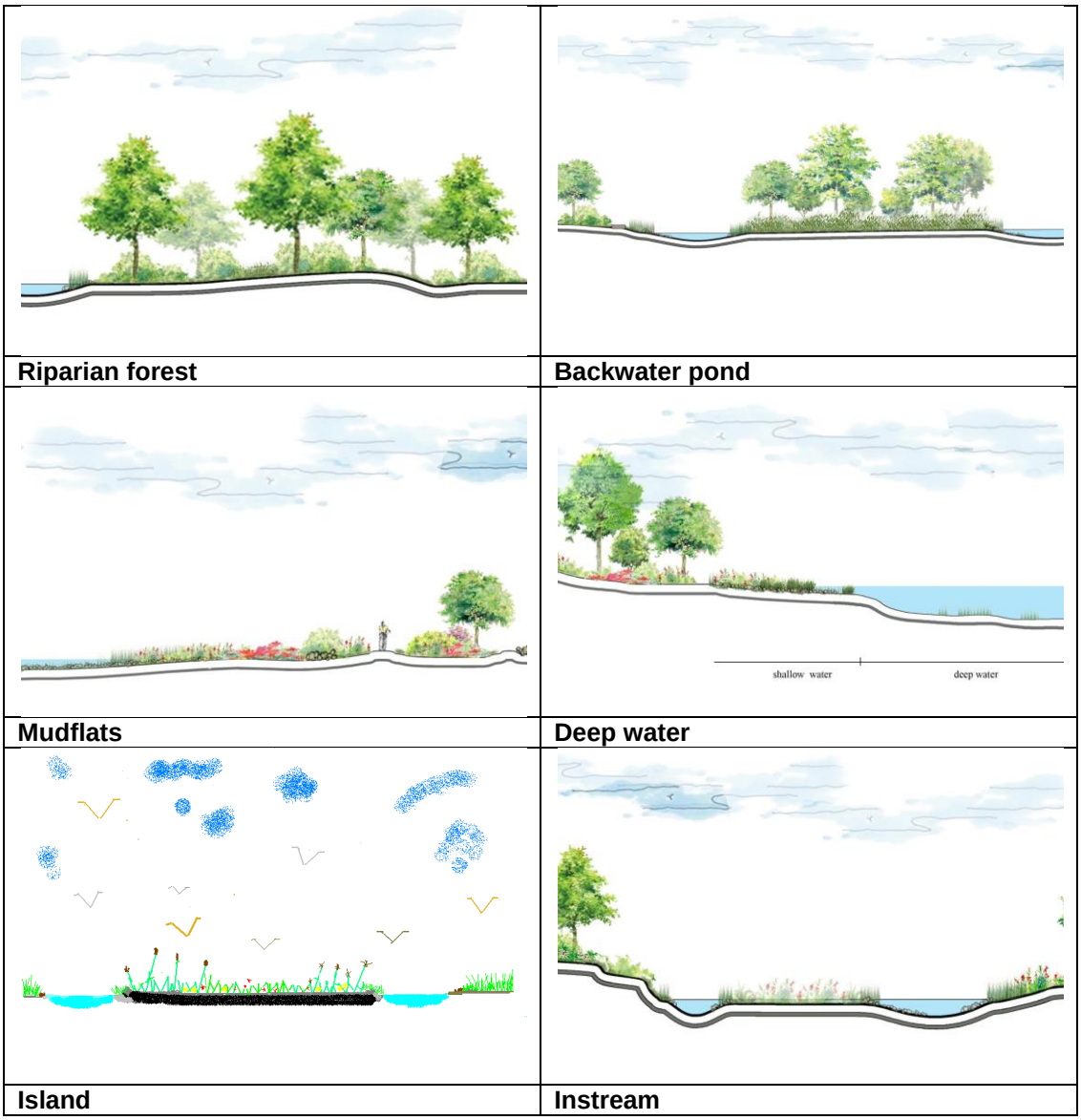


Figure IV-4c: Engineering sketches for each habitat type

59. **River bank protection.** Some sections of the Qi River banks in the NWP are eroded and/or subject to erosion. This activity will stabilize eroded and flood-prone banks and re-vegetate bare sections of river bank. Project works will include small wooden stakes (along about 1.8 km of river) and stone embankments (about 2.1 km of river) to stabilize the banks (Figure IV-4d).

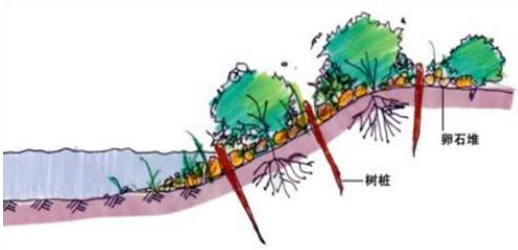
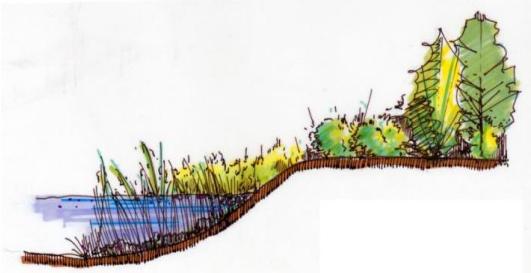
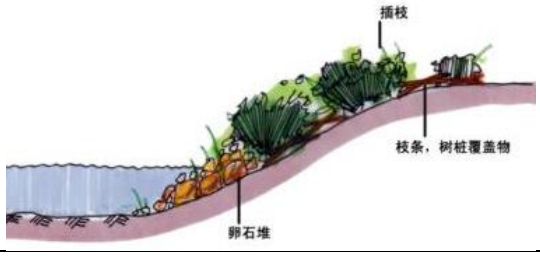
	**Wooden stakes** are resistant to hydraulic scouring, easy operation and low costs. Stakes would be placed in river mouth with fast flow. They can ensure the water regimes and exchange of the ground water, suitable for the plants growth and prevent the erosion during the high water flow season.
	**Grass turf or shrubs** will be placed or planted in sciences and public awareness zone of the wetland park. Native plants wil be used to stabilize the soil to control erosion.
	**Local cobbles** would be placed to improve banks protection when some terrains or waterfalls in the existing large ponds with hydrological restoration or water areas in the science and public awareness sub-zone. This approach would create water aquatic environment and could help nesting, breeding for fish and wildlife.

Figure IV-4d: Engineering sketches for river bank protection methods

60. **Vegetation recovery and aquatic plant planting.** Long term human intervention and unsustainable use has caused the original plants damaged or lost. A large area of poplars has been planted on both sides of the river banks to green the bare mudflat and control erosion. Nonetheless, the survival rate is low due to poor soil conditions or submerged by the water during high water flow. Some invaded species eg *Rhus typhina* is spreading fast therefore occupied habitats of other flora species. This component will support strengthening biodiversity by enriching plant compositions at the landscape level. The specific planting programs have been designed suitable for local site conditions, including evergreen and deciduous trees, shrubs and aquatic plants in different zones as illustrated below.

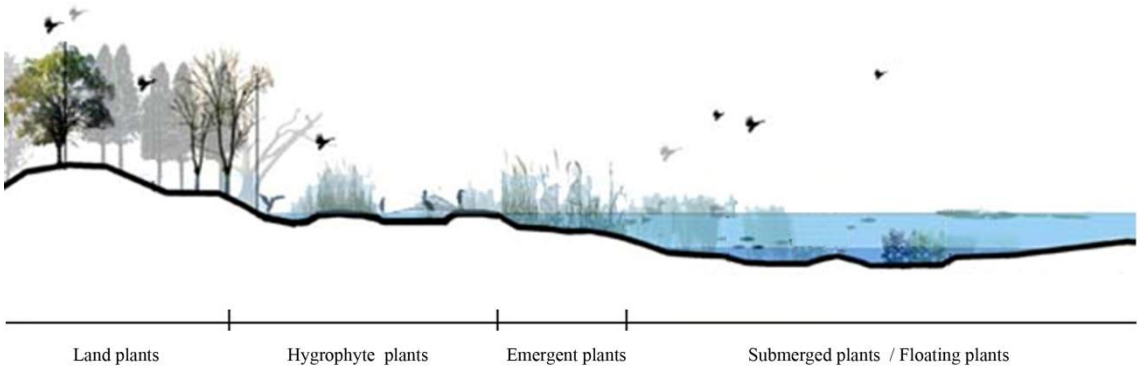


Figure IV-4f: Engineering sketch of vegetation recovery and plantation

61. **Sub-ecological conservation zone.** Located at the north part of Zhujia Village and right side of Lihezhai Village. This is a key habitat for waterbirds and is the core area of the NWP. Vegetation is mostly in good condition but some sites suffer from sparse vegetation.

Plant genera to be planted include *Ligustrum*, *Robinia, Diospyros, Prunus, Photinia, Mamdoma, Sabina, Acorus, Iris, Typha, Ophiopogon, Sogittaria, Vallisneria, Myriophyllum,* and *Hyrilla*, to increase species richness.

62. **Sub-restoration zone.** Located at middle and northern part of the river. This zone is severely degraded and dominated by exotic vegetation. These will be replaced by native species, including *Ligustrum, Pinus, Salix, Gleditisia, Platanus, Pistacia, Acer, Fraxinus, Pterocarya, Macella, Sapium, Xanthoceras*, *Photinia, Cercis, Forsythia, Amorhpa, Pyracantha, Kerria, Acorus, Liriope, Hosta, Typha, Zizania, Lythrum, Phragmites,* and *Nelumbo*.

63. **Ecological recreational zone.** This zone supports sparse vegetation cover and is dominated by exotic species. This will be replaced by native species. About 17 genera of flowering plants will be established, including *Ligustrum, Pinus, Salix, Gleditisia, Platanus, Pistacia, Acer, Fraxinus, Pterocarya, Macella, Sapium, Xanthoceras*, *Photinia, Cercis, Forsythia, Amorhpa, Pyracantha, Kerria, Acorus, Liriope, Hosta, Typha, Zizania, Lythrum, Phragmites,* and *Nelumbo*.

64. **Construction control zone.** This zone will be reserved as farmland. Plant genera to be planted will include *Ligustrum, Paulownia, Malus, Crataegus, Cercis, Amorpha, Euonymus,* and *Glycine.* These species occur along the Qi and/or are widely cultivated in the nurseries in Henan Province. Planting will be done by a contractor and local communities will be encouraged to participate in plantation and maintenance.

65. **Conservation of threatened flora and fauna.** The project will support specific management meausres for one threatened plant, wild soya (*Glycine soja*), and a fish, Qi River Crucian Carp (*Carassius auratus*). Both are protected under national and provicial regulations.

66. Wild soya is distributed in the northern tip of the NWP with area of 2.3 ha as surveyed in 2012. From the field survey in June 2015, wild soya has not developed a contiguous community at local site. An area of 7.5 ha will be fenced and signage installed to protect the wild population. A 300 m^2 research base will be constructed to support visiting researchers and students and to revegetate other parts of the NWP with the species. Education campaigns will be carried out to protect the species.

67. Qi River Crucian Carp (*Carassium auratus)*, a flagship species for the Qi River. The southern part of the NWP will be designed as a fish protection site with demarcation and re-vegetation to support fish recovery, as the species spawns on aquatic plants. The wetland and ecological monitoring specialists will facilitate the development of conservation targets for the species and inclusion in the NWP management plan and ecological monitoring program for the Qi River (see TORs for these specialists in Appendix 1 of the EMP).

68. **Infrastructure for the NWP.** The project will support construction of: (i) 2.5 km patrol roads and 4.4 km pedestrian paths; (ii) improvement of existing access roads and patrol trails; (ii) one parking lot (2,300 m^2); (iii) one research and monitoring station, 2 permanent ecological monitoring stations (80 m^2), observation sites and bird watching hides; and (iv) management services and facilities and a management building (1,000 m^2). These facilities will complement a visitor centre (10,000 m^2; 8 exhibition halls) to be constructed in the NWP by the government.

69. **Alignment of project activities with the NWP Master Plan.** All proposed project activities for the NWP were designed in close consultation with the Qi River Management Office and Forestry Bureaus of Hebi City, Qi County and Qibin District, the principal agencies responsible for management of the NWP. Staff confirmed that the project activities are

aligned with the NWP master plan: (i) for the planned wetland restoration, the project has developed specific measurable targets which extend beyond the relatively general objectives listed in the NWP; and (ii) the project has assisted in streamlining the master plan, through the removal of some features early in the project design phase, including a “reed maze”, “captive garden for wild cranes”, “wildlife rescue center”, and construction of two mainstream barrages within the NWP.

Output 2. Lower Qihe River Mainstream and Tributaries Improved

2.1 Qihe Mainstream Watercourse Improvement in Qi County (21 km)

70. Flood protection standards applied to Qi River are to withstand a 50-year flood for the river reach near the city and a 20-year flood for the rest of the lower Qi. The Qi mainstream has some embankments but which are degraded and inadequate to satisfy the target flood recurrence interval. The proposed project works for the Qi River mainstream comprise: (i) stability reinforcement with Gabion works (5 locations on left bank and 9 locations on right bank), at sites subject to recurring flood damages (Figure IV-5); and (ii) sealing of the river crest road (21 km on each river side x 2 sides = 42 km), with a surface 5 m wide and 70 mm thick asphalt concrete. Both sides of the roads will be filled with gravel at a thickness of 150 mm and a width of 500 mm.

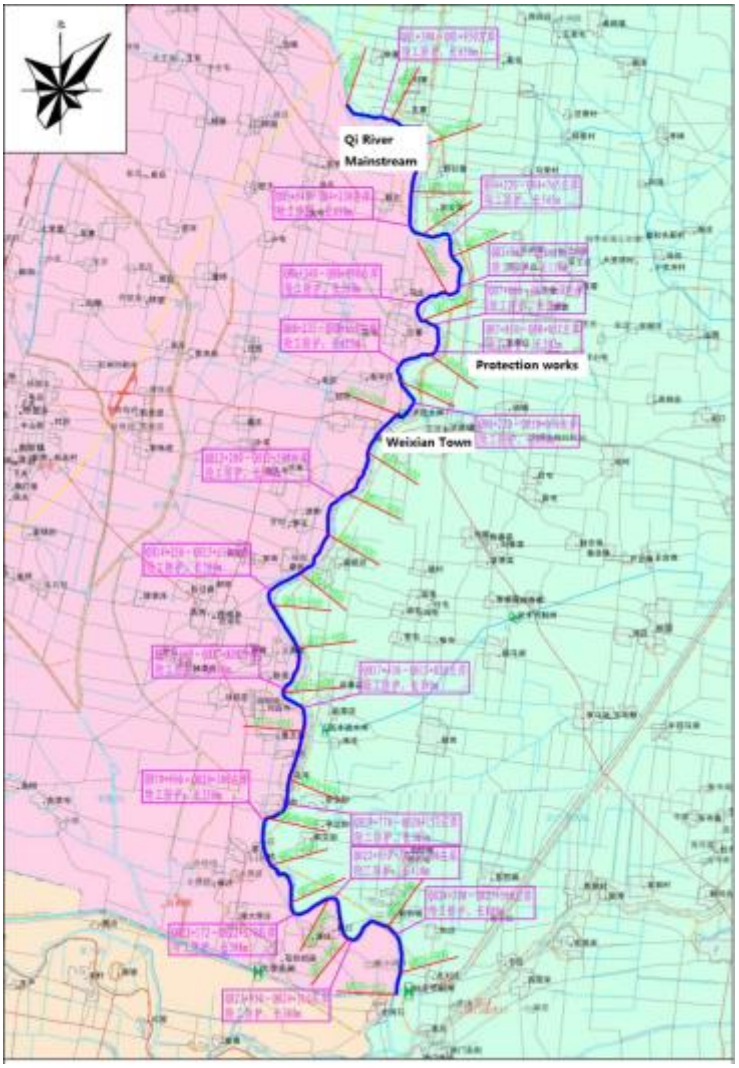
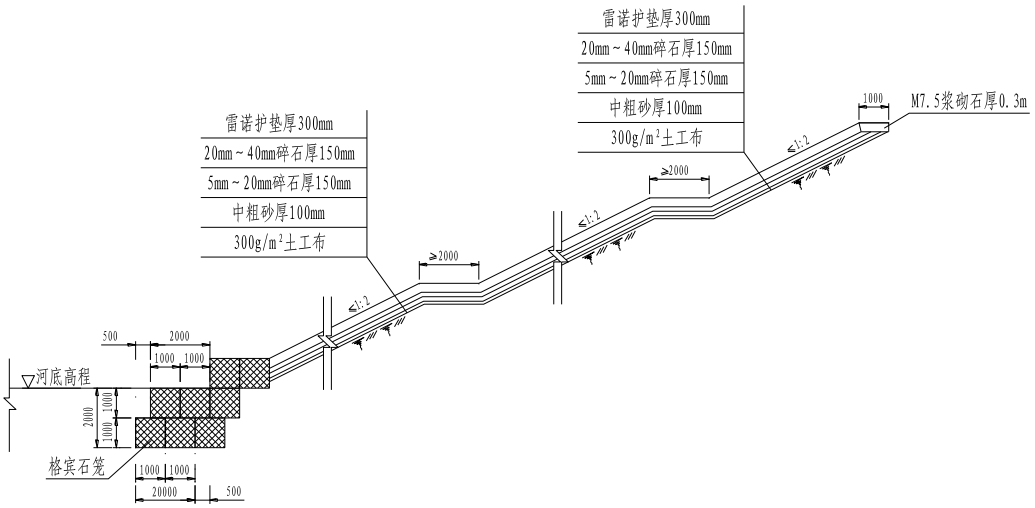


Figure IV-5: Proposed embankment works along mainstream of Qi River in Qi County

71. Two typical protections for vulnerable spots are illustrated below:

1. For slope less than 1:2:
- Layer 1:300g/m^2 geotextile;
- Layer 2: 100 mm coarse sand;
- Layer 3: 150 mm thick 5 mm-20 mm gravels +150 mm thick 20 mm-40 mm gravels;
- Layer 4: Reno mattress.

Gabion stone cages are arranged at the foot for toe protection.



2. For slope steeper than 1:2: in order to limit land cover, the slope is cleaned to 1 m high and 1 m wide steps; gabion revetment is arranged on the steps and at the foot.

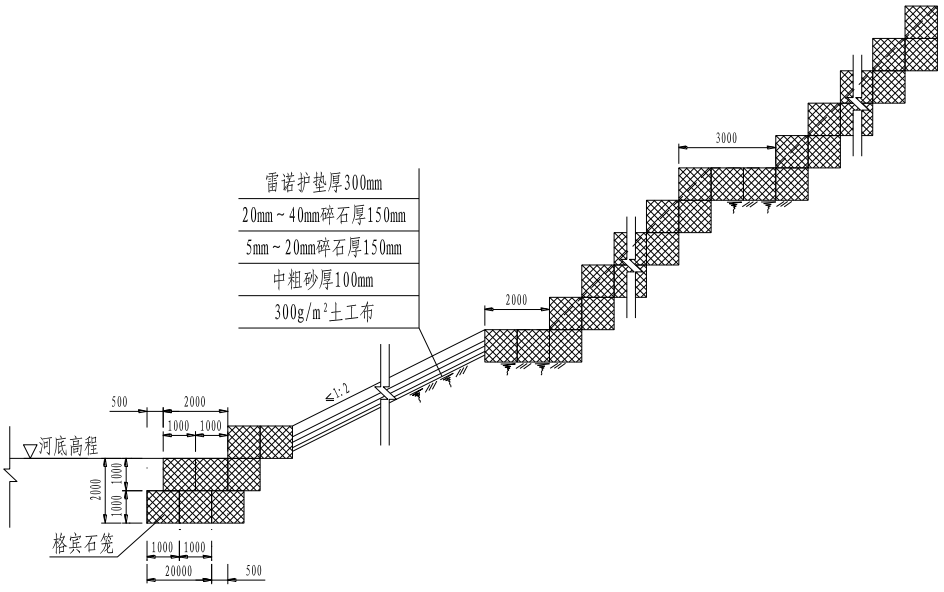


Figure IV-6: Typical protection sections for flood-prone river sections

2.2 Four Tributary Watercourse Improvement in Qi County

72. The proposed works in this subcomponent include river rehabilitation works on four tributaries of Qi River in Qi County: Side River, Zhaojia Canal, Moat (including Longxugou), and Zhejing River, with a total river length of about 31.84 km (Tables ES-1 and IV-3). The works include: (i) watercourse widening and dredging; (ii) riverbank protection (Gabion works, concrete frames, vegetation planting); and (iii) riverside greening on Side River and Zhaojia Canal (up to 10 m width each side with a total length of 11 km). The dredging works over the

four tributary rivers covers a total length of about 21.12 km (Table ES-1). The total area to be dredged is 187,126 m^2 and the estimated volume of dredged sediment will be 85,232 m^3.

73. Slope protection works will be conducted at 27 sites with a total length of 8.7 km, which includes 1.4 km of Side River (7 sites), 3.85 km of Zhaojia Canal (3 sites), 0.85 km of Zhejing River (5 sites) and 2.6 km of Moat (including Longxu Ditch) (12 sites). The rest of the river reaches will be embanked with turf. Greening works will be undertaken on two tributary rivers: Side River with a length of 5 km, and Zhaojia Canal with a length of 6.5 km. The greening works include planting of trees in green belts up to 10 m wide on each river bank. Species selected for river bank greening are listed in Table IV-2.

Table IV-3: Major project works for canals in Qi County of Qi River tributary

Canal	River length	Excavated volume	Filling volume	Grassed slope	Green surface
	(km)	(10,000 m^3)	(10,000 m^3)	(10,000 m^3)	(ha)
Side River	9.5	160.00	0.15	18.79	10
Zhao Drainage	9.802	63.61	1.94	22.60	13
Zhe Jing River	6.621	63.73	1.75	19.80	0
Moat (including Longxugou)	5.918	9.36	5.57	7.32	0
Total	31.841	296.71	9.41	68.51	23.0

2.3 Five Canal Watercourse Improve in Qibin District

74. The proposed works in this subcomponent include river rehabilitation works on five tributaries of Qi River in Qibin District: Tianlai, Mianfeng, Erzhi, Sanzhi, and Sizhi Canals. The main works activities include: (i) widening, dredging and bank protection of Tianlai, Mianfeng, and Erzhi Canals; (ii) canal reconstruction of Sanzhi and Sizhi Canals; and riverside greening along Tianlai, Mianfeng and Erzhi Canals (up to 15 m width on each bank along Tianlai, Mianfeng, and Erzhi Canals; up to 10 m width along Shanzhi and Sizhi Canals).

75. The total length of river reaches where engineering works will be carried on the five tributary canals is about 11.31 km (Table ES-1). The amount of earthwork excavation will be 922,600 m^3, with a backfill of 91,000 m^3, concrete works 14 400 m^3. Concrete works will be to a total amount of 14,400 m^3, and greening area along the river sides of Tianlai, Mianfeng and Erzhi Canals will be 29.44 ha. The project locations are shown in Figure IV-7a.

Figure IV-7a: Location of five canals to be rehabilitated in Qibin District and current status

76. Reconstruction of Sanzhi and Sizhi Canals will involve the construction of a new Shanzhi Canal to the north Lioujiang Road, and a new Sizhi Canal to the north of Chaoge Road. This is because the original two canals have been cut off and filled up due to the urban development. In order to maintain the integrity of the watercourse drainage system and meet the requirements for flood control, the two new canals will be constructed in the adjacent area to replace the drainage functions of the two old canals. For the greening of the 5 canals, the greening works will involve planting of trees at a zone up to 15 m wide on each river side of Tianlai, Mianfeng, and Erzhi Canals, and up to 10 m width on each river side of Sanzhi and Sizhi Canals. The design of greening works adopts a multilevel planting system that will include evergreen trees, deciduous trees, bamboos, evergreen shrubs, shrubs deciduous flowers, hedges, vine ground covers, lawns, aquatic plants and other types of plants.

Table IV-4: Major works of project contents of each canal in Qibin district of Qi River tributary

Major work	Unit	TianLai	Mianfeng	Erzhi	Sanzhi	Sizhi	Total
River length	km	5.15	0.97	0.733	2.844	1.6	11.3
Dredging	10^4 m^3	1.51	0.18	0.11			1.8
Excavated	10^4 m^3	59.53	7.98	4.35	10.3	10.1	92.26
Filling	10^4 m^3	3.448	0.77	0.705	2.497	1.677	9.1
Masonry retaining wall	10^4 m^3	0.863	0.12	0	0.283	0.17	1.44
Concrete	10^4 m^3	0.37	0.08	0.2	0.51	0.28	1.44
Grassed slope	10^4 m^3	5.724	2.62	1.426	2.102	2.074	13.95
Green area	ha	15.45	2.907	2.2	5.68	3.2	29.44

Figure IV-7b: typical cross sections of each canal after rehabilitation

77. **Justification for project flood control measures given the presence of Panshitou Reservoir.** Panshitou Reservoir, situated immediately upstream of the project area, was constructed in 2007 and has resulted in reduced flood risk for Hebi City (Section V.A). Hydrological modeling[3] was conducted by the PPTA team to assess: (i) whether the planned project flood control measures are justified given the flood control function of the reservoir; and (ii) the effectiveness of the project measures under the operating regime of the reservoir. The results confirm that: (i) numerous sections of the lower Qi River remain vulnerable to bank collapse and bursting of levees during 1 to 20-year flood events; (ii) the silted condition of many smaller channels in the middle section of the Qi continues to cause over-bank flooding and reduce the drainage capacity of these channels; (iii) the project flood controls measures complement the reservoir flood control function, and cumulatively result in the targeted flood recurrence intervals for the project area.

Output 3. Wastewater and Solid Waste Management

3.1 Qibin District Wastewater Management

78. The sub-component will involve the installation of about 81.53 km storm water sewers (DN250-1650) and about 90.33 km sanitary sewers (DN250-1200), as well as associated manholes in Dalaidian and Juqiao Area in Qibin District (Table ES-1). The storm water pipelines will be constructed together with road construction, and will drain to Liujia Canal and then finally to Gongchan Zhuyi Canal. Figure IV-8 shows the project area.

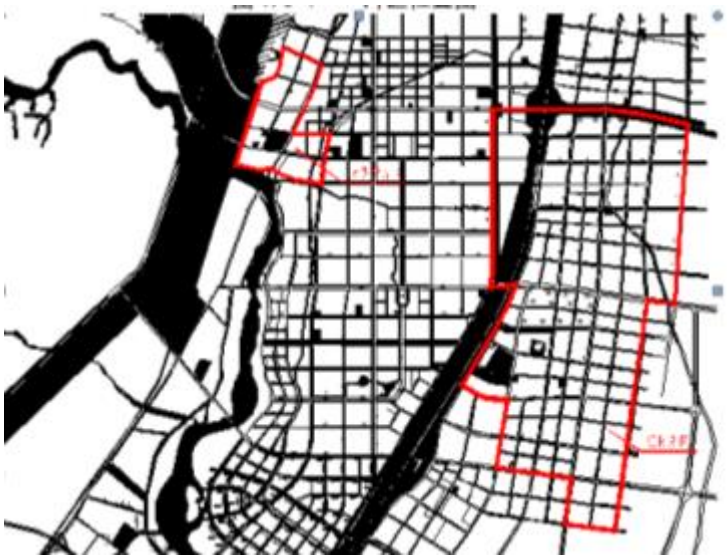


Figure IV-8: Location of Dalaidian and Juqiao Areas

79. Storm water will be discharged to adjacent Mianfeng Canal and Qi River for Dalaidian Area and LiuguiDitch-Gongchanzhuyi Canal for Juqiao Area by gravity in line with topographic conditions. For roads wider than 40 m, storm water pipelines will be laid on both sides of the road. For roads width less than 40 m, storm water pipelines will be laid on only one side of the road. Wastewater from the Dalaidian Area will be sent to the Qibin District WWTP. Wastewater from Juqiao Area will be conveyed to the Qibin District WWTP (yellow area in Figure IV-9) and the planned Qishuiwan WWTP (blue and pink area in Figure IV-9). The amount of wastewater collected is estimated assuming water consumption norm of 120 L capita per day (Table IV-5).

[3] HEC-RAS (River Analysis System) developed by Hydrologic Engineering Center of the U.S. Army Corps of Engineers was used. Details of the modeling are given in supplementary document 5 (Qi River Model Development & Flood Risk Modellilng Assessment) of PPTA report.

Table IV-5: Wastewater Projection of Dalaidian and Juqiao Area up to 2020

Area	Population	Water consumption (m^3/day)	Conversion rate	Wastewater Collection Rate	Wastewater production (m^3/day)
Dalaidian	23,000	2,760	0.8	100%	2,208
Juqiao	145,000	17,400	0.8	100%	13,920

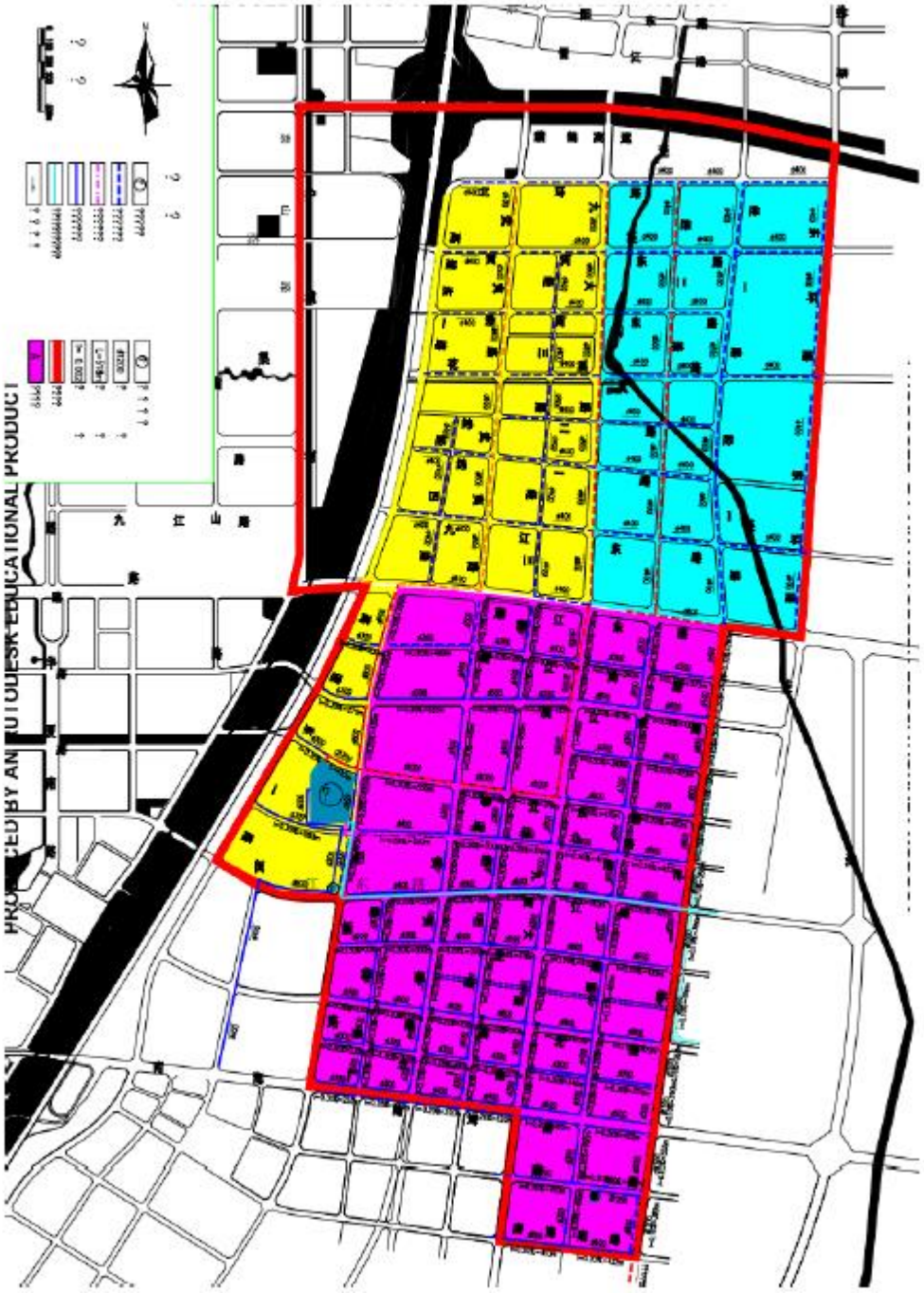


Figure IV-9: Sewage drainage zone of Juqiao Area

3.2 Qi County Wastewater Management

80. **Expansion of Qi County WWTP.** There are two existing WWTPs in Qi County, the Qi County North WWTP (Heqi WWTP) and the Qi County WWTP. Service areas of the two WWTPs are divided by Side River and Zhaojia Canal. The Qi County WWTP's service area includes the middle of Heqi Industrial Park (population 23,000), Old Town Area and Tiexi Industrial Zone (population 130,000). The design capacity of the Qi County WWTP is 30,000

m^3/d. The average current treatment volume reaches to 28,000 m^3/d. The Qi County WWTP uses the Carew Purcell Oxidation Ditch treatment process, and its effluent meets the Class 1B national effluent discharge standard. In a separate activity (not funded by the project), the government will upgrade the existing Qi County WWTP to improve the effluent quality to Class 1A in 2016. Despite this improvement, future wastewater discharge is projected to reach 51,800 m^3/d by 2020, and will exceed the treatment capacity of the WWTP. The project will support the expansion of the Qi County WWTP from the current 30,000 m^3/d to 60,000 m^3/d by the construction of a second WWTP. This will be located adjacent to the existing WWTP. The new WWTP will be constructed to Class 1A treatment standard. Table IV-6a lists the estimated influent and effluent quality to the Qi County WWTP in the future. The concentrations of the water quality parameters in the future influent is higher than the concentrations in the current influent as the current WWTPs in Hebi still treat wastewater from combined sewage and storm water sewer systems. Table IV-6b lists the reduction in pollutant load to be achieved by the new (project-supported) Qi County WWTP.

Table IV-6a: Estimated Influent and Effluent Quality

Item	COD	BOD_5	SS	NH_3-N	TN	TP
Influent (mg/L)	350	200	300	35	50	5
Effluent (mg/L)	50	10	10	5 (8)	15	0.5

Table IV-6b: Pollutant Loads Before and After Treatment, new Qi County WWTP

Item	COD	BOD_5	SS	NH_3-N	TN	TP
Influent	350	200	300	35	50	5
Effluent	50	10	10	8	15	0.5
Before	3,833	2,190	3,285	383	548	55
Annual reduction ton/year	3,285	2,081	3,176	296	383	49
% reduction	86	95	97	77	70	90

81. The expansion project of Qi County WWTP will use modified oxidation ditch as main biological process, which is the same process used in the existing WWTP. The process flow diagram is illustrated as below.

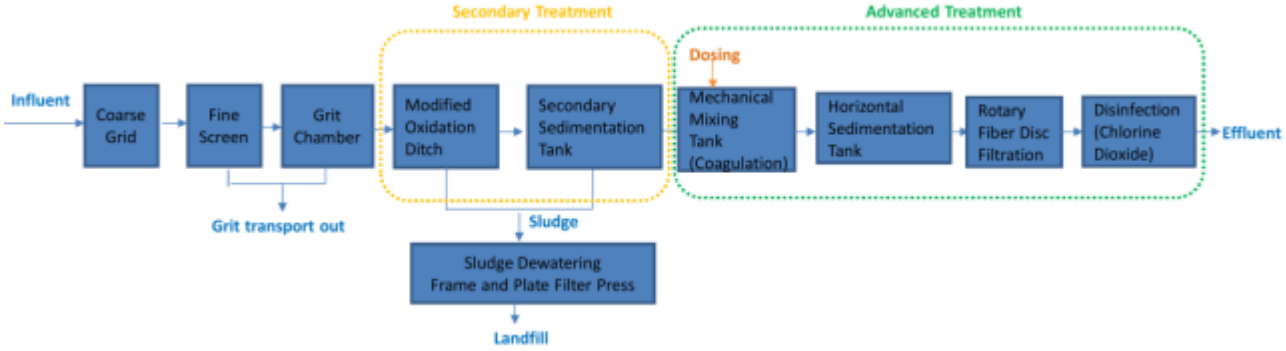


Figure IV-10: Process Diagram of the new Qi Count WWTP

82. Based on documentation of the existing industries in the service area of the WWTP, industrial wastewater is anticipated to account for about 40% of wastewater to be treated by the new WWTP. Existing industries include paper and pulp, clothing, and starch and sugar production. The new WWTP has been designed on the assumption that industries comply with PRC regulatory standards and effectively treat their effluent prior to discharge to the municipal sewage network. There is a potential risk that untreated industrial wastewater could be discharged to the new WWTP (either illegally or accidentally), and which might halt or delay the treatment process and/or damage the WWTP facilities. For example, untreated effluent from a paper and pulp factory could introduce bleaches or acids into the aerobic treatment system of the new WWTP and cause die-off of the bacteria used in the treatment process. As Hebi City is targeted for further industrial development, this risk could increase in the future. These risks are rated low because: (i) any such pollution events would be diluted

by mixing with domestic wasterwater prior to entering the WWTP; (ii) the nature of most industries in Hebi City (current and planned) do not produce high-risk industrial pollutants e.g. heavy metals or persistent organic pollutants (POPS); and (iii) all industry is required to treat water prior to discharge, and monitoring meters are installed at the factory discharge outlets and monitored by the Hebi Environmental Protection Bureau.

83. Sludge will be transported to Qi County Domestic Solid Waste Landfill for co-land filling with domestic solid waste after dewatering to water content of 60% with frame and plate filter dewatering press process. Qi County Sanitation Landfill is located 600 m south to the S222 Provincial Road, about 14 km from Qi County WWTP.

84. **Installation of stormwater and sanitation sewers.** Due to the direct discharge of untreated domestic (and possibly industrial) wastewater, the Qi River and tributaries in Qi County is severely polluted (Class V or worse). The sub-project will support separate storm water and sewage collection system in Qi County, including installation of about 132.49 km storm water sewer (DN500-1200), 69.12 km sewage sewer (DN300-1000) and associated manholes in Qi County Binhe Area (including Demonstration Area, Heqi Industrial Area and Old Town Area) (Table ES-1; Figure IV-11). The Demonstration Area is a new development area. Some storm water pipelines are constructed together with road construction but the storm water collection network is not complete. The Heqi Industrial Area only has few roads installed with storm water pipelines. The Old Town Area (including Tiexi Industry Zone) is still using the combined sewer system for both wastewater and storm water collection. Only Renming Road, Taishan Road and Yumeng Road are installed with separate wastewater and storm water pipelines. Most of the existing drainage network is covered drains.

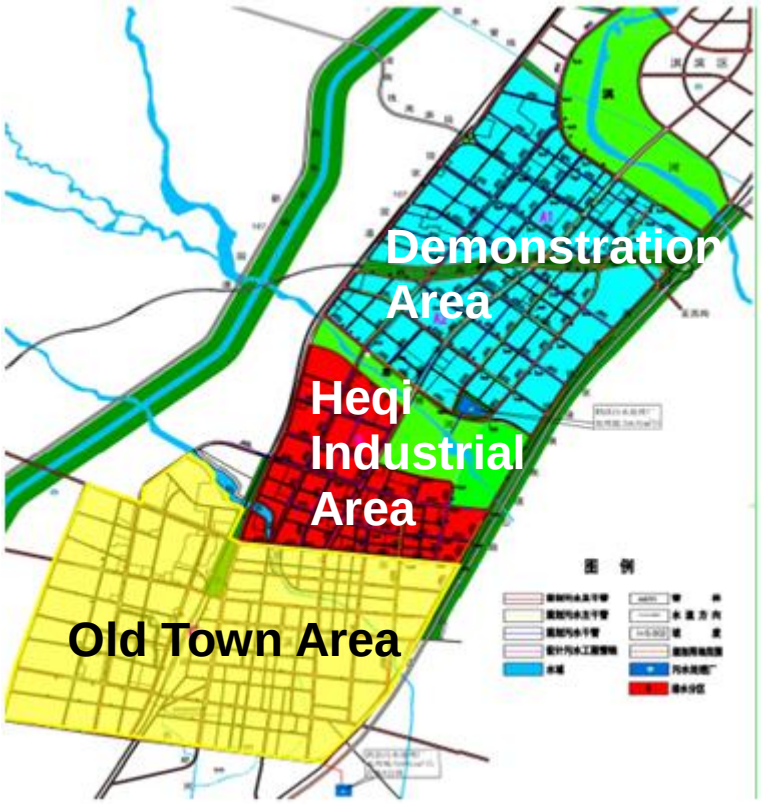


Figure IV-11: Drainage Zone of Qi County Binhe Area

85. Stormwater will be discharged to rivers and/or canals (Table IV-7). For roads wider than 40 m, storm water pipelines will be laid on both side of the road.

Table IV-7: Receiving Rivers/Canals for Storm water Discharges

Area	Accepting River/Canal
Demonstration Area	Qi River / Side River / Zhaojia Canal
Heqi Industrial Area	Side River / Zhaojia Canal
Old Town Area (including Tiexi Industrial Zone)	Zhejing River (Tiexi Industrial Zone) / Hucheng River / Zhaojia Canal

86. Wastewater is conveyed to the Qi County North WWTP (Heqi WWTP) for treatment. The design capacity of the Qi County North WWTP is 30,000 m^3/d. The actual treatment volume is currently around 10,000 m^3/d. The Qi County North WWTP adopts the Modified Carew Purcell Oxidation Ditch treatment process, and discharge an effluent that meets the Class 1A national effluent discharge standard. For road width ≤40 m, storm water pipeline will be laid on only one side of the road. For roads <30 m wide, sewage pipelines will be constructed only on one side of the road. For roads ≥30 m meters, sewage pipelines will be constructed on both sides of the road. Additional sewage pipelines are usually laid under sidewalk of road or under slow lane to minimize the excavation and impact to the traffic.

87. **Installation of sanitary sewers.** This subcomponent will support installation of about 69.12 km sewage pipelines (DN 300-1000) and associated manholes in Binhe Area of Qi County (including Demonstration Area, Heqi Industrial Area and Old Town Area) (Table ES-1). The service areas of this subcomponent are the same as the storm water pipelines as shown in Figure IV-11. Sewage pipelines will only be installed on one side of the road, and are usually laid under sidewalk of road or under slow lane to minimize excavation and impact to the traffic.

88. The destination of wastewater collected in each drainage zone is shown in Table IV-8.

Table IV-8: Receiving Wastewater Treatment Plants for Binhe Area

Area	Location	WWTP
Demonstration Area (14.97 km^2)	South of Qi River, north of Side River, east of 107 National Highway, west of Jinggangao Highway	Qi County North WWTP (Heqi WWTP)
Heqi Industrial Area (7.89 km^2)	South of Side River, north of Taishan Road, east of 107 National Highway, west of Jinggangao Highway	Qi County WWTP
Old Town Area (including Tiexi Industrial Zone) (20.12 km^2)	South of Zhaojia Canal and Taishan Road, north of Taoyuan Road, west of Jinggangao Highway, east of Zhaoyang Road and Zhonghua Road	Qi County WWTP

3.3 Solid Waste Management

89. **Construction of domestic waste transfer stations.** This sub-component involves the construction of 15 urban domestic waste transfer stations and associated facilities with a designed handling capacity of 30 t/d each in the Tiexi zone of Qi County. The 15 vertical compression transfer stations will cover a total land area of 4,500 m², which include a total floor area of 3,090 m² (206 m^2 per station), paved ground area of 1,050 m^2 (70 m^2 per station) and a turf landscaped area of 360 m^2 (24 m^2 per station). A list of the equipment to be included in the transfer stations is shown in Table IV-9 and activities for construction of the transfer stations are listed in Table IV-10.

Table IV-9: Equipment for the Proposed 15 Waste Transfer Stations

Name	Model and Parameters	Unit	Quantity	Remarks
Vertical type Compression type	Exterior dimension: (length x width x height): 6060 x 5180 x 5790; maximum working pressure of 20MPa. Power of 22kw; feed bin capacity of 5m3; dustbin capacity of 15m3.	Set	15	1 set per station

Name	Model and Parameters	Unit	Quantity	Remarks
Arm drag transfer vehicle	Exterior size: 8075 x 2496 x 3165; Total mass at full load of 25t, rated power of 196KW.	set	15	As above
Small trash collector	Engine power of 39 kw, maximum mass of 1.8 t, unloading height of 1.25 m, effective capacity of 2.2 m^3	set	45	3 sets per station
Methane detector		Set	15	1 set per station

Table IV-10: Sub-components of Solid Waste Transfer Station Construction

No.	Component	Unit	Quantity	Remark
1	● Vertical compression waste transfer stations ● 15 sets of methane detectors; Offices (206 m^2); Landscape area (24 m^2); Pavement (70 m^2)	Set	15	
2	Arm drawing transfer vehicle	Set	15	As above
3	Small type of small garbage collection carts	Set	45	3 sets each
4	Methane detector	set	15	1 set each

90. In accordance with project scale and operational characteristics, it is estimated that the operation and management of the 15 solid waste transfer stations will need full time 60 staff (4 persons for each station). A 7-day work schedule is needed each week, and two work shifts are arranged for each day. Each employee works for 5 days in each week. A total number of working days on duty will be 365 days per year.

91. **Improved solid waste management in 13 riverside villages.** This sub-component is to improve domestic solid waste management at 13 riverside villages along the river - 6 villages in Qibin District and 7 villages in Qi County (Table IV-11).

Table IV-11: Total13 Villages served along the River

No.	County domain	Village name	Number of households	Population (person)
1	Qibin District	Bailongmiao Village	37	155
2		Zhifang Village	60	246
3		Anledong Village	50	208
4		Luchang Village	260	1053
5		Qingshuiwan Village	16	61
6		Xin Village	230	664
7	Qi County	Zhujia Village	270	1126
8		Lihezhai Village	90	368
9		Magedang Village	580	2453
10		Yangzhuang Village	650	2678
11		Jinzhuang Village	230	929
12		Lihetun Village	500	2085
13		Wangdong Village	760	3078
Total			3,733	15,104

92. The proposed activities include the placement of litter bins, construction of waste collection stations, and procurement of garbage transfer trucks in the 13 village along Qi River. A total of 17 garbage collection stations, 747 dust bins, 8 mini type garbage transport tricycles, and 2 garbage transfer trucks will be included in this sub-component.

93. **Trash bins.** Trash bins will be placed following the principle of making households more convenient for dispose of garbage wastes to the trash bins, and enduring that garbage will not be exposed out of the bins. Mobile types of trash bins will be used and garbage will be disposed of in accordance to its type. One trash bin will be installed for every 5 households. There are a total of 3,733 households in the 13 villages, which will require 747 trash bins.

94. **Collection stations.** The refuse collection station shall be set at roadside of traffic lane farther from households in villages, which facilitates external transport of garbage and does not affect household life. The villages of Magedang Village, Yangzhuang Village, Lihetun Village and Wangdong Village have a higher population, and 2 trash bins will be placed in each of these 4 villages. For the rest 9 villages, 1 trash bin will be placed in each village. A total of 17 garbage collection stations with trash bins will be established in these 13 villages.

95. **Mini-type garbage transport tricycle and transport truck.** Collection spot in each village, mini-type garbage transport tricycles to facilitate the delivery of garbage from households to the trash bin will be procured and provided to each village. Most of the villages will be provide one tricycle, with the exception of 4 villages for which more than 1 tricycle will be provided. Consequently, a total of 18 tricycles will be procured and provided to the 13 villages. Each county and district will be equipped with 1 garbage transport truck, respectively to haul and transfer the garbage collected at each village to landfill sites, or city solid waste transfer stations. Two garbage transport trucks will be procured, one for Qibin District and the other for Qi County.

Output 4. Institutional and Technical Support System

96. Output 4 comprises the development and implementation of: (i) Qi River Ecological Monitoring Program; (ii) Qi River MIS; and (iii) associated project training (Table ES-1). The MIS will comprise a shared database that is linked across the bureaus of HCG involved in land and water management of the Qi River. The central database will be housed in a leading agency tasked with water resource management and coordination (e.g. Flood and Drought Management Office of Hebi City Water Resources Bureau). The database will be installed in each bureau office and linked by intranet, with defined user access, so that updates or new data entry made by a user will be reflected across the system. The leading agency will be responsible for overall management and maintenance of the database. The database will be used to support management of the Qi River by each agency, including flood warning and forecast, and water quality and ecological monitoring. Establishment of the database will require identification of appropriate software, tailored to the project needs, initial data entry (including layers for roads, topography, climate, location of water intake and discharge points), and training of users in data entry, maintenance protocol, and generating reports. A specialist agency (e.g. design institute) will be recruited to establish the system; and (iii) project management consulting services. These activities do not present risks to the environment and no assessment is required for environmental safeguards.

D. Institutional Arrangement for Construction and Operation

97. The executing agency (EA) is the Hebi City Government (HCG) responsible for overall project implementation. A project leading group (PLG) and a PMO have been established in the HCG. The PLG is chaired by the Executive Vice Mayor of HCG, with members from the Hebi City Government, Hebi Finance Bureau (HFB), Hebi Development and Reform Commission (HDRC), and other relevant agencies. The PMO is chaired by the Deputy Director of the HFB and comprises staff and representatives from the relevant government departments. The governments of Qibin District, Qi County and Xun County will be the implementing agencies (IAs). The IAs will establish Project Implementation Units (PIUs) to implement the sub-components. The PIUs include Qibin District Forestry Bureau, Qibin District Municipal Administration Office, Qibin District Housing and Urban-rural Construction Bureau, Qi County Water Resources Bureau, Qi County Housing and Urban-rural Construction Bureau, Qi County Urban Administrative Enforcement Bureau, Xun County Water Resources Bureau, Rural Urban Integrated District Land Administration Bureau. The scope of proposed works for each IA and PIU is shown in Table IV-12.

Table IV-12: Project Implementation Arrangements

No.	Proposed Subcomponent	Project Implementing Unit (PIU)
1. Ecological conservation and environmental management of upper Qihe River and its watershed enhanced		
1.1	Qi River Upstream Ecological Protection	Qibin District Forestry Bureau
1.2	Restoration and management of pilot Qihe River National Wetland Park	Qibin District Forestry Bureau and Qi County Forestry Bureau
2. **Lower Qihe River Mainstream and Tributaries improved**		
2.1	Qihe Mainstream Watercourse Improvement in Qi County (21 km)	Qi County Water Resource Bureau and Xun County Water Resource Bureau
2.2	Four Tributary Watercourse Improvement in Qi County	Qi County Water Resource Bureau
2.3	Five Canal Watercourse Improvement in Qibin District	Qibin District Municipal Administration Division
3. **Wastewater and Solid Waste Management in the Qihe River Basin improved**		
3.1	Qibin District Wastewater Management	Qibin District Housing and Rural and Urban Development Bureau
3.2	Qi County Wastewater Management	Qibin District Housing, Rural and Urban Development Bureau, Qi County Urban Administration Bureau, and Rural Urban Integrated District Land Administration Bureau
3.3	Solid Waste Management	As above
4. Institutional and technical support system for integrated management of the Qihe River Basin improved		
4.1	Qihe River Ecological Monitoring Program	Hebi City PMO
4.2	Qihe River Basin Management Information System	Hebi City PMO
4.3 – 4.6	Project start-up support consulting services; loan implementation consulting services; external resettlement monitoring and evaluation; training	Hebi City PMO

E. Associated Facilities

98. ADB's SPS (2009) defines associated facilities as "facilities that are not funded as part of a project but whose viability and existence depend exclusively on the project, or whose goods or services are essential for successful operation of the project." Panshitou Reservoir, and the existing and planned WWTPs in Qi County and Qibin District which will receive wastewater from the collection pipelines constructed in this project, are associated facilities. Operational details of these WWTPs are shown in Table IV-13. Due diligence for Panshitou Reservoir is given in Section V.A.

Table IV-13: WWTP Wastewater Treatment Plant for Qibin Wastewater Management sub-component

No.	Plant Name	Location	Designed Capacity	Discharge Standard	Operation Year	Operation Entity
1	Qibin District WWTP	Qibin District	50,000 m^3/d	1A	2005	Hebi Qibin Wastewater Treatment Co. Ltd
2	Qishuiwan WWTP (Planned)	Qibin District	30,000 m^3/d	1A	-	-
3	Qi County North (Heqi WWTP)	Qi County	30,000 m^3/d	1A	2014	Hebi Wastewater Treatment Co. Ltd

Qibin District WWTP

Existing Qi County WWTP

Figure IV-12: Associated WWTPs Under Operation.

V. DESCRIPTION OF THE ENVIRONMENT

A. Environmental Setting

99. **Climate.** Hebi is located in northern Henan, and has warm temperate and semi-humid monsoon climate. It experiences four seasons and large seasonal temperature variations. Hebi City has a dry and windy spring, hot and humid summer, clear autumn and cold and foggy winter. Mean annual temperature is 14.2^0C, maximum temperature is 41.5^0C, and minimum temperature is -14.2^0C. Pre-dominant wind direction is north, year round, with mean annual wind speed of 2.3 m/s. Maximum wind strength is Grade 9 out of 18 Grades and maximum wind velocity is 24 m/s. Inter-annual variation of the precipitation is large, with uneven distribution in the year. Mean annual precipitation is 674.8 mm, maximum annual precipitation is 1,926.9 mm (Xincun Station in 1956) and minimum annual precipitation is 316.3 mm. Precipitation from June to September accounts for 70% - 80% of the annual total. Mean annual evaporation capacity is 1,700 mm, mean annual sunshine duration is 2331.6 h, there is an annual frost-free period of about 200 days.

100. **Topography and soils.** Hebi City is located at the junction between the Taihang Mountains in the west of North Henan and the North China Plain. Rivers in Hebi are branches of Haihe River and Weihe River, of which Henghe River flows through the northwest region, Tanghe River originates from the central region, and Qi River passes through the new urban area in the south region. The Qi River flows through three geomorphic regions, mountain, hill, and plain. The river section from Panshitou Reservoir to a local landmark "NaturalTaijitu"[4] is in the mountain region, the section from this point downstream to Liuzhuang barrage (an existing barrage across the Qi mainstream) in Qibin District is in the hill region, and the section from the dam downstream to New Xiaohekou is in the plain region. The gradient of Hebi River decreases from 1/100 - 1/200 in the mountain region, 1/600 - 1/700 in the hilly midreaches, and 1/2,000 in the floodplain (lower reaches). Soils of Hebi City comprise six groups, 11 subgroups and 21 soil genera. Main categories are aeolian sandy soil, fluvial soil, cinnamon soil, swamp soil, and paddy soil. Wetlands support "cinnamon" and "swamp" soils. Cinnamon soil occurs in the hill slopes and flood land on both banks of Qi River. On steep slopes the soil layer is thin and with high gravel content. Lower hill slopes and plains support thick soil layers with high organic matter content.

101. **Hydrology and surface water resources.** The Qi River originates from Qizi Mountains in Shanxi Province. It flows through Huixian, Linzhou, and Qibin Districts, and Qixian and Xunxian counties to the new Xiaohekou in the west of Qimen and flows into Weihe River (a 283 km long tributary of Hai River). Total length of the Qi is 162 km. The drainage basin is 2,142 km^2. Total length of the river within Hebi City is 83 km, from Panshitou reservoir upstream to the confluence with the Weihe River downstream, through Qibin District and Qi County, with a drainage area of 225 km^2. The upper, middle, and lower reaches are 23.7 km, 14.3 km, and 45.0 km, with gradients of 1/100─1/200, 1/600─1/700, and 1/2,000 respectively. In the Qi River section located in Hebi, there are 12 barrages and one dam, Panshitou (below). In general, the Qi upper reaches are shallow, rocky, and swift-flowing. The main sources of water supply of the Qi River are precipitation, Panshitou Reservoir, and Xugou Hot Springs. In recent years, the recorded maximum flood volume was 7,080 m^3/s. Floods over 3,000m^3/s have occurred 7 times since 1949. The highest measured discharge was at Xincun Station in 1963 (5,990 m^3/s). The inter-annual difference of water volume in the Qi is large and within-year distribution is uneven. Mean annual discharge of Qi River in the project area is 10.69 m^3/s. June to August is the flood season.

[4] Taijitu is a Chinese symbol for the concept of yin and yang (Taiji). The Taijitu consists of a rotated pattern inside a circle. The typical Daoist taijitu is black and white with a black dot upon the white background, and a white dot upon the black background.

102. **Panshitou Reservoir**. Panshitou Reservoir is located immediately upstream of the project area and 35 km upstream from the urban area of Hebi City. The dam was constructed in 2007. The reservoir has a catchment area of 1,915 km^2 (89.4% of the total catchment area of Qi River). Total storage capacity of the reservoir is 608 Mm^3 (million cubic meters). The reservoir is for flood control, irrigation, domestic and industrial use. It is designed for a 100 year flood interval; the design flood level is 270.7 m, total storage capacity is 0.532 billion m^3, and the flood prevention storage capacity is 0.276 billion m^3. The 2,000-year return water level of the reservoir is 278.40 m, the corresponding storage capacity is 0.68 billion m^3, and the flood regulation storage capacity is 0.434 billion m^3. The beneficial use water level (normal pool level) of the reservoir is 254.0 m, and the storage capacity of beneficial use is 0.28 billion m^3. The industrial and urban water supply amount is 0.135 billion m^3. The discharge flows at 3–5 year flood, 5–10 year flood and 10–50 year flood are 100 m^3/s, 400 m^3/s and 800 m^3/s respectively. The reservoir maintains 0.5 m^3/s environmental flow during normal season and 0.25 m^3/d during dry season (i.e. when the water level is below 230 m). The reservoir is managed by Panshitou Reservior Construction and Operation Bureau. Dam safety, maintenance, and monitoring is regulated in compliance with the PRC's *Regulation on Dam Safety* (1991).

103. The reservoir has significantly improved the flood management capacity of Hebi City, but has also entirely changed the hydrology of the Qi, including alteration of seasonal flow regime and volume, reduced downstream flow; increased frequency and extent of winter ice cover in winter due to the shallow water levels; and reduced magnitude of discharge of groundwater.

104. **Tributaries of Qi River in Qi County.** Rivers in Qi County belong to the drainage system of Weihe River in the drainage basin of Haihe River. The main rivers are Qi River, Side River, Zhaojia Channel and Zhejing River. The mean quantity of groundwater is 66 million m^3. Per capita occupancy of water resource is 262 m^3, only one-ninth of the national per capita value. The Side River has a basin area of 310 km^2, total length of 41.5 km, and flows through Qixian County. Zhejing River, Zhaojia Channel, and Yangwu and Liangxiang Ditches form a small closed basin the county. In the north, the Xiaozhu River has a basin area of 138 km^2. It flows east into Qi River. The Zhaojia Canal originates from Xiaochunhua, is 21 km long, has a basin area of 225 km^2, is adjacent to Side River and flows south into Communism Channel. In the upstream of Zhaojia Channel, there is Hongwei Reservoir for flood storage. This river basin covers the new district of county, the station of Qiaomeng township government, Qiaomeng Town and Xigang Town. The Zhejing River originates from Taihe Spring of Quantou Village and flows through Qiaomeng, Chaoge, Beiyang and Xigang Towns into the Weihe River. Total length is 19.8 km and basin area is 100 km^2. The Hucheng River is in the urban area of Qi County and 3.6 km long.

105. **Qibin District.** Tianlai Canal receives water from Qi River. Mianfeng Canal is 4.03 km long and was originally an irrigation and flood control channel. Water in the second branch channel is drawn in from Tianlai Channel, flowing eastwards into Hucheng River, the channel to the east of Huangshan Road has carried out landscape renovation, which presents a pleasant scene with clear water and green bank, while the channel to the west of Huangshan Road has not carried out landscape renovation, which has deep groove and thriving trees and poor hydrophilicity. The third branch channel is newly excavated, next to Liujiang Road, whose water is drawn in from Tianlai Channel, flowing eastwards into Hucheng River. The third branch channel is newly excavated, next to Liujiang Road, whose water is drawn in from Tianlai Channel, flowing eastwards into Hucheng River. Hucheng River is an artificial channel in the east part of the new district of Hebi City, which borders Dalu Ditch in the north, connects Qi River in the north, connects with a branch canal of Tianlai Channel, mainly taking over the urban rainwater and assuming the function of flood control and drainage.

106. **Groundwater**. The total quantity of the groundwater resource of Qixian County is 97

million m^3. Mean total precipitation per year in Qixian County is 0.41 billion m^3, besides evaporation and infiltration, the mean runoff depth is 162 mm, the annual runoff total quantity is 94,371,000 m^3. The surface runoff often occurs in the rainy season, especially in the flood season, besides that part of it infiltrates and replenish the groundwater, most of it flows outside the region along Side River, Qi River, Xiaozhu River and Bami Ditch.

B. Physical Environment at the Project Sites

107. Baseline sampling of ambient environmental conditions (surface water quality, acoustic environment, air quality, sediment quality) was conducted by Pony Testing International Group in March and April 2014. Sampling of surface water quality was also conducted by the Hebi Environmental Monitoring Station in 2013 at four canals and the Side. Sampling locations are shown in Figure V-1.

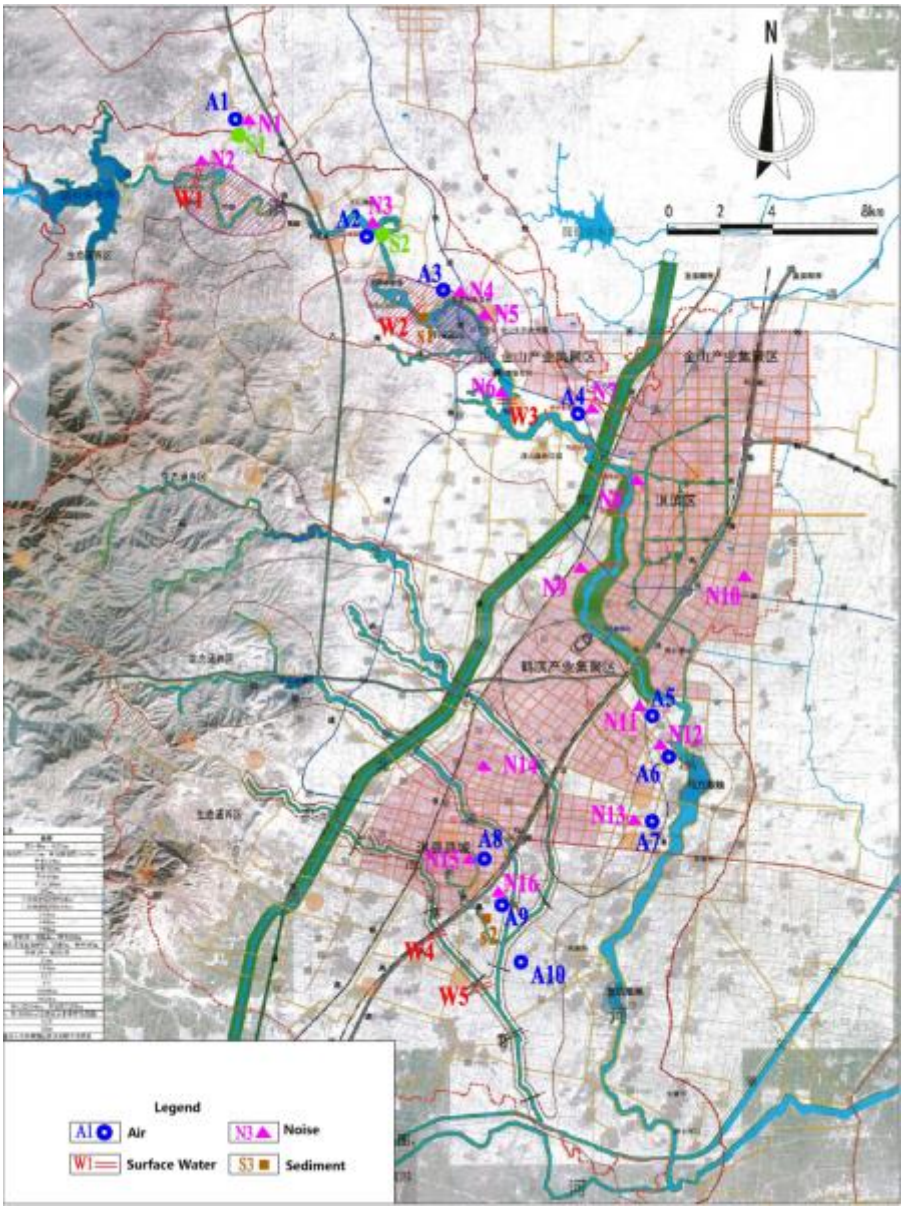


Figure V-1: Sampling locations for air, surface water, noise and sediment quality

108. **Surface water quality**. Sampling results (Table V-3) indicate that water quality of the mainstream Qi, and Tianlai, Mianfeng, Erzhi, and Sanzhi Canals exceeds the standards of Grade III of GB 3838-2002. Monitoring results showed exceedance of Category V standards

for COD, BOD_5, TN, TP and NH_3-N at Zhejing River and Side River. Pollution of the Side River is caused by discharge of untreated domestic sewage from residential area and industrial wastewater from Heqi Industrial cluster zone. Pollution of Zhejing River is mainly caused by discharge of untreated domestic sewage from residents along the river.

Table V-1: Baseline Surface Water Quality Sampling

Sampling Location	No.	Date	T (℃)	Flow (m^3/s)	pH	DO (mg/L)	I_{Mn} (mg/L)	COD (mg/L)	BOD_5 (mg/L)	NH3-N (mg/L)	TP (mg/L)	TN (mg/L)	Petroleum (mg/L)
七里沟砌石坝处 Qi River Qiligou	W1	2014/3/29	10.2	4.82	8.03	6.5	1	5L	0.5L	0.025L	0.01L	3.1	0.04L
		2014/3/30	9.9	4.8	8.08	6	0.98	5L	0.5L	0.025L	0.01L	3.56	0.04L
		2014/3/31	10.1	4.81	8.06	6.7	1.04	5L	0.5L	0.12	0.01L	3.06	0.04L
淇河胡家咀处 Qi River Hujiaju	W2	2014/3/29	17.8	7.51	8.08	6.8	0.88	5L	0.5L	0.025L	0.01L	1.9	0.04L
		2014/3/30	18.1	7.5	8.13	6	0.85	5L	0.5L	0.025L	0.01	2.41	0.04L
		2014/3/31	17.9	7.52	8.03	6.5	0.9	5L	0.5L	0.025L	0.01	1.86	0.04L
寒坡洞橡胶坝处 Qi River Hanpodong	W3	2014/3/29	15.2	1.62	8.26	6	1.18	5L	0.5L	0.025L	0.01	2.5	0.04L
		2014/3/30	15.5	1.6	8.13	6.7	1.2	5L	0.5L	0.12	0.01	2.36	0.04L
		2014/3/31	15.1	1.62	8.1	6.8	1.24	5L	0.5L	0.025L	0.01	2.49	0.04L
折胫河（污水处理厂上游）Zhejing River (upstream of WWTP)	W4	2014/3/29	18.3	0.35	**7.31**	1.2	**20**	**117**	**45.8**	0.025L	**2.06**	**8.25**	0.17
		2014/3/30	19.5	0.34	**7.37**	1.5	**18.5**	**85.3**	**28.4**	0.025L	**1.95**	**7.68**	0.15
		2014/3/31	18.8	0.34	**7.38**	1.7	**21.9**	**130**	**52.5**	0.025L	**2.12**	**8.13**	0.12
折胫河（污水处理厂下游）Zhejing River (downstream of WWTP)	W5	2014/3/29	18.5	0.29	**6.87**	1	**115**	**554**	**252**	0.025L	**1.36**	**10.1**	0.4
		2014/3/30	18.9	0.29	**6.89**	1.2	**109**	**610**	**265**	0.025L	**1.65**	**9.86**	0.53
		2014/3/31	19.2	0.3	**7.01**	1.4	**108**	**619**	**269**	0.025L	**1.18**	**8.65**	0.45
前枋城 Qianfangcheng	W6	2013/10/15			7.84	7	1	10L	0.5L	0.025L	0.026	/	0.04L
思德河 Side River	W7	2013/11/1	**12**	0.85	**7.72**	0.04	**43.2**	**92**		**28.5**	**4.72**	**39.8**	0.04L
天赍渠 Tianlai Canal	W8	2013/11/1	13.8	0.2	8.07	6.72	2.1	10L		0.146	0.022	0.402	0.04L
棉丰渠 Mianfeng Canal	W9	2013/11/1	13.8	0.24	7.91	6.08	1.9	10L		0.405	0.057	0.921	0.04L
二支渠 Erzhi Canal	W8	2013/11/1	13.7	0.72	7.81	5.92	2.5	10L		0.422	0.021	0.902	0.04L
三支渠 Sanzhi Canal	W9	2013/11/1	13	1.05	7.92	6.75	2.7	10L		0.514	0.076	0.979	0.04L
GB 3838-2002 Category III standard					6-9	5	6	20	4	1.0	0.2	1.0	0.05
GB 3838-2002 Category V standard					6-9	2	15	40	10	2.0	0.4	2.0	1.0

Note. Bold-highlighted values exceed Category V standards. L=below the limit of detection. I_{MN} = permanganate index.

109. **Air quality**. Baseline ambient air quality sampling was undertaken over seven consecutive days from 27 March to 2 April 2014. Parameters monitored included 24-h average TSP, PM_{10}, SO_2 and NO_2; 1-hr average SO_2 and NO_2; and for the wastewater treatment plant, 1-hr and 24-hr H_2S and ammonia gas. Sampling results are presented in Table V-3, indicating that the concentrations of the parameters measured on the days and at the locations shown in the table complied with Class II air quality standards and the World Bank Group's (EBG) Environmental Health and Safety (EHS) interim targets, except at five locations with exceedance of Class II standard for TSP and PM_{10}. For TSP, this is because the sampling was undertaken under windy conditions in spring.

Table V-3: Results of Air Quality Sampling in 2014

Sampling Location		Air Quality Parameter and Concentration Levels (mg/m^3)									
		TSP	PM_{10}	SO_2		NO_2		H_2S		NH_3	
No.	Name	24-h Av	24-h Av	1-h Av	24-h Av	1-h Av	24-h Av	1-h Av	24-h Av	1-h Av	24-h Av
A1	Niuhengling 牛横岭村	0.235	0.125	0.008-0.0064	0.03	0.005-0.052	0.025				
A2	Anledong Village 安乐洞村	0.249	0.132	0.007-0.056	0.023	0.005L-0.044	0.022				
A3	Luoguanzhong's hideaway 罗贯中隐居地	0.265	0.135	0.007L-0.033	0.019	0.005L-0.036	0.018				
A4	Liuzhuang barrage 刘庄	0.292	0.135	0.007-0.052	0.021	0.005-0.043	0.024				
A5	Dalaidian 大赍店	0.297	0.145	0.007L-0.029	0.015	0.004-0.039	0.020				

A6	Huawo Village 花窝	0.317	0.157	0.008-0.043	0.018	0.004-0.041	0.023				
A7	Shihean Village 石河岸村	**0.329**	**0.175**	0.007L-0.038	0.017	0.005L-0.048	0.023				
A8	Jinzhuang 靳庄	**0.322**	**0.176**	0.007L-0.042	0.02	0.006-0.057	0.028				
A9	Dongsongzhuang 东宋庄村	**0.3**	**0.16**	0.007-0.047	0.023	0.005-0.052	0.029				
A10	Qi County Health Supervision Institute 淇县卫生监督所	**0.315**	0.148	0.007-0.057	0.024	0.007-0069	0.033	0.001L-0.005	0.003	0.004-0.045	0.022
A11	Qi County WWTP 淇县污水处理厂	0.27	0.148	0.008-0.054	0.024	0.006-0.053	0.032	0.001L-0.007	0.004	0.007-0.055	0.032
A12	Poyuanzhuang 坡袁庄村	**0.354**	**0.17**	0.007-0.051	0.022	0.008-0.061	0.03	0.001L-0.009	0.005	0.005-0.05	0.029
Class II standard	GB 3095-1996	0.3	0.15	0.5	0.15	0.24	0.12				
	GB 3095-2012	0.3	0.15	0.5	0.15	0.2	0.08				
WBG EHS standard	Interim targets	0.075–0.150		0.050–0.125							
	AQG	0.05		0.02	0.2						

Note. Bold-highlighted values exceed Class II standards. L=below the limit of detection. Av = average.

110. **Sediment**. The PRC does not have standard for sediments in waterways such as streams, rivers, lakes, reservoirs and the sea. It is common practice in the PRC to use *Environmental Quality Standard for Soils* (GB 15618-1995) to assess sediment quality (see Table II.9) since most sediment would be disposed on land and mostly likely for future agricultural or planting uses. Some EIRs in the PRC have also used *Control Standards for Pollutants in Sludges from Agricultural Use* (GB 4284-84) for assessing sediment quality. The rationale being that the physical nature of river sediment is similar to sludge. Since the major potential beneficial usage of dredged sediment in this project might be reuse for agriculture, dredged sediment quality was assessed against GB 4284-84 in domestic TEIAs. As mainstream of Qi River will not involve dredging, its sediment was not monitored. Sediment data published in Environment Quality Bulletin of Hebi (2012) was referred. The tributaries of Qi River at Qi County and Qibin District were monitored on February 2015. The testing results indicated the sediment quality at selected locations meet with the requirement of *Control Standards for Pollutants in Sludges from Agricultural Use* (GB 4284-84).

Table V-4: Sediment sample testing results (unit: mg/kg)

Sampling Location	Date	Cd	Hg	As	Cu	Pb	Cr	Zn	Ni	TP	TN	Organic Matter
Huanghuaying of Qi River mainstream	2011	0.104	0.084	3.94	15.1	11.2	61.2	42.8				
Huanghuaying of Qi River mainstream	2012	0.096	0.097	3.44	14.8	10.6	21	31.8				
Side River	2015	0.16	0.046	4.94	29.4	44.2	41.0	74.6	26.6	0.82	1.78	23.1
Zhaojia Canal	2015	0.22	0.14	6.74	734	44.0	63.0	694	58.2	5.79	5.77	77.4
Hucheng River	2015	1.32	2.74	5.15	83.9	83.3	55.0	328	27.2	4.39	4.89	82.5
Zhejing River	2015	0.18	0.10	5.61	28.2	45.0	40.4	64.8	24.0	0.61	1.32	18.7
Tianlai Canal	2015	0.066	0.5	5.96	17.5	33.3	30.1	41	20.2	0.29	0.47	5.28
Mianfeng Canal	2015	0.85	2.58	5.32	38.5	54.8	37.4	152	24.4	1.00	2.52	33.7
Erzhi Canal	2015	0.28	0.26	5.52	31.4	51.7	35.3	97.9	21.8	0.89	1.77	30.0
GB 4284-84 (pH<7)		5	5	75	250	300	600	500				
GB 15618-1995 (pH>7)		20	15	75	500	1000	1000	1000				

C. Ecological Resources

111. Data on flora and fauna in the project area was compiled from ecological surveys by the Hebi Forestry Bureau (2012), PPTA team site visits to the project area in 2015, interviews with local experts, and desktop review. The project area has been subject to human activity for millennia and habitats are highly modified and mostly degraded. Virtually no original habitat remains. Habitats are rated as Ecological Impact Grade III (the lowest level) under the PRC's Technical Guideline on EIA Regarding Ecological Impact (HJ 19-2011) except in the pilot NWP, which is rated Ecological Impact Grade II (moderate level).[5] Inventories of fauna species in the project area are presented in Tables V-6a–e. The following summary of flora and fauna focuses on the pilot NWP.

112. **Pilot Qi River National Wetland Park**. The pilot NWP encompasses a 7.5 km section of the upper Qi River and is 332.5 ha (of which 271 ha is wetland habitat). The park was designated in 2011, by the Hebi Forestry Bureau and State Forestry Administration (SFA) in 2011.[6] The park supports shallow, swift-flowing river sections with rocky substrate, interspersed with slower-flowing sections with deeper pools. River banks are rocky and vegetated or support villages and associated agricultural land. Under SFA guidelines, nominees are required to prepare a master plan and initiate the development of NWP facilities within five years of the date of nomination. To date, the HCG has prepared a NWP Master Plan (2011–2020; approved in 2010) and initiated land preparation in the park for the future construction of project facilities. The NWP is presently managed by the Qibin District Forestry Bureau (intermittent patrols, litter collection) and Qi Management Office (sponsoring of community-based "river patrol guards" i.e. local residents who are paid a small allowance to monitor human activities in the park e.g. recreational fishing, litter.

113. In accordance with the SFA guidelines for NWPs, the pilot NWP comprises three zones, ecological conservation zone, recreational zone, and management and service zone (Figure IV-4). The ecological conservation zone is the core zone of the park and comprises two sub-zones: (a) conservation (drinking water source for Qibin District; relatively good ecological condition; strict protection); and (b) restoration (habitats targeted for restoration). The recreational zone comprises two sub-zones: (a) public awareness (walkways, signs); and (b) recreation. The management and service zone includes the main entrance of the park, visitor center, car park, office buildings and public facilities.

114. To identify the habitat types in the NWP, satellite imagery (SPOT 6) and site visits were applied by the EIA institute to generate a 1:50,000 land use map (Figure V-2), and quadrat surveys were conducted on 20 June 2014 in the upper, mid and lower sections of the NWP, including 4 herb quadrats (1×1 m), 1 shrub quadrat (5×5 m) and 3 tree quadrats (10×10 m).

[5] Protected natural and cultural areas including reserves, scenic spots, world heritage sites, forest parks, important wetlands, and natural habitats of threatened species.

[6] NWPs are a form of multiple-use protected area in the PRC. About 569 NWPs have been nominated, and which complement 570 national wetland nature reserves and 46 Ramsar Sites.

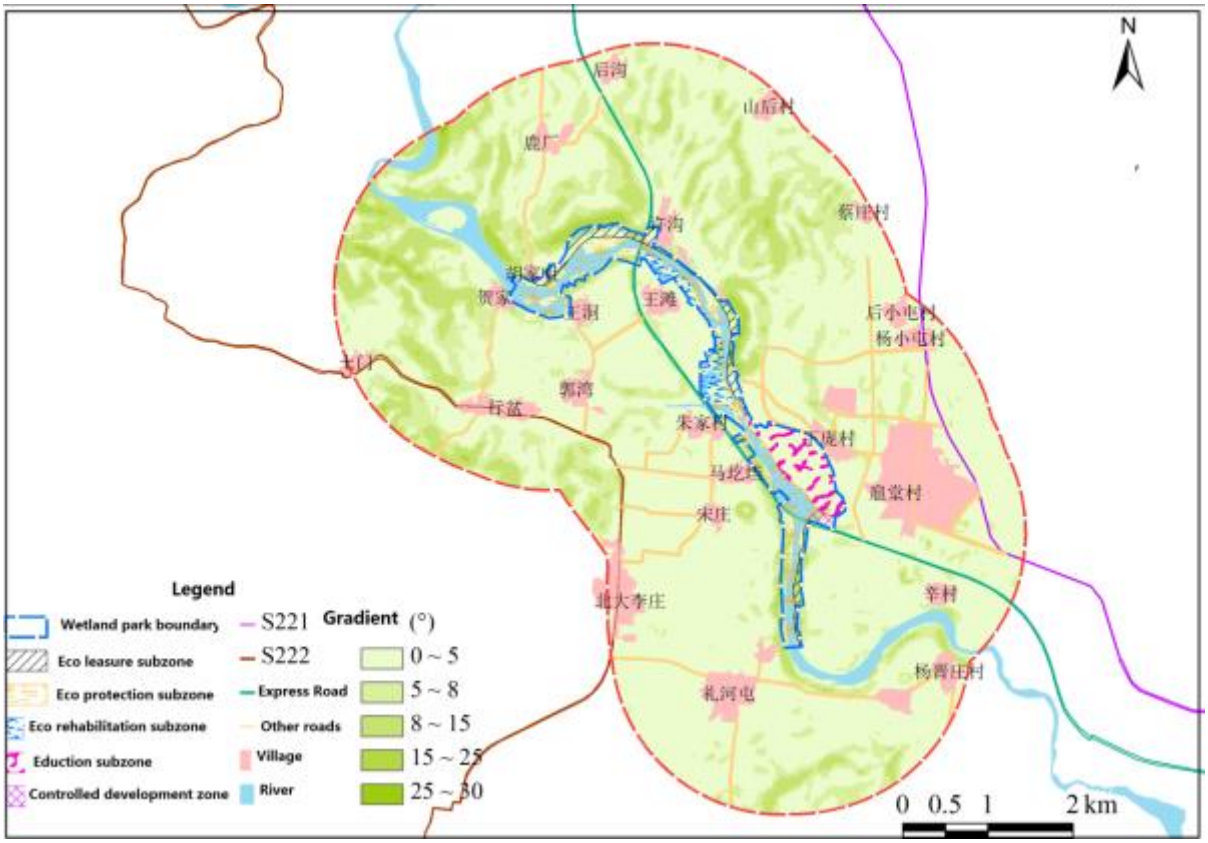


Figure V-2: Land use types in the upper Qi River project assessment area (green shading)

115. Major land categories in the NWP are cultivated land (93.1 ha, 33.5%), woodland (76.2 ha, 27.4%), and water (73.8 ha, 26.6%) (Table V-5).

Table V-5: Land cover in the pilot Qi River National Wetland Park

Land Cover		Ecological Conservation Zone		Recreational Zone		Controlled Developed Zone	
		Area (ha)	%	Area (ha)	%	Area (ha)	%
Cultivated land	Irrigated land	47.64	67.54	41.91	83.03	3.56	79.82
Woodland	Forest			25.84	61.52	0.9	20.18
	Shrub	5.58	13.7				
	Others						
Waters	River	53.74	41.9	3.46	8.97		
	Pond			14.13	25.29		
Urban/Industrial	Residential land			0.38	1.01		
	Industrial and						
Transportation	Urban road						
	Rural road			1.45	2.7		
Others	Agricultural land						
	swampland	23.87	30.14				
	Bare land						
Total		179.25	100	93.88	100	4.46	100

116. **Flora.** The original vegetation of Hebi City is classified as temperate deciduous broad-leaved forest by the *Vegetation Regionalization of China* (1980). Due to human activity the original vegetation has been replaced by secondary vegetation. Common shrub species include *Vitex negundol* and *Zizyphus jujube*. Cultivated trees along the river banks, roads and villages include *Sophora japonica, Anthus altissima, Salix matsudana, Populus tomentosa, Robinia pseudoacacia, Ulmus pumila,* and *Morus alba*. In the NWP, vegetation includes: willows (*Salix nstsudan*), reeds (*Phragmites australis*), bulrushes (*Typha angustifolia*) and

other trees, shrubs, and aquatic plants (e.g. *Cyperus microiria*, *Potamogeton distinctus*, *Spirodela minor*, *S. polyrrhiza*, *Hydrilla verticillata*). Lands along the river support maize, rape, potato and beans (e.g. *Triticum aestivum*, *Zeamays*, *Glycinemax*, *Arachish pogaea*) and planted trees (e.g. *Populus euramericana*, *Broussonetia papyrifera*, *Lagerstroemia indica*, *Rhus typhina*, *Sophora japonica*, *Ligustrun lucidum*, *Prunus persica*, *Malus domestica*, *Pyrus bretschneideri*). Weeds include *Imperata cylindrica var. major*, *Setaria viridis*, *Xanthium sibiricum, Artemisia argyi, Tribulus terrestris, Vitex negundo, Humulus scandens* and *Plantago asiatica.* One threatened species, Wild Soya (*Glycine soja*) occurs in the north part of the NWP.

Tree quadrat Herb quadrat Shrub quadrat

Figure V-3: Typical vegetation communities in Qi Wetland Park

117. **Vertebrate fauna.** According to the *Fauna Regionalization of China* (1959), Hebi City belongs to the Huabei (North China) Region. For birds, at least 188 species from 39 families have been recorded from the project area, including about 129 migratory species, 84 wetland species, 45 of conservation interest (i.e. listed on the IUCN Red List, Grade I or II National Protected Species Status, or provincial protected species in Henan). Almost all records of conservation significance are from the pilot NWP. For mammals, 20 species have been recorded from the pilot NWP, comprising over 50% rodents (rats and mice). There are few records for larger mammals. One species, Hog Badger (*Arctonyx collaris*) is IUCN Near Threatened, yet the date and accuracy of the record is unclear. Leopard Cat (*Felis bengalensis*) is listed as the Grade II in the state key protection wildlife list, and two species (Rock Squirrel *Sciurotamias davidianus*; Cape Hare *Lepus capensis*) are included under the "Three Have" list of SFA (2000).[7] Smaller mammals might persist in the NWP.

118. For reptiles, at least 19 species have been recorded in the project area. Three species are on the IUCN Red List, Chinese Softshell Turtle (*Trionyx sinensis*) and Peking Gecko (*Gekko swinhonis*) (Vulnerable) and Chinese Pond Turtle (*Mauremys reevesii*) (Endangered). Records in the study area are mainly from the upper Qi. Due to the degraded nature of the middle and lower sections of the Qi, it is likely that remaining populations in the project area will be in or near the NWP. For amphibians, at least six species have been recorded in the project area. One, Black Spotted Frog (*Pelophylax nigromaculatus*) is IUCN Near Threatened and is a provincial protected species. Mongolian toad (*Pseudepidalea raddei*) and Boreal Digging Frog (*Kaloula borealis*) are listed as significant (SFA, 2000). All species are known to or presumed to occur in the NWP (Figure V-4).

119. For fish, 64 species have been recorded in the Qi River. Cyprinidae account for over 60% of species. Four carp species (Common, Crucian, Grass, Silver) and catfish are the main species. All carp species have economic value and are cultured in the Qi i.e. wild and cultured populations are mixed. Three species are listed on the IUCN Red List: Silver Carp (*Hypophthalmichthys molitrix*) and Common Eel (*Anguilla japonica*) (Near Threatened) and Wild Common Carp (*Cyprinus carpio*) (Vulnerable). The eel is a migratory species which was once common in rivers throughout the PRC but has become scarce due to pollution, dams blocking passage, habitat loss and over-fishing. The local status of the species is unknown.

[7] A designation by the SFA on whether a species has three categories of values: ecological, scientific and economic.

The Qi River Crucian Carp (*Carassius auratus*) is a protected species and occurs in the NWP. Common Carp is introduced in Henan; local records refer to escaped domestic fish.

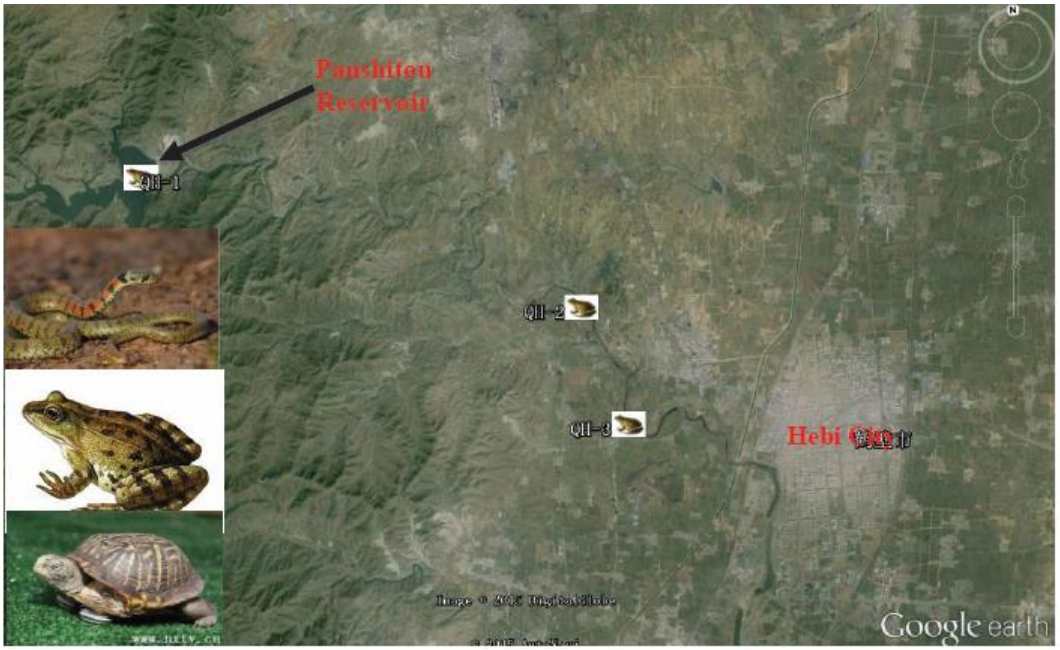


Figure V-4: Location of reptile and amphibian species of conservation interest

120. For aquatic invertebrates, 12 sites from upstream to downstream of the Qi River were sampled 25-28 March and 8-11 April 2015 (Figure V-5). Samples were taken using a D-frame aquatic net (30cm wide, 300mm mesh). Kick sampling method was used and followed a stratified random sampling scheme, in which subdivisions of the stream, such as riffles, runs, pools, intermediate zones and margins, were sampled at each site. In all case, the main objective was to sample the range of microhabitats at each site and so maximize the number of species collected. All specimens were directly placed into vials with 90% ethanol in the field and identified in the laboratory to the lowest practicable taxon.

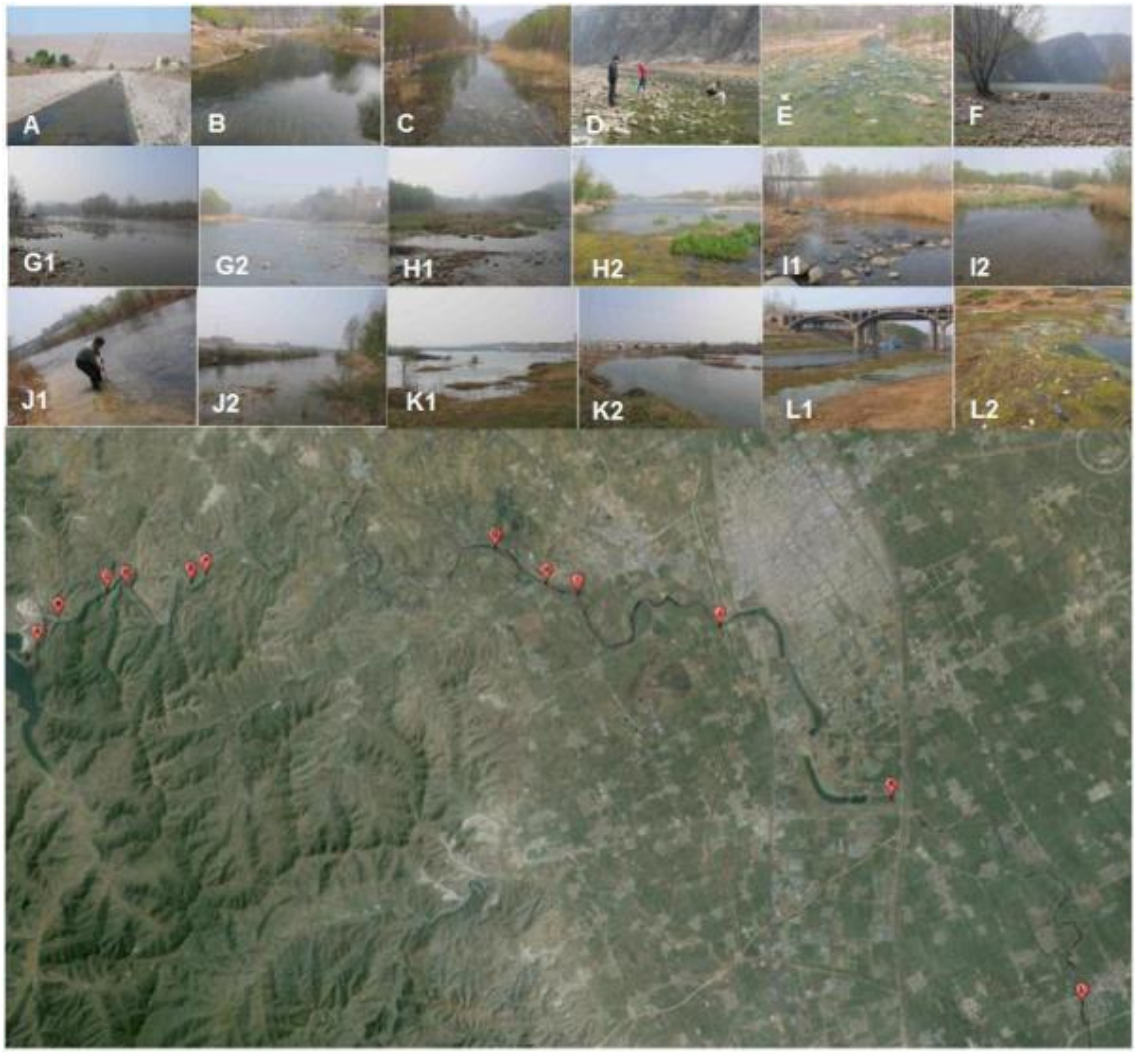


Figure V-5: Aquatic invertebrate sampling locations along Qi River

121. A total of 62 species (from 37 families of 16 orders in eight classes) were collected in the Qi River project area. Of these, 48 species are aquatic insects (77% of all species). The survey documented significant findings: two mayfly species (*Baetiella macani*, *Procloeon pennulatum*) are the first records for the PRC; four species are newly recorded from mainland PRC; and, 15 species are the first records for Henan Province. The mayflies and caddisflies are the most abundant groups, and with highest diversity documented in the habitats of the upper Qi and NWP. These are sensitive species that require high oxygen content and good water quality, which, to some extent, reflects the river ecosystem is natural and health.

122. The survey results showed that high species diversity occurs in the upstream areas of Qi River, particularly in the NWP, which supports a diverse range of wetland habitats. In two survey sites in the NWP, 35 species were recorded, accounting for 56% of all invertebrate species recorded, as compared to 5-8 species at sample site in the mid- and downstream sections, using the same survey effort. However, the species richness of Site G (Xugou) is much lower than other upstream sites. There are duck farms and villages near this site, and lower species richness of aquatic invertebrates is probably due to eutrophication (high organic matter from duck faeces; and, use of laundry detergent with phosphates by local communities), illegal electric fishing, and a coffer dam upstream of Site G, which regulates flow.

Table V-6a: Aquatic insects recorded in the project area

No.	Scientfic Name	English Name	Chinese Name	IUCN Status	National Protected Species	Henan Protected Species	Habitat Requirements[6]	Local Status	Distribution in Qi River					Source	Notes (7)
									Upstream (Up)	Upstream (Mid)	Upstream (Down)	Midstream	Downstream		
1	*Alainites lingulatus* Tong & Dudgeon	-	突丽翅蜉	NA	-	-	In riffle area with fast current	Common	X	X	X			6	Distributed at sites1–9 on map of sampling
2	*Alainites* sp.	-	丽翅蜉	NA	-	-	Riffle habitat	Common	X	X	X			6	Distributed at sites1–9 on map of sampling
3	*Baetiella macani* Müller-Liebenau	-	麦氏花翅蜉	NA	-	-	Mid to fast current stream	Rare		X				6	Distributed at sites6–7 on map of sampling
4	*Baetiella bispinosa* Gose	-	双突花翅蜉	NA	-	-	Fast current streams	Rare	X					6	Distributed at site 4 on map of sampling sites
5	*Baetis maculosus* Tong, Dudgeon et Shi	-	斑腹四节蜉	NA	-	-	Mid to fast current streams	Rare		X				6	Distributed at site 8 on map of sampling sites
6	*Baetis* sp.	-	四节蜉	NA	-	-	riffle areas with cobble and gravel substrates	Common	X	X	X			6	Distributed at sites1–9 on map of sampling
7	*Cloeon dipterum* L.	-	二翅蜉	NA	-	-	Lentic habitat with aquatic weeds	Common	X		X		X	6	Distributed at sites 2,10 and 12 on map of sampling sites
8	*Procloeon* sp.	-	原二翅蜉	NA	-	-	Fast current streams with aquatic weeds	Common	X		X			6	Distributed at sites 2 and 9 on map of sampling sites
9	*Nigrobaetis* sp.	-	黑四节蜉	NA	-	-	Fast current stream with gravel and sand substrates	Common		X	X			6	Distributed at sites5, 8 and 9 on map of sampling sites
10	*Uracanthella punctisetae* (Matsumura)	-	红天角蜉	NA	-	-	Slow current with gravel and sand substrates	Rare			X			6	Distributed at site 9 on map of sampling sites
11	*Isonychia kiangsiensis*	-	江西等蜉	NA	-	-	Riffle habitat with leaf litter	Rare		X				6	Distributed at site 8 on map of sampling sites
12	*Tenuibaetis pseudofrequentus* (Müller-Lieber	-	青腹刺垫蜉	NA	-	-	riffle areas with cobble and gravel substrates	Common	X	X	X			6	Distributed at sites1–9 on map of sampling
13	*Tenuibaetis* sp.	-	刺垫蜉	NA	-	-	riffle areas with cobble and gravel substrates	Rare	X					6	Distributed at sites 1 and 4 on map of sampling sites
14	*Cinygmina* sp.	-	似动蜉	NA	-	-	Slow current with cobble and sand substrates	Common	X	X	X			6	Distributed at sites1–9 on map of sampling
15	*Ephemera* sp.	-	蜉蝣	NA	-	-	Slow current with cobble and sand substrates	Common		X	X			6	Distributed at sites5–6 and 8–9 on map of sampling sites
16	*Cheumatopsyche brevilineata* (Iwata)	-	短线短脉纹石蛾	NA	-	-	riffle areas with cobble substrates	Common	X		X			6	Distributed at sites 1,4 and 9 on map of sampling sites
17	*Hydropsyche* sp.	-	纹石蛾	NA	-	-	riffle areas with cobble substrates	Common	X	X	X			6	Distributed at sites1–9 on map of sampling
18	*Stenopsyche* sp.	-	角石蛾	NA	-	-	riffle areas with cobble and gravel substrates	Abundant	X	X	X			6	Distributed at sites1–9 on map of sampling
19	*Neurobasis chinensis*	-	华艳色蟌	NA	-	-	Slow current streams with aquatic weeds	Common	X	X	X	X		6	Distributed at sites 3–10 on map of sampling
20	*Antocha* sp.	-	朝大蚊	NA	-	-	Slow current with sand substrates	Common	X	X	X			6	Distributed at sites1–9 on map of sampling
21	*Tipula* sp.	-	大蚊	NA	-	-	Slow current with sand substrates	Common	X	X	X			6	Distributed at sites1–9 on map of sampling
22	*Chironomus* sp.	-	摇蚊	NA	-	-	Lakes and ponds with plenty of organic matter	Abundant			X	X	X	6	Occurs in high densities throughout most of the Qi River wetland
23	*Orthocladius* sp.	-	直突摇蚊	NA	-	-	Slow current with sand and silt substrates	Rare		X				6	Distributed at sites 4 and 7 on map of sampling sites
24	*Tabanus* sp.	-	牛虻	NA	-	-	Slow current with sand substrates	Common		X	X			6	Distributed at sites 1–9 on map of sampling
25	*Gomphidia kruegeri kruegeri* Martin	-	并纹小叶春蜓	NA			Lentic habitat with aquatic weeds	Rare		X				6	Distributed at site 8 on map of sampling sites

26	*Sigara* sp.	-	小划蝽	NA			Lentic habitat with aquatic weeds	Rare		X			X	6	Distributed at site 7 on map of sampling sites
27	*Caenis* sp.	-	细蜉	NA			Slow current with sand and silt substrates	Rare		X			X	6	Distributed at sites 5 and 7 on map of sampling sites
28	*Radix swinhoci*	-	椭圆萝卜螺	NA			Slow current with sand and silt substrates	Abundant	X	X	X	X	X	6	Distributed at sites3–12 on map of sampling
29	*Lepidostoma* sp.	-	鳞石蛾	NA			Slow current with sand and silt substrates	Rare	X					6	Distributed at site 3 on map of sampling sites
30	*Coenagrion lanceolatum*	-	矛斑蟌	NA			Slow current with sand and silt substrates	Rare	X					6	Distributed at site 3 on map of sampling sites
31	*Agriocnemis lacteola*	-	白腹小蟌	NA			Slow current with sand and silt substrates	Rare	X					6	Distributed at site 3 on map of sampling sites
32	*Bezzia* sp.	-	贝蠓	NA			Slow current with sand and silt substrates	Rare	X					6	Distributed at site 3 on map of sampling sites
33	*Dytiscus* sp.	-	龙虱	NA	-	-	Lentic habitat with aquatic weeds	Rare			X		X	6	Distributed at sites 9, 11 and 12 on map of sampling sites
34	*Asellus hilgendorfii*		希氏栉水虱	NA			Riffle areas with cobble and gravel substrates	Abundant	X	X	X	X		6	Distributed at sites 1–11 on map of sampling
35	*Glossiphonia* sp.	-	扁蛭	NA	-	-	Fast current stream with gravel and sand substrates	Common	X	X	X	X		6	Distributed at sites 1–11 on map of sampling
36	Planorbidae	-	扁卷螺	NA	-	-	Lentic habitat with aquatic weeds	Common			X	X	X	6	Distributed at sites 9–12 on map of sampling
37	*Physa acuta*	-	膀胱螺	NA	-	-	Fast current stream with gravel and sand substrates	Common		X	X		X	6	Distributed at sites 6–9 and 10–12 on map of sampling sites
38	*Sinotaia aeruginosa* （Bellamya aeruginosa）	freshwater s	环棱螺	LC	-		Lakes, pond, stream	Common	X	X	X			1,2,4	Occurs in medium densities in part of the Qi River wetland
39	*Corbicula fluminea*	-	河蚬	LC	-	-	Fast current stream with gravel and sand substrates	Common	X	X	X			6	Occurs in low densities throughout most of the Qi River wetland
40	*Garmmrus* sp.	-	钩虾	NA	-	-	Slow current streams with aquatic weeds	Abundant	X	X	X	X	X	6	Distributed at sites 1–12 on map of sampling
41	*Neocaridina denticulata sinensis*		中华新米虾	NA			Slow current streams with aquatic weeds	Abundant	X	X	X	X		6	Distributed at sites 1–11 on map of sampling
42	*Penaeus monodon*	Asian tiger	斑节对虾	NA	-	-	Lakes, pond, stream with sand or mud bottom	Common	X	X	X			1,2,3	Occurs in medium densities throughout most of the Qi River wetland
43	*Macrobranchium nipponense*	Oriental Riv	日本沼虾	NA	-	-	Lakes, ponds, stream	Common	X	X	X			1,2,3	Occurs in low densities throughout most of the Qi River wetland
44	*Sinopotamon honanense*	freshwater c	河南华溪蟹	NA	-	-	Lakes, pond, stream with sand or mud bottom	Common	X	X	X			1,2,3	Occurs in medium densities throughout most of the Qi River wetland

Notes

1 http://www.iucnredlist.org/

2 Article 9 of the Law of the People's Republic of China on the Protection of Wildlife

3 Illustrated Handbook of Protected Wild Animals in Henan

4 R - Resident; M - Migrant

5 Morse, JC, Yang, LF, Tian LX. 1995. Aquatic Insects of China Useful for Monitoring Water Quality. Nanjing: Hohai University Press

6 Site specific surveys on 9-10 April 2015

7 Map of sampling sites

Table V-6b: Fish recorded in the project area

No.	Scientfic Name	English Name	Chinese Name		IUCN Status[1]	National Protection Status[2]	Henan Protection Status[3]	Local Occurrence[4]	Habitat[5]	Local Status	Distribution in Qi River					Source[6]	Notes[7]
											Up-stream (Up)	Up-stream (Mid)	Up-stream (Down)	Mid-stream	Down-stream		
1	*Anguilla japonica*	River eel	日本鳗鲡	鳗鲡目鳗鲡科	EN	-		M	Stream, shallow	rare		X	X			1,2,3	Low densities
2	*Cyprinus carpio*	Wild common carp	鲤	鲤形目鲤科	VU	-		R	Reservoir, pond,	++++	X	X	X			1,2,3	Medium
3	*Carassius auratus*	Crucian carp	鲫	鲤形目鲤科	LC	-	Y	R	Reservoir, stream	+++	X	X	X			1,2,3	Medium
4	*Misgurnus anguillicaudatus*	Pond loach	泥鳅	鲤形目鳅科	LC	-		R	Lake or stream	++++		X	X			1,2,3	Medium
5	*Silurus asotus*	Amur catfish	鲶鱼	鲶形目鲶科	LC	-		R	Reservoir, pond,	++	X	X	X			1,2,3	Medium
6	*Pseudobagrus ondon*	catfish	盎堂拟鲿	鲇形目鲿科	LC	-		R	Reservoir, pond,	Common, widespread		X	X			1,2,3	Medium
7	*Rhodeus lighti*	Light's bitterling	彩石鳑鲏	鲤形目鲤科	LC	-		R	Stream, pond	Common, widespread		X	X			1,2,3	Low densities
8	*Culter dabryi*	Humpback	达氏鲌	鲤形目鲤科	LC	-		R	Lakes, river,	Common, widespread		X	X			1,2,3	Low densities
9	*Parabotia fasciata*	Barred loach	花斑副沙鳅	鲤形目鳅科	LC	-		R	Lake or stream	Common, widespread		X	X			1,2,3	Low densities
10	*Sarcocheilichthys sinensis*	Chinese fat minnow	华鳈	鲤形目鳅科	LC	-		R	Lakes, pond, river	Common, widespread		X	X			1,2,3	Low densities
11	*Pseudolaubuca engraulis*	Minnow	寡鳞飘	鲤形目鲴科	LC	-		R	Lakes, pond, river	Common, widespread		X	X			1,2,3	Low densities
12	*Monopterus albus*	Rice swamp eel	黄鳝	合鳃鱼目合鳃鱼科	LC	-		R	Lake, channel,	Common, widespread		X	X			1,2,3	Low densities
13	*Opsariichthys bidens*	Chinese hook snout carp	马口鱼	鲤形目鲤科	LC	-		R	Stream, sand bottom	Common, widespread	X	X	X			1,2,3	Low densities
14	*Pseudorasbora parva*	Slender top-mouth gudgeo	麦穗鱼	鲤形目鲤科	LC	-		R	Lakes, pond, stream	Common, widespread		X	X			1,2,3	Low densities
15	*Megalobrama amblycephala*	Wuchang fish	团头鲂	鲤形目鲤科	LC	-		R	Lake, reservoir	Common, widespread		X	X			1,2,3	Low densities
16	*Rhinogobius giurinus*	Barcheek goby	吻鰕虎	鲈形目虾虎鱼科	LC	-		R	Stream	Common, widespread		X	X			1,2,3	Low densities
17	*Oryzias latipes*	Medaka	青鳉	鳉形目鳉科	LC	-		R	Stream	Common, widespread		X	X			1,2,3	Low densities
18	*Rhodeus sinensis*	Chinese bitterling	中华鳑鲏	鲤形目鲤科	LC	-		R	Lake	Common, widespread		X	X			1,2,3	Low densities
19	*Xenocypris argentea*	Freshwater yellowtail	银鲴	鲤形目鲤科	LC	-		M	Lake, river	Common, widespread		X	X			1,2,3	Low densities
20	*Pseudolaubuca sinensis*	Taiwan snakehead	银飘	鲤形目鲤科	LC	-		R	Lake, river	Common, widespread		X	X			1,2,3	Low densities
21	*Squaliobarbus curriculus*	Brown trout	赤眼鳟	鲤形目鲤科	DD	-		M	Lake, river	Common, widespread		X	X			1,2,3	Low densities
22	*Siniperca kneri*	Bigeye mandarinfish	大眼鳜	鲈形目鮨科	DD	-		R	Lake, river	Common, widespread		X	X			1,2,3	Low densities
23	*Elopichthys bambusa*	Yellowcheck carp	鱤	鲤形目鲤科	DD	-		M	Lake, river	Common, widespread		X	X			1,2,3	Low densities
24	*Rhodeus ocellatus*	Rosy bitterling	高体鳑鲏	鲤形目鲤科	DD	-		R	Lake, river	Common, widespread		X	X			1,2,3	Low densities
25	*Siniperca vietnamensis (Sinipe*	Mandarin fish	鳜	鲈形目鮨科	DD	-		M	Lake, river	Common, widespread		X	X			1,2,3	Low densities
26	*Gnathopogon tsinanensis*	-	济南颌须鮈	鲤形目鲤科	DD	-		R	Lakes, pond	Common, widespread		X	X			1,2,3	Low densities
27	*Gnathopogon intermedius*	-	中间颌须鮈	鲤形目鲤科	DD	-		R	Lakes, pond	Common, widespread		X	X			1,2,3	Low densities
28	*Mylopharyngodon piceus*	Black carp	青鱼	鲤形目鲤科	DD	-		M	River	Common, widespread		X	X			1,2,3	Low densities
29	*Ctenopharyngodon idellus*	Grass carp	草鱼	鲤形目鲤科	NA	-		M	Lake, river	+++	X	X	X			1,2,3	Low densities
30	*Hypophthalmichthys molitrix*	Silver carp	鲢	鲤形目鲤科	NT	-		M	Lake, river	++		X	X			1,2,3	Low densities
31	*Siniperca scherzeri*	Golden mandarin fish	斑鳜	鲈形目鮨科	DD	-		R	Lake, river	Common, widespread		X	X			1,2,3	Low densities
32	*Lefua costata*	Rice loach	北鳅	鲤形目鲤科	NA	-		R	Lakes, pond, stream	Common, widespread		X	X			1,2,3	Low densities
33	*Hemiculter leucisculus*	Sharpbelly	餐条	鲤形目鲤科	LC	-		R	Lakes, pond, stream	Common, widespread		X	X			1,2,3	Low densities
34	*Parabramis pekinensis*	White Amur bream	鳊	鲤形目鲤科	NA	-		M	River, lakes, pond	Common, widespread		X	X			1,2,3	Low densities
35	*Saurogobio dumerili*	Longnose gudgeon	长蛇鮈	鲤形目鲤科	NA	-		R	River, lake	Common, widespread		X	X			1,2,3	Low densities
36	*Hemibarbus labeo*	Barbel steed	唇鲿	鲤形目鲤科	NA	-		R	Stream	Common, widespread		X	X			1,2,3	Low densities
37	*Mastacembelus aculeatus*	Spiny eel	刺鳅	鲈形目刺鳅科	NA	-		R	Stream	Common, widespread		X	X			1,2,3	Low densities
38	*Ganthopogon wolterstorffi*	Dotted-linedgudgeon	点纹颌须鮈	鲤形目鲤科	NA	-		R	Lakes, pond	Common, widespread		X	X			1,2,3	Low densities
39	*Gnathopogon polytaenia*	striped gudgeon	多纹颌须鮈	鲤形目鲤科	NA	-		R	Stream	Common, widespread		X	X			1,2,3	Low densities
40	*Abbottina tungtingensis*	Chinese false gudgeon	棒花鱼	鲤形目鲤科	NA	-		R	Stream	Common, widespread		X	X			1,2,3	Low densities

No.	Scientfic Name	English Name	Chinese Name		IUCN Status[1]	National Protection Status[2]	Henan Protection Status[3]	Local Occurrence[4]	Habitat[5]	Local Status	Distribution in Qi River					Source[6]	Notes[7]
											Up-stream (Up)	Up-stream (Mid)	Up-stream (Down)	Mid-stream	Down-stream		
41	*Ctenogobius brunneus*	Spiny goby	**褐**栉鰕虎	鲈形目虾虎鱼科	NA	-		R	Stream	Common, widespread		X	X			1,2,3	Low densities
42	*Sarcocheilichthys nigripinnis*	Rainbow gudgeon	**黑**鳍鲅	鲤形目鲤科	NA	-		R	Stream	Common, widespread		X	X			1,2,3	Low densities
43	*Hemibarbus maculates*	Spotted steed	**花**鲟	鲤形目鲤科	NA	-		M	Stream	Common, widespread		X	X			1,2,3	Low densities
44	Cobitinae sp.	Spined loach	**花**鳅	鲤形目鳅科	NA	-		R	Lakes, pond,	Common, widespread		X	X			1,2,3	Low densities
45	*Pelteobagrus fulvidraco*	Pelteobagrus fulvidraco	**黄**颡鱼	鲇形目，鲿科	NA	-		R	Lake, ponds	Common, widespread		X	X			1,2,3	Low densities
46	*Micropercops cinctus*	Pale chub	**黄**黝鱼	鲈形目塘鳢科	LC	-		R	Lake, ponds	Common, widespread		X	X			1,2,3	Low densities
47	*Rhinogobius cliffordpopei*	-	**克氏鰕虎**	鲈形目虾虎鱼科	NA	-		R	Stream with sand	Common, widespread		X	X			1,2,3	Low densities
48	*Zacco platypus*	Common minnow	宽鳍鱲	鲤形目鲤科	NA	-		R	Stream	Common, widespread		X	X			1,2,3	Low densities
49	*Phoxinus lagowskii*	Fat minnow	**洛氏鱥**	鲤形目鲤科	NA	-		R	Stream	Common, widespread		X	X			1,2,3	Low densities
50	*Chanodichthys mongolicus*	Mongolian redfin	**蒙古**红鲌	鲤形目鲤科	LC	-		R	Lake	Common, widespread		X	X			1,2,3	Low densities
51	*Chanodichthys erythropterus*	Redfin culter	翘嘴红鲌	鲤形目鲤科	LC	-		M	Lake	Common, widespread		X	X			1,2,3	Low densities
52	*Pseudobagrus truncatus*	Cuttail bullhead	**切尾**拟鲿	鲇形目鲿科	NA	-		R	River, lake	Common, widespread		X	X			1,2,3	Low densities
53	*Saurogobio dabryi*	Longnose gudgeon	**蛇**鮈	**鲤形目**鲤科	NA	-		R	River, lake	Common, widespread		X	X			1,2,3	Low densities
54	*Toxabramis swinhonis*	-	**似鱎**	**鲤形目**鲤科	NA	-		R	River, lake	Common, widespread		X	X			1,2,3	Low densities
55	*Pseudogobio vaillanti*	Rhinogobio	**似**鮈	**鲤形目**鲤科	LC	-		M	River, lake	Common, widespread		X	X			1,2,3	Low densities
56	*Gobio coriparoides*	-	**似**铜鮈	**鲤形目**鲤科	NA	-		R	River, lake	Common, widespread		X	X			1,2,3	Low densities
57	*Ophiocephalus argus*	Snakehead	乌鳢	鳢形目乌鳢科	NA	-		R	Lake, pond	Rare, widespread		X	X			1,2,3	Low densities
58	*Pseudobagrus ussuriensis*	Ussuri catfish	乌苏里拟鲿	鲇形目鲿科	NA	-		R	Lake	Rare, widespread		X	X			1,2,3	Low densities
59	*Parabotia fasciata*	Wu's sand loach	**伍氏沙**鳅	鲤形目 鳅科	NA	-		R	Lake, pond, stream	Common, widespread		X	X			1,2,3	Low densities
60	*Acanthorhodeus chankaensis*	Khanka spiny bitterling	兴凯刺鳑鲏	鲤形目鲤科	NA	-		R	Shallow water	Common, widespread		X	X			1,2,3	Low densities
61	*Aristichthys mobilis*	Bighead carp	鳙	鲤形目鲤科	NA	-		M	Lake	Common, widespread		X	X			1,2,3	Low densities
62	*Hemiculter bleekeri*	-	**油餐条**	鲤形目鲤科	NA	-		R	Lake, pond	Common, widespread		X	X			1,2,3	Low densities
63	*Macropodus chinensis*	Roundtail paradisefish	圆尾斗鱼	鲈形目丝足鲈科	NA	-		R	Lake, pond, stream	Common, widespread		X	X			1,2,3	Low densities

Notes

1 http://www.iucnredlist.org/

2 Article 9 of the Law of the People's Republic of China on the Protection of Wildlife

3 Illustrated Handbook of Protected Wild Animals in Henan

4 R - Resident; M - Migrant

5 (1) Cheng, Q., Zheng, B. 1987. Retrieval system of Chinese fish. Beijing: Science press. (2) Liu Jiankang et al. 1992. Aquaculture of freshwater fish in China. 3rd Version. Science press.

6 Data collected from the field survey in Qihe wetland and the history record. The numbers of 1,2,3,4 refer to the above reference

Table V-6c: Reptiles recorded in the project area

English Name	Chinese Name		IUCN Status[1]	National Protection Status[2]	Three Animal list7	Henan Protection Status[3]	Local Occurrence[4]	Habitat[5]	Local Status	Distribution in Qi River					Source[6]	Notes[7]
										Up-stream (Up)	Up-stream (Mid)	Up-stream (Down)	Mid-stream	Down-stream		
Chinese softshell turtle	鳖	龟鳖目鳖科	VU	-			R	Pond, lake, river	+++	X	X	X			1,2,4	Medium
Chinese pond turtle	乌龟	龟鳖目龟科	EN	-			R	Pond, paddy	++	X	X	X			1,2,4	As above
Frog-eating rat-snake	红点锦蛇	有鳞目蛇亚目游蛇科	LC		Y		R	Pond, lake, river,	Rare		X	X			1,2,3,4	Low densities
Tiger keelback	虎斑颈槽蛇	有鳞目蛇亚目游蛇科	NA		-		R	Farm, forest,	++		X	X			1,2,4	Medium
dione rat-snake	白条锦蛇	有鳞目蛇亚目游蛇科	NA		Y		R	As above	Rare		X	X			1,2,3,4	Low densities
Stink rat snake	王锦蛇	有鳞目蛇亚目游蛇科	NA		Y		R	As above	Rare		X	X			1,2,3,4	Low densities
Red-banded snake	赤链蛇	有鳞目蛇亚目游蛇科	NA				R	As above	Rare		X	X			1,2,4	Low densities
Striped Racer	黑眉锦蛇	有鳞目蛇亚目游蛇科	NA		Y		R	As above	Rare		X	X			1,2,3,4	Low densities
white line snake	黄脊游蛇	有鳞目蛇亚目游蛇科	NA		-		R	As above	Rare		X	X			1,2,4	Low densities
big-eye rat snake	乌梢蛇	有鳞目蛇亚目游蛇科	NA		-		R	As above	Rare		X	X			1,2,4	Low densities
Mandarin rat-snake	玉斑锦蛇	有鳞目蛇亚目游蛇科	NA		-		R	As above	Common		X	X			1,2,4	Low densities
Kumaon japalure	丽纹龙蜥	有鳞目鬣蜥科	NA		Y		R	As above	Common		X	X			1,2,4	Low densities
Peking gecko	无蹼壁虎	有鳞目壁虎科	VU		Y		R	As above	Common		X	X			1,2,4	Low densities
Shanghai elegant skink	蓝尾石龙子	有鳞目石龙子科	NA		Y		R	As above	Common		X	X			1,2,4	Low densities
Brown forest skink	蝾蜓	有鳞目石龙子科	NA				R	As above	Common		X	X			1,2,4	Low densities
Mongolian racerunner	丽斑麻蜥	有鳞目蜥蜴科	NA				R	As above	Common		X	X			1,2,4	Low densities
Ordos racerunner	山地麻蜥	有鳞目蜥蜴科	NA		Y		R	As above	Common		X	X			1,2,4	Low densities
Northern grass lizard	北草蜥	有鳞目蜥蜴科	NA		Y		R	As above	Common		X	X			1,2,4	Low densities
Yellow speckled lancehead	菜花烙铁头	蛇目蝰科	LC				R	As above	Common		X	X			1,2,4	Low densities

Table V-6d: Amphibians recorded in the project area

No.	Scientfic Name	English Name	Chinese Name		IUCN Status[1]	National Protection Status[2]	Three Animal list7	Henan Protection Status[3]	Local Occurrence[4]	Habitat[5]	Local Status	Distribution in Qi River					Source[6]	Notes[7]
												Up-stream (Up)	Up-stream (Mid)	Up-stream (Down)	Mid-stream	Down-stream		
1	*Pelophylax nigromaculatus*	black-spotted frog	黑斑蛙	无尾目蛙科	NT	-		Y	R	Pond, lake, river	++++	X	X	X			1,2,3,5	Medium densities
2	*Pseudepidalea raddei*	Mongolian Toad	花背蟾蜍	无尾目蟾蜍科	LC	-	Y		R	Soil cave, grassland	+++	X	X	X			1,2,3,4,5	As above
3	*Bufo gargarizans*	Zhoushan toad	中华蟾蜍	无尾目蟾蜍科	LC	-			R	Soil cave, grassland	Common		X	X			1,2,3,5	Low densities
4	*Kaloula borealis*	Boreal Digging Frog	北方狭口蛙	无尾目姬蛙科	LC	-	Y		R	Soil cave, grassland	Common		X	X			1,2,3,4,5	As above
5	*Rana chensinensis*	Chinese brown frog	中国林蛙	无尾目蛙科	LC	-			R	Forest	Common		X	X			1,2,3,5	As above
6	*Fejervarya multistriata*	Paddy frog	泽陆蛙	无尾目蛙科	DD	-			R	Paddy, marsh, ponds	Common		X	X			1,2,3,5	As above

See key in Table V-6e.

Table V-6e: Mammals recorded in the project area

No.	Scientfic Name	English Name	Chinese Name		IUCN Status[1]	Three Animal List2	Henan Protected Species[3]	Local Occurrence[4]	Habitat[5]	Local Status	Distribution in Qi River					Source[6]	Notes
											Up-stream (Up)	Up-stream (Mid)	Up-stream (Down)	Mid-stream	Down-stream		
1	*Lepus capensis*	Cape hare	草兔	兔形目兔科	LC	Y		R	Farmland,	+++		X	X			1,2,3,4	Medium
2	*Erinaceus europaeus*	Hedgehog	普通刺猬	猬形目猬亚科	LC			R	Shrubland	Common		X	X			1,2,3,4	Low densities
3	*Myotis pequinius*	Peking myotis	北京鼠耳蝠	翼手目 蝙蝠科	LC		Y	R	cave, house	Common		X	X			1,2,3,4	As above
4	*Eptesicus serotinus*	Serotine bat	小夜蝠	翼手目 蝙蝠科	LC		Y	R	cave, house	Common		X	X			1,2,3,4	As above
5	*Pipistrellus savii*	Savi's pipistrelle	萨氏伏翼	翼手目 蝙蝠科	LC		Y	R	cave, house	Common		X	X			1,2,3,4	As above
6	*Pipistrellus abramus*	Japanese pipestrellte	普通伏翼	翼手目 蝙蝠科	LC		Y	R	cave, house	Common		X	X			1,2,3,4	As above
7	*Sciurotamias davidianus*	Rock squirrel	岩松鼠	啮齿目松鼠科	LC	Y		R	rock	Common		X	X			1,2,3,4	As above
8	*Tamiops swinhoei*	Swinhoe's striped squirre	隐纹花松鼠	啮齿目松鼠科	LC			R	tree hole	Common		X	X			1,2,3,4	As above
9	*Eutamias sibiricus*	Western chipmunk	花鼠	啮齿目松鼠科	NA			R	shrub, farmland	Common		X	X			1,2,3,4	As above
10	*Cricetulus tritonde*	Hamster	大仓鼠	啮齿目仓鼠科	NA			R	farmland, shrub	Common		X	X			1,2,3,4	As above
11	*Cricetulus Barabensis*	Chinese hamster	黑线仓鼠	啮齿目仓鼠科	LC			R	farmland, shrub	Common		X	X			1,2,3,4	As above
12	*Myospalax psilurus*	Transbaikal zokor	东北鼢鼠	啮齿目仓鼠科	LC			R	Farmland,	Common		X	X			1,2,3,4	As above
13	*Mus musculus*	House mouse	小家鼠	啮齿目鼠科	LC			R	Farmland,	Common		X	X			1,2,3,4	As above
14	*Apodemus agrarius*	Striped field mouse	黑线姬鼠	啮齿目鼠科	LC			R	Farmland,	Common		X	X			1,2,3,4	As above
15	*Rattus flavipectus*	Buff-breasted rat	黄胸鼠	啮齿目鼠科	NA			R	House	Common		X	X			1,2,3,4	As above
16	*Rattus norvegicus*	Rat	褐家鼠	啮齿目鼠科	NA			R	Farm, grassland	Common		X	X			1,2,3,4	As above
17	*Mustela sibirica*	Himalayan weasel	黄鼬	食肉目鼬科	LC			R	Farmland,	Common		X	X			1,2,3,4	As above
18	*Meles meles*	European badger	狗獾	食肉目鼬科	LC			R	Grassland, forest	Common		X	X			1,2,3,4	As above
19	*Arctonyx collaris*	Hog badger	猪獾	食肉目猫科	NT			R	As above	Common		X	X			1,2,3,4	As above
20	*Felis bengalensis*	Leopard cat	豹猫	食肉目鼬科	LC	Y	Y	R	As above	Common		X	X			1,2,3,4	As above

Notes

1 http://www.iucnredlist.org/

2 National protected species with beneficial or important economic, scientific values. National Forestry Bureau

3 Illustrated Handbook of Protected Wild Animals in Henan

4 R - Resident; M - Migrant

5 Provide reference for habitat requirements. Liu Lingyun, Zheng Guangmei, 《General Zoology （4th Version）》, High Education Press, 2009

6 Data collected from the field survey in Qihe wetland and the history record. The numbers of 1,2,3,4 refer to the above reference

D. Socio-economic Conditions

123. Hebi City administers two counties (Xun and Qi), and 3 districts (Shancheng, Heshan and Qibin), and the Hebi Economic and Technological Development Zone. In 2012, the total population of Hebi city was 1.603 million, with an urban population of 819,000 (51.6% of the total population). Qibin District, the political, economic and cultural center of Hebi city, is where Hebi City Municipal Party Committee and the HCG are located. The district occupies a total area of 335 km^2 and includes 2 townships, 2 towns, 4 subdistrict offices, 101 administrative villages and 35 communities. In 2012, Qibin district had a total population of 257,500, resident population of 279,500, urban population of 193,100, and rural population of 102,000. In 2012, the GDP in Qibin District was CNY10.807 billion, the public finance budget income reached CNY580 million, urban average disposable income per capita reached CNY20,545, and rural average per capita net income was CNY8,564. Urban average per capita disposable income and rural average per capita net income increased by 11% and 12%, respectively, both maintained the leading position in the province.

124. In early 2012, the total population in Qi County was 285,000, with 122,000 urban populations and 149,400 rural populations. In 2012, GDP in the district reached CNY12.951 billion, public finance budget income reached CNY346 million, urban average per capita disposable income reached CNY15,217; rural average per capita net income reached CNY8,592. Urban average per capita disposable income and rural average per capita net income increased by 10.3% and 21%, respectively. Qi County is national advanced township in food processing industry and technology, provincial advanced township in husbandry, economic management and it is also a key township in regard to opening-up policy. In 2013, the GDP of Xun County has increased 14% to CNY13.63 billion. At the end of 2010, the total population in Xun County is 665,000.

E. Protected Areas, Reserves, and Physical Cultural Resources

125. The project area includes one protected area, the pilot NWP (Section V.C). At least 13 protected heritage sites occur in Hebi City, including the Dalaidian Heritage Site in Qibin District (Figure V-6). This was formed during the Shang Dynasty. It was approved as National Cultural Relics Protection Site by State Council in May 2013. Along the Qi River, the Qi River Natural Taijitu is a 3A National Scenic Reserve located in the upstream of Qi River, 20 km to Hebi central city. It is the largest natural Taijitu founded in the PRC.

Figure V-6: Protected Heritage Sites in Hebi City

VI. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Design Phase

126. Project designs by the HCG were reviewed throughout the preparation phase and improved as far as possible to avoid impacts. This resulted in significant avoided impacts, including: (i) two barrages originally planned to be built across the Qi River in the HCG (intended to expand habitats for waterbirds) were removed from the design, once ecological values and the importance of maintaining running water were clarified; (ii) plans for the pilot NWP of a captive garden for wild cranes, wildlife rescue center, “reed maze”, fish releases, and construction of fish and bird nests, were removed from the designs, due to lack of alignment with ecological objectives and/or no clear justification or need; (iii) one invasive species, Torch Tree (*Rhus typhina*) was removed as a planting species; (iv) sediment sampling was expanded to include presence of heavy metals, to identify any potential dredging issues and for suitable disposal locations; and (v) a new project component on solid waste management component was added. In addition, three new non-structural measures were introduced to the project design during the preparation phase: preparation of the first five-year management plan for the pilot NWP, establishment of a management agency for the NWP, and development and implementation of a long-term ecological monitoring program for the Qi River.

B. Pre-Construction Phase

127. Prior to construction, the following measures will be implemented to ensure project’s environment management readiness. These include:

i) Institutional strengthening. Implementation of the EMP will be supported by the following specialist staff: (a) a full-time PMO Environment Officer, and one environment officer for each of the 9 PIUs (total 10 officers) will be assigned to the project; and (b) under the loan consulting services, the PMO will hire a loan implementation environment specialist (LIEC) to support EMP implementation. Terms of reference for these personnel are in the EMP (Attachment 1).

ii) Updating the EMP. In the event of any changes in project design, the EMP will be updated as needed, including mitigation measures and monitoring. This will be the responsibility of the PMO, PIUs, and design institutes.

iii) Confirmation of land acquisition and resettlement. The LAR Plans will be updated with the final inventory and the results will be incorporated into the detailed designs.

iv) Training in environmental management. The LIEC and personnel from provincial EPD and municipal EPBs will give training in implementation and supervision of environmental mitigation measures to contractors and construction supervision companies (CSCs).

v) Grievance Redress Mechanism (GRM). The PMO and PIUs will launch the project GRM at least three months before the start of construction, to ensure that communities are well informed and have the opportunity to discuss any concerns.

vi) Bidding document and contract documents. The EMP will be included in the bidding documents and contracts for procurement of civil works, goods and services. All contractors and subcontractors will be required to comply with the EMP.

vii) Contractor obligations. In their bids, contractors will respond to the environmental clauses for contractual terms and EMP requirements. Prior to construction, each

contractor will develop a Site EMP, based on the project EMP (Attachment 1), and assign a person responsible for environment, health, and safety (EHS). The site EMP shall include the following: (a) site drainage and soil erosion protection; (b) dredge spoil holding and treatment sites, material haulage routes, and waste disposal arrangements; (c) spill control and management; (d) health and safety; (e) surface water and groundwater protection; (f) temporary traffic management; and (g) construction site access control. The site EMP will be submitted to the environmental officers of each county PMO for approval, with support of the local EPBs.

C. Construction Phase

128. Construction-related risks include: (a) noise and odor disturbance to nearby communities from earthworks, embankments, and/or canal dredging; (b) temporary noise and visual disturbance of fauna in the pilot NWP during habitat improvement works; (c) temporary water quality deterioration due to embankment works along the Qi River (mainly increases in suspended solids) and dredging of canals (which may also release organic substances e.g. nitrogen, phosphorous); and (d) traffic congestion or delays due to construction vehicle traffic. Potential project impacts are divided into those common to all or most construction activities, and more specific impacts, such as dredging.

129. Table VI-1 lists the sensitive receptors vulnerable to air and/or noise disturbance by the project. These comprise villages, schools and medical clinics. Most receptors are within 150 m of construction activities. Some are 5 m or less from construction activities, especially for storm and wastewater pipeline construction where some pipeline routes go through villages and developed areas and very close to households.

Table VI-1: Air and noise sensitive receptors to proposed construction activities

Component Activities	Sensitive receptors	Distance
19 Barren Hills Greening	21 villages	150–500 m
Qi River Wetland Conservation and Rehabilitation	9 villages	0–120 m
Qi River Mainstream Water Course Improvement	46 villages	5–1,000 m, mostly >300 m
Four Tributary Watercourse Improvement in Qi County	46 villages, 3 schools	<5–1000 m; several villages along rivers
Five Canal Watercourse Improvement in Qibin District	6 schools, 2 hospitals and 61 villages/communities	2 villages alongside canals, others >100 m
Qibin District Wastewater Management	Residents along pipeline, including 5 schools, 1 hospital, 26 villages	<5–240 m, most are next to the proposed pipelines
Qi County Waste Management	Residents along pipeline, including 5 schools, 10 hospitals, 55 villages	5–250 m

1. Generic Physical impacts across Construction Sites and Mitigation

Noise

130. The major sources of noise pollution during construction are: movement of construction vehicles, the haulage of construction materials to the construction site, and the noise generating activities at the site itself. Construction facilities and equipment will include loaders, bulldozers, and excavators, piling machines, concrete mixer, travelling hoists, vibrators, air wrenches and cargo trucks. Concrete mixing and material movements are the primary noise generating activities and will be uniformly distributed over the entire construction period (Table VI-2). Construction activities are expected to produce noise levels in the range of 80-95 dB (A). Based on the types of powered mechanical equipment to be used and their cumulative sound level, impact distances for dredging, embankment construction, sewers installation and construction of WWTP and solid waste transfer stations is modeled to be

about 50 m in the day time and 150 m at night.

Table VI-2: Projected Results of Noise Attenuation of the Main Point Source (dB (A))

Name Equipment	Distance from Noise Source (m)			Limit	
	10	50	100	Day	Night
Loader	84	70	64	70	55
Bulldozer	80	66	60	70	55
Excavator	78	64	58	70	55
Pilling Machine	94	80	74	70	Forbidden
Concrete Mixer	85	71	65	70	55
Travelling Hoist	90	76	70	70	55
Vibrator	78	64	58	70	55
Air Wrench	89	75	69	70	55
Cargo Trunk	86	72	66	70	55

Note. These data represent outdoor noise levels without mitigation e.g. lack of sound barriers around the construction site. Limitation values are from the PRC Noise Limits for Construction Site (GB 12523-2011).

131. Pipelines will be installed in built-up areas and most sensitive receptors will be close to construction. The following measures will be implemented to comply with PRC construction site noise limits and protect sensitive receptors.

(i) Night time (22:00-06:00 h) construction will be prohibited ≤300 m of receptors.
(ii) Ensure noise levels from equipment and machinery conform to PRC standard of GB 12523-2011; properly maintain machinery to minimize noise.
(iii) Equipment with high noise and high vibration will not be used near village or township areas. Only low noise machinery or equipment with sound insulation will be employed.
(iv) Temporary anti-noise barriers will be installed to shield the nearby residences when there are residences within 50 m of the noise source.
(v) Regularly monitor noise at sensitive areas (see Attachment 1). If noise is exceeded by more than 3 dB, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation.
(vi) Provide the construction workers with suitable hearing protection.
(vii) Control the driving speed of vehicles and machinery on-site.
(viii) Inform residents prior to construction about the anticipated noise levels and duration. For residents very near the construction site and subject to prolonged noise exposure, provide hearing protection.
(ix) Conduct regular interviews with residents adjacent to construction sites to identify feedback. This will be used to adjust work hours of noisy machinery.

132. River dredging, embankment construction, pipeline installation and road construction are all linear activities. When construction is completed at a location, the activities move on and away. Construction noise impact is therefore short term. The above measures are defined in the EMP. With these measures in place and implemented, noise impacts during construction would comply with applicable standards.

Air Quality

133. Anticipated sources of air pollution from construction activities include dust generated by: (a) earthwork excavation, loading, hauling, and unloading; (b) movement of vehicles and heavy machinery on unpaved access and haul roads; (c) aggregate preparation, concrete-mixing, and haulage activities. Exhaust gas will be generated by: (a) asphalt melting, mixing, and spreading; and (b) vehicles and equipment. The exhaust gas from excavator, bulldozer and transportation vehicles mainly contains the pollutants of SO_2 and NO_2. Based on monitoring results of MV2A asphalt concrete equipment made by MARINI Company with capacity of 160 t/h, the fume concentration is about 22.7 g/m^3, which complies with the Integrated Air Pollutant Emission Standard (GB 16297-1996) (80-150 mg/m^3).

134. Dust emission depends on site conditions (e.g. soil, weather, season), construction activity and its management. The EIA institute predicted that the impact distance of fugitive dust from earthworks and uncovered stockpiles of earth material would be up 150 m downwind of the source. TSP levels would comply with GB 3095-2012 Class II standard of 0.3 mg/m^3 for 24-h average at 150 m and beyond downwind of the source. For river embankment works and river dredging, the impact distance is likely to be within 100 m due to the moist nature of the material. The construction of the pipeline network will be in residential areas and other public areas therefore, dust pollution caused by construction shall be controlled to keep the quality of ambient air.

135. In conclusion: (i) without mitigation, dust emissions may be high and exceed standards >100 m from the source; and (ii) with water sprinkling, dust emission is reduced significantly, with emission levels exceeding the standards reaching only 30 m downwind and with over half of TSP load reduced. The following mitigation measures are defined in the EMP to limit dust generation and ambient air pollution during construction:

(i) Assign haulage routes and schedules to avoid transport occurring in the central areas, traffic intensive areas or residential areas. For the areas with high-demand on environmental quality, transport should be arranged at night.
(ii) Spray water regularly on unpaved haul roads and access roads (at least once a day) to suppress dust; and erect hoarding around dusty activities.
(iii) Cover stockpiles with dust shrouds or tarpaulin. For the earthwork management for backfill, measures will include surface press and periodical spraying and covering. Extra earth will be cleared from the project site in time to avoid long term stockpiling.
(iv) Minimize the storage time of construction and demolition wastes on site by regularly removing them off site.
(v) Situate asphalt mixing and concrete batching stations at least 300 m downwind of the nearest air quality protection target.
(vi) Equip asphalt, hot mix and batching plants with fabric filters and/or wet scrubbers to reduce the level of dust emissions.
(vii) Install wheel washing equipment or conduct wheel washing manually at each exit of the works area to prevent trucks carrying mud and soils onto public roads.
(viii) Keep construction vehicles and machinery in good working order, regularly service and turn off engines when not in use.
(ix) Vehicles with an open load-carrying case, which transport potentially dust-producing materials, shall have proper fitting sides and tail boards. Dust-prone materials shall not be loaded to a level higher than the side and tail boards, and shall always be covered with a strong tarpaulin.
(x) During high wind, dust-generating operations shall not be permitted within 200 m of residential areas. Special precautions need to be applied in the vicinity of sensitive receptors such as schools, kindergartens and hospitals.

Soil erosion

136. Erosion is anticipated during construction of the treatment plant, pipeline easements, and embankments, when surface vegetation and soil removed. Erosion may occur after construction if site restoration has been inadequate. The following measures are defined in the EMP to minimize soil erosion during construction:

(i) Strip and stockpile the topsoil and cover or seal temporary such soil stockpiles.
(ii) Build drainage system and settling ponds at construction sites to minimize the soil erosion.
(iii) Lay straws or cloths at the entry/exist of runoff at each construction site.
(iv) Limit construction and material handling during periods of rains and high winds.
(v) Carry out river/canal embankment work and rehabilitation works section by section

with greening works implemented at the same time in order to avoid large scale soil erosion in rainy season.

(vi) Properly slope or re-vegetate disturbed surfaces, such as compacted pipeline trenches and river banks.

(vii) The soils on the tires of construction vehicles will be regularly cleaned.

(viii) The soil erosion monitoring program will cover the sites of the proposed sewage network, WWTP, dewatering sites for dredged sediment, temporary storage site for dewatered sediment, wetland creation, material storage site and municipal solid waste (MSW) transfer stations.

137. The costs for the re-vegetation and soil erosion monitoring program will be included in the environment management costs of the work contracts. Implementation of the water and soil conservation plan will be part of the contractual obligations for the contractors and supervised by the project owners and construction supervision companies throughout the project implementation.

Earthworks – spoil requirements, volumes, and borrow and disposal sites

138. The project earthworks will generate spoil in excess of that required for backfill, from: (i) trench excavation for sewage networks, pavement demolition, and basement excavation for the structures of WWTP; (ii) dredging of canals; (iii) soil filling for barren hills greening; and (iv) foundation excavation for solid waste component. Sediment dredging is described in Section VI.C-2 and earthworks are summarized in Table VI-3.

139. **Barren hills greening (output 1.1.1).** Plantings for barren hill greening will need 210,900 m^3 of borrowed soil. Seven borrow sites with total area of 13.93 ha have been identified, adjacent to the greening sites (0.3–0.6 km away). The average excavation depth is 1.86 m. Current land use of the borrow sites is uncultivated waste land. Temporary drainage channels will be constructed at the borrow sites, and all borrow sites will be revegetated after construction.

140. **Habitat restoration in the pilot NWP (output 1.2).** Construction of the backwater and deep water zones in the NWP (Section IV.C.2) will require dredging of about 10,000–15,000 m^3 spoil, mainly from sites away from the Qi mainstream. Earthworks within the mainstream will involve the removal of relatively small blockages (e.g. rock obstructions). The spoil will be reused for flood plain restoration. A total of 1,500 m^3 stone will be procured from an existing nearby quarry, Shipeng Stone Pit, for embankment protection.

Table VI-3a: Earthwork for Each Project Component

Component	Engineering Area		Excavation (10^4 m^3)	Fill (10^4 m^3)	Borrow (10^4 m^3)	Disposal (10^4 m^3)
Qi River Upstream Ecological Protection	Major works	Barren hill greening	21.09	42.18	21.09	
	Construction camps		1.52	1.52		
	Earth borrow site		4.18	4.18		
	Subtotal		**26.79**	**26.79**	**21.09**	
Qi River Wetland Conservation and Rehabilitation	Major works	Water system restoration	1.5			
		Flood plain restoration		1.5		
		Embankment		0.15	0.15	
		Landscaping	4.23	4.23		
		Pathway	1.99	1.99		
		Parking lot	0.17	0.17		
		Management facilities	0.12	0.12		
	Construction camps		1.2	1.2		
	Pioneer road		0.96	0.96		
	Subtotal		**10.17**	**10.32**	**0.15**	

Qi River Mainstream Watercourse Improvement (21 km)	Major works	Vulnerable spots protection	5.04			1.51
		Cofferdam construction		6.33		
		Removal of cofferdam	6.33			6.33
		Dyke crest road pavement	3.36			0.56
	Construction camps		0.4	0.4		
	Spoil disposal site		0.69	0.69		
	Pioneer road		0.22	0.22		
	Subtotal		**16.04**	**7.64**	**0**	**8.4**
Four Tributary Watercourse Improvement in Qi County	Excavation		286.2	10.46		275.74
	Sediment dredging		8.52			8.52
	Embankment protection		1.51	0.6		0.92
	Landscape greening		5.07	5.07		
	Construction camps		0.67	0.67		
	Spoil disposal site		6	6		
	Pioneer road		1.45	1.45		
	Subtotal		**309.42**	**13.79**	**0**	**295.64**
Five canals improved in Qibin District	Excavation		88.5			88.5
	Sediment dredging		1.79			
	Culvert		1.98	0.79		1.19
	Landscape greening		5.89	5.89		
	Construction camps		0.33	0.33		
	Spoil disposal site		3.52	3.52		
	Pioneer road		0.36	0.36		
	Subtotal		**102.37**	**10.89**	**0**	**91.48**
Qibin District Wastewater Management	Major works	Storm water and sewage pipes installation	295.71	295.71		
Qi County Wastewater Management	Major works	Storm water and sewage pipes installation	475.02	475.02		
		Qi County WWTP	4.07	4.07		
	Subtotal		479.62	479.62		
Solid Waste Management	Solid waste transfer station		0.53	0.53		
Total			**1240.12**	**844.76**	**21.24**	**374.75**

141. **Watercourse improvement in the middle and lower Qi River and canals (output 2).** The major earthworks required are excavation. Disposal sites are described in Table VI-3b. These comprise trenches, farmland, and uncultivated land with shrub and weeds of low ecological value. All sites will be rehabilitated after project completion. Four sites are located on cultivated land, and will be re-used for cultivation after completion. Arrangements for temporary land acquisition are described in the project resettlement plans.

Table VI-3b: Spoil Disposal Site for the Qi River Mainstream and Tributary Watercourse Improvement Component

Sub-project	Site	Spoil Disposal Location	Design Capacity (10^4 m^3)	Spoil Amount (10^4 m^3)	Distance to works (km)	Land Use
Main-stream in Qi County	6+500	East of Mazhuang Village		2.1	1	Cultivated land
	10+500	North of Hekou Village		2.1	1	As above
	15+500	North of Sanjiaotun Village		2.1	1	As above
	23+000	West of Shinanmiao Village		2.1	2	As above
Tributaries in Qi County	Hucheng River	in the neighborhood	1.04	1.04	1	Uncultivated waste land
	Longxu Channel	in the neighborhood	1.77	1.77	1	As above

Sub-project	Site	Spoil Disposal Location	Design Capacity (10^4 m^3)	Spoil Amount (10^4 m^3)	Distance to works (km)	Land Use
	Side River	1# Guozhuang Site	13.34	159.38	1	As above
		2# Guozhuang Site	6.67		1	As above
		3# Dongqiao Site	6.67		1	As above
		4# Guanyuzhuang Site	20.01		1.5	As above
		5# Haojie Site	10.01		6	As above
		6# Baogongmiao Site	10.01		6	As above
		7# Xigang Site	6.67		6	As above
		17# Huangdui Site	33.35		6	As above
		18# Liangxiang Site	52.66		6	As above
	Zhaojia Canal	8# Qiaomeng Site	14.52	61.33	3	As above
		9# Zhongshanjie Site	10.01		3	As above
		10#Beixiaguan Site	13.4		3	As above
		11#Weizhuang Site	13.4		4	As above
		12# Fuzhuang Site	10.01		4	As above
	Zhejing River	13#Nanguang Site	20.01	61.66	1.5	As above
		14#Shiqiao Site	16.67		2.5	As above
		15# Shuitunnan Site	12.49		1	As above
		16# Shuitunbei Site	12.49		1	As above
Tributaries in Qibin District	Tianlai Canal	East of Xugou 506 storage		55.48	12	Trenches
	Mianfeng Canal	East of Xugou Village		13.45	13	Trenches
	Erzhi Canal	East of Xugou Village		3.53	11	Trenches
	Sanzhi Canal	East of Xugou Village		7.36	15	Trenches
	Sizhi Canal	East of Xugou Village		8.13	15	Trenches
	Total			381.53		

142. **Storm water and sewage pipeline installation (output 3).** This will mainly involve open cut. The earth cut material will be used for backfilling the pipeline trenches. No spoil generation is anticipated.

Water Quality

143. Construction wastewater will be produced from the maintenance and cleaning of mechanical equipment and vehicles, water from mixing and curing concrete, inappropriate storage and handling of fuel, accidental spills, wash-down water for machinery and vehicles, and disposal of domestic wastewater from construction camps. The project will use commercial concrete; it is estimated that 0.5 m^3 wastewater containing 5,000 mg/L suspended solids (SS) will be produced each time a batch of concrete is prepared. In contrast, vehicle and machinery washing wastewater contain 500-1,000 mg/L SS. Approximately 5,059 workers will be employed over the five years of the construction phase, and which will generate wastewater. It is not possible to estimate the on-site wastewater volumes over this time, as worker numbers will vary between years and sites, and some workers will be local residents and will not reside on-site. Portable latrines and sewage management facilities are included in the project EMP. Estimated pollutant concentrations at construction camps is in Table VI-4.

Table VI-4: Pollutant concentrations of municipal wastewater from construction camps

Indicator	BOD_5	CODcr	SS	NH_3-N
Range (mg/L)	200-250	300-400	200	30-40

144. To avoid or minimize impacts on water resources from wastewater generation and risks from chemical handling, the following mitigation measures defined in the EMP will be incorporated in the bid documents and construction contracts.

(i) Unauthorized discharge of wastewater will be prohibited within the project sites.
(ii) Wastewater will be treated in grid and settling tanks before discharge into sewers.
(iii) Septic tanks and mobile toilets will be installed in the project sites, and the wastewater from work camps and canteens will be pre-treated with grid and settling tanks before discharge to the municipal sewer in compliance with national standards.
(iv) Each contractor will be required to develop contingency plans for control of oil and other dangerous substances (i.e. spill management plan). Chemicals will be stored away from watercourses and retention areas will be provided to contain accidental spills of such toxic and harmful construction materials as caustic and acidic substances, oil and petroleum products; Storage facilities for fuels, oil, and other hazardous materials will be placed within secured areas on impermeable surfaces, and provide bunds and cleanup installations.
(v) Each contractor will develop and implement an emergency response plan and train the workers on safe and diligent handling of chemicals to avoid accidental spills and on emergency response when a spill would occur. All areas where construction equipment is being washed will be equipped with water collection basins and sediment traps.
(vi) Additional measures for sediment dredging are described in Section VI.C-2.

Solid waste

145. Solid waste will result from labor camps and demolition waste of construction sites. Inadequate disposal and management of solid waste could have adverse impacts on the soil, water and health of laborers and the community. Waste streams will include different types of waste such as (i) inert construction waste (soil, debris, concrete), (ii) municipal solid waste (workers' food and packaging wastes from consumables), and (iii) hazardous wastes (fuel containers, oil filters, oily rags). It is estimated that each worker will generate 1 kg municipal solid waste per day on average. Potential impacts arising from solid waste production and disposal will be mitigated through the following activities defined in the EMP and which will be incorporated in the bid documents and construction contracts.

(i) Storage and containment: Provide appropriate waste storage containers for worker's construction and hazardous wastes; Install confined storage points of solid wastes away from sensitive receptors, regularly haul to an approved disposal facility.
(ii) Transport and disposal: The city sanitation department will remove all wastes from sites; hold contractors responsible for proper removal and disposal of any significant residual materials, wastes and contaminated soils that remain on the ground after construction.
(iii) Management: Prohibit burning of waste; multi-compartment collection bins will be installed to facilitate reuse, recycle of solid wastes.

Vibration

146. Vibration impacts are expected during construction of treatment plants, pipeline trenches, and river dredging, including from pilling, pipeline trench compaction, and embankment stone crushing. Mechanical vibration may be sudden and discontinuous, which can cause stress among workers and communities. To address these issues: (i) piling and compaction operations will be prohibited at night; (ii) communities will be consulted prior to large earthworks to ensure they are informed, and, to avoid sensitive timing e.g. exams at nearby schools or festivals.

2. Specific Physical Impacts Related to Dredging and Mitigation

147. Risks associated with the project sediment dredging comprise (i) impacts to surface water quality, (ii) appropriate disposal of the dredge spoil, and (iii) odor from dredged sediments. Specifically these include the following.

- Spoil production by dredged material to be treated and stored (temporarily);
- Odorous gases from dredged material during the removal, transportation, treatment including storage site (pond) but with little impact downwind;
- Water pollution by (i) sediment disturbance during dredging with temporary increase of local SS, TN, TP and heavy metal concentrations; and (ii) residual wastewater from dredged material; and (c) leachate from storage of dredged material;
- Noise from dredging activities: impact limited to 50 m in daytime and 150 m at night;
- Disturbance of existing aquatic ecosystem causing temporary imbalance of aquatic ecosystem;
- Traffic disturbance on the transport routes from the on-site dewatering facilities to the temporary storage site, including noise nuisance;
- Possible public complaints due to community disturbance.

148. The detailed impact and mitigation measures are discussed below.

Dredged sediment

149. Rehabilitation of the project canals will generate dredged sediment (Table VI-5).

Table VI-5: Sediment dredged from each river/canal

Waterway	Dredged section	Dredged length (m)	Dredged area (m^2)	Average depth (m)	Wet sediment volume (m^3)
Tianlai Canal	0+000～0+401; 1+401～5+150	4150	37765	0.4	15106
Mianfeng Canal	0+000～0+948	948	6162	0.3	1849
Erzhi Canal	0+270～0+770	500	3650	0.3	1095
Subtotal		**5,598**	**47,577**		**18050**
Side River	From Gongchanzhuyi Canal to 9+500（9.5 km）	9000	126360	0.5	63180
Zhaojia Canal	From South-north water transfer joint to Side River (9.802 km)	4000	28496	0.4	11398.5
Zhejing River	From Wukong Bridge to junction of Side River (6.621 km)	6621	27410	0.3	8223
Hucheng River	Whole river section (5.918 km)	1500	4860	0.5	2430
Subtotal		**21,121**	**187,126**		**85,231.5**

150. Tianlai Canal and other two canals in Qibin District are narrow. Water flows of these canals are slower than 1 m^3/s during dry season. The sediment will be natural dried in canal by controlling flow through the gate at upstream. About 490 m^3 sediment will be dredged per day. Dredged sediment will be drained and used as soil supply for project component 1.1 (re-greening of barren hills). The solid waste cleaned up from canals in Qibin District will be transported to Caizhuang Landfill Site. Caizhuang Landfill is about 10 km to the construction site with designed capacity of 530 t/d. The total capacity of Caizhuang Landfill is 2.79 million m^3. The lifetime of usage is 13 years. The sediment will be used for barren greenings under this project.

151. For the four tributaries in Qi County, the daily dredged amount is 2,500 m^3. The wet dredged sediment will be dried by belt dewatering machine then transported to an abandoned borrow pit at Huangzhuang Village, Qi County. This pit was formed in the 1990s for excavation of earth and gravel for road construction. The pit is about 250 m from the village. The sediment quality is suitable for agriculture, and the site will be used by local residents for agriculture after project completion. The garbage cleaned up in these four tributaries will be delivered to Qi County Sanitation Landfill. The landfill site has been in operation since 2008

with design capacity of 0.87 million m^3. The designed lifetime is 14 years. The daily capacity is 120 tons.

Figure VI-1: Location of the proposed dredged sediment disposal pit

Air quality

152. On-site dewatering and solidification may generate odors that can affect surrounding sensitive receptors. The sediment contains some anoxic or anaerobic organic pollutants due to micro-organism metabolism, which enhances the formation of hydrogen sulfide, ammonia, and other odorous gases. When the bottom sediment is disturbed during dredging, odorous gases can be released into the air, and this may affect sensitive receivers within 30 m of the dredging site. Dredging is a temporary and localized activity and the potential odor impacts will be temporary. Dredging will be undertaken in the autumn when it is cooler and residents are less inclined to open windows. For dust, during temporary storage, dust from dried sediment may affect nearby residential areas on windy days. The following measures are defined in the EMP to minimize air quality impacts:

(i) Storage location. The sediment pre-treatment sites will be located at least 200 m downwind from residential areas and other sensitive receptors such as schools (the dominant wind direction) as a precautionary measure.
(ii) Storage conditions. At the temporary storage site, the sediment will be covered with a layer of mulch then soil, and then compacted with ventilation holes to reduce odor emissions. This is a precautionary measure since the dewatered and solidified sediment will not be an odor source. Enclosure with dust screen or dust cloth outside will be installed around the temporary storage site to minimize dust emissions.
(iii) Vehicles. Vehicles delivering pre-treated sediment to the temporary storage site will be covered with tarpaulin sheets. Overloading of these vehicles will be avoided. Vehicle speeds will be controlled, in particular near residential areas.
(iv) Monitoring. Odor levels will be regularly monitored at sensitive areas (as defined in the monitoring plan in the EMP).

Surface water quality

153. Dredging will increase the level of suspended solids (SS) and release nitrogen and phosphorus in the water by stirring up the bottom sediment, especially immediately around the dredging areas. High SS can lead to the physical, chemical and biological changes of the water body. This may cause temporary ecological degradation of aquatic environments. The dredging will be conducted in the dry season (October to May), the time of lowest and slowest flow. For the canals in Qibin District, the flow in dry season is only about 1 m^3/s; therefore there is no need for diversion. For the tributaries in Qi County, temporary cofferdams will be

erected with every section of 1 km (and then dismantled after completion), and water will be diverted by pumping during dredging. After dredging is completed, it is expected that the concentrations of SS, TN, TP and heavy metals will gradually drop to the baseline levels, and the above-mentioned impacts will disappear.

3. Impacts on Ecological resources

154. Ecological and/or hydrological impacts resulting from construction could specifically cause: (i) disturbance to migratory and/or nesting waterbird communities, including storks, ducks and geese; (ii) damage to aquatic habitats, fish, and aquatic invertebrates due to elevated sediment levels; and (iii) altered flow regimes due to the construction of temporary cofferdams to divert flows during the embankment works. Most of these risks are associated with project works in the pilot NWP and upper section of the Qi, due to the degraded nature and low ecological values of the middle and lower sections.

155. The project will not result in the loss of any natural wetland habitats in the NWP. The amount of forest and shrub vegetation will increase due to the project habitat revegetation activities, and area of wetland will be increased by conversion of old farmland (Table VI-6).

Table VI-6: Project restoration of wetland habitats in the pilot Qi River National Wetland Park.

Habitat Type	Current Area (ha)	Changes caused (ha)	After project (ha)
Farmland	93.11	-93.11	0
Forest	76.19	+49.2	125.39
Waters	73.82	+12.5	86.32
Village	0.38	-0.38	0
Public Road	2	0	0

156. No dredging or permanent in-channel structures will be implemented in the Qi mainstream. However, embankment works will necessitate the use of temporary cofferdams to divert flows. These works will be implemented in the dry season, at the time of lowest flow, to minimize disturbance to the existing flow regime in the NWP. The following mitigation measures are defined in the EMP to minimize negative impacts on flora and fauna during construction.

(i) Protect existing vegetation found nearby construction sites.
(ii) Properly backfill, compact and re-vegetate pipeline trenches after pipeline installation.
(iii) Native plant species of local provenance will be used for replanting and site rehabilitation.
(iv) Carry out works of embankment protection section by section while implementing greening works at the same time in order to minimize soil erosion and restore habitats.
(v) Take special precautions during construction for the protection of fauna, i.e., protect sites where small animals, reptiles, and birds of common species live, such as trees, along the river banks.
(vi) The construction supervision companies (CSCs) and the environmental officer of the PMO will regularly inspect construction sites to ensure that habitats are well demarcated prior to any workers, and, that workers are fully informed of “no-go” areas.
(vii) Increase awareness of construction workers on the need to protect the environment, wildlife and vegetation around the construction sites. Construction site staff employed to work within the pilot NWP will be given basic awareness training by the PMO and/or PIU Environment Officers and LIEC on the importance of the area for plants and wildlife, including: (i) description of key habitats and species; and (ii) background on the establishment of the wetland park.
(viii) Inform workers that hunting or catching of wild animals, littering, and using the park habitats as a public toilet is strictly prohibited.

(ix) In the event that any injured animals are found during construction, these will be immediately reported to the PMO Environment Officer. Injured animals will be left undisturbed by workers. The PMO Environment Officer and Hebi City Forestry Bureau will identify the species and make a decision on whether to take it into captivity or leave it where it is. Unless it is a rare or threatened species and captive facilities are available, it is better to leave the animal where it is, undisturbed, in case it may recover naturally.

157. Overall these impacts are considered to be low, and manageable, due to the temporary and small-scale extent of the works. Ecological impacts resulting from other project components and in the middle and lower sections of the Qi, and canals, are expected to be low or negligible due to the degraded and polluted nature of these lower river sections.

4. Social-economic Impacts and Mitigation

158. **Livelihood impacts through environmental media.** Adverse impacts to livelihoods in the project area through environmental media might be caused by reduction or changes in flow allocations or regime in the Qi River, or restrictions on livelihoods. The project does not involve such activities. Benefits for livelihoods will be achieved by improved flood protection, which will reduce the risk of flooding of agricultural lands along the lower Qi.

159. **Land acquisition.** The project encompasses 70 villages in 16 towns, townships and sub-districts belonging to two districts (Qibin District and the Demonstration District of urban-rural integration) and two counties (Qi and Xun counties). Permanent and temporary land acquisition and/or leasing of collective-owned and/or state-owned land is required. Some rural houses will also need to be demolished. Over 5,000 persons will be permanently and/or temporarily affected. These issues are described in the project Land Acquisition and Resettlement Plan (LARP), which includes resolutions agreed with the affected people.

160. **Occupational health and safety.** The construction industry involves potentially hazardous operations and materials. Intensive use of heavy construction machinery, tools, and materials poses risk of physical hazards such as noise and vibration, dust, handling heavy materials and equipment, falling objects, work on slippery surfaces, fire hazards, chemical hazards such as toxic fumes and vapors. The civil works contractors will implement adequate precautions to protect the health and safety of construction workers. Occupational health and safety risks will be managed by avoiding, controlling, and minimizing hazards, and providing adequate protective equipment and practices. Each contractor will appoint an Onsite Environment Engineer (OEE) to supervise the Environmental, Health, and Safety Management Plan, and implement an Environmental Health and Safety Management Plan (EHSMP) prepared on the basis of the project EMP. This will be submitted to the PMO, IA and HEPB for review. The EHSMP will include the following provisions.

(i) Clean water. Provide a clean and sufficient supply of fresh water, for construction and for all camps, offices and workshops.
(ii) Sewage and wastewater. Provide adequate number of latrines and other sanitary arrangements at the site and work areas and ensure that they are cleaned and maintained in a hygienic state.
(iii) Solid waste. Install garbage receptacles at construction site and camps, which will be periodically cleared to prevent outbreak of diseases.
(iv) Personal protection. Provide personal protection equipment (PPE), such as safety boots, helmets, gloves, protective clothing, goggles, and ear protection, in accordance with relevant health and safety regulations, for workers.
(v) Emergency Preparedness and Response. An emergency response plan to take actions on accidents and emergencies, including environmental and public health emergencies associated with hazardous material spills and similar events will be

prepared. Emergency phone link with hospitals will be established. A fully equipped first-aid base in each construction camp will be organized.

(vi) Records Management. A Records Management System that will store and maintain easily retrievable records protected against loss or damage should be established. It will include documenting and reporting occupational accidents, diseases, and incidents. The records will be reviewed during compliance monitoring and audits.

(vii) Safety communication. Ensure that safety, rescue and industrial health matters are given a high degree of publicity to all persons regularly or occasionally on the sites. Posters rowing attention to site safety, rescue and industrial health regulations will be made or obtained from the appropriate sources and will be displayed prominently in relevant areas of the sites.

(viii) Training, awareness and competence. Train all construction workers in basic sanitation and health care issues, general health and safety matters, and on the specific hazards of their work. Implement HIV/AIDS and other communicable diseases awareness and prevention program to target the local community and construction workers.

161. **Community health and safety** Traffic congestion may worsen as construction traffic in urban areas increases during rush hours; roads and intersections may be partially closed during construction, causing temporary inconvenience to traffic, residents, commercial operations, and institutions. Construction sites will be partly located close to residential and commercial urban areas, presenting a threat to public health and safety. The Project may also contribute to road accidents through the use of heavy machinery on existing roads, temporarily blocking pavements for pedestrians etc. The potential impacts on community health and safety will be mitigated through a number of activities defined in the EMP and the contractors will implement the following measures:

(i) Traffic management. A traffic control and operation plan will be prepared with the local traffic management authority prior to any construction. The plan shall include provisions for diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at road crossings with an emphasis on ensuring public safety through clear signs, controls and planning in advance.

(ii) Information disclosure**.** Residents and businesses will be informed in advance of the construction activities and dates and duration of expected disruption.

(iii) Construction sites. Clear signs will be placed at construction sites in view of the public, warning people of potential dangers such as moving vehicles, hazardous materials, and excavations, and raising awareness on safety issues. Heavy machinery will not be used after day light. All such equipment will be returned to overnight storage areas before night. All construction sites will be made secure, discouraging access by members of the public through appropriate fencing whenever appropriate.

162. **Other social issues.** No other significant social risks are anticipated as a result of the project. Construction workers will be engaged locally to the possible maximum. Prevention and control of transmissible diseases and HIV/AIDS, and community disturbance training and sensitization will be provided to the contractor crews, as ensured in the loan assurances and will be monitored in the social action plans. Civil works contracts will stipulate priorities to: (i) employ local people for works; (ii) ensure equal opportunities for women and men; (iii) pay equal wages for work of equal value; and (iv) not employ child or forced labor.

163. **Utilities provision interruption.** Construction may require relocation of municipal utilities such as power, water, communication cables. Temporary suspension of services (planned or accidental) may affect the economy, industries, businesses and daily life of residents. Potential impacts on utilities will be mitigated through the following measures, which are included in the EMP and will be incorporated in the bid documents and construction contracts: (i) contractors will assess construction locations in advance to identify potential

disruption to services and risks before starting construction; and (ii) if temporary disruption is unavoidable the contractor will, in collaboration with relevant local authorities (e.g. power, water, communications), develop a plan to minimize the disruption and communicate the dates and duration in advance to all affected people.

164. **Physical cultural resources.** No cultural heritage or archaeological sites are known from the project areas. However, construction activities have the potential to disturb unknown underground cultural relics. The EMP mitigation measures include immediate suspension of construction activities if any archaeological or other cultural relics are encountered, in accordance with the PRC Cultural Relics Protection Law 2002. The Hebi Cultural Heritage Bureau, PMO, and implementing agency will be promptly notified. Construction will resume only after investigation and with the permission of the appropriate authority. The clause for protection of unknown underground cultural relics will be included in construction contracts.

D. Operational Phase

1. Project Works in the Pilot Qi River National Wetland Park

165. The project may result in larger numbers of visitors to the pilot NWP, which will increase overall human activity in the park. The internal zoning of the park is clearly mapped and defined, and core zones of the park will be maintained for minimum human disturbance. For the restored habitats and planted vegetation, maintenance including pruning, weeding and replacement of dead or dying trees and shrubs will be undertaken by the Qibin County and Qi District Forestry Bureaus. Pesticide use will be avoided along the river and in the wetlands. If severe or unexpected pest infestations occur, only low toxicity pesticide will be applied. Overall management of the project facilities and NWP in general will be guided by the management agency and plan to be established under the project, and which will include training in wetland management for HCG agencies and community river guards.

2. Embankments Along the Qi River and Tributaries

166. The operation of the river component is not expected to generate major impacts. The mitigation measures for environmental impact during operation includes properly maintaining all river embankment vegetation, emergent aquatic plants and other vegetation; and inspecting all river embankments for stability issues. If signs of failure are discovered, a repair program will be implemented immediately. Periodic maintenance to remove garbage or excessive plant growth will be conducted.

3. Wastewater and Solid Wastewater Management Facilities

3.1 Wastewater Management

167. For sewage, the transfer of sewage will be by the use of gravity, through the pipeline networks, avoiding energy use and the need to construct lift pumps. For effluent treatment, the Qi County WWTP extension has been designed to discharge high quality treated effluent to Zhejing River. The discharge quality will meet the highest standard, Class 1A, of Discharge Standards of Pollutants for Municipal WWTPs (GB18918-2002). The potential effect of discharging treated effluent to the Zhejing River (which eventually joins with the Gongchan Zhuyi Canal and then Wei River) was predicted by application of the “completed mixture model”, which assumes (i) complete mixing of the effluent with channel water, and (ii) there is limited breakdown of pollutants with distance. The results show that the river water quality will be improved due to the treated effluent input (Table VI-7). The effluent water quality will be regularly inspected by local EPB. This component will clean up the receiving waters in two ways: (i) by discharging into the river a treated effluent which is significantly higher in quality than that of the receiving waters; and (ii) by the upgrade and extension of sewage reticulation

into areas with no existing networks.

Table VI-7: Anticipated impact to surface water by Qi County WWTP

Section	Flow (m^3/s)	COD_{Cr}	BOD_5	TN	TP
Discharge outlet of Qi County WWTP	0.625	50	10	15	0.5
W5 section	0.29	594.33	262	9.54	1.40
When the receiving water mixted	0.915	222.52	89.87	13.27	0.79
GB3838-2002	—	40	10	2.0	0.4

168. **Noise.** Noise will be generated by mechanical equipment such as waste water lift pumping, return sludge pump and grid screen rotation. The estimated operating noise level from various pumps is 85 dB (A). To mitigate potential noise impacts, low noise equipment and building walls with sufficient thickness and acoustic measures, such as barriers or sound absorbing materials, will be installed. Equipment maintenance will be required as part of standard operating procedures. These measures are expected to reduce noise levels to 70 dB (A). Noise levels at the WWTP boundaries would met Grade II noise requirements of 60 dB (A) during day time and 50 dB (A) at night under PRC's Noise Standards at the Boundary of Industries and Enterprises (GB 12348-2008).

169. **Odor.** Odor generated during sewage treatment (including sewage grating room, sedimentation tank, oxidation pond, secondary sedimentation tank) will impact upon the environment within and around the plant area. The concentration of odor is related to wastewater quality, and its dispersal is related to meteorological conditions and terrain. Odor is a composite of pollutants of which ammonia (NH_3) and hydrogen sulfide (H_2S) are the key parameters for measurement. The distance from the plant where maximum concentration of these gases will occur has been calculated using the air environmental protection distance computation method regulated in Technical Guidelines for Environmental Impact Assessment - Air Environment (HJ 2.2-2008). The maximum ground concentration is presented in Table VI-8.

Table VI-8: Maximum Ground-level Concentrations of Odors

Name	**Distance downwind (m)**	**NH_3**	**H_2S**
Qi County WWTP	321	0.01586	8.92E-05
Standard for residences (TJ36-79)		0.20	0.01

170. In addition to PRC regulations for odor standards, the project also complies with PRC Development of Local *Atmospheric Pollutant Emission Standards Technical Methods* (GB/T3840-91) standard for health protection distances from odor. The results show that the maximum ground concentrations of NH_3 and H_2S are about 7.93% and 0.89% respectively of the requirements of standards (TJ 36-79). A buffer distance of 100 m downwind of the WWTP to mitigate potential odor impacts is identified as suitable; there are no residential areas within 100 m around the boundary of the proposed site.

171. **Solid waste.** Initial filtering of wastewater removes large objects such as discarded plastic, sticks and leaves. These materials, along with incidental litter produced by operating staff, will be transported by municipal waste collection vehicle to the Qi County Sanitation Landfill.

172. **Sludge.** The WWTP will generate 8.1 tons of sludge (60% moisture) per day. For disposal at sanitary landfill, the moisture content of the sludge should not be more than 60% according to PRC's *Disposal of Sludge from Municipal Wastewater Treatment Plant–Quality of Sludge for Co-landfilling* (GB/T 23485-2009). The dewatered sludge cake will be delivered to Qi County Sanitation Landfill, situated 14 km from the WWTP.

173. **Health and safety**. Plant operators may be injured by slips on wet floors, falls into treatment ponds, and splashes of treatment chemicals. The following measures will be

implemented to safeguard the safety and health of WWTP operators: (i) use of safety shoes or boots with non-slip soles; (ii) posting of safety instructions in each workshop regarding the storage, transport, handling or pouring of chemicals; (iii) check electrical equipment for safety before use; verify that all electric cables are properly insulated; take faulty or suspect electrical equipment to a qualified electricity technician for testing and repair; (iv) wearing of safety goggles in all cases where the eyes may be exposed to dust, flying particles, or splashes of harmful liquids; and (v) wearing of respiratory mask in the sludge dewatering and de-odor workshops and when moving and transporting sludge. Finally, health and safety will be incorporated into the regular staff training programs.

174. **Emergency plan**. The WWTP will prepare and implement an emergency preparedness and response plan before operation. This will comply with the requirements of the Henan Plan for Public Emergency Preparedness and Response, which is based on the National Master Plan for Public Emergency Preparedness and Response (State Council, 2006). The plan will include requirements for training, resources, responsibilities, communication, and procedures. Appropriate information about emergency preparedness and response activities, resources, and responsibilities will be disclosed to affected communities.

3.2 Solid Waste Management

175. Solid waste collection, transport and treatment will: (i) generate odor, leachates and noise at the transfer stations; (ii) generate dust and traffic noise by the collection vehicles; (iii) require efficient separation of waste materials prior to disposal; and (iv) require clear operating procedures and personnel training, for worker and community health and safety. A facility operation plan will be developed and include operating schedule, staff roles and responsibilities, procedures for waste collection, transport and sorting, handling of hazardous materials and leachate, maintenance of facilities, employee training, health and safety, and record keeping. A detailed waste collection schedule and route will be developed for each station. The plan will set daylight operating hours and weekly collection of waste. Drivers will be trained to drive safely and at prescribed speed limits.

176. For odor and noise at the stations, the project design includes: (i) a minimum width of buffer zone and green belt around each station, to comply with PRC Technical Specifications for Domestic Solid Waste Transfer Stations (CJJ47-2006); (ii) stations will be fully closed to minimize release of odors to the surrounding environment – ventilation is ensured in the designs; (iii) equipment and stations will be regularly cleaned with disinfectant to maintain hygiene, reduce the risk of disease, and control odor and pests.

177. Five of the 15 solid waste transfer stations are currently not connected to municipal sewers. The wastewater generated from these five stations will be temporarily stored in tanks and transported to municipal sewers by suction sewage trunks.

178. All employees will be trained in health and safety measures and to identify problems such as accidental release of trash from trucks, or the risk of “hot loads”. This is where trash has been disposed which is partly burning or smoldering (but which is unnoticed by residents or the vehicle operator), is subsequently collected, and fire starts within the waste collection vehicle or back at the station. Fire safety equipment will be present in the stations and collection vehicles. Emergency plans will include immediate reporting to the local fire station and warning local neighbors.

E. Potential Indirect, Induced, and Cumulative Impacts

179. Increased visitor numbers to the NWP may cause increased disturbance to fauna and/or inadvertent damage to flora. This risk is minimized by: (i) the inclusion of signs and fencing by the project; (ii) well defined internal zoning, which allocates specific areas for

human access, recreation, and conservation; (iii) the visitor center to be constructed (under a separate government project) will include leaflets and signage for visitors; and (iv) the river conservation guards currently employed to help supervise visitor access will continue. Cumulative benefits of the flood protection and wastewater control measures include: (i) the combination of the project flood control measures together with Panshitou Reservoir collectively strengthen flood protection for Hebi City; and (ii) the project-supported WWTP, in combination with the three other WWTPs (one existing, one to be upgraded, one to be constructed; see Table IV-13) managed by the government, will collectively provide sufficient wastewater management capacity for Hebi City.

F. Project Benefits and Features

180. The project will implement an integrated and holistic approach to water resources management for the most flood-prone, and ecologically sensitive, sections of an inland river system, within the most populated province in the PRC. The project area encompasses half of the total length of the Qi, including part of its upper section and all of its middle and lower sections. Project components are tailored to the different management, hydrological, and topographic conditions of each river section, and comprise a range of structural and non-structural measures as follows: wetland protection and control of soil erosion in the upper section; reduction of pollution loads by sewage and solid waste management in the upper and middle sections; flood control measures in the middle and lower sections; and capacity building for integrated water resources management (IWRM), and implementation of a Qi River MIS to support flood warning and other measures, over the project area. This integrated approach supports the PRC's model of "ecological civilization", which promotes sustainable development, emphasizes the importance of water resources management, and the need to provide demonstration models for river governance.

181. Specific project benefits include: (i) soil erosion in the Qi catchment reduced by 11,000 tons per year,[8] due to the re-vegetation of barren hills (forest cover in Hebi City increased by 7%, from 53% to 60%; output 1.1.1); (ii) carbon sink established due to the re-vegetation activities, which will sequester approximately 16,000 tons CO_{2e} per year and reduce net greenhouse gas emissions during project construction and operation by 26% (Section VI.G); (iii) flood control capacity improved from a 1 in 5-year to 1 in 20-year flood recurrence interval for the lower Qi River, <1 in 5 to 1 in 20-year interval for three main tributaries (Side and Zheijang Rivers; Zhaojia Canal), and drainage capacity strengthened for six minor waterways (Tianlai, Mianfeng, Second Branch, Third Branch, and Fourth Branch Canals; Hucheng channel) (output 2); (iv) the volume of untreated wastewater discharged into the Qi River and canals will be reduced by 20%, from 57,200 m^3/d in 2015 to 45,840 m^3/d in 2022; (v) the pollutant loads being discharged from the Qi County WWTP will be reduced by 70–97%, due to improved treatment levels; and (vi) IWRM for the Qi River improved, through training of city bureaus and adoption of the MIS for water and land resource management, including flood warning. The ecological services of the Qi will also be strengthened through these measures, including improved water retention and filtration on hill slopes and along riverbanks.

G. Climate Risk Vulnerability Assessment

182. **Historical trends.** To review historical climate trends, daily mean temperature and precipitation data from 1994 to 2014 at two stations in Hebi city were provided by Hebi Meteorological Bureau. Only rain season (June to September, JJAS) was analyzed, because in this region, extreme climate events such as floods and high temperatures mainly occur

[8] Derived using the following assumptions: (i) a baseline erosion rate of 800-1,200 t/km^2/year, given in the *Henan Soil Erosion Zoning Map*; (ii) a reduction of 300-500 t/km^2/year, as measured by the *Henan Yiluo River Ecological Rehabilitation Project* (a national project with similar soil conservation activities); and (iii) a total area of 1,345 ha for the barren hills component (output 1.1.1).

during this season. The other reason was that most annual rainfall occurs in this season due to the dominant influence of summer monsoon. Historical trends for JJAS mean temperature and precipitation trends were calculated using linear regression method based on data from 1994 to 2014. Figure V-7 shows the temperature and precipitation at the two stations in Hebi City. There is increasing temperature trend observed in Qi County whereas a decreasing trend in Xun County. JJAS precipitation shows a slight negative tendency at both stations.

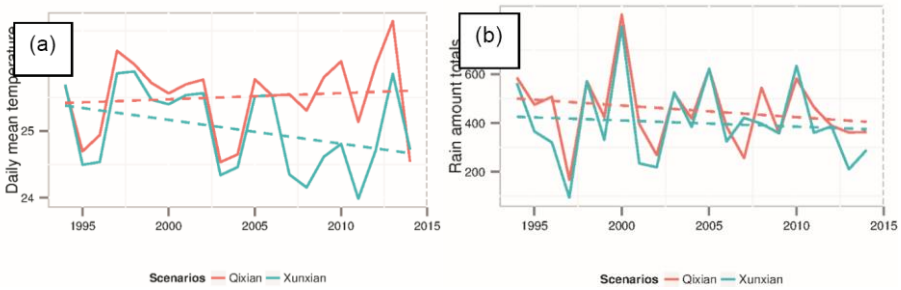


Figure V-7: Historical trends in temperature and precipitation in Hebi City

183. **Projected climate change**. The statistical downscaling method was applied to downscale the IPCC AR5 global climate change simulations (HadGEM2-ES) under RCP4.5 (median) and RCP8.5 (extreme) scenarios to project future daily temperature and precipitation at two stations in Hebi stations. Three time scales, 2020-2039, 2050-2069 and 2080-2099, were analyzed. The projected climate change trends are summarized as follows.

- Compared with historical trends, there is a shift toward larger values of rainfall under the two scenarios. However, the amplitudes of the changes vary with scenario and station. The increase is the most significant during 2080-2099 under RCP8.5.
- There is an obvious rising trends in rainfall amount totals under two scenarios, especially the greatest increase appears during 2080-2099 under the RCP8.5. For rainy days, there is a weaker increase under RCP4.5 than under RCP8.5.
- For heavy rain events (precipitation >50mm), there is a slight increase during the two periods 2020-2039 and 2080-2099 and decrease during the period of 2050-2069 under RCP4.5, whereas there is an obvious increase under RCP8.5.
- The very heavy rain events (precipitation >100 mm) increases at Qixian during 2020-2039 and 2080-2099 under RCP4.5, but obviously increases during 2080-2099 under RCP8.5. For Xunxian, there is no obvious increase under RCP4.5, but a notable increase under RCP8.5.
- Changes of JJAS mean temperature in Hebi shows a considerable increase under two scenarios. Especially, there is a more significantly increasing trend at two stations in Hebi under RCP8.5, compared with RCP4.5.

184. **Adaptation**. Potential climate risks and impacts and project adaptation measures are given in Table VI-9.

Table VI-9: Potential impacts of climate change and project adaptation measures

Activity	Potential Impacts	Adaption/Resilience
Barren hill greening	• Increased flood events damage planted vegetation and cause soil erosion • Increased drought and heat waves affect plant survival	• Regular watering during extreme drought events • Planting undertaken in spring to maximize survival rates • Native plant species selected for adaptation to the dry and shallow, rocky soils
Qi Wetland Rehabilitation	• Increased drought and heat waves reduce wetlands and cause die-off of plants • Floods damage the park infrastructure–banks, roads,	• Planting undertaken in spring to maximize survival rates • Native plant species selected for adaptation to seasonal flood/drought wetland conditions

Activity	Potential Impacts	Adaption/Resilience
	building, signs, fencing	
Watercourse improvement	• Flood damage to river banks and river bank road	• Widening and dredging of canals • Reinforcement of flood-prone sites in Qi mainstream • Regular maintenance of canals • Qi River MIS to improve flood forecasting and warning
Wastewater and solid waste management	• Floods increase the risk of contaminate runoff • Floods increase risk of soil erosion and sediment deposition in Qi River	• Separate storm water and sanitary drainage systems • Improve efficiency and capacity of collection and treatment of initial runoff collection • Locate WWTPs above the 1 in 20 year return flood level

185. **Greenhouse gas (GHG) emissions during construction**. This project will generate GHG emissions during construction (vehicles, machinery, workers). The following assumptions were made to estimate of GHG emissions during construction: 1,000 workers employed over the project duration; articulated trucks (100 t) driven a total of 100,000 km; light commercial trucks (10 t) drive 100,000 km; and 10,000 tons construction waste produced. This yields a coarse estimate of GHG emissions of 9,643 tonnes CO_{2e} for the total construction phase, using an online carbon calculator (http://carbonneutral.com.au/). On this basis, no significant GHG emissions will be generated during the project construction phase.

186. **GHG emissions during operation**. The main source of GHG emissions from the project will be from the operation of the wastewater components. Carbon dioxide (CO_2) and nitrous oxide (N_2O) are the main GHGs produced during the wastewater treatment processes. GHG emissions were estimated using the U.S. EPA GHG emission estimation methodology (EPA, 2010). Aerobic wastewater treatment system produces primarily CO_2, whereas anaerobic systems produce a mixture of methane (CH_4) and CO_2. It is estimated that the project CO_2 and CH_4 emissions for WWTP operation will be approximately 56,166 tonnes CO_{2e} yr-1; estimated N_2O emissions in the WWTP treatment process are 2,055 tonnes CO_{2e} yr-1; estimated CO_2 emissions produced by power use in the WWTP are about 3,813 tonnes CO2e yr-1, if it is assumed that electric use is 0.2 kwh when treating 1.0 m^3 of wastewater in the WWTPs. According to the above calculations, a coarse estimation of the total GHG emission by the project is 62,035 tonnes CO_{2e} yr-1 during operations.

187. **Carbon sinks and net project GHG emissions.** The proposed greening works in the project include barren hill greening , riverside tree planting, and wetland restoration. The total barren hill tree planting area is about 1,345 ha, which will be the biggest carbon sink source of the project. The carbon sink capacity of these plantations is estimated using the calculation method of carbon sinks defined in IPCC Guidelines for National GHG Inventories (IPCC, 2006).[9] The annual increase in biomass carbon stocks due to tree-planting is estimated to be about 3,476 tonnes C yr-1. The annual increase in carbon stock is converted to units of CO_2 emission by multiplying the carbon change by -44/12. The barren hill greening works will achieve about 15,929 tons CO_{2e} of carbon sink per year. During the operation period the project activities will generate net GHG emissions of 46,106 tonnes CO_{2e} yr-1 (62,035 minus 15,929 tonnes CO_{2e} per year), which is less than half of 100,000 tonnes CO_{2e} yr-1 (the level defined by ADB as presenting a significant risk).

[9] Annual increase in biomass carbon (C) stocks due to biomass growth C_G is calculated by the following equation:

$$C_G = A \cdot G_W \cdot (1 + R) \cdot CF$$

where: C_G=annual increase in biomass carbon stocks due to biomass growth
A=area of barren hill greening, here A=1330ha
G_W=average annual above-ground biomass growth, here G_W=5.0 tonnes d. m. ha^{-1} yr^{-1}
R=ratio of below-ground biomass to above-ground biomass, here R=0.39 tonne d. m. (tonne d. m.)$^{-1}$
CF=carbon faction of dry matter (d.m.), CF=0.47 tonne C (tonne d. m.)$^{-1}$

Here, G_W, R and CF use the values of Asian temperature mountain system of forest plantations in Tables 4.3, 4.4 and 4.10 of IPCC (2006).

VII. ANALYSIS OF ALTERNATIVES

188. **No project alternative.** The outcome of “doing nothing” would be: (i) continued serious soil erosion from upstream of Qi River Basin due to non-covered barren hills; (ii) the residents and properties will at high flood risk; (iii) riverbank scouring and erosion; (iv) continued and increased outflow of untreated wastewater into rivers and canals; and (v) dumped solid waste in to rivers that cause river blockage and pollution.

189. **Revetment design**. Revetment types considered for the rivers and canals were grass, concrete, stone masonry, gabion, and interlocking blocks. Embankment options were reviewed as follows: (i) on-site cast concrete method – adaptable, simple and short construction; (ii) masonry – low-cost, good anti-washout effect, optimal option for river sections at high risk of flood damage; (iii) Gabion material – anti-washout, high permeability, plant-friendly. To optimize the project benefits, a tailored approach was used for each project waterway. For Longxu Ditch and Hucheng River, which operate for urban flood discharge, flow velocity on river bends is small. For these courses, “pre-cast six edged concrete sash grass protection” will be applied on river bends. For Side and Zhejing Rivers and Zhaojia Canal, the river bends are subjected to scouring during floods. For sections with a gradient of >1:100, simple re-vegetation of banks is insufficient. For these sections, gabion and masonry protection will be applied.

190. **Dredged sediment treatment.** Three methods for treating the dredged sediment were evaluated. The first method is drying the dredged material by natural means (i.e. in the sun). This will take long time and depends on the weather conditions. The second method is to fill the dredged sediment into tube-shaped geotextile bags in a sediment storage area, with the addition of a flocculent such as poly acrylamide. The water pressure inside the geotextile bag would squeeze the water out of the geo-textile bag. The geotextile bags with dewatered sediment inside would then be transported to the disposal site. The third method is belt press. The moisture content can be reduced to 34% or less after belt press dewatering process. Belt press was recommended by the design institute considering its high efficiency and small land occupied.

191. **Final sludge disposal**. Three destinations were evaluated, sanitary landfill, incineration, and soil application. There is no existing sludge incineration plant in Hebi. The garbage cleaned from the rivers/canals will be delivered to the landfill site after dewatering. For the purpose of waste reduction, agricultural use and landscaping use are assessed. Based on the sediment monitoring results, the nutrient content in the sediment is too low, which is not effective to use for beneficial use.

192. **Site Selection for Qi County WWTP**. There locations were assessed, and option 3 selected because: (i) it is next to the existing Qi County WWTP; (ii) it is far from residential areas; (iii) wastewater can flow by gravity so as to save pumping cost (Table VII-1).

Table VII-1: Site selection for Qi County WWTP

Criteria		Alternative Site 1	Alternative Site 2	Alternative Site 3
Compliance	Planning	Compliance with Urban Master Plan	Compliance with Urban Master Plan, but too close to neighborhoods	Compliance with Urban Master Plan, but too close to neighborhoods
	Comments from Supervising Authorities	Agree	Agree	Agree
Traffic	Traffic Condition	Convenient	Convenient	Convenient
	Road Construction	No need	No need	No need
Economic	Land Acquisition	Agricultural land	Agricultural land	Agricultural land
	Investment	Low	Low	Relatively High
	Distance to major	Close	Close	Relatively Far

Criteria		Alternative Site 1	Alternative Site 2	Alternative Site 3
Engineering	dischargers			
	Reserved Land	Yes	No	Yes
	Pumping Station	Yes	No	No
	Pipeline Length	Low	Low	Relatively High
Environmental	Distance from neighborhoods	The closest neighborhood is 300m away	The closest neighborhood is 50m away	The closest neighborhood is more than 300m away
	Prevailing Wind Direction	Not in prevailing wind direction in summer	At upstream of prevailing wind direction in summer	Not in prevailing wind direction in summer

193. **Wastewater Treatment Process**. Biological treatment process with nitrogen and phosphorous removal should be selected, continuous operation such as A2/O, oxidation ditch, or intermittent operation, such as SBR, ICEAS, CASS, Unitank, and MSBR. All these processes have been widely used in the PRC. Considering local operational experience, A2/O and modified oxidation ditch are shortlisted for further comparison (Table VII-2).

Table VII-2: Alternative Biological Treatment Processes

Content of comparison	Alternative I (Modified A2/O)	Alternative II (Modified Oxidation Ditch)
Civil works	Many	Average
Method of aeration	Blower aeration, high oxygen utilization efficiency	Oxygen delivered and internal flow speed maintained using impellers, excellent effect of mix and impact resistance
Technical features	A technologically proven phosphorus and nitrogen removal system comprising of pre-anoxia + anaerobic + anoxia + aerobic. Provision of the pre-anoxia pond increases effect of biological phosphorus removal. Large quantities of successful applications available both home and abroad.	Diversified forms, good resistance to impact load, stable effluent quality.
Supporting unit	Requiring blower house and secondary sedimentation tank.	Requiring secondary sedimentation tank.
Operation and management	Simple process, proven operational experience, not demanding on operator competence, simple to operate and manage.	Involving relatively fewer equipment and structures, easy to manage
Equipment	Requiring fewer equipment types and quantity	Requiring few equipment types and quantity
Capital investment	AAO tank + blower house + secondary sedimentation tank	Oxidation ditch + secondary sedimentation tank
Cost of operation	Relatively low electricity consumption	High cost of electricity due to low oxygenating efficiency
Land use	Involving a large number of structures and buildings and large land use	Shallow tank and large land use
Operation Experience	No	Yes

194. Considering the operation experience and integration with the existing Qi County WWTP (Qi County WWTP is currently using modified oxidation process), the modified oxidation ditch process is recommended as the main treatment process for the WWTP expansion project.

195. **Sludge Treatment and Disposal.** Sludge quality of existing WWTPs in Hebi was tested to determine the proper destination of sludge (Table VII-3).

Table VII-3 Sludge Quality Test Result (samples taken on 11 March 2013)

		Total Cu (mg/kg)	Total Pb (mg/kg)	Total Cr (mg/kg)	Total Cd (mg/kg)	Total Hg (mg/kg)	Total Ni (mg/kg)	Total As (mg/kg)	Total Zn (mg/kg)
Qibin District WWTP		215	56.4	95.2	2.17	0.442	35.2	6.83	2380
Qi County WWTP		52.1	33.2	28.6	0.512	0.394	10.7	8.28	158
Quality Standard for afforestation (GB/T 23486-2009)	Acid Soil	<800	<300	<600	<5	<5	<100	<75	<2000
	Alkaline Soil	<1500	<1000	<1000	<20	<15	<200	<75	<4000
Quality Standard for production cement clinker (CJ/T309-2009)		<1500	<1000	<1000	<20	<25	<200	<75	<4000

196. Future sludge of Qi County WWTP should have similar quality of the sludge from the existing plant. The heavy metal content in the sludge can meet the requirement for reuse in afforestation and production cement clinker. However, further analysis (organic substance%, TK, TP, TN and seed germination) should be conducted to further assess the feasibility of sludge land application.

197. Since the downstream market for sludge product (land application as fertilizer or used in cement clinker) is uncertain, the sludge disposal method recommended in FSR is to transport out sludge to Qi County Landfill for domestic solid waste, which is 14km away from Qi County WWTP.

198. According to *Comments on Sludge Treatment Disposal of Municipal Wastewater Treatment Plant in Henan Province* (2010) issued by Henan Province EPB, water content of sludge from WWTP must be reduced to less than 60% before disposal in landfill. To achieve 60% water content target, the frame and plate filter press process was selected. Frame and plate filter press the only commonly used dewatering method with proven track record can dewater sludge to less than 60% water content. In addition it's capital and operational cost is lower than sludge heat drying processes.

VIII. PUBLIC CONSULTATION, PARTICIPATION AND INFORMATION DISCLOSURE

199. Meaningful participation and consultation during project planning, feasibility study, design and implementation are important safeguard requirements. Administration of Construction Project Environmental Protection (Order No. 253 of the State Council) requires that a domestic EIA solicits the opinions of organizations concerned and residents within and near the project sites. In August 2012, the PRC National Development and Reform Commission (NDRC) issued a requirement for *Social Risk Assessment of Large Investment Projects*, which emphasizes the importance of public consultation in an effective manner, and requires that the results of public consultation are clearly summarized in the DEIA report, including the dates of consultations, number of stakeholders, who the affected people are, and the comments received. The updated *Environmental Protection Law* (effective January 2015) strengthens public involvement and information disclosure requirements (including disclosure of full EIAs for projects or programs with significant environment impacts).

200. ADB's SPS (2009) also requires meaningful public participation, consultation and information disclosure. The consultation process for this project followed PRC law and the SPS.

201. The following sections describe the public consultations for the environmental assessment, undertaken between September 2014 and June 2015. Consultation included: (i) information disclosure; (ii) questionnaire surveys; (iii) informal visits to villages and households in the project area; and (iv) stakeholder meetings attended by residents and other concerned stakeholders, including a questionnaire survey after the meetings. Concurrent with this process, social and poverty analyses were conducted by the PPTA social, resettlement and gender specialists based on group discussions with key agencies, beneficiaries, and adversely affected communities. For the preparation of resettlement plans, information disclosure and public consultations were conducted, by questionnaire surveys, community meetings, and focus group discussions.

A. Information Disclosure

202. Information disclosure of project information and related environmental issues was conducted twice on the website of Hebi EPB (http://www.hbhb.gov.cn/) in December 2013 and May 2015 respectively. The first time was at the commencement of domestic environmental assessment preparation and the second was when the draft domestic assessments were completed. The duration of each web-site disclosure was ten working days. No objection to the project was received during disclosure. A sample web-posting is shown in Figure VIII-1.

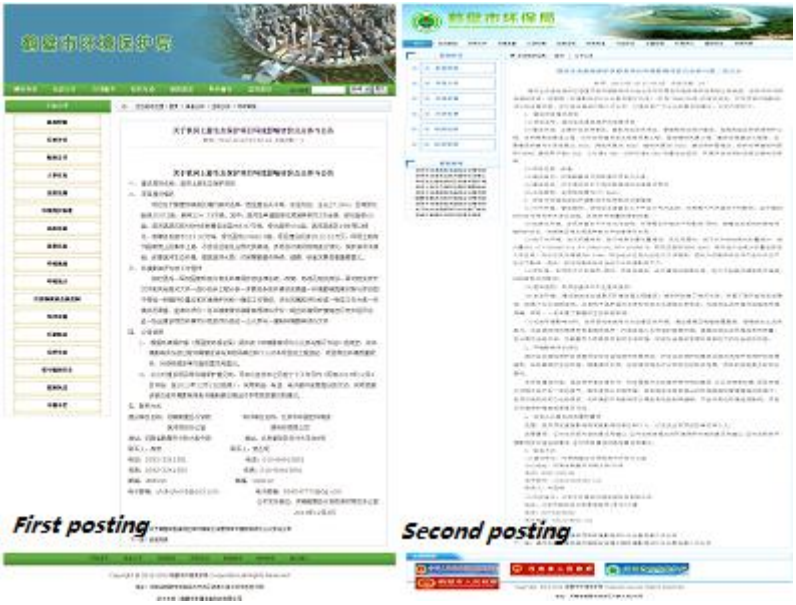


Figure VIII-1 Project information disclosed on Hebi EPB website

B. Questionnaire Survey

203. The questionnaire survey (Table VIII-1) was conducted during May-June by the EIA institute to the potential affected residents and groups.

Table VIIII-1 Environmental impact questionnaire

1.	To what extent do you know this project construction? A. Clearly Understand B. Understand C. Partially Understand D. I know nothing
2.	How will you describe the current environment near the project? A. Great B. Satisfying C. Not bad D. Unsatisfying E. Terrible
3.	Which one do you think is the key problem in the area where the project built in? A. Air Pollution B. Water Pollution C. Noise Pollution D. Solid Waste Pollution E. Ecological Damage
4.	What effect do you think the operation of the project will have on this area? A. Beneficial Effects B. No Effects C. Harmful Effects
5.	Which factor is the one you care about most among the environment factors under the risk caused by this project? A. Exhaust Gas B. Waste Water C. Noise D. Solid Waste E. Others
6.	To what extent do you think the construction of this project will have effect on your life? A. Beneficial Effects B. Harmful Effects (Serious) C. Harmful Effects (slightly) D. No effects
7.	How will you describe the environment protection measurements used in this project? A. Perfect B. Deficient C. Hardly seen
8.	To what extent do you think the construction of this project will improve the environment nearby? Greatly Improve B. Improve a lot C. Not really effective D. No Improvement
9.	To what extent do you think the project will promote the economic development in this area? A. Strongly B. Beneficial C. Not really effective D. No promotion
10.	Taking all factors into consideration, what's your attitude to the construction of this project? A. Support B. Oppose C. I have no idea
11.	Do you have any suggestion or requirement to this project?

204. For the barren hill greening sub-component, 69 questionnaires were issued and 100% were returned, including 44 individuals and 25 village committees in the area of this sub-component. Individual participants consisted of 36 males and 8 females. Most (80%) were 40 years old or above. 97% of participants are farmers. 50% participants have received high school education. All (100%) regarded construction impact to be acceptable. The majority (75%) reviewed the project would be beneficial to local environment. 98% are very

supportive to the project and 2% had no opinion.

205. For the Wetland Rehabilitation subcomponent, 70 questionnaires were issued, including 64 individuals and 5 village committees and Miaokou Township Government. 100% were returned. Participants consisted of 50 males and 14 females. Most (61%) were 40 years old or more. Farmers comprised 89% of participants. The major environmental problems identified by the participants are water quality and solid waste. The major concern during construction is regarded as noise. All agreed to the project and 91% believed the project would be beneficial to local environment.

206. For the watercourse improvement component, 215 questionnaires were issued, including 205 individuals and 10 organizations. All questionnaires (100%) were returned. Participants consisted of 183 males and 22 females. Most (77%) were 40 years old or more. Farmers accounted for 76% of participants. Close to half (44%) received high school education and other half (41%) received junior school education. 28.8% and 28.3% were concerned about the wastewater and solid waste issue during construction. The major local environmental issue identified by the participants was solid waste problem. Most (99%) agreed to have the project and deemed the project to be beneficial to local environment and 1% had no opinion.

207. For the wastewater and solid waste management component, 146 questionnaires were issued, including 138 individuals and 8 organizations. All (100%) questionnaires were returned. Participants consisted of 118 males and 19 females. Most (83%) were 40 years old or more. 39% received junior school education and 40% received high school education. Farmers accounted for 93% of participants. The participants viewed potential construction impacts to include water quality (23%), solid waste (27%) and noise (20%). More than half (54%) deemed the major current environmental issue is water quality. All (100%) agreed to have the project and most (93%) deemed the project to be beneficial to local environment.

C. Discussion Forums on the Environmental Assessments

208. Discussion forums with 81 (Qibin District) and 83 (Qi County) stakeholders from government departments and village representatives were conducted on 26-27 May 2015 (Figure VIII-2 and VIII-3). Representatives from the EIA institute explained the project scope, findings from domestic EIAs on potential environmental impacts and mitigation measures. The PPTA national environmental specialist explained the EMP and project-specific GRM.

Figure VIII-2: Environmental discussion Forum in Qibin District

Figure VIII-3: Environmental discussion Forum in in Qi County

209. The Qibin District stakeholder representative asked whether treated construction wastewater could be re-used. The EIA institute confirmed the construction wastewater will be treated by sedimentation tank and re-used for flush. The representative from Dalaidian Township government expressed interest in the PRC's "Sponge City" concept (referring to a city with adaption to environmental change). The project team confirmed the project will enhance Hebi's capability to respond to natural disaster and environment change, such as improved flood control capacity and storm management. Concerns expressed by residents included the risk of potential construction delays and need for clarification of resettlement issues. Measures to address these concerns have been incorporated in the mitigation measures (EMP; Attachment 1) and resettlement plans respectively. No specific comment or concerns was raised by the forum participants in Qi County. All participants expressed support for the project.

D. Future Information Disclosure and Public Consultation

210. Consultation and information disclosure to safeguard the local environment and residents will continue throughout the construction and operation phases. The PMO and the PIUs will be responsible for organizing the public consultations with support of the LIEC. The detailed consultation and communication plan is defined in the EMP (attachment 1). The project's environmental information will be disclosed as follows:

(i) Domestic EIA reports (in Chinese) will be disclosed on Hebi EPB's websites before formal approval by Hebi EPB;
(ii) Copies of the domestic assessments are available on request in the PMO;
(iii) The draft EIA (in English) will be disclosed on the project website at www.adb.org.
(iv) Project semi-annual environmental monitoring reports will be available at www.adb.org; and,
(v) Public notice boards will be set at each work site to provide information on the purpose of the project activity, responsible entities on site, and the project level GRM. Contact information of all GRM entry points will be disclosed on the construction site information boards.

IX. GRIEVANCE REDRESS MECHANISM

211. In addition to the PRC's public environmental compliant hotline (12369A), a project-specific grievance redress mechanism (GRM) has been developed in compliance with ADB's SPS (2009) requirement to address environmental, health, safety, and social concerns associated with project construction, operation, land acquisition, and leasing arrangements. The GRM is designed to achieve the following objectives: (i) provide channels of communication for local communities to raise concerns about environment- and social-related grievances which might result from the project; (ii) prevent and mitigate adverse environmental and social impacts to communities caused by project construction and operation, including those associated with resettlement; (iii) improve mutual trust and respect and promote productive relationships between the project agencies and local communities; and (iv) build community acceptance of the project. The GRM is accessible to all members of the community, including women, youth, and poverty-stricken residents. Multiple points of entry are available, including face-to-face meetings, written complaints, telephone conversations, e-mail, and social media.

212. Public grievances to be addressed by the GRM will most likely include disturbance of agricultural activities, traffic, dust emissions, construction noise, odor caused by sediment dredging, soil erosion, inappropriate disposal of construction wastes, damage to private houses, safety measures for the protection of the general public and construction workers, and/or water quality deterioration. Grievances related to involuntary resettlement may relate to the lack, or un-timely payment of, compensation monies, other allowances, and/or lease monies as per entitlements described in the resettlement plan and associated documents. The details of the GRM, including a time-bound flow chart of procedures, are included in the project EMP.

X. ENVIRONMENTAL MANAGEMENT PLAN

213. The project EMP is in Attachment 1. Development of the EMP drew on the domestic EIA reports, discussions with the PMO, implementing agencies, Hebi EPBs, other government agencies, and local communities. The EMP defines mitigation measures for the anticipated environmental impacts, institutional responsibilities, and mechanisms to monitor and ensure compliance with PRC's environmental laws, standards and regulations and ADB's SPS. The EMP specifies major environmental impacts and mitigation measures, roles and responsibilities, inspection, monitoring, and reporting arrangements, training, and the grievance redress mechanism. The EMP will be updated after detailed design, as needed. It will be included as separate annex in all biding documents for subcomponents involving civil works. Contractors will be required to develop site-EMPs that are fully responsive to the EMP.

XI. CONCLUSIONS

214. The project will generate socio-economic and environmental benefits by improving water resources management along the Qi River, wetland restoration and management, and urban services for flood control and wastewater collection and treatment. Construction risks arise from the planned embankments and dredging of canals, which may cause pollutants and odor to be released from the dredged sediments. For the pilot NWP, the small infrastructure works and habitat restoration may cause temporary noise and visual disturbance to fauna and elevated sediment levels which impact breeding habitats for fish and aquatic invertebrates. Transport and disposal of spoil and/or construction materials may cause fugitive dust, leakage, and damage to roads along transport routes and leakage at spoil sites. Other construction risks include soil erosion from uncontrolled earthworks, uncontrolled solid waste disposal, interference with traffic and municipal services during pipeline construction, permanent and temporary acquisition of land, involuntary resettlement, and occupational and community health and safety. Operational risks include odors from the new treatment plant, inadequate maintenance of facilities, and low capacity of managing agencies for wetland management in the pilot NWP.

215. Measures to avoid, minimize, and mitigate potential project impacts have been developed within an environmental management plan (EMP; Attachment 1). The EMP is the key document to manage, monitor and report on environmental impacts of the project. Public consultation was conducted in the project counties in accordance with PRC and ADB requirements, and public concerns have been integrated into the domestic feasibility study reports and project EMP. Public consultation will continue throughout project implementation. A project-specific grievance redress mechanism (GRM) has been developed, and will be implemented at the provincial, county, and site levels. The EMP will be implemented by the PMO and contractors, with assistance and training from the loan implementation environmental consultant and wetland and river specialists.

216. **Project assurances.** Loan assurances for ADB-funded projects require that the project is implemented in accordance with national laws and the project EMP. In addition, the following project-specific assurances are included in the project agreement between ADB and the HCG.

(i) HPG and HCG shall ensure, and shall cause the Project Implementing Agencies to ensure that all industrial wastewater is appropriately pre-treated prior to discharge into sewage systems in accordance with national and local standards

(ii) HPG and HCG shall ensure, and shall cause the Project Implementing Agencies to ensure that all sludge dredged in the course of implementing the Project will be treated and disposed of according to the design requirements and national standards.

(iii) Collection and Treatment of Waste. HCG shall ensure that, for the entire Project period, solid waste is properly collected from the areas surrounding the mainstream and tributaries of Qihe River and the canals and transferred to existing landfills.

(iv) Industrial waste water. HCG shall ensure that during the detailed design stage: (i) the design institute shall assess the risk of untreated industrial waste water entering the project-supported Qi County WWTP and damaging and/or affecting the efficiency of the WWTP; (ii) based on this assessment, design the WWTP accordingly, including, if needed, a "regulation" or "pre-treatment" process to withstand the potential toxicity and loading shocks to the WWTP resulting from unregulated and/or illegal discharges of industrial waste water and (iii) an in-depth examination of the composition and toxicity of the influent to the WWTP is conducted. HCG shall ensure that the risk assessment fully considers the following issues: (i) the fact that unregulated discharge of untreated

industrial waste water almost certainly occurs in Hebi City, although the extent is unclear; (ii) existing industries include some which involve the use of significant pollutants and toxic substances (e.g. paper and pulp production) that are toxic to microorganisms in the wastewater treatment process of the WWTP; and (iii) that Hebi City is targeted for industrial expansion so that such risks are likely to increase.

(v) HPG and HCG shall ensure, and shall cause the Project Implementing Agencies to ensure that for all Project embankments, barren hill greening, wetland rehabilitation, planting of green belts, and post-construction rehabilitation, the Project shall only use native plant species which are locally sourced to strengthen the rehabilitation of natural habitats and to avoid the introduction of non-native invasive weeds.

(vi) To further avoid the risk of spreading weeds, pest animals, and/or soil-based organisms, HPG and HCG shall ensure, and shall cause the Project Implementing Agencies to ensure that the Project shall: (a) prohibit the use of any plant species classified in the People's Republic of China as weeds, as defined by the China National Invasive Plant Database (http://www.agripests.cn; 229 species) and by the Ministry of Environment Protection and Chinese Academy of Sciences (19 species); (b) prohibit the introduction of soil, rocks, or plants from outside the Project area; (c) ensure that construction soil and dredge spoil is disposed within the boundaries of Hebi City; and (d) ensure that Project vehicles and machinery are washed down before leaving the boundaries of construction sites; provided that, if the use of fast-growing non-native species (e.g. grasses) is required for stabilizing bare construction surfaces, only sterilized seedlings (i.e. which cannot propagate) shall be used.

(vii) Wetland specialist. HPG and HCG shall ensure that the PMO shall recruit a wetland specialist to: (a) design the habitat-specific features of the embankments and constructed wetlands, focusing on creating breeding and foraging habitats for native flora, fish, amphibians, and turtles; and (b) inspect the new structures immediately after completion, and while the contractor and machinery are still present, to ensure compliance with the habitat designs.

(viii) As the operation of the Panshitou reservoir, situated immediately upstream of the Project area, may impact the viability and operation of the project activities, especially the reliability of water supply to the pilot Qi River National Wetland Park and downstream flood control, if any changes are made to the operating regime of the reservoir, HCG shall advise ADB and ADB and HCG shall jointly review the risks this may pose to Project viability and will identify needed actions.

217. **Conclusion.** Based on the information presented in this EIA, and assuming full and effective implementation of the project EMP, loan assurances, and training, potential adverse environmental impacts are expected to be minimized and/or mitigated to acceptable levels and to within the standards applied in this EIA.

ATTACHMENT 1. ENVIRONMENTAL MANAGEMENT PLAN

People's Republic of China: Henan Hebi Qi River Environmental Improvement and Ecological Conservation Project

A. Objectives

1. This Environmental Management Plan (EMP) is for the Henan Hebi Qi River Environmental Improvement and Ecological Conservation Project in Hebi City of Henan Province, the People's Republic of China (PRC). The EMP complies with the Asian Development Bank's (ADB) Safeguard Policy Statement (SPS, 2009) and is based on the domestic Environmental Impact Assessments (DEIAs) prepared by Beijing Zhonghuan Guohong Environment and Resource Technology Limited Company and project EIA. The EMP describes: roles and responsibilities of all project agencies to implement this EMP; mitigation measures; inspection, monitoring, and reporting arrangements; training and institutional strengthening; grievance redress mechanism (GRM); and future public consultation.

2. In the design stage the PMO will pass this EMP to the design institutes for incorporating mitigation measures into the detailed designs. The EMP will be updated at the end of the detailed design, as needed. To ensure that bidders will respond to the EMP's provisions, the PMO and local project implementation units (PIUs) will prepare and provide the following specification clauses for incorporation into the bidding documents: (i) a list of environmental management requirements to be budgeted by the bidders in their proposals, (ii) environmental clauses for contractual terms and conditions, and (iii) component DEIAs, and project EIA including updated EMP for compliance.

B. Organizations and Their Responsibilities for EMP Implementation

3. Hebi City Government (HCG) is the project Executing Agency (EA). A Project Leading Group (PLG) and a Project Management Office (PMO) have been established in the HCG. The PLG is chaired by the executive vice mayor of HCG, with members from the Hebi City Government, Hebi Finance Bureau, Hebi Development and Reform Commission, and other relevant agencies. The PMO is located in the Hebi Finance Bureau and comprises staff and representatives from the relevant government departments. Qi County Government, Qibin District Government and Xun County Government will be Implementing Agencies (IAs)

4. HCG (through PMO) and the IAs (through the PIUs) will assume overall responsibility for implementing, supervising, monitoring and reporting on the EMP. Their capacity to implement the EMP, as well as the capacity of the PIUs to manage project facilities, will be strengthened through capacity building and training activities defined in the EMP.

Table EMP-1: Project Implementation Units

No.	Proposed Subcomponent	Project Implementing Unit (PIU)
1. Ecological conservation and environmental management of upper Qihe River and its watershed enhanced		
1.1	Qi River Upstream Ecological Protection	Qibin District Forestry Bureau
1.2	Restoration and management of pilot Qihe River National Wetland Park	Qibin District Forestry Bureau and Qi County Forestry Bureau
2. **Lower Qihe River Mainstream and Tributaries improved**		
2.1	Qihe Mainstream Watercourse Improvement in Qi County (21 km)	Qi County Water Resource Bureau and Xun County Water Resource Bureau
2.2	Four Tributary Watercourse Improvement in Qi County	Qi County Water Resource Bureau
2.3	Five Canal Watercourse Improvement in Qibin District	Qibin District Municipal Administration Division
3. **Wastewater and Solid Waste Management in the Qihe River Basin improved**		
3.1	Qibin District Wastewater Management	Qibin District Housing and Rural and Urban Development Bureau
3.2	Qi County Wastewater Management	Qibin District Housing, Rural and Urban Development Bureau, Qi County Urban Administration Bureau, and Rural

		Urban Integrated District Land Administration Bureau
3.3	Solid Waste Management	As above
4. Institutional and technical support system for integrated management of the Qihe River Basin improved		
4.1	Qihe River Ecological Monitoring Program	Hebi City PMO
4.2	Qihe River Basin Management Information System	Hebi City PMO
4.3 – 4.6	Project start-up support consulting services; loan implementation consulting services; external resettlement monitoring and evaluation; training	Hebi City PMO

5. **PMO Environment Officer.** The PMO will have main EMP coordination responsibility. The PMO will assign a full-time PMO Environment Officer to coordinate EMP implementation. The officer will: (i) ensure that environmental management, monitoring, and mitigation measures are incorporated into bidding documents, construction contracts and operation management plans; (ii) coordinate the project level GRM; (iii) on behalf of PMO, prepare semi-annual EMP monitoring and progress reports, for submission to ADB; (iv) coordinate the training and consultation plans defined in the EMP; (v) respond to any unforeseen adverse impacts beyond those mentioned in this EMP; and (vi) coordinate work with the PIU Environment Officers.

6. **PIU Environment Officers.** Each PIU will assign one full-time PIU Environment Officer to coordinate EMP at local level i.e. total of nine officers. These officers will: (i) implement the EMP at a day-to-day site level; (ii) coordinate the recruitment of construction supervision companies; (iii) act as local entry points to the GRM; (iv) report to the PIUs and PMO on EMP implementation progress; and (v) work closely with the PMO Environment and Social Officers to coordinate EMP work, including reporting and the GRM, across the project area.

7. **Loan implementation environment consultant.** A LIEC will be hired under the loan implementation consultant services. The LIEC will advise the PMO, PIUs, contractors, and construction supervision companies on all aspects of environmental management and monitoring for the project. The LIEC will (i) assist in updating the EMP and environmental monitoring program, as needed; (ii) supervise the implementation of the mitigation measures specified in the EMP; (iii) train the PMO and PIUs in how to prepare the semi-annual EMP monitoring and progress reports to ADB and during the early stages of training, lead the preparation of these documents; (iv) provide training to the PMO, PIUs, and CSCs on the PRC's environmental laws, regulations and policies, ADB's SPS (2009), EMP implementation, and GRM in accordance with the training plan (Table EMP-6); (v) identify any environment-related implementation issues, and propose necessary corrective actions; and (vi) undertake site visits for EMP inspection as required. TOR for the LIEC is in Appendix 1.

8. **Construction Contractors and Construction Supervision Companies (CSCs).** Construction contractors will be responsible for implementing relevant EMP mitigation measures during construction, under the supervision of the CSCs and PIUs. Contractors will develop site-specific EMPs on the basis of this project EMP. CSCs will be selected through the PRC bidding procedure by the PIUs. The CSCs will be responsible for supervising construction progress and quality, and EMP implementation on construction sites. Each CSC shall have at least one environmental engineer on each construction site to: (i) supervise the contractor's EMP implementation performance; and (ii) prepare the contractor's environmental management performance section in monthly project progress reports submitted to the PIUs and PMO.

C. Potential Impacts and Mitigation Measures

9. Prior to construction, the PMO will assess the project environmental readiness using Table EMP-2 and review with ADB. If necessary, corrective actions will be identified to ensure that all requirements are met.

Table EMP-2: Project Readiness Assessment Indicators

Indicator	Criteria	Assessment	
		Yes	No
EMP update	The EMP was updated after technical detail design, and approved by ADB	☐	☐
Compliance with loan covenants	The borrower complies with loan covenants related to project design and environmental management planning	☐	☐
Public involvement effectiveness	• Meaningful consultation completed • GRM established with entry points	☐ ☐	☐ ☐
Environmental supervision in place	• LIEC is in place • Environment Officer appointed by PMO • EMS and CSCs contracted by PMO • EMC appointed by each PIUs	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Bidding documents and contracts with environmental safeguards	• Bidding documents and contracts incorporating the impact mitigation and environmental management provisions of the EMP.	☐	☐
Site construction planning (Environmental)	Site environmental management and supervision plan prepared for each work site by the PMO, PIUs and contractors.		
EMP financial support	The required funds have been set aside by contractors, PMO and PIUs to support the EMP implementation	☐	☐
Note. ADB=Asian Development Bank; IA = Implementing Agency, PMO=Hebi Project Management Office; LIEC = Loan Implementation Environmental Consultant, PIU=Project Implementing Unit,			

10. Table EMP-3 lists the potential project impacts and mitigation measures during the pre-construction, construction and operational phases. Those that will be permanently become part of the infrastructure such as noise reduction materials and odor removal facilities for the wastewater treatment plant will be included in the design of the facilities by the contracted design institute. The costs of building and maintaining these systems have already been included in the infrastructure construction and operating costs and therefore will not be double-counted as part of the EMP costs.

11. Those mitigation measures that are temporary measures particularly during the construction stage, such as dust suppression by watering and wheel washing, the use of quiet and low-powered mechanical equipment and temporary noise barriers will need to be included in the tender documents. Contractors will be required to include the EMP in their bid packages to satisfy the environmental contract clauses for implementing the EMP.

Table EMP-3: Potential Impacts and Mitigation Measures during Pre-construction and Construction Phases

Item	Potential issues	Mitigation measures	Implement	Supervise	Source of Funds
A. DESIGN AND CONSTRUCTION PHASES					
Design for barren hills greening	Introduction of weed species to local vegetation communities	Only utilize native plant species of local provenance, as listed in Table IV-2 in Section IV of EIA. These are native species selected adapted to the local climate and soil conditions.	LDI	PMO, PIUs, LIEC	Included in design contract
Design for Qi River wetland conservation and rehabilitation	Protection of flora and fauna species	Comply with the approved internal zoning of the park as described in the NWP Master Plan and Section IV.C.2 of this EIA; and, roads and pathways will follow existing disturbed areas	LDI	PMO, PIUs, LIEC	Included in design contract
Design Qi River Mainstream and tributary improvement	Disposal of dredged sediment	Technical design of dredged sediment disposal site shall be approved	LDI	PMO, PIUs, LIEC	Included in design contract
	Eco-friendly design	Technical design of embankments shall be adequate and stable enough to withstand the strong force of heavy storm water flow but maximize the adoption of eco-friendly embankment designs	LDI	PMO, PIUs, LIEC	Included in design contract
Wastewater and storm water collection pipeline	Pipe burst	Design of the storm water and wastewater collection pipelines must be adequate to prevent pipe burst	LDI	PMO, PIUs, LIEC	Included in design contract
Design for Qi County wastewater treatment plant expansion	Odor removal	Technical design of the WWTP shall include facility and equipment to remove odor generated during plant operation	LDI	PMO, PIUs, LIEC	Included in design contract
		Establish 100 m buffer distance from boundary of WWTP to the nearest sensitive receiver for potential odor impact	LDI	PMO, PIUs, LIEC	Included in design contract
	Operational noise	Technical design of the WWTP shall contain proper acoustic design for pumps, blowers and other noisy equipment	LDI	PMO, PIUs, LIEC	Included in design contract
	Effluent standard	Design of WWTP shall achieve Class 1A treatment and discharge standards and safety of plant operation, with dual power supply to avoid interruption to plant operation due to power failure	LDI	PMO, PIUs, LIEC	Included in design contract
	Sludge	Design of WWTP shall include dewatering machine and temporary dry bed to produce sludge with water content of lower than 60%	LDI	PMO, PIUs, LIEC	Included in design contract
Design for solid waste management	Odor removal	Design of the solid waste transfer stations shall include facility and equipment to remove odor generated during plant operation	LDI	PMO, PIUs, LIEC	Included in design contract
B. PRE-CONSTRUCTION PHASE					
Institutional Strengthening	Lack of environment management capacities within PMO	-PMO to appoint qualified environment specialist on its staff -Each PIU to appoint qualified environment specialist on its staff -LIEC to conduct environment management training	LIEC	PMO	HCG

Item	Potential issues	Mitigation measures	Implement	Supervise	Source of Funds
	and PIUs				
	Environment Monitoring Station (EMS)	-PMO to contract EMS to conduct independent verification of the project's environment performance and compliance with the approved EMP	EMS	PMO	HCG
EMP update	EMP does not reflect the final project design	Review mitigation measures defined in this EMP, update as required to reflect detailed design, disclose updated EMP on project website, and include updated EMP in all bid documents	PMO, assisted by LIEC	ADB	HCG
Grievance redress mechanism (GRM)	Handling and resolving complaints	Establish the project GRM; train all PMO and PIU staff in the GRM; disclose GRM to affected people before construction begins; maintain a complaint register to document all complaints	PMO and PIU Environment and Social Officers	PMO, PIUs, LIEC	HCG
Tender documents and works contracts	Environmental clauses for tender documents and contracts	Put into tender documents and works contracts the respective environmental clauses listed in the EMP	PIU, Tender Agent	PMO, LIEC	Included in tender agent contract
C. CONSTRUCTION PHASE					
Air Quality	Dust	− Assign haulage routes and schedules to avoid traffic intensive areas or residential areas − Spray water regularly on unpaved haul roads and access roads (at least once a day) to suppress dust; and erect hoarding around dusty activities − Cover material stockpiles with dust shrouds or tarpaulin. For the earthwork management for backfill, measures will include surface press and periodical spraying and covering. Extra earth will be cleared from site to avoid long term stockpiling − Minimize storage time of construction and demolition wastes on site by regularly removing them off site − Site asphalt mixing and concrete batching stations at least 300 m downwind of the nearest air quality protection target − Equip asphalt, hot mix and batching plants with fabric filters and/or wet scrubbers to reduce the level of dust emissions − Install wheel washing equipment or conduct wheel washing manually at each exit of the works area to prevent trucks from carrying muddy or dusty substance onto public roads − Keep construction vehicles and machinery in good working order, regularly service and turn off engines when not in use − Vehicles with an open load-carrying case, which transport potentially dust-producing materials, shall have proper fitting	Contractor	PIU, CSC, LIEC	Included in construction contract

Item	Potential issues	Mitigation measures	Implement	Supervise	Source of Funds
		sides and tail boards. Dust-prone materials shall not be loaded to a level higher than the side and tail boards, and shall always be covered with a strong tarpaulin − In periods of high wind, dust-generating operations shall not be permitted within 200 m of residential areas. Apply extra vigilance near sensitive receptors such as schools, kindergartens and hospitals			
	Odor from dredged sediments	− **Storage location**: sediment pre-treatment sites will be located at least 200 m downwind from residential areas and other sensitive receptors e.g. schools − **Storage conditions**: At the Pond (temporary storage site), sediment will be covered with mulch then soil, then compacted with ventilation holes to reduce odor emissions. Install dust screens around the temporary storage site − **Vehicles:** Vehicles delivering pre-treated sediments to the temporary storage site will be covered with tarpaulin sheets. Overloading of these vehicles will be avoided. Vehicle speeds will be controlled, in particular near residential areas − **Monitoring:** Odor levels will be regularly monitored at sensitive areas (as defined in the monitoring plan)	Contractor	PIU, CSC, LIEC	Included in construction contract
Noise	Noise from mechanical equipment and vehicles	− Ensure noise levels from equipment and machinery conform to PRC standard GB 12523-2011 − Properly maintain machinery to minimize noise − Equipment with high noise and/or vibration will not be used near village or township areas. Only low noise machinery or equipment with sound insulation will be employed − At work sites within 50 m of residences, install temporary noise barriers − No night time (between 22:00 and 06:00) construction within 300 m of sensitive receptors − Monitor noise levels (Table EMP-4). If noise exceeded by $\geq$3 dB, equipment and construction conditions shall be checked, and mitigation measures implemented − Provide workers with hearing protection − Control the driving speed of vehicles and machinery on-site	Contractor	PIU, CSC, LIEC	Included in construction contract

Item	Potential issues	Mitigation measures	Implement	Supervise	Source of Funds
		– Inform residents prior to construction about anticipated noise levels and duration. For residents near the site and subject to prolonged noise exposure, provide hearing protection – Conduct regular interviews with residents adjacent to construction sites to identify feedback. This will be used to adjust work hours of noisy machinery			
Vibration	Vibration caused by mechanical equipment and vehicles	– Piling and compaction prohibited at night – Communities will be informed prior to large earthworks and to avoid sensitive timing e.g. exams at nearby schools	Contractor	PIU, CSC, LIEC	Included in construction contract
Surface water Quality	Construction wastewater and municipal wastewater from construction camps	– Unauthorized discharge of wastewater at sites is prohibited – Wastewater will be treated in grid and settling tanks before discharge into local sewers – Install septic tanks and portable toilets in project sites – Pre-treat wastewater from work camps and canteens with grid and settling tanks before discharge to municipal sewer, in compliance with national standards – Each contractor to develop a Spill Management and Emergency Response Plan for oil and other dangerous substances – Chemicals will be stored away from watercourses – Retention areas will be provided to contain accidental spills of toxic materials e.g. acids, oils, petroleum products – Storage facilities for fuels, oil, and other hazardous materials will be in secured areas on impermeable surfaces – Bunds and cleanup measures will be installed – Train workers on safe handling of chemicals and emergency response – Equipment wash-down sites to be equipped with water collection basins and sediment traps	Contractor	PIU, CSC, LIEC	Included in construction contract
	Increase SS concentrations during construction works in canals and wetland	– All supernatant water from dredged sediment storage or disposal sites shall be treated to GB 8978-1996 Class I standard before discharging	Contractor	PIU, CSC, LIEC	Included in construction contract

Item	Potential issues	Mitigation measures	Implement	Supervise	Source of Funds
Soil erosion		- Stockpile topsoil and cover - Install drainage system and settling ponds at construction sites - Lay straws or cloths at the entry/exit of runoff at each construction site - Limit works during rains and high winds - Carry out river/canal embankment work and rehabilitation works section by section with greening works implemented at the same time in order to avoid large scale soil erosion in rainy season - Properly slope or re-vegetate disturbed surfaces, such as compacted pipeline trenches and river banks - Regularly clean tires of construction vehicles - Soil erosion monitoring program will cover the sites of the sewage network, WWTP, dewatering sites for dredged sediment, temporary storage sites for dewatered sediment, wetland creation, material storage site and MSW transfer stations	Contractor	PIU, CSC, LIEC	Included in construction contract
Solid waste		- Storage and containment: install waste storage containers for worker and hazardous wastes, away from sensitive receptors; regularly dispose to an approved disposal facility - Transport and disposal: city sanitation department will remove all wastes from sites; hold contractors responsible for proper removal and disposal of any significant residual materials, wastes and contaminated soils after construction - Management: prohibit burning of waste; multi-compartment collection bins will be installed to facilitate reuse, recycle of solid wastes.	Contractor	PIU, CSC, LIEC	Included in construction contract
Ecological Resources	Destruction of habitats and wildlife	- Prior to construction, demarcate and protect vegetation, fauna habitats, and any nests or other fauna found at construction sites - For Qi River Crucian Carp, protect known spawning locations in the Qi River: (i) prior to any mainstream or bank-side works, consult HCG Agricultural Bureau on locations; (ii) avoid any river works in the NWP in the spawning season (May-June) - Properly backfill, compact and re-vegetate pipeline trenches	Contractor	PIU, CSC, LIEC	Included in construction contract

Item	Potential issues	Mitigation measures	Implement	Supervise	Source of Funds
		after pipeline installation - Use native plant species of local provenance for site rehabilitation (Table IV-2 in Section IV of EIA) - Carry out works of embankment protection section by section while implementing greening works at the same time, to minimize soil erosion and restore habitats - Immediately report any injured wildlife to PMO and/or PIU Environment Officer: do not catch or disturb the animal - CSCs and PMO / PIU Environment Officers will regularly inspect construction sites to ensure flora and fauna are well protected - For the pilot Qi River National Wetland Park and barren hills greening, train and instruct workers in strict protocols: no littering, hunting, catching or eating of wildlife, or using natural areas as toilets			
Impacts on socio-economic resources	Occupational health and safety	- Provide a clean and sufficient supply of fresh water, for construction and for all camps, offices and workshops - Provide sufficient latrines and other sanitary arrangements at the site and work areas, and ensure that they are cleaned and maintained in a hygienic state - Install garbage receptacles at construction site and camps and regularly empty them to prevent diseases - Provide personal protection equipment to workers e.g. safety boots, helmets, gloves, protective clothing, goggles, ear protection, in accordance with health and safety regulations - Prepare emergency response plan for accidents and emergencies, including hazardous material spills. Emergency phone link with hospitals will be established. A fully equipped first-aid base in each construction camp will be organized - Install and maintain a Records Management System to record and report occupational accidents, diseases, and incidents. Records will be reviewed during compliance monitoring and audits - Publicize safety, rescue and industrial health matters at all sites. Display posters on site safety and regulations - Train all workers in basic sanitation, health care	Contractor	PIU, CSC, LIEC	Included in construction contract

Item	Potential issues	Mitigation measures	Implement	Supervise	Source of Funds
		– Implement awareness and prevention program for HIV/AIDS and other communicable diseases for workers and local community			
	Community health and safety	– Prior to construction, prepare and implement a traffic control plan, with local traffic management authority. This shall include provisions for diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at road crossings, and emphasis on public safety, signs, controls and planning in advance – Inform residents and businesses of the construction activities, given the dates and duration of expected disruption – Install clear signs at construction sites to warn people of potential dangers (moving vehicles, hazardous materials, excavations, etc.) and raise awareness on safety issues – Prohibit use of heavy machinery at night – Return equipment to overnight storage sites – Secure all construction sites from public access	Contractor	PIU, CSC, LIEC	Included in construction contract
	Utilities provision interruption:	– Assess construction locations in advance to identify potential disruption to services and risks before starting construction – If temporary disruption is unavoidable the contractor will, with relevant local authorities (e.g. power, water, communications) develop a plan to minimize the disruption and communicate the dates and duration in advance to all affected people	Contractor	PIU, CSC, LIEC	Included in construction contract
	Other Social Issues	– Civil works contracts will stipulate priorities to: (i) recruit workers locally to the extent possible; (ii) ensure equal opportunities for women and men; (iii) pay equal wages for work of equal value; (iv) not employ child or forced labor – Employment targets are included in the gender action plan	Contractor	PIU, CSC, LIEC	Included in construction contract
C. OPERATION PHASE					
Barren Hill Greening and Qi River Wetland	Maintenance of vegetation and landscape	Daily maintenance: manage the vegetation including pruning, weeding and replacement of dead or dying trees and shrubs. Pest control: the guiding principle will be prevention first followed by integrated treatment to avoid/reduce pollution from pesticide	O&M Unit	PMO, LIEC	O&M Unit Budget

Item	Potential issues	Mitigation measures	Implement	Supervise	Source of Funds
River rehabilitation	Maintenance of vegetation and landscape	Daily maintenance: pruning, weeding, replacement of dead or dying trees and shrubs. Pest control: none in wetland areas and along river; low-toxicity pesticides to be used in event of severe pest outbreak	O&M Unit	PMO, LIEC	O&M Unit Budget
	Embankment stability	Inspect all river embankment stabilization works for physical integrity. If signs of failure are discovered, a repair program will be implemented immediately	O&M Unit	PMO, LIEC	O&M Unit Budget
Qi County WWTP and 15 solid waste transfer stations (SWSs)	Air quality	WWTP shall maintain a buffer distance of 100 m from site boundary within which no development shall be allowed	O&M Unit	PMO, LIEC	O&M Unit Budget
	Noise	Maintain all mechanical equipment in good order and ensure operational noise at WWTP boundaries meets Grade II noise requirements of 60 dB (A) during daytime and 50 dB (A) at night (PRC Noise Standards at the Boundary of Industries and Enterprises; GB 12348-2008)	O&M Unit	PMO, LIEC	O&M Unit Budget
	Water quality	Treat effluent to Class 1 A of PRC Discharge Standard of Pollutants for Municipal Wastewater Treatment (GB 18918-2002)	O&M Unit	PMO, LIEC	O&M Unit Budget
		Transport wastewater from the SWSs that not connected to municipal sewers timely by suction trunk	O&M Unit	PMO, LIEC	O&M Unit Budget
	Sludge	Sludge shall be dried to <60% moisture content to meet PRC Disposal of Sludge from Municipal Wastewater Treatment Plant-Quality of Sludge for Co-landing (GB/T 23485-2009) standard prior to landfill disposal	O&M Unit	PMO, LIEC	O&M Unit Budget
	Occupational Health and safety	Compulsory use of safety equipment and clothing as necessary (e.g., non-slip boots, chemical resistant clothing, safety goggles, respiratory mask); safety instructions for storage, transport, handling or pouring of chemicals	O&M Unit	PMO, LIEC	O&M Unit Budget

Sources: ADB = Asian Development Bank, EIA = environmental impact assessment, LIEC = loan implementation environmental consultant, EPB = Environment Protection Bureau, IA = implementing agency, DI = design institute, O&M = operation and maintenance, PMO = project management office, PIU= project implementation unit, SEMSP = site environmental management and supervision plan, SWS = solid waste transfer station.

D. Monitoring and Reporting

12. Three types of project environmental monitoring will be conducted under the EMP: (i) internal monitoring and supervision and reporting by CSCs and PIUs; (ii) EMP implementation monitoring and progress reporting by the LIEC; and (iii) compliance monitoring by local EMS. The monitoring program (Table EMP-4) covers the scope of monitoring, parameters, time and frequency, implementing and supervising agencies, and estimated costs. Monitoring shall comply with the relevant national standards.

13. **Internal monitoring and supervision and reporting by CSCs.** During construction, the CSCs and PIUs will be responsible for conducting internal environmental monitoring in accordance with the monitoring and reporting plans (Tables EMP-4 and EMP-5). Supervision results will be reported through the CSC reports to the PIUs.

14. **EMP implementation monitoring and progress reporting**. The LIEC will review project progress and compliance with the EMP based on field visits, and the review of the environmental monitoring conducted by the EMS. The findings of the LIEC will be reported to ADB through the semi-annual EMP monitoring and progress reports. The reports will include (i) progress made in EMP implementation, (ii) overall effectiveness of the EMP implementation (including public and occupational health and safety), (iii) environmental monitoring and compliance, (iv) institutional strengthening and training, (v) public consultation (including GRM), and (vi) any problems encountered during construction and operation, and the relevant corrective actions undertaken. The LIEC will help PMO prepare the reports and submit the English report to ADB for appraisal and disclosure.

15. **Environmental compliance monitoring by local EMS.** The PIUs in each county or district will contract the local EMS to conduct environmental monitoring in accordance with the monitoring program (Table EMP-4). A detailed cost estimate will be provided by the EMS prior to implementation. Monitoring will be conducted during construction and operation period, until a project completion report (PCR) is issued. Semi-annual monitoring reports will be prepared by the EMSs and submitted to PMO and the PIUs.

16. **Project completion environmental audits.** Upon completion of each subproject, environmental acceptance monitoring and audit reports shall be (i) prepared by a licensed environmental monitoring institute in accordance with the PRC's Guideline on Project Completion Environmental Audit (2001), (ii) reviewed for approval by the environmental authorities, and (iii) reported to ADB through the semi-annual progress reports. Subproject completion reports shall be finalized within 3 months after each subproject completion, or no later than 1 year with permission of the local environment protection bureaus.

17. **Quality assurance (QA) /quality control (QC) for compliance monitoring.** To ensure accuracy of the monitoring, QA/QC procedures will be conducted in accordance with the following regulations:

i) Regulations of QA/AC Management for Environmental Monitoring issued by the State Environmental Protection Administration in July 2006;
ii) QA/QC Manual for Environmental Water Monitoring (Second edition), published by the State Environmental Monitoring Centre in 2001; and
iii) QA/QC Manual for Environmental Air Monitoring published by the State Environmental Monitoring Centre in 2001.

Table EMP-4: Environmental Impact Monitoring Program

Sub-component	Phase	Factor	Indicators	Location	Frequency	Implementing Entity	Supervising Entity
Qi River National Wetland Park	Construction	Surface water quality	CODcr, BOD_5, TN, TP, SS, oil	Near the Hanpodong water intake	Four times a year during peak construction	EMS	PMO, LIEC
Qi River Mainstream and Tributary Water Course Improvement	Construction	Air Quality	Dust, TSP, PM_{10}	Construction sites where there is resident areas within 300 m	1 day per month during construction	EMS	PMO, LIEC
			Odor (H_2S, NH_3)	Each storage site for dredged sediment for: Zhejing, Side, and Hucheng Rivers; Zhaojia, Tianlai, Mianfeng, and Erzhi Canals, where there are residents ≤300 m	1 day per month during construction	EMS	PMO, LIEC
		Noise	Leq	Construction sites where there is resident areas within 200 m	2 times per day (day time, night time), 2 consecutive days every month	EMS	PMO, LIEC
	Operation	Water Quality	CODcr, TN, TP, SS	Zhejing, Side and Hucheng Rivers; Zhaojia, Tianlai, Mianfeng, Erzhi Canals	1 time per day, 3 consecutive days	EMS	PMO, LIEC
Wastewater and Solid Waste Management	Construction	Air Quality	Dust: TSP, PM_{10}	Construction sites where there is resident areas within 300 m	1 day per month during construction	EMS	PMO, LIEC
		Noise	Leq	Construction sites where there is resident areas within 200 m	1 day per month during construction	EMS	PMO, LIEC
	Operation	Wastewater	CODcr, BOD_5, TN, TP, SS	Qi County WWTP effluent outfall	1 time per day, 3 consecutive days every 3 months for first 3 years of operation	EMS	PMO, LIEC
		Noise	Leq	At four site boundaries of: Qi County WWTP; 15 solid waste transfer stations if there is residential area within 200 m	1 time per day, 1 day every 3 months for first years of operation	EMS	PMO, LIEC
		Air Quality	Odor (H_2S, NH_3)	At four site boundaries of: a) Qi County WWTP b) 15 solid waste transfer stations if there is residential area within 300 m	1 time per day, 1 day every 3 months for first years of operation	EMS	PMO, LIEC

BOD_5 = 5-day biochemical oxygen demand; COD_{cr} = chemical oxygen demand; CSC = construction supervision company; EMS = environmental monitoring station; LAeq = equivalent continuous A-weighted sound pressure level; LIEC = loan implementation environmental consultant; LSMI = licensed soil erosion institute; NH_3-N = ammonia nitrogen; PM_{10} = particles measuring ≤10μm; PMO = project management office; PIU= project implementing unit; SO_2 = sulfur dioxide; SS = suspended solids; TSP = total suspended particle.

18. Environmental reporting for the project is described in Table EMP-5.

Table EMP-5: EMP Reporting Plan

Reports		From	To	Reporting Frequency
Construction Phase				
Internal progress reports by contractors	Internal project progress report by construction contractors, including EMP monitoring results by CSCs	Contractors, CSCs	PIUs	Monthly (during construction season)
Internal progress reports by PIUs	Internal project progress report including EMP implementation progress	PIUs	PMO	Quarterly
Environmental impact monitoring reports	Environmental impact monitoring report	EMS	LIEC, PMO	Monthly
Reports to ADB	Project progress report (including section on EMP implementation and monitoring)	PMO with support of LIEC	ADB	Semi-annual
	Environment monitoring reports	PMO with support of LIEC	ADB	Semi-annual
Acceptance reports	Environmental acceptance monitoring and audit report	Licensed institute	Hebi EPB	Once for each engineering subcomponent, not later than one year after completion of physical works
Operation Phase				
Environmental impact monitoring	Environmental impact monitoring report (during first three year of operation and/or up to 1 year after project completion, whichever is first)	LIEC	PIUs, PMO	Quarterly
Reports to ADB	Project progress report (including section on EMP implementation and monitoring)	PMO	ADB	Semi-annually
	Environment progress and monitoring report	PMO	ADB	Once (after first year of operation)
ADB=Asian Development Bank; EMS=Environment Monitoring Station, LIEC = loan implementation environmental consultant, PIU = project implementation unit, PMO = project management office.				

E. Training

19. The project agencies have no previous experience with ADB-funded projects or safeguard requirements. To ensure effective implementation of the EMP, the capacity of PMO, PIUs, O&M Units, contractors, CSCs, and local bureaus (especially forestry and water resources) will be strengthened. The project will implement institutional capacity building, and training, as follows:

(i) Appointment of PMO and PIU Environment Officers and Social Officers;
(ii) Contracting of a wetland specialist and river specialist to support detailed design and implementation;
(iii) Contracting of a LIEC to support the PMO and PIUs with EMP implementation and ensure compliance with ADB's Safeguard Policy Statement (SPS, 2009); and,
(iv) Implementation of a training program for all relevant agencies (Table EMP-6). Training will be facilitated by the loan implementation consultants, including the LIEC, wetland,

and river specialists.

Table EMP-6: Training Program

Training	Attendees	Contents	Times	Period (days)	No. of persons
EMP update and implementation	PMO, PIUs, contractors, CSCs, local EPB	Development and update EMP, roles and responsibilities, monitoring, supervision and reporting procedures, review of experience (after 12 months)	Twice - Once prior to, and once after one year of project implementation	2x0.5	40
Grievance Redress Mechanism	PMO, PIUs, contractors, CSCs, local EPB	Roles and responsibilities, Procedures, review of experience (after 12 months)	Twice - Once prior to, and once after one year of project implementation	2x0.5	40
Environmental aspects of facilities operation	PMO, O&M unit	Environmental housekeeping; Sludge treatment and disposal process; Safety operation regulations Emergency preparedness and breakdown response procedures	Once during project operation	1	50
Wetland management	PMO, PIUs, river guards, EPBs, QRMO	Basic principles of wetland management; maintaining the restored habitats; wetland species protection	Ongoing during implementation	Ongoing	tbd
Flood management and operation of MIS	PMO, PIUs, EPBs, QRMO	Operation of the Qi River MIS for flood warning and forecasting	Ongoing during implementation	Ongoing	tbd

EPB = environment protection bureau, MIS = Qi River management information system, O&M = operations and maintenance, PIU = project implementation unit, PMO = project management office, QRMO = Qi River Management Office, tbd = to be decided.

F. Public Consultation

20. Two rounds of public consultation were conducted during project preparation (Section VIII of the EIA). During construction, the project will continue public consultations and raising awareness of project activities, especially those which may impact the public such as noise or dust. The public consultation plan (Table EMP-7) includes public participation in evaluating environmental benefits and impacts. The PIUs are responsible for public participation. They will be supported by the PMO Environment and Social Officers and the LIEC.

Table EMP-7: Public Consultation and Participation Plan

Organizer	Approach	Times/Frequency	Subjects	Participants
Construction				
PMO, PIUs, LIEC	Questionnaire survey, site visits, informal interviews	Once a year during peak construction	Construction impacts; adjusting mitigation measures if necessary; feedback	Workers, residents in construction areas
	Public workshops	At least once during peak construction	EMP implementation progress; construction impacts; adjusting mitigation measures if necessary; feedback	Residents, affected persons, social sectors

Organizer	Approach	Times/Frequency	Subjects	Participants
Operation				
PMO, PIU, operators of project facilities	Public consultation and site visits	At least once in first year of operation	Effects of mitigation measures, impacts of operation, feedback	Residents, affected persons adjacent to project facilities
	Public workshop	As needed based on public consultation	Effects of mitigation measures, impacts of operation, feedback	Residents, affected persons, social sectors
	Public satisfaction survey	At least once after one year of operation	Comments and suggestions	Project beneficiaries

G. Grievance Redress Mechanism

21. A project-specific grievance redress mechanism (GRM) has been established to receive and manage any public environmental and/or social issues which may arise due to the project. This complements the PRC's national environmental complaint hotline (12369). The PMO and PIU Environment Officers and Social Officers will coordinate the GRM. All project agencies and staff will be trained in the GRM and will take an active role in supporting the GRM when necessary.

22. At the PMO level, the PMO Environment Officers and Social Officers will establish a GRM tracking and documentation system, conduct daily coordination with the PIU officers, arrange meetings and conduct site visits as necessary, maintain the overall project GRM database, and prepare the reporting inputs for progress reports to ADB. At the PIU level, the environment and social officers will instruct the contractors and CSCs on the GRM procedures, and coordinate with the county EPBs and other government divisions as necessary. PMO and PIU staff will be trained and supported by the LIEC.

23. The contact persons for different GRM entry points, such as the PMO and PIU Environmental Officers and Social Officers, contractors, operators of project facilities (OPFs), and county EPBs, will be identified prior to construction. The contact details for the entry points (phone numbers, addresses, e-mail addresses) will be publicly disclosed on information boards at construction sites and on the websites of the PMO and county EPBs.

24. Once a complaint is received and filed, the PMO and PIU officers will identify if complaints are eligible. Eligible complaints include those where (i) the complaint pertains to the project; and (ii) the issues arising in the complaint fall within the scope of environmental issues that the GRM is authorized to address. Ineligible complaints include those where: (i) the complaint is clearly not project-related; (ii) the nature of the issue is outside the mandate of the environmental GRM (such as issues related to resettlement, allegations of fraud or corruption); and (iii) other procedures are more appropriate to address the issue. Ineligible complaints will be recorded and passed to the relevant authorities, and the complainant will be informed of the decision and reasons for rejection. The procedure and timeframe for the GRM is as follows and also summarized in Figure EMP-1.

- **Stage 1 (5 days)**: If a concern arises during construction, the affected person may submit a written or oral complaint to the contractor. Whenever possible, the contractor will resolve the issue directly with the affected person. The contractor shall give a clear reply within five (5) working days. The contractor will keep the PIU fully informed at all stages.

- **Stage 2 (5 days)**: If the issue cannot be resolved in Stage 1, after five days, the PIU and/or PMO will take over responsibility. Eligibility of the complaint will be assessed and a recommended solution given to the complainant and contractors within five (5) working days. If the solution is agreed by the complainant, the contractors and/or facility

operators will implement the solution within seven days. Written records will be made of all stages and outcomes.

- **Stage 3 (10 days)**: If no solution can be identified by the PMO and/or PIU, and/or the complainant is not satisfied with the proposed solution, the PMO and/or PIU will organize, within ten (10) days, a stakeholder meeting (including the complainant, contractor and/or operator of the facility, county EPB, PIU, PMO). A solution acceptable to all shall be identified including clear steps. The contractors (during construction) and facility operators (during operation) will immediately implement the agreed solution. Written records will be made of all stages and outcomes.

25. The GRM does not affect the right of an affected person to submit their complaints to any agency they wish to, for example the local village committee, community leaders, courts, PMO, PIU, and/or Asian Development Bank.

26. The PMO and PIUs shall bear any and all costs of implementing the GRM, including meeting, travel, and/or accommodation costs of the project staff or affected person. The GRM will be implemented throughout project construction and at least the first year of operation for each project facility.

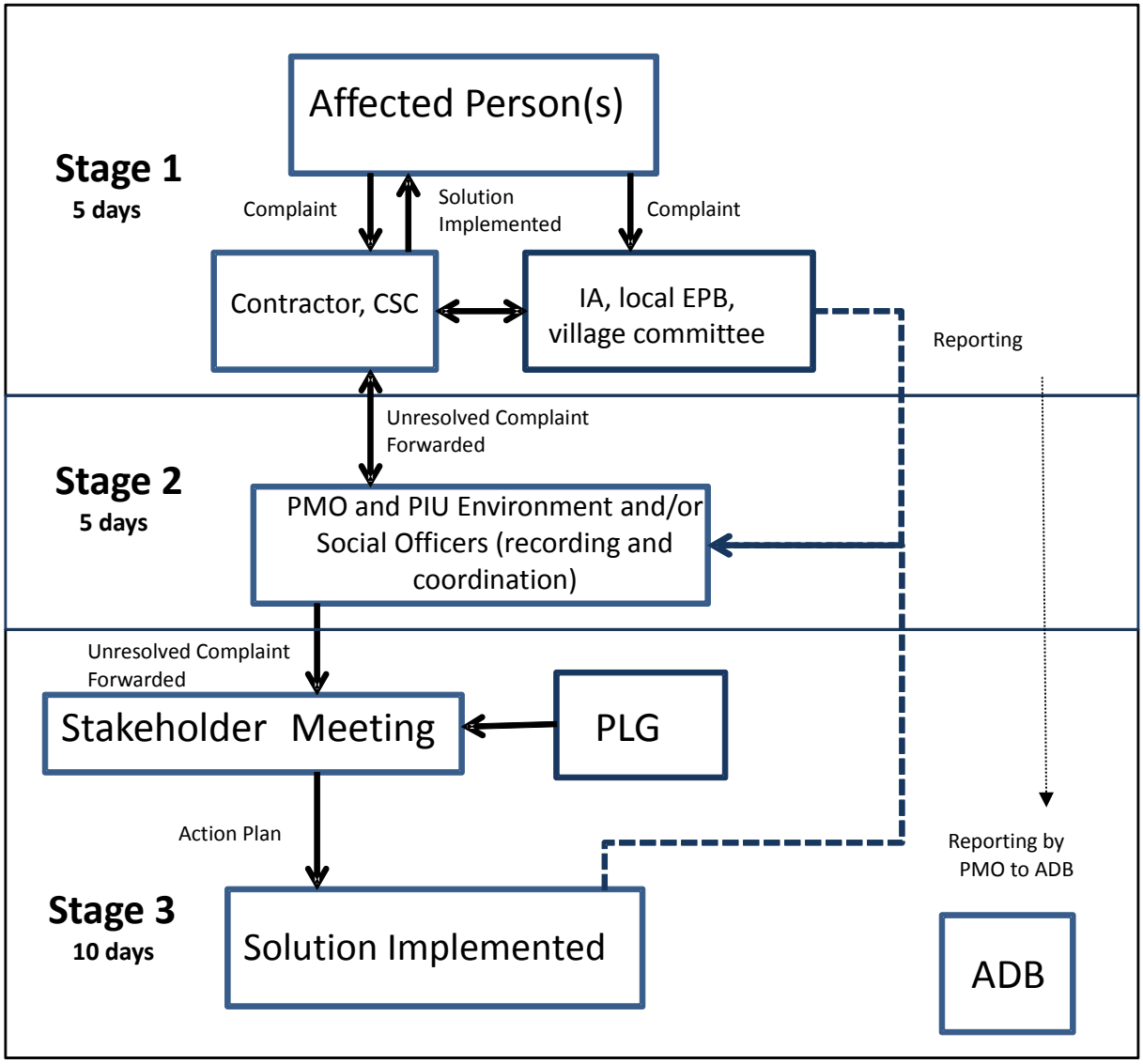


Figure EMP-1: Grievance Redress Mechanism

H. Cost Estimates

27. The cost estimates for EMP implementation comprises mitigation measures (Table EMP-3); monitoring (Table EMP-4); training (Table EMP-6) and public consultation (Table EMP-7) and are summarized in Table EMP-8. The costs do not include: (i) detailed design revisions and adjustments; (ii) internal monitoring/inspection of solid wastes disposal, soil erosion and re-vegetation, occupational health and safety during construction, as this will be included in the construction supervision contracts; (iii) salaries of PMO and PIU staff; (iv) infrastructure costs related to environment and public health that are already included in the project direct costs; and (v) environmental mitigation measures cost during operation as it is covered by O&M budget. The cost is estimated based on information in the FSR, domestic EIAs and/or the experience of the PPTA team from other projects. All costs were discussed with the EIA Institute, PMO and IAs.

28. The total estimated cost for EMP implementation is CNY15.7646 million (USD2,542,677) (Table EMP-8). The estimated cost for the PMO is CNY 1,500,000 (9.5%) and for contractors is about CNY14,264,600 (90.5%).

Table EMP-8 Estimated Cost for EMP Implementation

EMP Item		Cost (CNY10,000)
Mitigation measures Implementation during construction	Qi River Wetland Conservation and Rehabilitation	139.6
	Qi River Mainstream Watercourse Improvement in Qi County	118.94
	Four Tributary Watercourse Improvement in Qi County	106.24
	Five Canal Watercourse Improvement in Qibin District	147.99
	Qibin District Wastewater Management	50.6
	Qi County WWTP Expansion	63.9
	Storm water and wastewater pipelines	760.17
	Construction of urban 15 domestic waste transfer stations and associated facilities	39.02
	Subtotal	**1,426.46**
External Environmental monitoring by LIEC		130
Public Consultation		10
Training		10
Total		**1,576.46**

I. Mechanisms for Feedback and Adjustment

29. Based on environmental inspection and monitoring reports, the PMO and PIUs shall decide, in consultation with the LIEC, whether (i) further mitigation measures are required as corrective actions, or (ii) some improvements are required for environmental management practices. The effectiveness of mitigation measures and monitoring plans will be evaluated by a feedback reporting system. Adjustment to the EMP will be made, if necessary. The PMO Environmental Officers will play a critical role in the feedback and adjustment mechanism.

30. If during inspection, substantial deviation from the EMP is observed or any changes are made to the project that may cause substantial adverse environmental impacts or increase the number of affected people, then the PMO and PIUs will immediately consult with ADB and form an environmental assessment team to conduct additional environmental assessment. If necessary, further public consultation will be undertaken. The revised domestic EIAs and project EIA, including this EMP, will be submitted to the ADB for review, appraisal, and public disclosure. The revised EMP will be passed to the contractors, CSCs and OPFs for implementation.

APPENDIX 1. DRAFT TERMS OF REFERENCE FOR ENVIRONMENTAL POSITIONS

1. PMO ENVIRONMENT OFFICER

A. Background

1. Development projects supported by the Asian Development Bank (ADB) routinely include a project management office (PMO). The PMO is responsible for project implementation and comprises the provincial and/or municipal agencies involved in the project. Compliance with the loan and project agreements include implementation of an environment management plan (EMP), which is prepared as part of the project environment impact assessment. The EMP is the critical guiding document to manage, monitor, and report upon potential project environmental impacts. Implementation of the EMP is a full-time task. For this reason, the PMO assigns at least one full-time officer for this role. These terms of reference describe the requirements for this officer.

B. Scope and Duration of Work

2. The officer will work on behalf of the PMO to implement the project EMP. The officer will report directly to the PMO. The position is for the entire project duration (5 years).

C. Qualifications

3. The officer will have: (i) a bachelor's degree or higher in environmental management or related field; (ii) at least 5 years of experience in environmental management, monitoring, and/or impact assessment; (iii) ability to communicate and work effectively with local communities, contractors, and government agencies; (iv) ability to analyze data and prepare technical reports; (v) willingness and health to regularly visit the project construction sites and in different seasons; and (vi) ideally, good spoken and written English.

D. Detailed Tasks

4. The officer will have a detailed understanding of the project EMP and supporting documents, including the domestic environmental reports, the project environmental impact assessment (EIA), and environmental assurances. The officer will have the following tasks.

(i) Assess whether the EMP requires updating due to any changes in project design, which may have occurred after the EMP was prepared.
(ii) Distribute the Chinese language version of the EMP to all relevant agencies, including the implementing agencies, and provincial and municipal agencies for environment protection. This should occur at least 3 months before construction begins.
(iii) Conduct meetings with agencies as necessary to ensure they understand their specific responsibilities described in the EMP.
(iv) Ensure that relevant mitigation, monitoring, and reporting measures in the EMP are included in the bidding documents, contracts, and relevant construction plans.
(v) Confirm that the implementing agencies responsible for the internal environment monitoring described in the EMP understand their tasks and will implement the monitoring in a timely fashion.
(vi) At least 3 months before construction begins, establish and implement the project grievance redress mechanism (GRM) described in the EMP. This will include: (a) preparation of a simple table and budget identifying the type, number, and cost of materials needed to inform local communities about the GRM and starting dates and scope of construction; (b) design, prepare, and distribute these materials, and plan and conduct the community meetings; (c) prepare a form to record any public complaints; (d) preparation of a summary table to record all complaints, including dates, issues, and how they were resolved; and (e) ensure that all relevant agencies, including contractors, understand their role in the GRM.

(vii) Prior to construction, ensure that the implementation agencies and their contractors have informed their personnel, including all construction workers, of the EMP requirements. This will include all mitigation measures relating to impacts to air, water, noise, soil, sensitive sites, ecological values, cultural values, worker and community health and safety, respectful behavior when communicating with local communities, and responding to and reporting any complaints.
(viii) During project construction, make regular site visits with the loan implementation environment consultant (LIEC) to assess progress, meet with contractors and/or local communities, and assess compliance with the EMP.
(ix) Ensure that all relevant agencies submit required progress reports and information, including environmental monitoring and reports of any issues or grievances.
(x) Compile, review, and store environmental progress reports from the implementation agencies, records of any grievances, and any other relevant issues. Maintain digital copies of all information. When necessary, enter data into summary tables in digital format (e.g., to transfer records of grievances from hard copy forms). Ensure that all information is stored in the PMO filing system, backed up, and can be easily retrieved.
(xi) Prepare semi-annual environment progress reports.
(xii) Work closely with the PMO, implementation agencies, loan implementation consultants, and other agencies and personnel as necessary to conduct these tasks.

E. Reporting Requirements

5. Semi-annual environment monitoring reports using the template provided by ADB or a domestic format reviewed and approved by ADB.

F. Logistical Support Provided by the PMO to the Environment Officer

(i) Provision of hard and soft copies of the project EMP, domestic and project environmental reports, feasibility study reports, loan and project agreements, maps, and other supporting materials as necessary to ensure the officer can implement the tasks.
(ii) Vehicle transport, office materials, and other logistical support, as necessary for the officer to visit the project construction sites and local communities, arrange and conduct meetings, and prepare and distribute consultation materials.
(iii) Overall coordination, including review of the draft semi-annual monitoring reports, and final responsibility for submission of the monitoring reports to ADB.

2. PROJECT IMPLEMENTATION UNIT (PIU) ENVIRONMENT OFFICER

A. Background

6. The project will be coordinated by a PMO. Overall coordination of the project EMP is the responsibility of the PMO Environment Officer. At the field level, implementation of the EMP will be undertaken by the project implementation office (PIU) in each district or county. For this purpose, the PIUs each require a PIU Environment Officer. There will be one PIU Environment Officer per PIU i.e. nine officers.

B. Scope and Duration of Work

7. The officer will work on behalf of the PIU for daily site-level implementation of the project EMP. The officer will report directly to the PIU manager and work closely with the county environment protection bureau (EPB), environment monitoring station (EMS), and PMO Environment Officer. The position is for the entire project duration (5 years).

C. Qualifications

8. The officer will have: (i) a bachelor's degree or higher in environmental management or related field; (ii) at least 5 years of experience in environmental management, monitoring, and/or impact assessment; (iii) ability to communicate and work effectively with local communities, contractors, and government agencies; (iv) ability to analyze data and prepare technical reports; (v) willingness and health to regularly visit the project construction sites and in different seasons; and (vi) ideally, proficiency in spoken and written English.

D. Detailed Tasks

9. The PIU Environment Officers will have a detailed understanding of the project EMP and supporting documents, including the domestic environmental reports, project EIA, and project environmental assurances. The officer will have the following tasks.

(i) Work closely with the PMO Environment Officer, EPB, EMS, contractors, construction supervision companies, and all other relevant agencies to implement the EMP.
(ii) Distribute the Chinese language version of the EMP to all relevant agencies, including the implementing agencies, provincial and municipal agencies for environment protection. This should occur at least 3 months before construction begins.
(iii) Conduct meetings with agencies as necessary to ensure they understand their specific responsibilities described in the EMP.
(iv) Ensure that contractors implement the relevant mitigation measures in the EMP.
(v) Implement the monitoring and reporting requirements in the EMP, including timely submission of progress reports to the PIUs and PMO Environment Officer.
(vi) Implement the project GRM.
(vii) Make regular inspections of construction sites to assess progress, meet with contractors and/or local communities, and assess compliance with the EMP.
(viii) Maintain digital records of all progress and information.
(ix) Support the PMO Environment Officer in all of their tasks.

E. Reporting Requirements

10. Monthly reports to the PIU and PMO Environment Officer.

3. LOAN IMPLEMENTATION ENVIRONMENTAL CONSULTANT

A. Background

11. The project will be coordinated by a PMO, whose overall responsibility includes implementation of the project EMP. At the field level, the project will be implemented by nine PIUs in each of the project counties and districts. The PMO and PIUs will be assisted by a loan implementation consultant team. The loan implementation environmental consultant (LIEC) will be a part of this team and will support the PMO and PIUs to implement the project EMP.

B. Scope and Duration of Work

12. This position could be a firm or an individual engaged by the PMO. It is an independent position. It is not part of the PMO in-house environmental team or the implementing agencies. The specialist will report directly to the PMO. The position is [xxx person-months] over the entire project duration (5 years). The LIEC should be recruited as soon as possible after loan effectiveness, as the first task is to confirm project environmental readiness.

C. Qualifications

13. The specialist will have: (i) a bachelor's degree or higher in environmental management or related field; (ii) at least 8 years of experience in environmental management, monitoring,

and/or impact assessment; (iii) familiarity with ADB project management requirements and national environmental management procedures; (iv) ability to communicate and work effectively with local communities, contractors, and government agencies; (v) ability to analyze data and prepare technical reports; (vi) willingness and health to regularly visit the subproject sites; and (vii) proficiency in spoken and written English.

D. Tasks

14. Working closely with the PMO and PIU environmental officers, the LIEC will do the following.

15. Before construction:

(i) Ensure project environmental readiness, including: (i) all contractor contracts include, and will comply with, the EMP; and (iii) relevant sections of the EMP are incorporated in construction plans and contracts.
(ii) Assist the PMO and PIUs to implement the GRM, including: (i) establish and publicize the GRM; and (ii) collate and evaluate grievances received.
(iii) Develop procedures to: (i) monitor EMP implementation progress; (ii) collate and evaluate data collected in the EMP environmental monitoring program; and (iii) prepare and submit the semi-annual environmental monitoring reports to ADB (to continue until project completion report).
(iv) Undertake training of project agencies as required by the EMP training plan.
(v) Provide hands-on support and on-the-job training to the PMO, implementing agencies, and contractors on the specific requirements of the EMP as required.

16. During project implementation:

(i) Undertake site visits to all implementing agencies during subproject construction and operating phase.
(ii) Assist in the ongoing public consultation process as described in the project EIA.
(iii) Conduct EMP compliance assessments, identify any environment-related implementation issues, and propose necessary responses in corrective action plans.
(iv) Undertake training of project agencies as required by the EMP training plan.
(v) Assist the PMO to prepare semi-annual environmental monitoring progress reports for submission to ADB.

4. WETLAND ECOLOGIST

E. Background

17. The project will be coordinated by a PMO, whose overall responsibility includes implementation of the project EMP. At the field level, the project will be implemented by nine PIUs in each of the project counties and districts. The PMO and PIUs will be assisted by a loan implementation consultant team. The wetland ecologist will be a part of this team and will support the PMO and PIUs to implement the project wetland activities, focusing on the pilot Qi River National Wetland Park (NWP).

F. Scope and Duration of Work

18. This position could be a firm or an individual engaged by the PMO. It is an independent position. It is not part of the PMO in-house environmental team or the implementing agencies. The specialist will report to the PMO. The position is [xxx person-months] over the entire project duration (5 years). The specialist should be recruited as soon as possible after loan effectiveness, as the first tasks include review of the detailed wetland designs.

G. Qualifications

19. The specialist will have: (i) a master's degree and/or equivalent experience in wetland ecology and management; (ii) at least 10 years work experience in wetland ecology, research, including wetland flora and/or fauna, wetland design, and the ecological impacts and management of river dredging and embankment; (iii) demonstrated experience in the preparation of wetland management plans; (iv) detailed knowledge and understanding of national regulations, policies, and requirements for wetland management in the People's Republic of China; and (v) ideally, proficiency in spoken and written English.

H. Tasks

20. Working closely with the PMO and PIU environmental officers, design institutes, other loan implementation consultants, river guards, and other stakeholders as relevant, the specialist will do the following.

21. Before construction:

(i) Work with the design institutes to prepare the detailed project designs for the NWP, including: location, extent and design of the wetland habitats, management services, access roads, fencing, and signs; and, avoidance of sensitive sites.
(ii) In particular, minimize the bank-side excavation for the establishment of deep pools and ensure the timing of this activity is restricted to the peak dry and time of lowest and slowest flows.
(iii) Train the project agencies, including PMO and PIU Environment Officers, contractors, and construction supervision companies, on staff protocols while working in the wetlands (e.g. workers prohibited to catch wild animals, what to do if an injured animal is found etc) as required by the EMP training plan.

22. During project implementation:

(iv) Provide hands-on support and on-the-job training to the PMO, forestry bureaus, river guards, and other relevant agencies for wetland management and monitoring for the NWP. The aim of the training is to enable these agencies to effectively manage the NWP and project facilities after project completion.
(v) Conduct pre- and post-training capacity assessments (at the beginning and end of the project) to assess stakeholder capacity for wetland management.
(vi) Prepare training topics and materials tailored to the capacity and needs of local agencies and the specific objectives for management of the NWP i.e. ecological conservation, restoration of wetland habitats, and sustainable use for recreation and public education.
(vii) Facilitate the participatory establishment of a management agency for the NWP. This may include: assisting the relevant bureaus of the Hebi City Government (HCG) to identify roles, tasks, and specific steps; drafting the roles and responsibilities of each agency; drafting the overall guiding charter for the management agency.
(viii) Lead the preparation of the first five-year management plan for the NWP. This will be based on the NWP Master Plan (2011–2020) and describe, for the first five years: specific objectives; measurable (quantitative- and time-based) targets for capacity building, ecological values, tourism, and management; roles and responsibilities of all relevant stakeholders; operation and maintenance of facilities in the park, including the project-supported facilities; and financing arrangements for operation and maintenance.
(ix) With the ecological monitoring specialist, develop specific wetland ecological targets for the NWP, including (but not limited to): recovery of the Wild Soy and Qi River Crucian Carp populations; seasonal counts of migratory waterbirds; and, survival and health of the seven types of wetland habitats and vegetation restored by the project.
(x) Identify the potential for: (a) expanding the role of the community river guards in management of the NWP; (b) new partnerships to support the NWP management,

including with academic institutions in Henan Province or elsewhere.

(xi) Circulate drafts of the management plan, organize and facilitate stakeholder consultation meetings to discuss the draft plan, and ensure that comments are addressed.

(xii) Deliverables: (i) a final-draft five-year management plan for the NWP, which is ready for submission to the HCG for final review and official approval; (ii) a final report, describing the work of the specialist, lessons learned, and recommendation for follow-up.

(xiii) Timelines: the final draft five-year management plan shall be submitted to the HCG no later than by the end of the second year of the project. This will give the specialist sufficient time to prepare the plan and remain working on the project while the plan is officially approved.

5. ECOLOGICAL MONITORING SPECIALIST

I. Background

23. The project will be coordinated by a PMO, whose overall responsibility includes implementation of the project EMP. At the field level, the project will be implemented by nine PIUs in each of the project counties and districts. The PMO and PIUs will be assisted by a loan implementation consultant team. The ecological monitoring specialist will be a part of this team and will support the Hebi City Government (HCG), through the PMO and PIUs, to develop and implement a long-term ecological monitoring program for the Qi River in Hebi City.

J. Scope and Duration of Work

24. This position could be a firm or an individual engaged by the PMO. It is an independent position. It is not part of the PMO in-house environmental team or the implementing agencies. The specialist will report to the PMO. The position is [xxx person-months] over the entire project duration (5 years). The specialist should be recruited as soon as possible after loan effectiveness, to enable an early start to ecological monitoring.

K. Qualifications

25. The specialist will have: (i) a master's degree and/or related discipline in ecology; (ii) at least 10 years applied experience in the design of ecological monitoring programs for flora and/or fauna, including statistical design and software programs, data entry, analysis, and reporting; (iii) applied research and management experience in biodiversity conservation, including expertise in at least one area of wetland ecology, e.g. fish, wetland vegetation, and/or waterbirds; and (iv) ideally, proficiency in spoken and written English.

L. Tasks

26. Working closely with the PMO and PIU environmental officers, design institutes, wetland ecologist and other loan implementation consultants, and other stakeholders as relevant, the specialist will do the following.

(i) Clarify and establish the specific objectives of the long-term ecological monitoring program, including: (a) to measure the ecological health of the Qi River in Hebi City; and (b) to measure progress of the project activities for wetland conservation and species protection in the pilot Qi River National Wetland Park (NWP).

(ii) Identify the specific variables to be monitored, which may include: (a) within the NWP – Qi River Crucian Carp, Wild Soybean, migratory waterbirds, wetland vegetation restored by the project; (b) Qi River in the entire project area – water quality, hydrology.

(iii) Describe existing HCG activities and arrangements for ecological and hydrological monitoring along the Qi River, including within the NWP, including the locations of existing hydrological monitoring stations.

(iv) For parameters which are already subject to some monitoring (e.g. water quality, hydrology), assess current strengths, weaknesses and opportunities. If existing arrangements are sufficient for the program objectives, assess and facilitate the integration of these into the program (or vice versa).
(v) For new and/or existing parameters, develop the monitoring methods, frequency, training needs, and equipment.
(vi) Work with the wetland ecologist to identify and design the parameters for the NWP.
(vii) Design the monitoring program and methods for each parameter to be: (a) as simple as possible; and (b) requiring as little specialist equipment as possible.
(viii) Prepare field data collection template forms for each parameter.
(ix) Prepare a series of specific, simple, and direct questions to be answered by the results of long-term monitoring. These will help guide implementing agencies to prepare progress reports based on the monitoring data.
(x) Work with the HCG agencies that are developing the Qi River Management Information System (MIS) to be established by the project, in order to: (a) ensure that data is collected in a format that can be entered into the MIS; and (b) develop simple pre-programmed questions or analyses to assist analyses and preparation of progress reports.
(xi) Prepare a user manual which describes all steps in the program, including procedures for field monitoring of each parameter, specific agencies assigned to each task, roles and responsibilities, data collection, data entry to the MIS, data analyses, and the preparation of progress reports.
(xii) Pilot the monitoring program with all relevant agencies, including data collection, entry, analyses, and reporting.
(xiii) Support the implementation of at least the first six months of the monitoring program.
(xiv) For all tasks, include stakeholder consultations as needed to ensure strong inter-agency support and participation for the program.
(xv) Deliverables: (i) a final report, which includes (a) final draft long-term ecological monitoring program, (b) user manual, (c) description of all activities, lessons learned, and recommendation for follow-up.
(xvi) Timelines: the program and user manual shall be completed within the first year of project implementation. This will give the specialist sufficient time to lead the piloting and at least first six months implementation of the program.

APPENDIX EMP-2. ECOLOGICAL MONITORING PROGRAM – GUIDING NOTES

1. The project will establish a long-term ecological monitoring program for the Qi River within Hebi City, including the pilot Qi River National Wetland Park (NWP). An ecological monitoring specialist will be recruited as part of the loan implementation consulting services to support the design, piloting, and implementation of the program. The objectives of the program and tasks of the specialist are described in the terms of reference in Appendix EMP-1. It is anticipated that the program will include monitoring of: (i) vegetation restoration in the barren hills and NWP by the project; (ii) population monitoring for a small number of threatened species e.g. Qi River Crucian Carp, Wild Soybean, and key communities such as migratory waterbirds. This appendix provides guiding notes to assist the design of the program.

2. **Barren hills component.** The 19 barren hills in the project have been divided into four types (see PPTA Supplementary Document 1). Monitoring could be conducted at one hill from each type, with two survey locations (one south facing and one north facing) identified at each hill. Monitoring could be conducted two times every year (May and August) during the construction phase and once a year (August) in the operation phase. Fieldwork would comprise surveying a 20x30 m quadrat, including record of relative frequency/coverage of each species, measuring height and diameter of trees in the sampling area, and taking representative photos of different species.

3. **Wetland restoration component in the pilot NWP.** For the wetland restoration component, six locations (1x1 m) are suggested for monitoring: two for aquatic area, two for riparian buffer strips, and two for the river bank.

4. Data could be recorded using a table similar to Table 1 below.

Table 1: Vegetation Monitoring Record Table

Species name	Habitat (tree/shrub/herb)	Height	Diameter	Protection Status	Exotic/ Native
Species1					
Species2					
Species3					
Etc.					

5. **Migratory waterbirds along the QI River, including the pilot NWP.** For this program, “waterbirds” could be defined as ducks, geese, storks, and herons. Point counts should be conducted three times a year: once in the winter, once in the early summer, and once in the peak autumn migration season. Survey route should follow along the bank of the Qi River (from Panshitou Reservoir to the confluence of Qi River with Wei river), with point counts undertaken approximately 5km apart. Within the pilot NWP, point counts should be selected at 1 km intervals. All waterbirds heard or observed should be recorded at each point count location, as well as the following information: date, GPS location, weather condition, and habitat description. Any notable behavior (e.g., roosting, nesting) should also be recorded.

6. **Fish.** Species and/or communities for monitoring should be selected. At the least, Qi River Crucian Carp, a key species of the Qi River, should be included in the program. Monitoring methods will need to be tailored to the species and/or communities selected. In general, the methods might include: (i) monitoring once a year (in the autumn) at three to five sampling sites in the upper, middle, and down-stream sections of the Qi; (ii) fish sampled could be by netting and/or non-lethal electro-fishing. Records should be made of the species, relative abundance and sex ratio of fish recorded; (iii) at each site, general habitat condition and water quality parameters should also be monitored, including temperature, speed, depth, sediment type, dissolved oxygen, pH, water transparency, and electrical conductivity. Survey staff should carry out interviews with local residents, fishing management department, and fisherman to collect the fishing data along the Qi River.

Table 2. Sample Fish Monitoring Record Table

Site	No.					
Survey time	Investigators					
Fishing method	Total fishing catch / kg					

Composition information						
Common name	Scientific name	Numbers	Body weight	Body length	Index of gonad	Sex ratio

7. **Aquatic Invertebrates**. Aquatic invertebrates could be sampled at the same 12 locations described shown in section IV of this report. At each site, it is suggested two hand screen samples are collected. Kick samples (whereby an aquatic net is positioned in the water at arms' length downstream and the stream bottom is disturbed by foot, so that the dislodged invertebrates are carried into the net) should be collected from fast-water habitats. Dip-net samples (whereby an aquatic net is pushed through vegetation and sediments) should be collected from slow water habitats (especially bank areas). Each kick-sample should cover an area of at least one square meter, and each dip-net sample should be taken from about 10-20m of pool and bank habitat. These four samples would be supplemented by “visual” collections for a period of 10-20 minutes per site. A total of at least 100 organisms is recommended, if fewer than 100 specimens are sampled, additional kick-net, dip-net, and visual samples should be taken.

8. The net contents are emptied into a pan of stream water. Larger rocks, sticks, and plants may be removed from the sample if invertebrates are first removed from them. The contents of the pan are poured into a sieve to remove smaller organisms and debris. The sample is then transferred to a bottle and preserved by adding 95% ethyl alcohol. Samples can then be sorted in the laboratory, and specimens identified using a stereo-microscope. To maintain taxonomic-level consistency, organisms should be identified to as lowest level as possible. Specimens too immature to identify with confidence to the taxonomic level in references should be discarded.

Table 3. Aquatic Invertebrates Monitoring Record Table

Name of Sample Site_____ Site No. ___
Collected by_____ Sampler Type_____
Sorted by_____ Collection Card No._____
Analyst_____ Date Collected_____

Ephemeroptera			Megaloptera		
			Crustacea		
Plecoptera					
			Oligochaeta		
			Diptera		
Trichoptera					
Odonata					
			Mollusca		
Coleoptera					
			Other		

Total No. Organisms_____ Diversity Index (H’)_____
Species richness _____ Percent Model Affinity _____
EPT richness _____
Notes: _____