Environmental Impact Assessment (DRAFT)

Project number: 51005-002
June 2018

People's Republic of China: Chongqing Longxi River Basin Integrated Flood and Environmental Risk Management Project

Prepared by the Chongqing Municipal Government for the Asian Development Bank

CURRENCY EQUIVALENTS

(as of March 2018)
Currency Unit - Yuan (CNY)
CNY 1.00 = US$ 0.16
US$ 1.00 = CNY 6.32

ABBREVIATIONS

ADB	-	Asian Development Bank	LIC	-	Loan implementation consultant
CNY	-	Chinese Yuan	MEP	-	Ministry of Environmental Protection
CS-EMP	-	Construction Site EMP	MSW	-	Municipal Solid Waste
CSC	-	Construction supervision company	Mu	-	Chinese land unit (1 ha = 15 mu)
EA	-	Executing Agency	NDRC	-	National Development and Reform Commission
EHS	-	Environmental, health and safety	OPF	-	Operators of project facility
EIA	-	Environment Impact Assessment	PIC	-	Project Implementation Consultant
EMA	-	Environmental monitoring agency	PMO	-	Project Implementation Unit
EMP	-	Environmental management plan	PMO	-	Project Management Office
EPB	-	Environmental Protection Bureau	PPTA	-	Project Preparatory Technical Assistance
EPD	-	Environmental protection department	PRC	-	People's Republic of China
FERM	-	Flood and environmental risk management	REA	-	Rapid environment assessment
FSR	-	Feasibility Study Report	SPS	-	Safeguard Policy Statement
GAP	-	Gender action plan	TOR	-	Terms of Reference
GDP	-	Gross Domestic Product	TRTA		Transaction Technical Assistance
GHG	-	Greenhouse Gas	WSCP	-	Water and soil conservation plan
GRM	-	Grievance redress mechanism	WSP	-	Water Supply Plant
IA	-	Implementing Agency			
LAR	-	Land Acquisition and Resettlement			

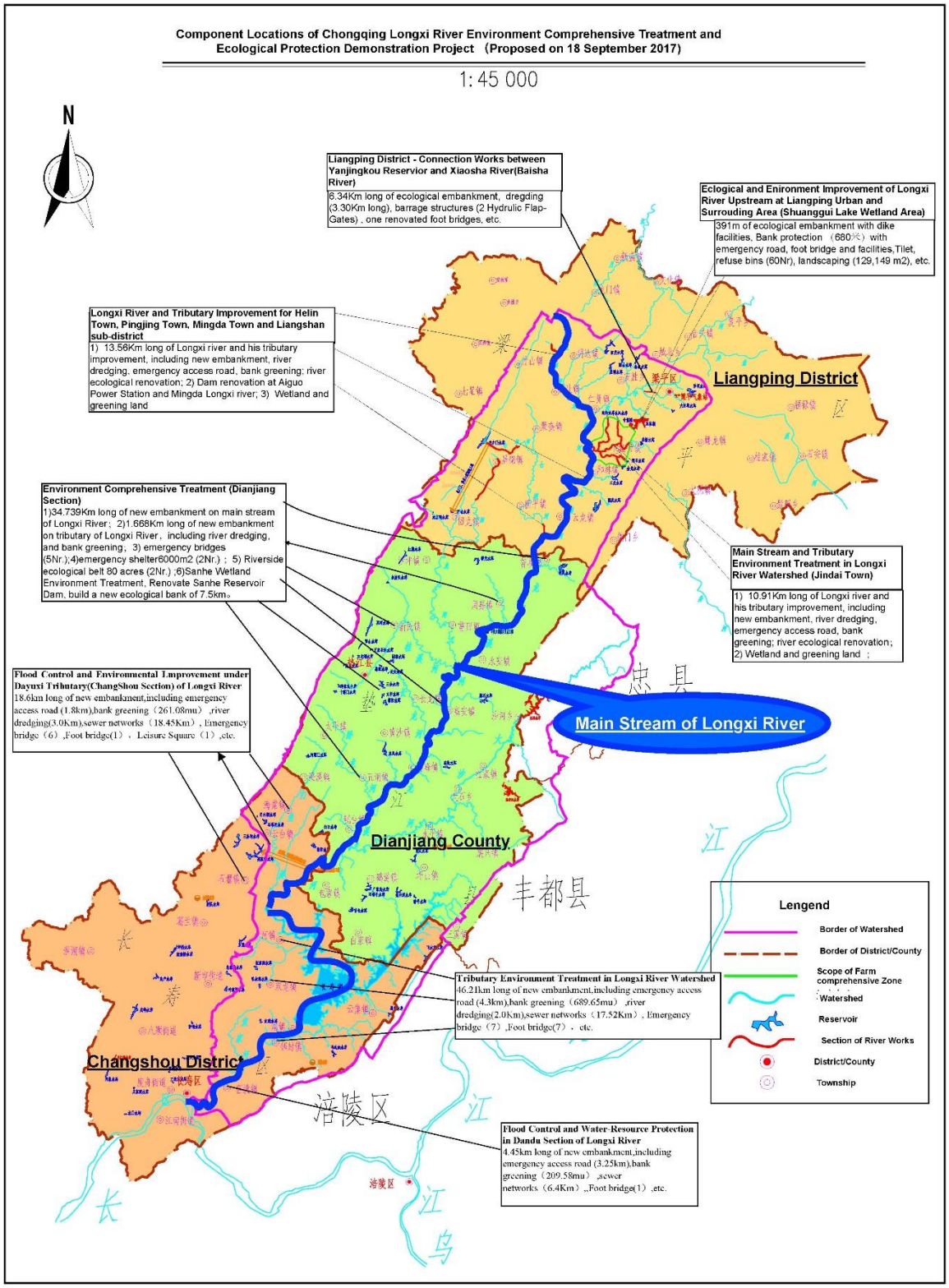
WEIGHTS AND MEASURES

^{o}C	degree centigrade	m^2	square meter
dB	decibel	m^3/a	cubic meter per annum
g	gram	m^3	cubic meter
ha	hectare	m^3/d	cubic meter per day
km	kilometer	m3/s	cubic meter per second
km^2	square kilometer	mg/l	milligram per liter
kW	kilowatt	mg/m^3	milligram per cubic meter
L	liter	mm	millimeter
L_{Aeq}	Equivalent continuous A-weighted sound	t	metric ton
MW	megawatt	t/d	metric ton per day
m	meter	t/a	ton per annum

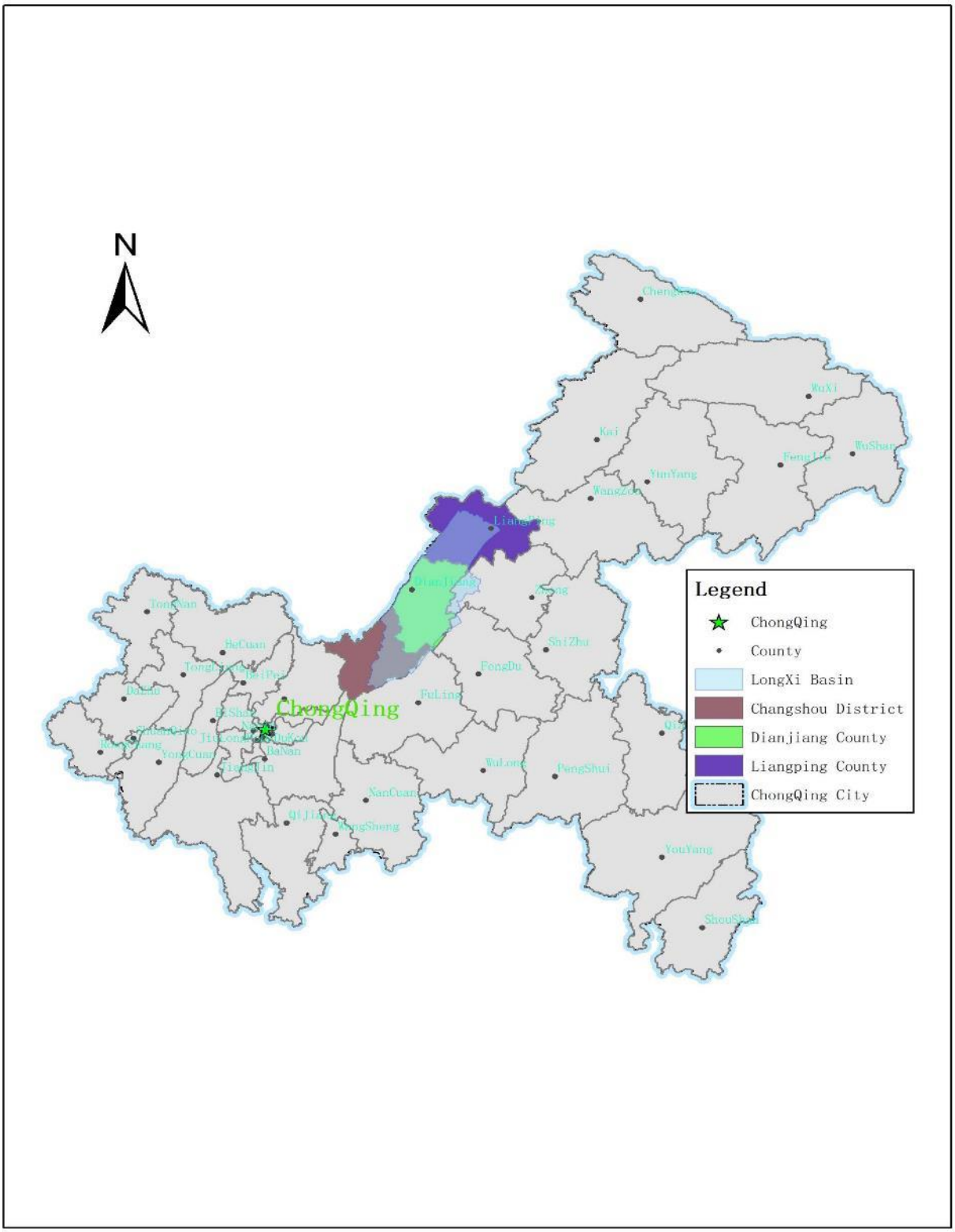
NOTE

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

Table of Contents



Map 1: Project Locations and Proposed Scope of Works in Chongqing Municipality, People's Republic of China



Map 2: Longxi River Watershed in Chongqing Municipality

I. EXECUTIVE SUMMARY

A. Introduction

1. The Chongqing Municipal Government (CMG), People's Republic of China (PRC) has requested the Asian Development Bank (ADB) to provide investment and technical assistance support for the Chongqing Longxi River Environment Comprehensive Treatment and Ecological Protection Demonstration Project (the project). The project will help the CMG to improve integrated river basin management for the Longxi River, which is a first-order tributary of the Yangtze River and within the Ecological Conservation Zone of the Three Gorges Reservoir. The project will develop an integrated and balanced approach for flood reduction, water pollution control and ecological restoration in the river watershed, within two districts (Liangping and Changshou) and one county (Dianjing). Based on the ADB Safeguard Policy Statement (SPS, 2009) the project is classified as environmental Category A, requiring the preparation of a project environmental impact assessment (EIA).

2. This project EIA has been prepared in accordance with the ADB SPS requirements and the PRC's related environmental laws, regulations and standards. It is based on information and data from: (i) five domestic EIAs (DEIAs) in Chinese prepared by four certified EIA institutes; (ii) three Feasibility Study Reports (FSRs) developed by the Chongqing Jianghe Engineering Consulting Center (FSR Institute); (iii) the Study Report of Longxi River Watershed Planning (June 2016); (iv) the urban development master plans for Chongqing Municipality and the three project districts and county; and (v) environmental, social, and economic assessments conducted from September 2017 to February 2018 by the consultants for the project transaction technical assistance (TRTA), in cooperation with the FSR institute, the DEIA institutes, and the municipal and local governments.

B. Background

3. Chongqing Municipality is one of the PRC's four provincial-level municipalities and is the west hub of the Yangtze River Economic Belt (YREB), a region targeted for national economic development. The municipality suffers from annual flooding. One of the worst flood affected areas in the municipality is the Longxi River basin. The Longxi River is 229.8 km long and its river basin has a total area of 3,280 km^2. The river originates in Liangping District, passes through Dianjiang County, and merges into the Yangtze River in Changshou District. The project area encompasses the entire basin. In 2015, the population in the river basin was 2.8 million (about 9.3% of the municipal population of about 30 million).

4. Water quality in the Longxi River is lower than the Grade III national Surface Water Standard, due to point (industrial and household wastewater and rubbish) and non-point (agriculture) pollution. About 40% of residents in the basin are not connected to the municipal networks for solid waste or wastewater collection. The water quality of the river, its tributaries, and lakes, have deteriorated and are subject to eutrophication, due to untreated wastewater discharge and improper solid waste disposal. Sedimentation of the rivers, lakes, and reservoirs is occurring due to river bank erosion and landslides as well as mining activities in upstream areas. This has resulted in reduced river flows, increased flooding, and water contamination. Climate change is contributing to these issues through decreased annual river flow and increased rainfall intensity, which is resulting in increased flooding and deteriorated water quality.

5. The PRC government has issued policies and strategies for environmental restoration and protection of the Longxi River. In 2001, the State Council issued the Three Gorges Reservoir Area and Its Upper Water Pollution Control Planning. In 2016, the State Council issued the Construction

Plan of Comprehensive Management of Water Environment in Key River Basins, which stated the requirement to improve the quality of water environment and outlined the national river environment protection strategy. In the PRC 13th Five Year Plan (2016–2020), the need for river protection is emphasized, including requirements for river environment restoration and ecological protection.

6. In 2017, the CMG issued the Longxi River Ecological and Restoration Implementation Plan 2030. Other sectoral plans, including the Environmental Protection Plan, Water Pollution Control Action Plan, Ecological Conservation Plan, and the municipal 13th Five Year Plan (aligned to the national plan), have been prepared. The CMG is prioritizing its efforts for flood and environmental risk management (FERM) and is seeking support from ADB to address these challenges. The project aims at demonstrating an integrated approach for FERM by applying structural and nonstructural measures in the Longxi River basin.

C. Project Components

7. The expected project impact is environmental sustainability in the watershed. The project outcome is improved environmental protection, river restoration and management of the Longxi River and its tributaries. The project will adopt several principles, including comprehensive FERM plan, balanced flood control and ecosystem protection, integrated water resources management, and strengthening management and institutional capacity. The project has four outputs.

8. **Output 1: Flood Risk Management Infrastructure Constructed.** This output includes: (i) flood preventive measures including construction of discontinuous embankments, river dredging, pilot flood-sensitive road planning and design, and transformation of small barrages to gated structures; (ii) water retention measures including temporary flood retention areas, and installation of flood diversion structures; and (iii) flood preparedness measures including construction of the shelters, emergency access roads.

9. **Output 2: Wastewater Management and Pollution Control Infrastructure Developed.** This output includes: (i) wastewater management system including installation of wastewater collection network to existing wastewater treatment facilities, and (ii) non-point source water pollution control measures including the bio-shield along the river banks adjacent to the farmland.

10. **Output 3: Ecological Conservation Facilities Improved.** This output includes: (i) wetland conservation including restoration of wetlands in existing lakes and expansion of wetlands in lakes and rivers; (ii) landscaping including greening and gardening along the river corridors; (iii) river bank protection and erosion control and watershed conservation, water sources protection, lake and river banks protection, and lakeside greening and gardening in Shuanggui Lake.

11. **Output 4: Flood and Environmental Risk Management Capacity Enhanced.** This output includes: (i) hydro-meteorological and water quality monitoring services in the Longxi River watershed including the establishment of flood footprint accountability mechanism, development and installation of flood risk and water pollution simulation models, introduction of real-time flood and water quality monitoring system with geographic information system interface, and installation of telemetric water level and water quality measurement stations; (ii) development planning and programming including preparation of FERM investment roadmap and formulation of medium- and long-term comprehensive FERM plans, and draft recommendation for land-use planning and regulations; and (iii) capacity development of CMG, local governments, and communities including training programs; piloting the flash-flood early warning system; promotion of community-based FERM including household level solid waste management pilot works; establishment of Longxi River coordination unit in CMG to aid river chief system, drafting recommendation for land-use planning

and regulation, and updating reservoir operational guidelines.

D. Project benefits and features

12. The project will contribute to municipal targets for environmental and social improvement, as follows.

13. **Improved water quality.** The project will contribute to the following targets in the Chongqing Master Plan: by 2020, water quality in the Longxi mainstream improved from Grade IV to Grade III, and for tributaries, from Grade V (or worse) to Grade IV. The project designs to contribute to these targets include: (i) construction of 77.89 km sewer pipelines along the river and tributaries for improved wastewater interception, which is estimated to increase the rate of wastewater collection from 42-47% to 80% (based on survey data of current collection rates); (ii) dredging of 7.85 km of river channels, to remove 215,000 m^3 of polluted sediment; and (iii) establishment of about 354 ha (5,314 mu) of vegetated green belts along the river, tributaries, and two reservoirs (Shanggui and Sanhe), comprising (a) "ecological buffer strips" (planted vegetation belts 2–6 m wide, strategically located between settlements, farmlands, and the river channels, to intercept non-point source pollution in runoff) [about 50 ha (747 mu)], (b) constructed wetlands, mainly around the perimeter of Shanggui and Sanhe Reservoirs [about 133 ha (1,988 mu)], to improve water filtration and retention capacity, and (c) green landscaping in all project sites [about 133 ha (1,988 mu)], to improve public amenities. Based on the application of national published rates for pollution reduction through natural methods (Section III.C), these revegetation and greening measures are estimated to capture about 40% to 70% of non-point pollutants of the runoff intercepted by the new green belts.

14. **Improved flood control and reduced siltation in the Yangtze River.** The project will contribute to the following targets in the Chongqing Master Plan: (i) raise the flood protection standard of the Longxi River mainstream and the tributaries from the current 1 in 2-5 years to 1 in 20 years; (ii) reduce siltation input to the Yangtze River by 18,600 m^3/a; and (iii) increase flood retention capacity in the Longxi River basin by 33% or 2.27 million m^3, from 6.86 million m^3 in 2017 to 9.13 million m^3 in 2023. These measures are expected to avoid about CNY85.8 million ($13.2 million) per year in flood damages. The project designs to contribute to these targets include: (i) the construction of 158.08 km of embankments along the Longxi mainstream and tributaries; (ii) improved water retention and filtration capacity through the greenbelts to be established (see previous paragraph); and (iii) improved water resources management, including new flood forecasting and warning systems, for the Longxi River basin. These benefits will help reduce flood risks to downstream populations in Chongqing Municipality and along the Yangtze River mainstream, as well to reduced silt load to the downstream catchment area of the Three Gorges Reservoir.

15. **Climate change adaptation.** The project will support afforestation and re-vegetation of 209 ha, comprising 198.3 ha terrestrial vegetation and 10.7 ha aquatic vegetation. It is estimated that tree and shrub planting by the project will result in annual carbon sequestration of about 232.7 tons per year (assuming a rate of 3.32 t/ha.yr based on consideration of local weather conditions and PRC sequestration rates for different vegetation types; see Table V-18 and notes).

16. **Long-term integrated river basin management.** The project will pilot an integrated river basin management approach for the Longxi River, which will gradually replace the existing approach of many small and fragmented projects in the basin. The national and municipal governments are already moving toward more centralized approaches for river basin management, including the appointment of "river chiefs" (officials accountable for river-related targets for quality and flood control). Through output 4, the project will help consolidate this approach, by focusing on non-structural measures, including improved government capacity for flood forecasting and warning,

monitoring of water quality, improved community involvement in flood management, and capacity building for stakeholders.

17. **Social and economic benefits.** The total population of the project county and two districts was 2.80 million in 2016. The project will directly benefit about 895,000 residents in 19 towns, including 563,000 (62.9%) rural residents, 20,718 (2.3%) low-income residents [of which 1,250 (0.14%) are below the PRC poverty line; defined as annual net income per capita of CNY2,300], and 436,000 (48.7%) are female. These benefits comprise: (i) reduced flood risks, resulting in reduced annual loss of life and damage to land and property; (ii) improved sanitation, due to the improved systems for wastewater and solid waste collection and disposal, which will contribute to improved health and reduced medical costs. The project facilities are public services and will have equitable social and gender benefits. The project will also promote the employment of women for project construction and operation, such as for tree planting, landscaping, and/or sanitation services. The project will also indirectly benefit the other 1.91 million residents in the project area.

E. Baseline environment

18. **Project area.** The project area was defined as: (i) the project construction sites, comprising 77 locations in the two project districts and county, including dredging, embankments, pipelines, and other features. The proposed works are located along 31.4 km of the Longxi River mainstream and 56.19 km of tributaries; and (ii) the total area of potential project influence, including downstream sections of the Longxi and/or Yangtze Rivers potentially affected by the project. Most of the project area and the Longxi River basin comprises a modified landscape of farmland and townships, which has been settled and cultivated for many centuries. Mean population density in the two project districts and county in 2016 was 442 persons/km^2. Habitats within these three administrative regions comprise agricultural land [2.98 million mu (198,178 ha); 40.7% of total land area] and planted and/or secondary forest and grassland [3.19 million mu (212,685 ha); 44.0%]. Along the project sections of the Longxi and tributaries, many river sections retain scattered stands of secondary forest and/or shrubland, usually comprising a “green belt” about 2 to 25 m wide. These form a natural barrier for flood control, bank stabilization, and water quality improvement. The flow regime of the Longxi River and its tributaries is regulated by over 150 small dams, reservoirs, sluice gates, and culverts.

19. **Water, air, noise and soil quality.** Water quality of the Longxi River mainstream is Grade IV-V Surface Water Quality Standard (lower than the Grade III target specified by the Chongqing Municipal Environment Protection Bureau) and water quality of the tributaries ranges from Grade IV to worse than Grade V. Sediment quality in the project river sections comply with the Standards for Pollutants in Sludge and Sediment for Agricultural Use (GB4284-84) and Grade II of the PRC Soil Quality Standard (GB15618-95). Ambient air quality meets Grade II of the PRC Ambient Air Quality Standard (GB 3095-1996), and ambient noise levels meet the PRC Environmental Quality Standard for Noise (GB3096-2008)–Grade II and the World Bank Group’s EHS guideline values.

20. **Ecological values.** The project area supports about 62.9 ha of secondary riverine forest along 87.6 km (including both banks) of the Longxi River and the five project tributaries. Most of this vegetation is degraded and subject to frequent human disturbance (multiple cycles of clearing and regrowth), but nonetheless maintains a greenbelt along waterways. Around 218 species of vertebrate fauna (fish, birds, mammals, amphibians and reptiles) have been recorded in the project area, but none are listed as protected, rare, threatened, or restricted-range species. There are no protected areas in the project area and no known records of rare, threatened, or protected flora or fauna. There are no habitats which meet the ADB definition of “critical habitats” (SPS 2009) in the project area.

21. **Cultural and physical values.** One site of national cultural significance is known in the project area, the Shuangguitang Temple (Jindai Town in Liangping District). This is a Buddhist temple and is also ranked as a “AAAA” (national level) tourist scenic spot.

F. Potential environmental impacts and mitigation measures

22. Environmental risks are anticipated from the construction and operational phases of the project. Key risks are associated with the hydrology, water quality, and ecology of the Longxi River and its tributaries.

23. **Construction phase.** Key impacts anticipated to result from construction are: (i) short-term damage to aquatic habitats in the river channels, due to dredging and embankment; (ii) removal of riverine vegetation, for the construction of embankments; (iii) short-term alteration of river flow, from the temporary installation of diversion weirs during construction; and (iv) construction noise, particularly for 281 households which will be located within 40 m of some works. Other temporary impacts include: odor from the dredging of polluted sediments; air pollution (mainly fugitive dust); soil erosion from uncontrolled earthworks; uncontrolled solid waste disposal; interference with traffic and municipal services, due to construction vehicle movements and any works alongside roads (pipelines, easements); permanent and temporary acquisition of land; involuntary resettlement; and, occupational and community health and safety.

24. *Loss or damage of aquatic and terrestrial habitats.* The embankment construction will require the replanting of 0.41 ha (6.18 mu) of riverbank vegetation. The existing vegetation to be cleared are mainly planted stands with low ecological value. Under PRC regulations, revegetation is required to have a minimum 80% planting success rate, and this includes planting over a larger area than the actual area to be cleared. In this case, the area to be replanted (0.82 ha) will be double the area cleared. For potential impacts related to dredging, there will be no dredging on the mainstream, and this has been secured through a project assurance (Section X). Dredging will be restricted to about 7.85 km of five tributaries, in discrete sections 0.4 to 2.45 km long, representing 20-50% of the total length of the individual tributaries. Dredging will be conducted to a depth of 0.5-0.7 m, to achieve the project objectives for flood control and removal of polluted sediments. The target tributaries are small, second- or third-order streams of the Longxi River, about 3-25 m wide. Habitats along the channels comprise scattered stands of degraded vegetation, agricultural lands, residences. The channels contain woody debris, sediments, and solid waste, and are highly polluted (Grade V or worse) and subject to flooding. Potential risks of the dredging include: (i) short-term removal of habitats and increases in sediment load and turbidity, resulting in mortality of fish and invertebrates and/or the loss of food and breeding habitats; (ii) release of pollutants and/or odor from the dredged sediments, causing localized impacts to aquatic fauna and/or nearby residents; and (iii) “head-cutting” of the channel bed, in which the removal of channel sediments causes upstream scouring of the channel bed, which may impact a larger area than the dredging itself.

25. Except for odor, these risks are considered to be low, due to: (i) the degraded and polluted condition of the channels (both water and sediment quality); (ii) the dynamic nature of the Longxi River, which undergoes regular flooding (it is likely that surface sediments are regularly replaced); (iii) the location of the dredging, which will be restricted to small tributaries and not the mainstream; and (iv) the safeguard measures to be implemented, including “ecological dredge methods” to minimize disturbance and sediment dispersion, timing (restricted to the dry season and lowest water levels), and short, staged work in discrete river sections (Section V). For odor, short-term disturbance to residents may occur as sediments are dredged and dewatered. Disturbance will be minimized by limiting the time that exposed sediments are retained on site (for dewatering only; no extended on-site storage), transport in sealed containers, and disposal in certified sites.

26. A total of 158.08 km of embankments will be constructed, comprising 58.36 km along the mainstream and 99.72 km along five tributaries. Some embankments will be conducted on both sides of the mainstream and tributaries i.e. the 158.08 km of embankments will encompass 87.56 km of river (31.4 km of the mainstream and 56.19 km of tributaries). Embankments will range in size from 10–15 m wide and 2.0–16.51 km long (mainstream) to 5–10 m wide and 0.5–11.7 km long (tributaries). Construction of the embankments will cause the permanent loss of about 0.41 ha (6.18 mu) of riverine vegetation, mainly secondary forest and shrubland (about 0.28 ha along the mainstream and 0.13 ha along tributaries). There is currently about 62.5 ha of natural and/or modified habitats within the project sites where embankment is planned: the proposed embankments would comprise the loss of about 0.66% of habitat in these sites. Construction of the embankments may cause: (i) damage to vegetation; (ii) fragmentation and reduced ecosystem function of the existing corridors of riverine vegetation; and (iii) increased runoff and soil erosion along banks.

27. For noise impacts, comparison of the locations of sensitive receptors with the planned works indicated that about 281 households will be within 40 m of works and may be subject to noise levels above 70 dB(A), the maximum permitted daytime threshold identified for this project following national standards. Prolonged exposure to construction noise could result in stress or physical injury to hearing.

28. Mitigation measures to address these risks include: (i) the use of “green” embankment designs (e.g. gabion blocks) with shallow sloping gradients and vegetated and porous banks to maximize soil infiltration; (ii) revegetation along the tops of the embankments; (iii) the use of native plant species for site rehabilitation; (iv) replanting of twice the area to be cleared; and (iv) a net gain in vegetation in the project area, through the planting of 209 ha of afforestation and re-vegetation area, comprising 198.3 ha terrestrial vegetation and 10.7 ha. No threatened species or communities of flora or fauna, or critical habitat, is known from the river sections where the dredging and embankments are planned. Overall, construction-phase impacts to ecology are expected to be low, because: the construction sites are small, the existing vegetation is common and widespread, there are no protected areas or “critical habitat” in the project area, and no known records of rare, threatened, or protected species. For noise impacts, focusing especially on 281 households of concern, measures include the installation of noise barriers, reinforcement of residential windows, regular community consultations before and during the works to adjust works as needed, and contractor performance targets to ensure noise levels are reduced to minimal levels.

29. *Cultural values.* For the Shuangguitang Temple, the nearest project construction works will be 2.5 km away. No impacts are expected.

30. **Operational phase.** Potential adverse risks during operation mainly include changes in hydrology and flow regime, and/or risks resulting from inadequate maintenance of the project facilities.

31. *Altered hydrology and flow regime.* The project embankments and dredging may result in higher water velocities and/or volumes, posing increased flood risk to downstream communities and lands, as well as changes in river morphology. Climate change may further increase this impact. This risk is concluded to be low: (i) the project will result in very small velocity increases (0.05-0.1 m/s) to mean annual flood velocities downstream of Longxi River; (ii) the channel gradient of the river and tributaries will not be changed by the construction as there will be no dredging in the mainstream, and the dredging in the tributaries will maintain the existing gradient; (iii) the “green” embankment designs will improve water retention and flow velocity; and (iv) mean annual

precipitation is predicted to increase by only 1% under RCP8.5 modeling during the period of 2021-2050.

32. *Inadequate maintenance of project facilities.* Inadequate maintenance could lead to damage of the embankments, blocked pipelines, increased siltation, accumulation of solid waste, and other issues. To avoid this risk, responsibility for maintenance of the project facilities has been assigned to the district and county water resources bureaus (WRBs). The facilities will be integrated into the existing work programs and budgets of the WRBs. Maintenance will include: regular inspection of the embankments for stability, condition of habitat features and vegetation plantings, and the presence of illegal structures (which would be removed). Establishment of the integrated Longxi River river basin management system will be supported by training for the Water Resources Department, WRBs, and designated river chiefs.

G. Public Consultation and Grievance Redress Mechanism

33. Two rounds of information disclosure and public consultation were conducted in the project county and two districts. Feedback from residents included 100% support for the project for improving flood control and river environmental restoration, and also concerns over potential construction noise, soil erosion, dust, and odor from dredged sediments. Measures to address these concerns have been incorporated in the updated FSRs and DEIAs and mitigation measures (Appendix 1). Public consultation will continue during project construction and operation for early resolution of any grievances. A grievance redress mechanism (GRM) has been developed to address environmental, health, safety, and social concerns associated with the project. The GRM was introduced to residents during the design phase and will be implemented throughout project implementation. A third round of consultations will be completed by April 2018 and the EIA will be updated with the results.

H. Climate Change

34. A climate risk vulnerability assessment (CRVA) was conducted by the TRTA consultant to identify the risk climate change presents to project viability, assuming a design life of 30-40 years. The annual mean temperature has increased 0.14℃/10a in Longxi River basin during 1961-2015, which was lower than the warming rate for the PRC average (about 0.22℃/10a). Modeling (RCP4.5) indicates that mean annual temperatures will increase by 0.9℃ from 2020-2030 and 1.2℃ by 2050. In the Longxi River basin, the rainfall intensity will be changed due to climate change. The frequency analysis suggests that the maximum daily rainfall of 50 years return period will be increased by 3% during the period of 2021-2050. variability in precipitation will increase, and storm severity may increase. Increasing flood volumes could exceed the flow capacity of embankments, channels, pipelines, and pump stations. To accommodate this, all structures will be constructed to a flood protection standard of once in 20 years, and embankments have been designed to be porous for improved infiltration. Overall, the existing project design, which is focused on water conservation and management, is strongly oriented to achieve resilience to climate impacts. Increased storm water retention and improved water monitoring and allocation will strengthen water security; channel rehabilitation will improve water flows and reduce flood risk; increased water storage in Shaunggui Lake will increase resilience to drought; and, training will be given in natural disaster (flood) reduction and water resource management. Of the 209 ha to be planted, about 70.1 ha will comprise woody trees and shrubs, which will achieve 232.7 tons of carbon sequestration per year. These reductions will be offset by the emissions generated during project construction and operation, resulting in a net emission of 344.8 tons CO_2e per year i.e. well below the SPS threshold of concern of 100,000 t CO_2e per year.

I. Environmental Management Plan

35. As part of this EIA, a project environmental management plan (EMP) has been developed (Appendix 1). This describes the project requirements and methods for environmental mitigation measures, monitoring, reporting, roles and responsibilities, budget, and the GRM. The EMP will be the key guiding document for environmental-related issues for project construction and operation.

J. Risks and Assurances

36. The CMG has implemented several ADB-funded projects and is experienced in ADB safeguard procedures and requirements. However, the government agencies for the project county and two districts have no previous experience in ADB safeguards and low institutional capacity for environmental management. This may result in limited implementation of the project EMP and inadequate operation of the project facilities. These risks have been minimized as follows: (i) appointment of a full-time environment officer in the Chongqing Municipal CPMO and one officer respectively in each of the implementing agencies of the project county and two districts; (ii) the inclusion of a loan implementation environmental consultant in the loan consulting services; (iii) clear roles and responsibilities of all relevant agencies for EMP implementation, including contractors and construction supervision companies; (iv) capacity building for EMP implementation; and (v) the recruitment of an independent agency to conduct the external environmental monitoring described in the EMP. Environmental assurances (Section X) have been agreed upon and are included in the loan and project agreements.

K. Conclusion

37. It is concluded that full and effective implementation of the project EMP, 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 project EIA.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Overview

39. The project is classified as environmental 'Category A' under the ADB SPS (2009), requiring the preparation of a project EIA. ADB's country partnership strategy for the PRC (2016-2020) supports the PRC's realizing an 'ecological civilization' through: environmental sustainability, pollution control, and climate change adaptation measures; achieving greenhouse gas emissions commitments ahead of its 2030 target; and, the overarching strategic goal of building a well-off society by focusing on the three strategic pillars of inclusive growth, environmentally sustainable development, and urban-rural integration. Under PRC EIA regulation, the project is classified as 'Class-1' (equivalent to ADB Category A) and preparation of full domestic EIA (DEIA) Reports is required.[1] The project is consistent with the PRC and Chongqing municipal 13th Five Year Plan.

40. The PRC has a range of laws, regulations, technical guidelines and standards that govern the way in which environmental protection and environmental impact assessment for projects must be implemented, including for pollution prevention and control on air, noise, water, ecology and solid waste, and technical guidelines on assessing ambient air, noise, surface water, groundwater, and ecological impacts. The five DEIA Reports upon which this project EIA is largely based were prepared in accordance with the PRC Law on Environmental Impact Assessment (2016 revision); Management Regulation on EIA Categories of Construction Projects (MEP, 2017); Guidelines on Public Participation in EIA (MEP, 2006); and, Technical Guidelines for Environmental Impact Assessment (HJ/T2-93).

B. PRC Environmental Laws, Regulations, Guidelines, and Standards

41. The primary national laws and regulations that govern DEIA are in Tables II-1 and II-2. Table II-3 shows the relevant Chongqing municipal laws and regulations.

Table II-1: Relevant National Laws and Year Issued

Law	Year of Effectiveness
Environmental Protection Law (revised)	2015
Urban and Rural Planning Law	2008
Environmental Impact Assessment Law (revised)	2016
Water Pollution Prevention and Control Law (revised)	2017
Cleaner Production Promotion Law	2002
Prevention and Control of Environment Pollution Caused by Solid Wastes (revised)	2015
Air Pollution Prevention and Control Law (revised)	2000
Noise Pollution Prevention and Control Law	1996
Land Administration Law (revised)	2004
Forest Law (revised)	2009
Water and Soil Conservation Law (revised)	2011
Flood Control Law	1998
River Administration Law	1988

Table II-2: National Administrative Regulations and Year of Effectiveness

Regulation	Effective Year
Pollution Control for Drinking Water Protection Zone	1989

[1] The PRC's *Directory for the Management of Different Categories of Project Environmental Impact Assessment* classifies EIAs into three categories with different reporting requirements: (i) Full EIA Report – for projects with potentially significant environmental impacts; (ii) Tabular Environmental Impact Assessment (TEIA) – for projects with less significant impacts; (iii) EIA Registration Form – for projects with the least environmental impacts.

Regulation	Effective Year
Environmental Protection for Construction Projects (revised)	2017
Strengthening Wetland Protection and Management (revision)	2013
Environmental Protection Rules for Construction	1998
Protection of Wild Flora	1997
Requirements for EIA Summary of Construction Project	2010
Classification of Construction Project Environmental Protection Management (MEP)	2001
National Biodiversity Strategy and Action Plan (2011-2030)	2010
Social Risk Assessment of Large Investment Projects	2012
Public disclosure of EIAs (NDRC)	2012
Methodology on Public Participation in Environmental Protection	2015
Regulations for Road Transport of Dangerous Goods	2010

Table II-3: Chongqing Municipality Laws and Regulations and Date Issued

Law and Regulation	Effective Date
Environmental Protection Regulations of Chongqing Municipality (revision)	1 June 2017
Dusty pollution control measures in Chongqing Urban Area (Order No.272)	August 2013
Methods for Implementation of the PRC's Soil and Water Conservation Law (Order No.272)	January 2013
Noise Pollution Control Measures in Chongqing	May 2013
Surface Water Function Zoning in Chongqing Municipality (updated 2012) No.4.	2012
Ambient Air Function Zoning in Chongqing Municipality (updated 2016) No.19.	2016
Ambient Noise Function Zoning in Chongqing Municipality (updated 2007) No.78.	2007
Environmental and Ecological Function Zoning (updated 2016) No.130.	2016
Water Resource Management Regulation of Chongqing Municipality	1 October 2015
Regulations on Landscaping Management (revised, September 2014)	September 2014
Regulation on Soil Erosion Control in Chongqing Municipality (No. 197)	2015
Ecological functional zoning in Chongqing Municipality (revised)	August 2008

42. Implementation of PRC laws and regulations is supported by associated management and technical guidelines. Those applicable to the project are summarized in Table II-4.

Table II-4: Applicable Environmental Guidelines

Guideline	Year/Code
Technical Guideline on EIA: Surface Water Protection	2006
List of Construction Projects Subject to Environmental Protection Supervision	2008
Guideline on EIA Classification of Construction Projects	2017
Guideline on Jurisdictional Division of Review and Approval of EIAs for Construction Projects	2009
Interim Guideline on Public Consultation for EIA	2006
Circular on Strengthening EIA Management to Prevent Environmental Risks	2005
Technical Guideline on EIA: Surface Water Environment	HJ/T 2.3-1993
Technical Guideline on Environmental Risk Assessment for Construction Project	HJ/T169-2004
Technical Guideline on EIA: Acoustic Environment	HJ 2.4-2009
Technical Guideline on EIA: Atmospheric Environment	HJ 2.2-2008
Technical Guideline on EIA: Ecological Assessment	HJ 19-2011
Technical Specification for Water and Soil Erosion Control FOR Construction	GB50434-2008

43. The national environmental quality standard system that supports and evaluates the implementation of the environmental protection laws and regulations in the PRC is classified into two categories by function, i.e. pollutant emission/discharge standards and ambient environmental quality standards. The relevant latest standards applicable to the proposed project are in Table II-5.

Table II-5: Applicable Environmental Standards

Standard	Code

Standard for Flood Control (revised)	GB50201-2014
Urban Ambient Acoustic Quality Standard	GB3096-2008
Noise Limit of Industrial Enterprises	GB12348-2008
Noise Limit for Social Activities	GB22337-2008
Drinking Water Quality Standard	GB5749-2006
Surface Water Quality Standard	GB3838-2002
Standard on Pollutant Discharges from Municipal Wastewater Treatment Plants	GB18018-2002
Ambient Air Quality Standard (revised)	GB3095-2012
Integrated Emission Standard of Air Pollutants (revised)	GB16297-1996
Integrated Wastewater Discharge Standard (revised)	GB8978-2002
Soil Quality Standard (revised)	GB15618-2008
Groundwater Quality Standard	GB/T14848-1993
Noise Limit for Construction Sites (revised)	GB12523-2011
Control Standards for Pollutants in Sludge for Agricultural Use	GB4284-1984
Pollution Control Standard for MSW Landfills (revised)	GB16889-2008
PRC Specification of Domestic MSW Sanitation Landfill	CJJ17-2004

C. International Agreements

44. The PRC is signatory to major international agreements dealing with biodiversity, wetland protection, and climate change. Relevant agreements are listed in Table II-6.

Table II-6: Applicable International Agreements

Agreement	Year	Purpose
Ramsar Wetland Convention	1975	Promote 'wise use' of wetlands
Convention on Biological Diversity	1993	Wetland ecology
UN Framework Convention on Climate Change	1994	Carbon sink from re-vegetation
Kyoto Protocol to UN Framework Convention on Climate Change	2005	Climate change and carbon sink
Montreal Protocol on Substances That Deplete the Ozone Layer	1989	Protect ozone layer (as above)
UN Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification	1996	Fight desertification and soil erosion control

D. Applicable ADB Policies and World Bank's EHS

45. ADB's SPS (2009) provides the basis for this EIA. All projects funded by ADB must comply with the SPS. The purpose of the SPS is to ensure that projects are environmentally sound, designed to operate in line with applicable regulatory requirements, and are not likely to cause significant environment, biology, health, or safety hazards. The SPS also promotes the use of international standards, including the World Bank Group's Environmental, Health and Safety (EHS) Guidelines.[2] EHS guidelines relevant to the project include environment protection, water conservation, hazardous materials, waste management, noise control, sanitation, and community and occupational health and safety. Where EHS standards are higher than national standards, efforts are made for ADB-funded projects to target the EHS standards. The standards applied to this project (Section II.E) are based on comparison of national and EHS thresholds: in cases where no EHS thresholds are available, or the PRC standards are the same or higher than the EHS standards, the national standards are applied. In general, many PRC standards are the same as, or higher than, the EHS standards.

[2] World Bank Group. 2007. Environmental, Health, and Safety Guidelines. Washington, USA. http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines

46. Compared with the PRC EIA requirements, the SPS emphasizes additional requirements, including: (i) a project grievance redress mechanism; (ii) definition of the project area of influence; (iii) assessment of indirect, induced and cumulative impacts; (iv) due diligence of associated facilities; (v) protection of physical cultural resources; (vi) climate change mitigation and adaptation (partly addressed under the PRC's requirement for project-specific energy efficiency and pollution reduction plans); (vii) occupational and community health and safety; (viii) impacts on livelihoods through environmental media; (ix) biodiversity conservation; and (x) a project-specific EMP. This project EIA complies with the SPS requirements.

E. Assessment Standards for Proposed Project Components

a. Surface Water Quality

47. The applicable PRC standards for the project (components for embankments, sediment dredging in Longxi River and its tributaries, and the wetland restoration) are PRC Surface Water Environment Quality Standard (GB3838-2002) – Grades III, IV and V respectively (Table II-7).

Table II-7: Surface Water Quality Standards (mg/L, pH excluded)

Parameter	Grade II	Grade III	Grade IV	Grade V
pH	6~9	6~9	6~9	6~9
COD_{Mn}	≤4	≤6	≤10	≤15
BOD_5	≤3	≤4	≤6	≤6
COD_{cr}	≤15	≤20	≤30	≤40
TP	≤0.1	≤0.2	≤0.3	≤0.4
TN	≤0.5	≤1.0	≤1.5	≤2.0
NH_3-N	≤0.5	≤1.0	≤1.5	≤2.0
Petroleum	≤0.05	≤0.05	≤0.5	≤1.0
Fecal coliform	≤2000	≤10,000	≤20,000	≤40,000

Key: BOD_5= 5 days biochemical oxygen demand, CODcr = chemical oxygen demand, COD_{Mn} = permanganate index, NH_3-N=ammonia nitrogen; TN = total nitrogen; TP = Total Phosphorus.

b. Drinking Water Quality

48. The component for Changshou District includes protection of drinking water source. As existing systems for water treatment cannot remove most of pollutants, the raw water quality of the drinking water must comply with the PRC Drinking Water Quality Standard (GB5749-2006), in which 106 parameters and disinfectant guidelines must be met (Tables II-8 and II-9).

Table II-8: Drinking Water Quality Standards (GB5749-2006)

Parameter	Standard
Routine Parameter of Drinking Water Quality	
Microbiological parameter[3]	
Total coliform (MPN/100 ml or CFU/100 ml)	LD
Thermo-tolerant coliform (MPN/100ml or CFU/100 ml)	LD
Escherichia coli (MPN/100ml or CFU/100 ml)	
Total bacterial count (CFU/ml)	100
Toxicological parameter	
Arsenic (As, mg/L)	0.01
Cadmium (Cd, mg/L)	0.005
Chromium Hexavalent (Cr 6+, mg/L)	0.05
Lead (Pb, mg/L)	0.01

[3] MPN= most probable number; CFU = colony forming unit.

Parameter	Standard
Mercury (Hg, mg/L)	0.001
Selenium (Se, mg/L)	0.01
Cyanide (CN-, mg/L)	0.05
Fluoride (mg/L)	1.0
Nitrate (mg/L)	10
Trichloromethane (mg/L)	0.06
Carbon tetrachloride (mg/L)	0.002
Bromate (when O3 is applied) (mg/L)	0.01
Formaldehyde (when O3 is applied) (mg/L)	0.9
Chlorite (when ClO2 is applied) (mg/L)	0.7
Chlorate (when compound chlorine dioxide is applied) (mg/L)	0.7
Sensory Properties and General Chemical Parameter	
Chromaticity (Unit of platinum cobalt color)	15
Turbidity (diffusing turbidity unit) NTU	1
Odor and Taste	No odor, no taste
Appearance	None
pH	6.5≤X<8.5
Aluminum (Al, mg/L)	0.2
Iron (Fe, mg/L)	0.3
Manganese (Mn, mg/L)	0.1
Copper (Cu, mg/L)	1.0
Zinc (Zn, mg/L)	1.0
Chloride (Cl-, mg/L)	250
Sulfate (SO4-mg/L)	250
TDS (mg/L)	1000
Total Hardness (CaCO3) (mg/L)	450
CODMn (mg/L)	3
Volatile phenols (phenol) (mg/L)	0.002
LAS (mg/L)	0.3
Radioactivity Parameter4	
Total α radioactivity (Bq/L)	0.5
Total β radioactivity (Bq/L)	1
Non-Routine Parameter	
Microbial indicators	
Giardia cysts (count/10L)	<1
Cryptosporidium oocysts (count/10L)	<1
Toxicological parameter (mg/L)	
Antimonium (Sb, mg/L)	0.005
Barium (Ba, mg/L	0.7
Beryllium (Be, mg/L)	0.002
Boron (B, mg/L)	0.5
Molybdenum (Mo, mg/L)	0.07
Nickel (Ni, mg/L)	0.02
Silver (Ag, mg/L)	0.05
Thallium (Ti, mg/L)	0.0001
Cyan chloride (CN- mg/L)	0.07
Chlorodibromomethane (mg/L)	0.1
Bromodichloromethane (mg/L)	0.06
Dichloroacetic acid (mg/L)	0.05
1,2-dichloroethane (mg/L)	0.03
Dichloromethane (mg/L)	0.02

4 Radionuclide phase analysis is conducted if radioactivity value exceeds limits, to determine if the water is drinkable.

Parameter	Standard
THMs	1
1,1,1 - trichloroethane (mg/L)	2
Trichloroacetic acid (mg/L)	0.1
Trichloroaldehyde (mg/L)	0.01
2,4,6- trichlorophenol (mg/L)	0.2
Bromoform (mg/L)	0.1
Heptachlor (mg/L)	0.0004
Malathion (mg/L)	0.25
PCP (mg/L)	0.009
HCH (total amount, mg/L)	0.005
Hexachlorobenzene (mg/L)	0.001
Dimethoate (mg/L)	0.08
Parathion (mg/L)	0.003
Bentazone (mg/L)	0.3
Parathion-methyl (mg/L)	0.02
Chlorothalonil (mg/L)	0.01
Carbofuran (mg/L)	0.007
Lindane (mg/L)	0.002
Chlopyrifos (mg/L)	0.03
Glyphosate (mg/L)	0.7
DDVP (mg/L)	0.001
Arazine (mg/L)	0.002
Deltamethrin (mg/L)	0.02
2, 4 - dichlorobenzene oxygen ethanoic acid (mg/L)	0.03
Dichloro-diphenyl-dichlorothane (mg/L)	0.001
Ethylbenzene (mg/L)	0.3
Dimethylbenzene (mg/L)	0.5
1,1- dichloroethylene(mg/L)	0.03
1,2- dichloroethylene(mg/L)	0.05
1,2- dichlorobenzene(mg/L)	1
1,4- dichlorobenzene(mg/L)	0.3
Trichloroethylene(mg/L)	0.07
Trichlorobenzene(mg/L)	0.02
Hexachlorobutadiene(mg/L)	0.0006
Acrylamide (mg/L)	0.0005
Tetrachloroethylene (mg/L)	0.04
Toluene (mg/L)	0.7
DEHP (mg/L)	0.008
ECH (mg/L)	0.0004
Benzene (mg/L)	0.01
Styrene (mg/L)	0.02
Benzopyrene (mg/L)	0.00001
Chloroethylene(mg/L)	0.005
Chlorobenzene(mg/L)	0.3
Microcystin-LR(mg/L)	0.001
Physical Properties and General Chemical parameters (mg/L)	
Ammonia Nitrogen (NH_3-N, mg/L)	0.5
Sulfide (S, mg/L)	0.02
Sodium (Na, mg/L)	200

CFU = colony-forming unit.

Table II-9: General Parameters and Requirements for Drinking Water Disinfectant

Disinfectant (mg/L)	Exposure duration with water	Limit in water supplied (mg/L)	Residue in water supplied (mg/L)	Residues in network end (mg/L)
Chlorine and free chlorine	≥30 min	4	≥0.3	≥0.05
Monochloramine (total chlorine)	≥120 min	3	≥0.5	≥0.05
Ozone (O_3)	≥12 min	0.3	-	0.02/ ≥0.05 if chlorine is added
Chlorine Dioxide (ClO_2)	≥30 min	0.8	≥0.1	≥0.02

c. Wastewater Discharge

49. Wastewater discharged from construction sites must comply with PRC Integrated Wastewater Discharge Standard of GB8978-1996 – Grade II (Table II-10).

Table II-10: Integrated Wastewater Discharge Standards (mg/L, pH excluded)

Parameter	pH	CODCr	BOD5	SS	NH3-N	Petroleum	TN	TP
Grade II Standard	6–9	100	30	30	25	10	-	3

d. Air Quality

50. Ambient air quality in the project sites meets Grade II of PRC Ambient Air Quality Standard GB3095-1996, GB3039-2012 (January 2016), and World Bank EHS guidelines (Table II-11).

Table II-11: Ambient Air Quality Standard - Grade II (mg/m3).

Pollutant	Time	GB 3096-1996 (Grade II)	GB3095-2012 (Grad II)	EHS
SO_2	Annual average	0.06	0.06	n/a
	Daily average	0.15	0.15	0.125-0.05 (0.02 guideline)
	Hourly average	0.50	0.50	n/a
$PM_{2.5}$	Annual average	-	0.035	0.035
	Daily average	-	0.075	0.075
PM_{10}	Annual average	0.10	0.07	0.07-0.03 (0.02 guideline)
	Daily average	0.15	0.15	0.075-0.15 (0.05 guideline)
NO_2	Annual average	0.08	0.04	0.04 guideline
	Daily average	0.12	0.08	n/a
	Hourly average	0.24	0.2	0.20 guideline
CO	Daily average	4.0	4.0	n/a
	Hourly average	10.0	10.0	n/a

e. Ambient Noise for Environmental Sensitive Spots

51. In accordance with the PRC Ambient Acoustic Quality Standard of GB3096-2008, the noise standards for the proposed project components must comply with Class II. Noise-sensitive areas such as villages, residential communities, and schools are evaluated in accordance with Grade II standards; while the applicable standard along roads is “Grade 4a”, according to the environmental function zoning identified by Chongqing Municipal EPBs (Table II-12).

Table II-12: Acoustic Quality Standards (dB (A))

Standard Category	PRC		World Bank Group EHS	
	Day	Night	Day	Night
I	55	45	n/a	n/a

Standard Category	PRC		World Bank Group EHS	
	Day	Night	Day	Night
II	60	50	55	45
4a	70	55	70	70

f. Noise Levels During Project Construction

52. Construction activities must comply with PRC Noise Limits for Construction Site standard (GB12523-90) (Table II-13).

Table II-13: Noise Limits for Construction Sites Standard (dB(A))

Noise limits	
Daytime	Night
70	55

g. Construction Emissions

53. Asphalt smoke during road re-pavement after pipeline works will be in accordance with Grade II of PRC Integrated Emission Standard of Air Pollutants (GB16297-1996) (Table II-14).

Table II-14: Integrated Emission Standard for Air Pollutants (mg/m^3)

Pollutant	Maximum allowable Emission	Fugitive emission limits at monitoring points
Particles	——	1.0
Asphalt Smoke	40-75	0

54. The PRC Government has a comprehensive program for the control and reduction of vehicle emissions.[5] This includes: (i) improvement and stricter enforcement of national emission standards for new vehicles; (ii) improvement of conventional fuels to make them cleaner with less GHG emissions; (iii) use of alternative or cleaner fuels; (iv) improved maintenance and inspection of vehicles; and (v) encouragement for the scrapping of older high emission vehicles.

h. Standards for Grading of Soil Erosion Intensity

55. Chongqing is located mainly in the “Chinese southwest soil rock area”, which is subject to hydraulic erosion, and where the allowable soil erosion is 500-876 t/km^2 per year. The applicable standard is the Standard for Grading of Soil Erosion Intensity (SL190-2007; Ministry of Water Resources) (Table II-15.)

Table II-15: Standards for Grading of Soil Erosion Intensity

Grade	Average erosion modulus (t/km2·a)	Average erosion thickness(mm/a)
Micro	＜500	＜0.37
Light	500～2500	0.37～1.9
Medium	2500～5000	1.9～3.7
Strong	5000～8000	3.7～5.9
Very Strong	8000～15000	5.9～11.1
Extremely strong	＞15000	＞11.1

[5] PRC Air Pollution Control Action Plan (2013). Ministry of Environment Protection.

i. Construction-induced Vibration

56. Construction activities may cause vibration impact and must comply with PRC Standard for Urban Area Environmental Vibration (GB10070–88) (Table II-16).

Table II-16: Vertical (Z) 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

F. Domestic EIA Preparation and Approval

57. Five domestic “environmental impact reports” (DEIAs) were prepared for the project, by four certified EIA institutes (DEIA institutes) (Table II-17). All reports were approved on or by 14 March 2018, by the environment protection bureaus (EPBs) of the project county and two districts. The approval authority by the EPBs for the DIAs was delegated to them by the Chongqing Municipal Environment Protection Department.

Table II-17: Domestic EIA Preparation and Approval

No.	Region	Town	Institute	Approval Number	Authority
1	Changshou District	All	Chongqing Yujia EIA Co.	CS-Env-(2018)-01; CS-Env-(2018)-02	Changshou District EPB
2	Dianjiang County	All	Chongqing Yujia EIA Co.	DJ-Env- (2018)-38	Dianjiang County EPB
3	Liangping District	Jindai	Environmental Research Institute of Chongqing Industrial and Commercial University	LP-Env- (2018)-18	Liangping District EPB
4		Upreach of Longxi River	Chongqing Houke Environment Protection Company		As above
5		Heline, Pingjin	Chongqing Zhonglian Design Institute	LP-Env- (2018)-19	As above

EPB = environment protection bureau.

III. DESCRIPTION OF THE PROJECT

A. Rationale

58. Chongqing Municipality is located in the Yangtze River Economic Belt (YREB), a region targeted for economic development. The YREB covers nine provinces and two specially-administered cities (Shanghai and Chongqing) within the Yangtze River Basin. The Yangtze River is the third longest river in the world and flows from west to east across the PRC. The basin is over 2 million km^2 in size and covers one-fifth of the country's total area. Over 40% of the PRC's population and 40% of its freshwater resources is located in the YREB: the region provides drinking water resources for 400 million people, contributes about 45% of the PRC's economic output, and has 20% of the PRC's total wetland area.

59. The YREB has benefitted from extensive development over the last three decades particularly in the Yangtze River Delta Area (mainly Shanghai City and the partial provinces of Jiangsu and Zhejiang), yet economic growth in the middle and upper reaches of the Yangtze River Basin is lagging. This is due to: (i) slow transformation for green development and economic diversification; (ii) limited integration of waterways, ports, and intermodal logistics; (iii) increasing pollution and pressure on natural resources; and (iv) weak institutional coordination for strategic planning.[6] At the same time, the YREB is facing environmental problems and a widening disparity between urban and rural areas. The Government has started focusing on environmental and ecological protection and social inclusiveness as laid out in the YREB development plan.

60. The PRC Government requested ADB to support and strengthen efforts in the environmental protection and restoration of the Yangtze River. A four-year (2017-2020) strategic approach is being implemented, comprising $1.8 billion ADB lending support for the YREB to be implemented through several linked projects. These projects will address the priority areas of (i) ecosystem restoration, environmental protection and management of water resources; (ii) transformation for green and inclusive development; and (iii) institutional strengthening and policy reform. The projects will contribute to the targets of the PRC's YREB development plan (initiated in 2016)[7] to guide local governments towards the overarching goal of ecological restoration and green development. It includes ambitious targets to improve environmental quality of the Yangtze River by 2020 e.g.: over 75% of water to meet Grade III[8] standard, and forest cover to reach 43%. "Industrial transformation" is a priority in the plan and promotes an innovative and modern industrial system to be implemented by 2030.[9]

61. Chongqing Municipality suffers from frequent flooding. One of the worst flood affected areas in the municipality is the Longxi River basin, where the project is located. The total length of Longxi River in in Chongqing is 230 km with a basin area of 2,966 km^2 and a current population of 2.1 million. The river originates in Liangping District, passes through Dianjiang County, and merges into the Yangtze River in Changshou District. The water quality in Longxi River is lower than the Grade III national Surface Water Standard, resulting from point and non-point pollution. About 40% residents in the basin do not have access to modern solid waste and wastewater facilities. There are over 10 km^2 of active fish ponds along the river corridors, which discharge polluted water directly

---

[6] ADB. 2016. *Yangtze River Economic Belt Environmental Protection and Rehabilitation Project—A Preliminary Study.* Manila (staff consultant report).

[7] E.g.: http://www.chinadaily.com.cn/china/2016-01/08/content_22986241.htm; http://www.chinadaily.com.cn/china/2016-03/09/content_23802132.htm ; and http://en.xfafinance.com/html/Policy/2016/259222.shtml

[8] Water quality of Grade III or above is suitable as the source water for centralized supply of drinking water.

[9] ADB Institute. 2017. Industrial transfer and the remaking of the People's Republic of China's competitive advantage. ADBI Working Paper Series No. 762. Tokyo.

into the river. Available data on pollution loads to the Longxi River indicates that in 2013 (the most recent available), pollutants from fishponds contributed the following proportions to total river pollution: 4.2% COD_{cr} (1,678 tons/year), 2.09% TN (163 tons/year) and 4.85% TP (31 tons/year). In comparison, the categories of "urban sewers" and "industry" contributed the highest amounts of pollutants to the river (over 50% of total COD_{cr} and over 29% each for TN and TP).[10] This issue of fishpond pollution will be addressed by the government in a separate project under the Chongqing Master Plan. The water quality in one lake (Changshou; 65 km^2) has deteriorated due to eutrophication from untreated waste disposal. High sediment loads, due to bank erosion, landslides, and mining, has contaminated the water and exacerbated flooding. Climate change impacts may worsen the water quality (due to decreased annual river flows), and increased rainfall intensity may cause increased flooding (from 1:50 years to 1: 10 year returns by 2050).

62. The project will pilot an integrated river basin management in the Longxi River and aims to achieve river basin level impact instead of fragmented projects at a smaller scale. The past approach of discrete projects managed by individual departments will be replaced by a more centralized system, coordinated by the river chiefs, who are the heads of the local governments under the new River Chief system being implemented in the PRC. This will be demonstrated under the project. The Longxi river basin is strategically important as it is a part of the ecological conservation zone of Three Gorge Reservoir, which plays a significant role in managing flood and water quality in the middle and lower Yangtze river basin. Flood, waste and ecological management in the Longxi river basin may impact the Yangtze River basin. The project will contribute to a demonstration of environmentally sustainable growth for the YREB.

63. The project focus on flood control, water quality, and IWRM is consistent with the Thirteenth Five Year Plan of the PRC (2016–2020) and in turn the Thirteenth Five Year Plan of Chongqing Municipality. These plans promote environmentally friendly and resource-efficient development, reduction of natural disasters, improvement of residents' living standard and an all-around well-off society. The CMG has issued specific guidelines and policies to promote river management. In 2016, CMG developed (a) the Thirteenth Five Year Plan of Water Resource Development, which outlined five "function areas" (Urban Functional Core Area, Urban Function Development Area, Urban Development New District, Chongqing Northeast Ecological Conservation Development Area and Chongqing Southeast Ecological Protection Development Area); and (b) with the Ministry of Water Resources, issued the Strategic Planning for Water Conservancy Development in Five Function Areas in Chongqing. The plans identify development targets to 2030, for water supply, irrigation, flood control, water resources protection, and IWRM. In 2017, the CMG issued the Implementation Program for Longxi River Watershed Ecological Restoration and Management, which included the need to address non-point source pollution and to improve water quality of the Longxi River to Grade III or above. The project design is also consistent with ADB's Strategy 2020 and ADB's Country Partnership Strategy for the PRC, 2016–2020, which supports innovation, inclusive growth, the removal of economic constraints, climate change abatement, and the promotion of sustainable economic growth and policy and institutional reforms.

[10] Eastern China Design and Research Institute / Chongqing Jianghe Engineering Consulting Center / Chongqing Zhongxin Engineering Consulting Center. 2016. Study Report for Longxi River Watershed Planning. Hangzhou.

B. Impact, Outcome and Outputs

64. The expected project impact is environmental rehabilitation, protection, and management of the Yangtze River improved. The project outcome is environmental sustainability in the Longxi River watershed improved. The project has four outputs, as follows.

65. **Output 1: Flood risk management infrastructure constructed.** This output will implement: (i) flood preventive measures including construction of discontinuous embankments, river dredging, pilot flood sensitive road planning and design, and transformation of small barrages to gated structures; (ii) water retention measures including temporary flood retention areas, and installation of flood diversion structures; and (iii) flood preparedness measures including construction of the shelters, emergency access roads.

66. **Output 2: Wastewater management and pollution control infrastructure developed.** This output will implement: (i) wastewater management system including installation of wastewater collection network to existing wastewater treatment facilities, and (ii) non-point source water pollution control measures including the bio-shield along the river banks adjacent to the farmland.

67. **Output 3: Ecological conservation facilities improved.** This output will implement: (i) wetland conservation including restoration of wetlands in existing lakes and expansion of wetlands in lakes and rivers; (ii) landscaping including greening and gardening along the river corridors; (iii) river bank protection and erosion control and watershed conservation, water sources protection, lake and river banks protection, and lakeside greening and gardening in Changshou Lake.

68. **Output 4: Flood and environmental risk management capacity enhanced.** This output will include: (i) hydro-meteorological and water quality monitoring services in the Longxi River watershed including the establishment of flood footprint accountability mechanism, development and installation of flood risk and water pollution simulation models, introduction of real-time flood and water quality monitoring system with geographic information system interface, and installation of telemetric water level and water quality measurement stations; (ii) development planning and programming including preparation of FERM investment roadmap and formulation of medium- and long-term comprehensive FERM plans, and draft recommendation for land-use planning and regulations; and (iii) capacity development of CMG, local governments, and communities including training programs; piloting the flash-flood early warning system; promotion of community-based FERM including household level solid waste management pilot works; establishment of Longxi River coordination unit in CMG to aid river chief system, drafting recommendation for land-use planning and regulation, and updating reservoir operational guidelines.

69. The project involves 19 towns in the two districts of Liangping (6 towns) and Changshou (7 towns) and Dianjiang County (6 towns), including 31.4 km mainstream of Longxi River (12.9% of the total river length in the three county/districts), and 17 tributaries with the total length of 59.1 km. the project involved towns and river/tributaries are summarized in Table III-1, and the construction works are summarized in Table III-2. All project outputs and subprojects (structural and non-structural) are described in Table III-3.

Table III-1: Towns and Rivers in the Project Area

District/ County	Town/Subdistrict	River/Tributary	Numbers of construction site
Liangping District	Shuanggui, Jindai, Helin, Pingjin, Mingda, Liangshan (6)	• Longxi River Mainstream • Seven tributaries: Huilong, Sandengpo, Longdong, Shizhu, Huashi, Xiaojia, Baisha	33

Dianjiang County	Gao'an, Gaofeng, Pushun, Guixi, Zhoujia, Xinmin (6)	• Longxi River Mainstream • Five tributaries: Huilong, Longdong, Shizhu, Huishi, Xioajia	15
Changshou District	Dandu, Haitang, Yuntai, Shiyan, Shuanglong, Longhe, Linfeng (7)	• Longxi River Mainstream • Nine tributaries: Dayu, Tuqiao, Qingmailiangyuan, Yuntai, Shuanglong, Qilin, Longdong, Jiaojia, Lanjia	23

Table III-2: Summary of Project Construction Works

Item	Embankment (km)	Dredging (km)	Bridge	Road*	Sewer Pipeline	Wetland (mu)	Green belt (mu)	Ecological buffer zone (mu)
Liangping District								
Longxi River mainstream	16.40	0	0	0	0	10.8	308.24	68.45
Seven tributaries	33.22	0.4	11	0	0	21.66	511.46	125.7
Shanggui Lake						1,830.46		
Subtotal	49.62	0.4	11	0	0	32.46	819.7	194.15
Changshou District								
Longxi River mainstream	4.45	0	1	3.25	6.4	0	209.58	32.18
Nine tributaries	64.81	5.0	20	6.1	33.22	0	950.73	313.83
Subtotal	69.26	5.0	21	9.35	39.62	0	1160.31	346.01
Dianjiang County								
Longxi River mainstream	37.51	0	5	0	0	114.98	560.98	195.08
Xinmin tributary	1.69	2.45	0	0	0	9.6	38.4	12.0
Subtotal	39.2	2.45	5	0	0	124.58	599.38	207.08
TOTAL	**158.08**	**7.85**	**37**	**9.35**	**39.62**	**1,987.50**	**2,579.39**	**747.24**

*The project-supported roads will be located on the tops of the embankments and will be for emergency access use including flood evacuation.

Table III-3: Summary of Outputs and Components

No.	Output/Component	Major Contents
Output 1: Flood Management Infrastructure Constructed		
L1	**Liangping District**	
L1.1	**Longxi River and tributary improvement for the towns of Helin, Pingjin, Mingda and Liangshan**	
L1.1.1	Helin Town flood control works	
(i)	Barrage construction	Renovation to steel barrage at Aiguo Power Station
(ii)	Ecological embankment	6.62 km embankment along Longxi River (river length of 3.31 km), including riverbank landscaping
L1.1.2	Mingda Town flood control works	
(i)	Eco-embankment along Longxi River	5.56 km of ecological embankment along Longxi River including renovation of two barrages
(ii)	Eco-embankment at Sandengpo tributary	3.99 km of ecological embankment along Sandengpo tributary
L1.1.3	Pingjin Town Flood Control Works	
(i)	Eco-embankment along Huilong River	8.76 km of eco-embankment along Huilong Tributary including dredging (0.4 km)
L1.2	**Ecological and Environmental Improvement of Longxi River Upstream at Liangping Urban and Surrounding Area (Shuanggui Lake Wetland Area)**	
(i)	Northern Bank Area	391 m eco-embankment with subsidiary facilities

No.	Output/Component	Major Contents
(ii)	North bank – Phase II	680 m eco-embankment with emergency road, foot bridge and facilities
(iii)	Emergency road on western side of Shuanggui Lake Park	1.4 km emergency road and one bridge
L1.3	**Jindai Town Longxi River and tributary comprehensive treatment - Flood Control Works**	
(i)	Longxi River	4.22 km of eco-embankment along Longxi River.
(ii)	Longdong River (tributary)	6.38 km of eco-embankment on Longdong tributary with ancillary facilities.
(iii)	Shizhu River (tributary)	4.53 Km of eco-embankment with ancillary facilities
(iv)	Huashi Stream (tributary)	0.82 km of eco-embankment on Huashi Stream with ancillary facilities.
(v)	Xiaojia Stream (tributary)	2.40 km of eco-embankment on Xiaojia Stream with ancillary facilities.
L1.4	**Connection between Yanjingkou Reservoir and Xiaosha River**	
(i)	Baisha tributary	6.34 km on Baisha River, including 3.3 km sediment dredging and two hydraulic flap-gates
D1	**Dianjiang County**	
D1.1	**Pushun Town Flood Control Works**	
(i)	Eco-embankment (Longxi mainstream)	3.75 km along Longxi River
D1.2	**Gaoan Town Flood Control Works**	
(i)	Eco-embankment (Longxi mainstream)	25.86 km eco-embankment on Longxi mainstream including 4 emergency access bridges
D1.3	**Gaofeng Town Flood Control Works**	
(i)	Eco-embankment (Longxi mainstream)	7.9 km including one emergency access bridge
(ii)	Emergency evacuation shelter	Emergency evacuation shelter (3,000 m^2)
D1.4	**Zhoujia Town Flood Control Works**	
(i)	Emergency evacuation shelter	Emergency evacuation shelter (3,000 m^2)
D1.5	**Xinmin Town Flood Control Works**	
(i)	Eco-embankment (Xinmin River)	1.69 km on tributary of Xinmin River
C1	**Changshou District Flood Management**	
C1.1	**Dandu Town Flood Control and Water Resource Protection**	
(i)	Eco-embankment (Longxi mainstream)	4.45 km including one emergency foot bridge
C1.2	**Dayuxi Tributary Comprehensive Treatment – Flood Control Works**	
C1.2.1	**Haitang Town Flood Control Works (Dayuxi tributary)**	
(i)	Eco-embankment (Dayuxi stream)	7.4 km including i) one emergency access road, i) one emergency foot bridge; iii) two emergency bridges; and iv) 2.0 km sediment dredging
(ii)	Eco-embankment (Tuqiao tributary) **（Non ADB financed）**	1.0 km on Tuqiao Tributary
(iii)	Emergency shelter	Emergency shelter (5,000 m2)
C1.2.2	**Yuntai Town Flood Control Works (Dayuxi tributary)**	
(i)	Eco-embankment (Dayu Stream)	10.2 km including 3 emergency bridges and 1.0 km sediment dredging
C1.2.3	**Shiyan Town Flood Control Works (Dayuxi tributary)**	
(i)	Emergency bridge	Emergency bridge on Dayu Stream
C1.3	**Longxi River Tributary Comprehensive Treatment – Flood Control Works**	
C1.3.1	**Shuanglong Town Flood Control Works**	
(i)	Eco-embankment (Shanglong River)	11.45 km eco-embankment on Shuanglong River including three emergency bridges
(ii)	Flood diversity works	518 m flood diversity channel at Wangjiagou
C1.3.2	**Longhe Town Flood Control Works (Longhe River tributary)**	

No.	Output/Component	Major Contents
(i)	Eco-embankment (Longhe River tributary)	23.4 km eco-embankment on Longhe River including 4.3 km emergency road, one emergency foot bridge and three emergency bridges
C1.3.3	**Lingfeng Town Flood Control Works**	
(i)	Eco-embankment on Jiaojia River and Lanjia River (tributaries)	4.0 Km eco-embankment on Jiaojia River and 4.0 km on Lanjia River, including 6 emergency foot bridges, 2 emergency bridges and 2.0 km sediment dredging
Output 2: Wastewater Management and Pollution Control Infrastructure Developed		
L2.1	**None-point Pollution control in the towns of Helin, Pingjin and Mingda**	
(i)	Helin Town	Eco-vegetation buffer zone (30,093 m^2).
(ii)	Mingda Town	Eco-vegetation buffer zone (20443 m^2).
(iii)	Pingjin town	Eco-vegetation buffer zone (23793m^2).
L2.2	**Ecological and Environment Improvement of Longxi River Upstream at Liangping Urban and Surrounding Area (Shuanggui Lake Wetland)**	
(i)	Northern Bank Area	Installation of 60 refuse bins
L2.3	**Jindai Town Longxi River and Tributary Comprehensive Treatment - Non-Point Pollution Control**	
(i)	Longxi River mainstream	Eco-vegetation buffer zone (15539 m^2)
(ii)	Longdong river (Tributary)	Eco-vegetation buffer zone (13923 m^2)
(iii)	Shizhu River Tributary	Eco-vegetation buffer zone (15256 m^2)
(iv)	Xiaojiagou stream (tributary)	Eco-vegetation buffer zone (10385 m^2)
D2	**Dianjiang County Wastewater Management and Pollution Control**	
D2.1	Gao'an Town	Riparian eco-vegetation belt (99,829 m^2)
D2.2	Gaofeng Town	Riparian eco-vegetation belt (36146 m^2)
D2.3	Xinmin Town	Riparian eco-vegetation belt (13200 m^2)
D2.4	Pushun Town	Riparian eco-vegetation belt (5682 m^2)
C2	**Changshou District Wastewater Management and Pollution Control**	
C2.1	**Dandu Town Wastewater Management and Pollution Control**	
(i)	Eco-vegetation buffer zone	Eco-vegetation buffer zone (21450 m^2)
(ii)	Sewer interception network	6.4 km sewer interception network; and two pumping stations
C2.2	**Dayuxi Tributary Comprehensive Treatment – Wastewater Management and Pollution Control**	
C2.2.1	**Haitang Town Wastewater Management and Pollution Control**	
(i)	Sewer interception **(Non-ADB financed)**	8.8 km sewer interception network
(ii)	Bio-shield	Eco-vegetation buffer zone (16,280 m^2)
C2.2.2	**Yuntai Town Wastewater Management and Pollution Control**	
(i)	Sewer interception **(Non-ADB financed)**	6.9 km Sewer interception network
(ii)	Bio-shield	Eco-Vegetation buffer zone (22,440 m^2)
C2.2.3	**Shiyan Town Wastewater Management and Pollution Control**	
(i)	Sewer interception **(Non-ADB financed)**	2.75 km sewer interception network
C2.3	**Longxi River Tributary Comprehensive Treatment– Wastewater Management and Pollution Control**	
C2.3.1	**Shuanglong Town Wastewater Management and Pollution Control**	
(i)	Bio-shield	Eco-Vegetation buffer zone along Shuanglong River (24200 m^2)
(ii)	Sewer interception **(Non-ADB financed)**	7 km sewer interception network
C2.4	**Longhe Town Wastewater Management and Pollution Control**	
(i)	Bio-shield	Eco-vegetation buffer zone (1,287,800 m^2)
(ii)	Sewer interception **(Non-ADB financed)**	7.0 km sewer Interception trunk pipeline
(iii)	Small wastewater treatment facility	Small wastewater treatment facility at the nursing home (13m3/day)

No.	Output/Component	Major Contents
C2.5	**Lingfeng Town Wastewater Management and Pollution Control**	
(i)	Sewer interception (Jiaojia area)	1.8 km sewer interception network
(ii)	Sewer interception **(Non-ADB financed)**	1.72 km sewer interception network in Linfeng Town
(iii)	Bio-shield	Eco-vegetation buffer zone (8800m^2)
Output 3: Ecological Conservation Facilities Improved		
L3	**Liangping District Ecological and Environmental Improvement**	
L3.1	**Ecological and Environmental Improvement in the towns of Helin, Pingjin and Mingda Town**	
(i)	Helin Town	Riparian eco-landscaping (95778 m2), aquatic plant (5200 m2) and subsidiary facilities.
(ii)	Mingda Town	Riparian eco-landscaping (58445 m^2), aquatic plant (4200 m^2), and subsidiary facilities
(iii)	Pingjin Town	Riparian eco-landscaping (78973 m^2), aquatic plant (3800 m^2), and subsidiary facilities
L3.2	**Ecological and Environment Improvement of Longxi River Upstream at Liangping Urban and Surrounding Area (Shuanggui Lake Wetland Area)**	
(i)	Northern Bank area	Eco-landscaping (19,590 m2)
(ii)	North bank – Phase II	The wetland (1712 m^2), and eco-landscaping (153,070 m2)
(iii)	Zhangxingqiao lakeside area	Eco-landscaping (129,149 m^2)
L3.3	**Ecological and Environmental Improvement in Jindai Town**	
(i)	Longxi River mainstream	Riparian eco-landscaping (64072 m^2), aquatic plant (2000 m^2) and subsidiary facilities
(ii)	Longdong River Tributary	Riparian eco-landscaping (32133 m^2), aquatic plant (1800 m^2), and subsidiary facilities
(iii)	Shizhu River Tributary	Riparian eco-landscaping (71955 m^2), aquatic plant (3780 m^2), and subsidiary facilities
(iv)	Xiaojiagou stream tributary	Riparian eco-landscaping (15656 m^2), aquatic plant (860 m^2), and subsidiary facilities
L3.4	**Liangping District - Connection Works between Yanjingkou Reservoir and Xiaosha River**	
(i)	Baisha River	Eco-embankment protection (41303 m^2)
D3	**Dianjiang County Ecological and Environmental Improvement**	
D3.1	Gao'an Town	Binghe wetland (80 mu) and eco-landscaping
D3.2	Gaofeng Town	Eco-landscaping (88530 m2)
D3.3	Chengxi town	Sanhe Reservoir (300 mu) including barrage fixed, and bank improved
D3.3	Pushun Town	Eco-landscaping (5682 m2)
D3.5	Xinmin Town	Eco-landscaping (13330 m2)
C3	**Changshou District Ecological and Environmental Improvement**	
C3.1	**Dandu Town Flood Control and Water Resource Protection**	
(i)	Dandu Town	Eco-landscaping (118243 m^2)
C3.2	**Dayuxi Tributary Comprehensive Treatment - Ecological and Environmental Improvement**	
(i)	Haitang Town	Eco-landscaping (60460 m^2)
(ii)	Yuntai Town	Eco-landscaping (74826 m^2)
C3.3	**Longxi River Tributary Comprehensive Treatment - Ecological and Environmental Improvement**	
(i)	Shuanglong Town	Eco-landscaping (69575 m^2)
(ii)	Longhe Town	Eco-landscaping (43243 m^2)
(iii)	Linfeng Town	Eco-landscaping (38060 m^2)
Output 4: Flood and Environmental Risk Management Capacity Enhanced		
L4.1	Procurement of monitoring equipment in Liangping District	Establishment of hydrological and water quality monitoring points and procurement of monitoring equipment (Liangping District)

No.	Output/Component	Major Contents
D4.1	Procurement of monitoring equipment in Dianjiang County	Establishment of hydrological and water quality monitoring points and procurement of monitoring equipment (Dianjiang County)
C4.1	Procurement of monitoring equipment in Changshou District	Establishment of hydrological and water quality monitoring points and procurement of monitoring equipment (Chaoshou District)
CS4.1	Consulting services for early warning and forecasting system of flood control and water pollution in Longxi River watershed	i) Development of a GIS based quantitative hydraulic model in Longxi River; ii) Development of a GIS based quantitative water quality model in Longxi River iii) Purchase of equipment for flood control monitoring and water quality monitoring center; and iv) Assessment for establishment of monitoring points and upgrade of monitoring equipment in the county/districts; and v) Establishment of flood and water quality system including hydrologic information and water quality tracking, emergency response and river-chief functions.
CS4.2	Consulting services to support Project Management	

L = Liangping District; C = Changshou District; D = Dianjiang County. Source: FSRs (February 2018). Barrage = small weir constructed for “run-of-the-river” hydropower generation.

70. The project will support limited works in one reservoir, Shanggui, and improved water resources management for two reservoirs, Shanggui and Sanhe. Both are multiple-purpose reservoirs, designed for recreation and flood regulation, and comprise vegetated banks surrounded by agricultural land and settlements. The government is implementing separate (non ADB-funded) development works at both reservoirs. Shanngui Reservoir is currently under review by the State Forestry Administration for designation as a national wetland park. The project will support landscaping and revegetation of wetland habitats. For Sanhe Reservoir, there is no ADB financing of works; the domestic-financed proportion of the project will support the construction of embankments and planting of about 20 ha (300 mu) of wetland habitats (Section III.C).

C. Design scheme and Construction Methods

71. **Ecological river sediment dredging:** the project includes 7.85 km river sediment dredging, with a total dredged sediment of 215,000 m^3 (with 80% water content). There is no dredging work in Longxi mainstream, but the five tributaries. The dredging will be conducted to a depth of 0.5–0.7 m, to achieve the project objectives for flood control and removal of polluted sediments. Based on available studies, dredging may remove up to 80% of polluted sediments.[11]

72. For four of the five channels to be dredged (Table V-9), the “ecological dredge method” will be applied. This method is implemented in two stages: dredging of the top layer of the sediments (about 0.5 m), then, dredging to target depth. The top layer of sediment will be transferred to existing cleared land on the channel banks adjacent to the dredge sites, where it will be placed on top of a simple textile layer (to protect the ground) for dewatering and drying. A small temporary earth drain will be established around each drying site to drain the water back into the channel. For these four channels, the dredging equipment to be used will include a specialized ‘cutter head’, which sucks

[11] Po Tao and Ji Min. 2017. Study for Inner Pollution Removal Technology. *Ecological and Environmental Science* 26(3): 514-521; and, Bao Taofang and Zhu Lijuan. 2011. Ecological Dredging Technology in Yixing Tai Lake Restoration. *Jianshu Hydraulics*.

up sediment and limits dispersion and therefore turbidity impacts. For Yuntai River in Changshou District, because the river is highly polluted (worse than Grade V) and it is a seasonal river, the dredging will be dry excavation rather than wet dredging, as the works will be done in the dry season. This will be much less impacting than wet dredging. Final disposal of the dredged sediment will be subject to the results of a second round of sediment and water sampling (Section V.D.5).

73. **Ecological embankment.** The project includes 158.08 km embankment. During the TRTA, two embankment designs were assessed for the embankment construction, traditional concrete embankment and ecological embankment. The ecological embankment method will be used. The traditional reinforced concrete river banks used to be widely constructed in the PRC, which is good for flood control, but has high ecological impacts. The ecological embankment method minimizes ecological impacts, through the use of permeable natural beds and bank bases, to reduce impacts to riparian ecology and ecosystem function such as water filtration and retention. Figures III-1 to III-21 show the ecological embankment designs.

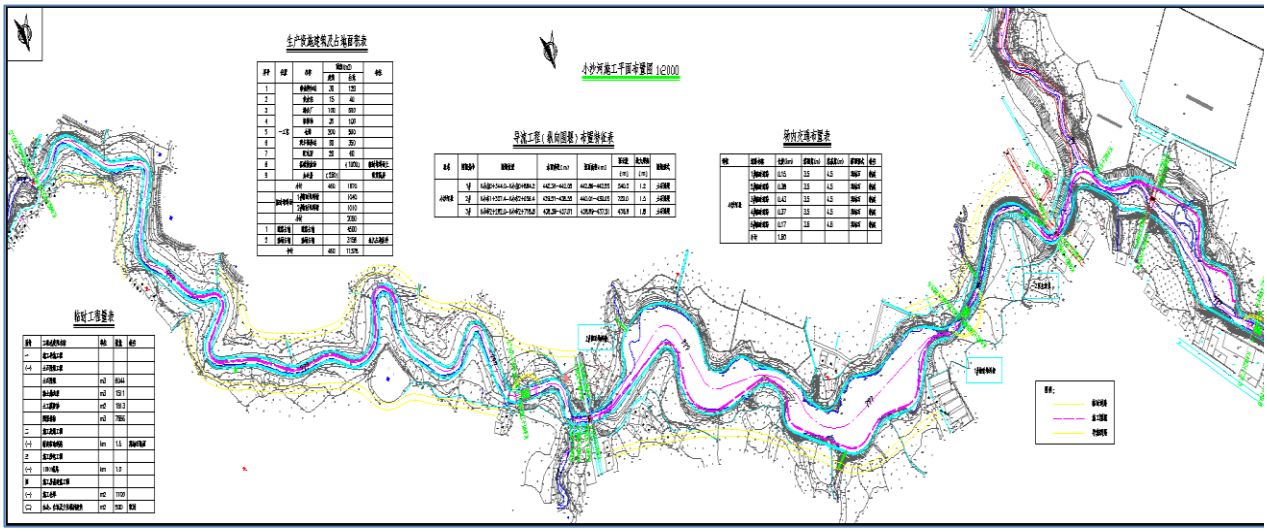


Figure III-1: Plan of Xiaosha River Rehabilitation Component (Liangping Section)

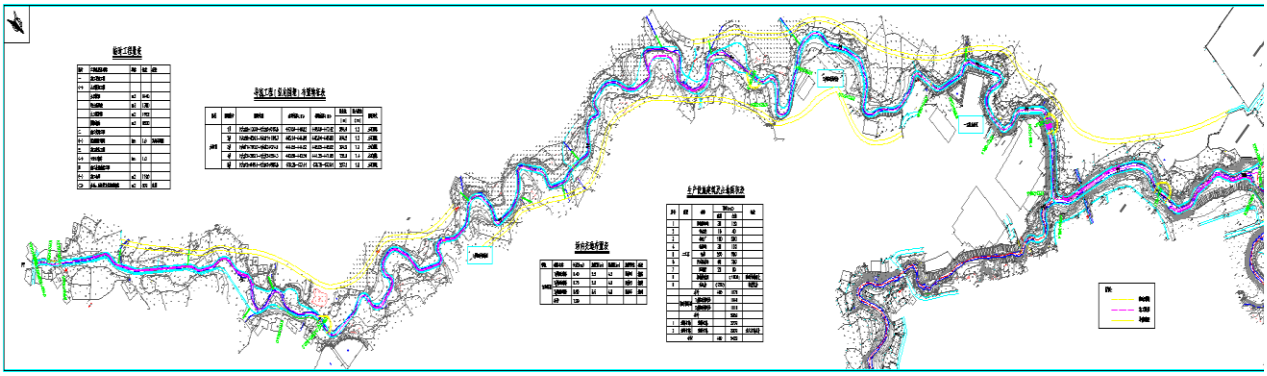


Figure III-2: Plan of Dahe River Rehabilitation Component (Liangping Section)

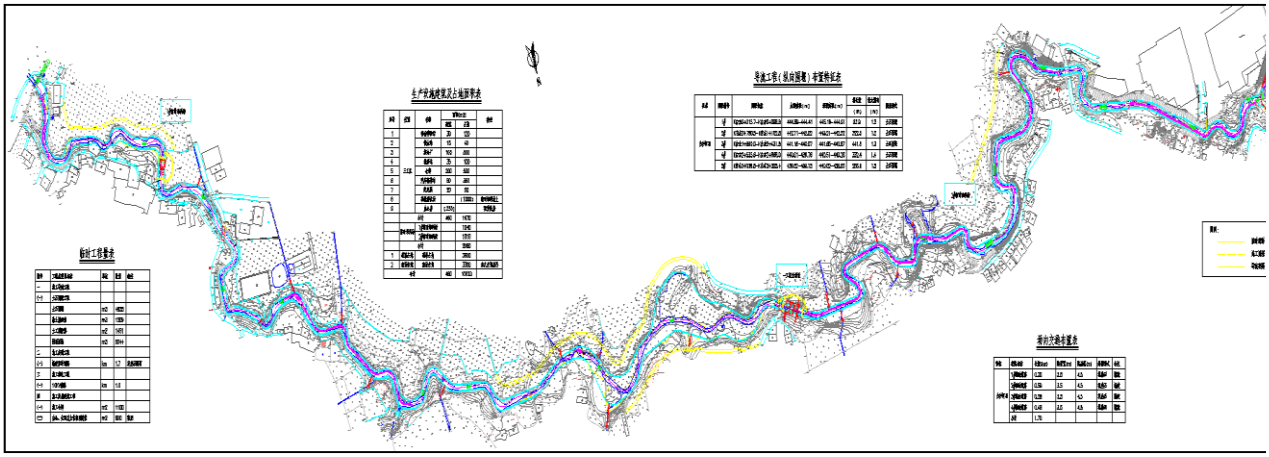


Figure III-3 Plan of Baisha River Rehabilitation Component (Liangping Section)

Figure III-4+5: Proposed Cross Section of Longxi River (Helin Town of Liangping District)

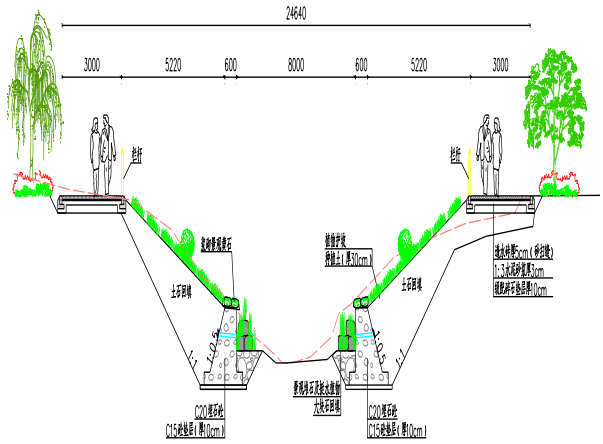


Figure III-6+7: Proposed Cross Section of (Huilong River, Sandengpo Branch, Baisha River, Dahe River and Xiaosha River (Liangping)

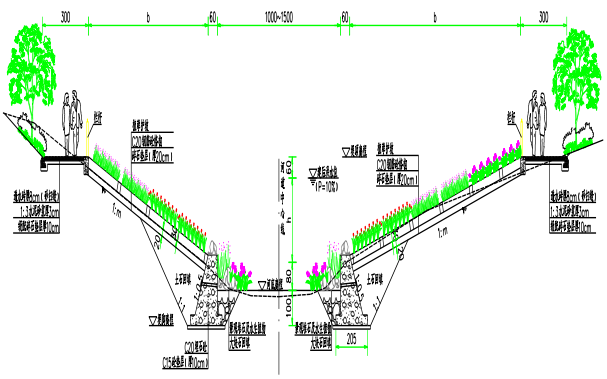


Figure III-8+9: Proposed Cross Section of Longxi River (Mingda Town of Liangping District)

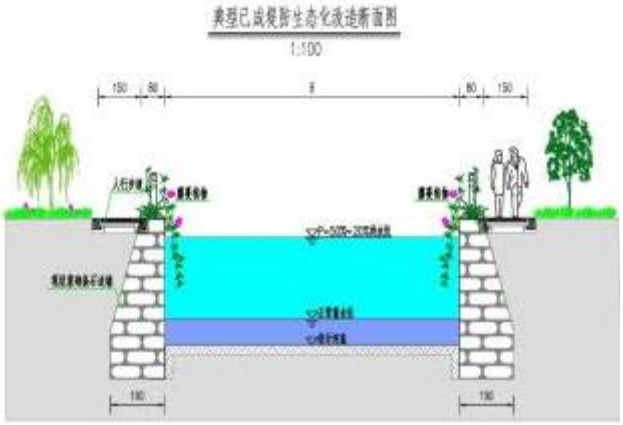


Figure III-10+11: Eco-renovation for the rivers with built embankments along Huilong River, Baisha River, Dahe River and Xiaosha River (Liangping District)

Figure III-12+13: Existing river weir and Proposed hydraulic flap gate at Aiguo Power Station

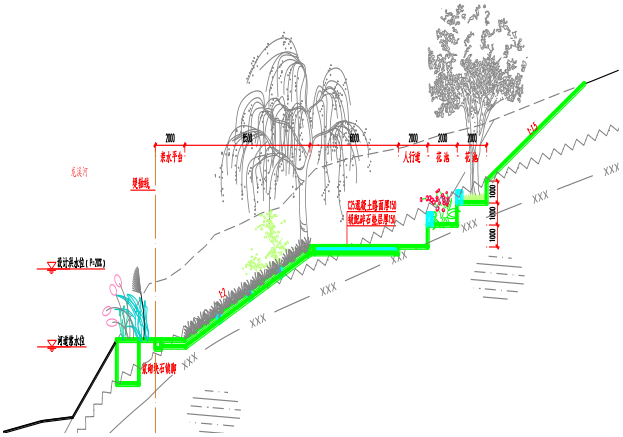


Figure III-14: Proposed Cross Section of Longxi River (Dianjiang Section)

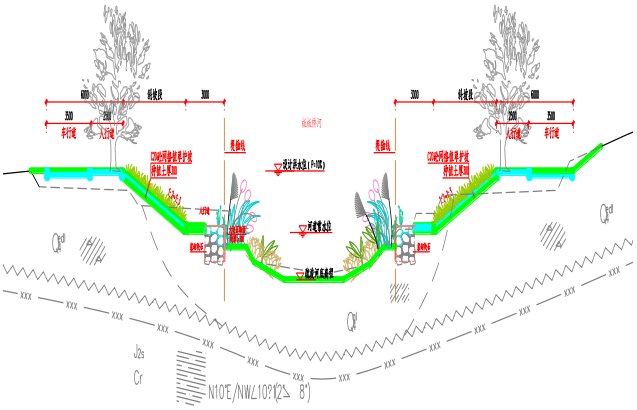


Figure III-15: Proposed Cross Section of Banqiao River (Dianjiang)

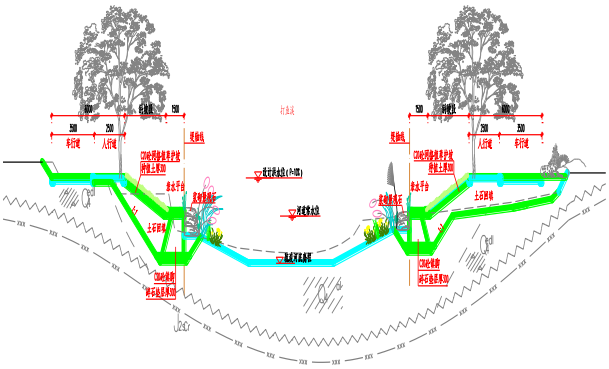


Figure III-16 Proposed Cross Section of Dayu Stream (Dianjiang)

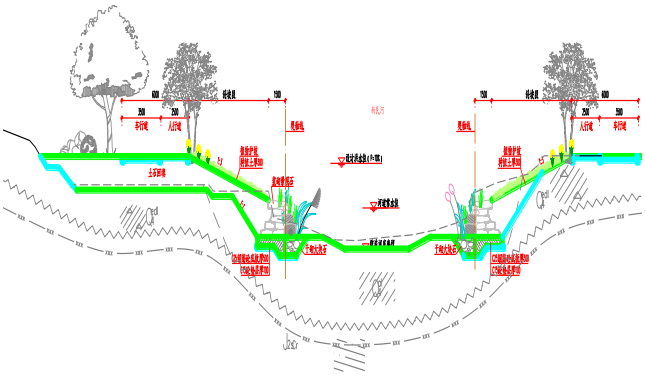


Figure III-17 Proposed Cross Section of Xinmin River (Dianjiang)

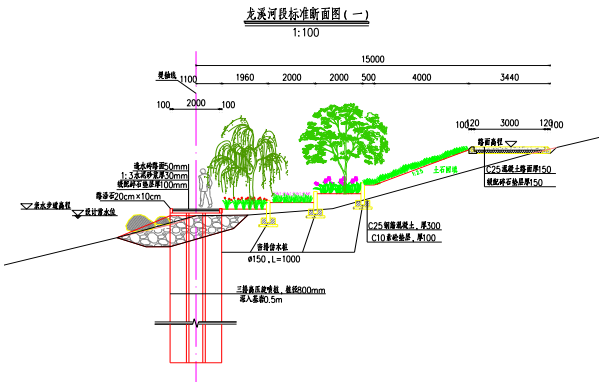


Figure III-18 Proposed Cross Section of Longxi River (Changshou)

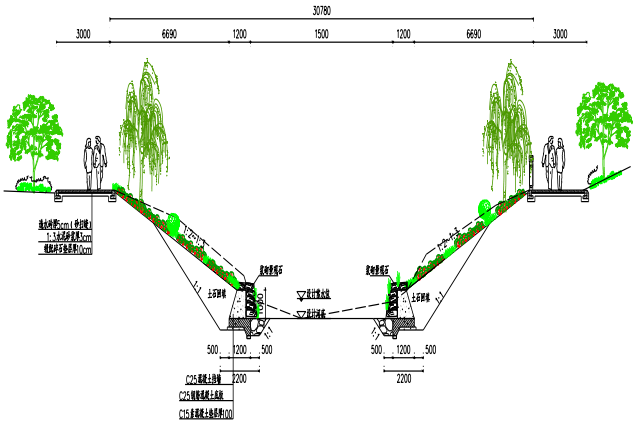


Figure III-19 Proposed Cross Section of Dayu Stream (Changshou)

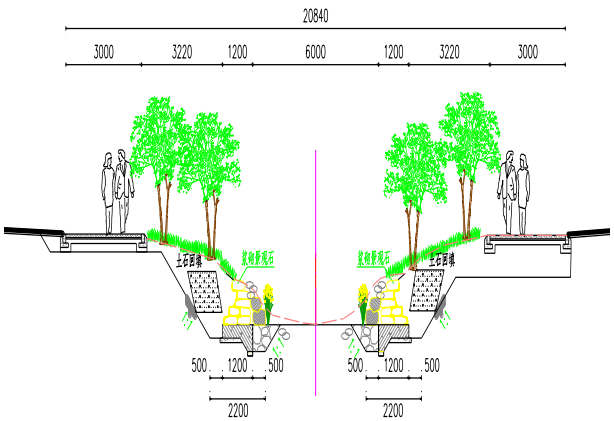


Figure III-20 Proposed Cross Section of Tuqiao River and Shita River (Changshou)

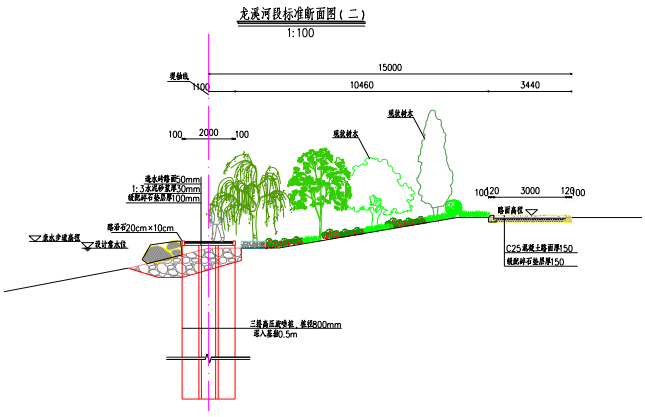


Figure III-21 Proposed Cross Section of Longxi River (Dandu Tang, Changshou)

74. **Green belts.** Non-point source pollution is a major pollution source in the Longxi River watershed. Mean annual non-point pollutant loads of COD_{cr}, NH_3-N, TN and TP entering the river are estimated to be 1,995 t/a (4.86% of total pollution load), 399 t/a (12.41%), 3,991 t/a (49.85%) and 200 t/a (30.49%) respectively.[12] To contribute to reducing the amount non-point source pollution entering the Longxi River and tributaries, as well as to reduce soil erosion and improve water retention and filtration, the project will pilot the use of vegetated green belts. About 354 ha (5,314 mu) of green belts will be established along the river, tributaries, and two reservoirs (Shanggui and Sanhe), comprising: (i) "ecological buffer strips" [about 50 ha (747 mu)]; (ii) constructed wetlands, [about 133 ha (1,988 mu)]; and, (iii) green landscaping [about 133 ha (1,988 mu) (Table III-2).

75. The ecological buffer strips will comprise planted vegetation belts 2–6 m wide, strategically located between the project river embankments and farmlands, to intercept non-point source pollution in runoff. The strips will be planted with a mosaic of trees (Dawn redwood, Cassia, *Cinnamomum camphora, Ginkgo biloba, Hibiscus mutabilis*, *Sakura* spp., *Magnolia denudate*, *Chimonanthus fragrans*), shrubs, grasses, and for sites in shallow depressions, aquatic plants (*Canna indica, Rosa chinensis, Imperata cylindrica, Scirpoides holoschoenus, Acorus calamus*). The removal rate of non-point pollution through a buffer strip depends on many factors including pollutant types and concentrations in storm water runoff, width of buffer strip, retention time of runoff in the buffer strip, the vegetation species, vegetation growth condition, soil, and weather. Overall, studies indicate that buffer strips with a diverse and mature mosaic of trees, shrubs and grasses can absorb and reduce from 40% to 70% ammonia nitrogen (NH_3-N) and total phosphorus (TP) in runoff.[13]

76. The constructed wetlands will be mainly established around the perimeter of Shanggui and Sanhe Reservoirs, to improve water filtration and retention capacity. These wetlands will be designed as "surface flow artificial wetlands", a type of constructed wetland which has a similar function to natural wetlands. Runoff or sewage will flow through the wetland surface, which will intercept and absorb nutrients. The wetlands will be 0.3 to 0.5 m deep. Water flow is by gravity and pollution removal is by the planted vegetation. Oxygen is provided through natural surface diffusion and nutrients required by the plants come from the runoff. This type of constructed wetland has the

[12] East China Design & Research Institute / Chongqing Jianghe Engineering Consulting Center / Chongqing Zhongxin Engineering Consulting Center. 2016. *Study Report of Longxi River Watershed Planning.* Hangzhou.
[13] China Water Conservancy and Hydropower Press. 2016. Water Ecology. Beijing.

advantages of low investment, simple operation, and low operating costs.[14] The green landscaping will be established in all project sites, to provide a combined role of improved public amenities and as a soft barrier to polluted overland runoff.

77. The green landscaping will be located on the tops and slopes of the channel embankments. They will be planted with a mosaic of trees (*Cinnamomum pedunculatum, Metasequoia* spp., Willow, *Hibiscus mutabilis*, Oriental Cherry, *Sophora xanthantha*, Chinese Crabapple, Red Plum), shrubs and grasses (*Canna*, *Rosa chinensis, Ligustrum vicaryi, Photinia glabra, Iris tectorum, Ophiopogon japonicus, Imperata cylindrica, Oxalis corniculate, chamaemelum nobile*) and for sites in shallow depressions and landscaped ponds, aquatic plants (*Monstera deliciosa, Phyllostachys heteroclada, Water Lilies, Agaricus, Juncus roemerianus*).

78. All plant species to be used for the green belts are native species and will be sourced within Chongqing Municipality.

79. **Community-based solid waste management (CBSWM).** Flood and environmental risk management requires investment in structural and non-structural measures. The project will implement a small pilot initiative for CBSWM in six communities in Liangping District, Dianjiang County, and Changshou District. These communities do not have reliable SWM systems and as a result, households are disposing waste in open spaces, drains, and the project tributaries. The project will invest USD60,000 (to be mobilized under the FERM consulting budget) for: community awareness campaigns; establishing good household practices to store, sort, recycle, reuse, and discard waste; and improved collection and transport to nearby waste collection centers. A key objective will be to complement and support the existing government SWM systems. Activities will be facilitated by a loan implementation consultant team, working in collaboration with local communities and civil society organizations. This initiative will contribute to the Chongqing Master Plan targets for the Longxi River, which states that by 2020, the solid waste collection rate will be 100%; uncollected waste in the six pilot villages will be 50% or less; and the rate or reuse or recycling of solid waste will be at least 35%.

80. **Integrated approach to point- and non-point source pollution.** Under project output 4, a FERM plan and investment road map for the Longxi River basin will be developed. This will include action plans to address two important sources of water pollution which are not addressed through civil works under the current project: (i) integrated pest management (IPM) and the use of agricultural chemicals; and (ii) the management of industrial wastewater. For IPM, the project will also provide training to farmers in the efficient use and application of pesticides and fertilizers, combined with non-chemical approaches. For the issue of industrial wastewater, in 2017 there were 110 factories within the river basin (14 in Changshou District, 40 in Liangping District, and 56 in Dianjiang County), which discharged 18.775 million m^3 of wastewater into the river, and which contributed to 9,024 t/a CODcr and 745 t/a NH3-N (22.6% and 23.8% respectively) of total pollution load. The CMG aims to reduce industrial wastewater pollution by 20% by 2020 and is implementing separate (non-ADB financed) activities to address this, including improved enforcement of on-site treatment and discharge standards by individual companies, the installation of auto-samplers at factory discharge outlets, and the construction of eight industrial wastewater treatment plants. Industrial park management in Changshou and Dianjiang is also being integrated under another ADB-funded project and will include the management of industrial wastewater.[15] The project will complement these initiatives by integrating them within the overall FERM planning process, to

[14] Yan, C. and M. Zhang. 2005. Countermeasures for Wetland Vegetation and Protection in China. *Wetland Science* 3: 210–215. And, Liu, Q. and Y. Li. 2003. *Wetland and Wetland Protection.* China Environmental Science press, Beijing.
[15] 2013. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the People's Republic of China for Chongqing Urban–Rural Infrastructure Development Demonstration Project II.* Manila

achieve an IWRM approach for point- and non-point pollution.

D. Associated Facilities

81. Associated facilities are those which are not funded by the project but whose viability and existence depend exclusively on the project and/or whose operation and services are essential for successful operation of the project (SPS 2009). A total of seven facilities, all wastewater treatment plants (WWTPs), meet the SPS definition of "associated facilities" (Table III-4). The sewage pipeline network to be constructed by the project will transfer waste directly to these WWTPs, which will be essential for the function of the pipelines. The WWTPs are all existing facilities and are located in Changshou District (the only location where the project sewage pipelines will be built). Environmental due diligence was conducted for the WWTPs. The WWTPs have approved domestic EIAs (Table III-4), are operating in accordance with domestic regulations, and are functioning according to the required treatment standards.

Table III-4: Associated Facilities (Wastewater Treatment Plants) in Changshou District

WWTP	Treatment process	Design capacity (m^3/d)	Actual treatment amount (m^3/d)	Date of operation	Service scope	Service population (persons)	Length of pipeline (m)	Effluent Standard	Approval Document
Dandu Town	high-speed anaerobic reactor	400	200	2011	Dandu Town	4,613	15,000	Grade I-B	Env.2007-138
Linfeng Town	Contact oxidation+ rapid infiltration	1,250	750	2012	Linfeng Town	4,396	7,000	Grade I-B	Env.2009-87
Longhe Town	Biofilm packed-bed reactor	2,000	1,200	2011	Longhe Town	4,921	10,280	Grade I-B	Env.2009-84
Shiyan Town	high-speed anaerobic reactor	2,200	1,200	2012	Shiyan Town	8,754	7,600	Grade I-B	Env.2008-119
Yuntai Town	Contact oxidation+ rapid infiltration	1,800	1,300	2010	Yuntai Town	12,838	5,680	Grade I-B	Env.2009-83
Shuang-long Town	Contact oxidation+ rapid infiltration	3,300	2,000	2012	Shuang-long Town	8,959	12,000	Grade I-B	Env.2009-85
Haitang Town	A/O + chemical phosphorus removal	750	400	2010	Haitang Town	17,000	9,800	Grade I-B	Env.2009-89
Total		**11,700**	**7,050**			**61,481**	**67,360**		

Note: (i) The approval authority for all the WWTPs is Changshou District EPB, (ii) Operation = meet the standard operation;
Source: the DEIA Institute.

IV. DESCRIPTION OF THE ENVIRONMENT (BASELINE)

A. Overview of Chongqing Municipality

82. Chongqing Municipality is one of four cities directly administered by the PRC central government (the others are Beijing, Shanghai, and Tianjin). The municipality is located on the southeast edge of the Sichuan Basin, adjacent to Hubei, Hunan and Guizhou Provinces, in the southwest region of the PRC. The municipality covers an area of 82,403 km^2 with the total population of 30.4843 million in 2016 including urban and rural populations of 19.0845 million (62.6%) and 11.3998 million (37.4%), and the male and female populations of 15.4266 million (50.6%) and 15.0577 (49.4%), respectively. There are 14 districts and 22 counties in the municipality. Chongqing is a "development hub" to lead economic development for the western region of the PRC, in the National Grand Western Development Strategy.[16] The average GDP per capita of Chongqing in 2015 was CNY52,321 (USD7,903): higher than the national average (CNY 49,992) and less than Beijing (CNY 106,497), Tianjin (CNY107,960), and Shanghai (CNY103,796). Chongqing is the major economic hub of three major urban agglomeration areas of Yangtze River Economic Belt (YREB) Region.

B. Environmental Setting of Longxi River Basin

(a) Geography, Topography and Geology

83. Longxi River basin, the proposed project areas including Liangping District, Dianjiang County and Changshou District, is situated in the east Sichuan mountain valley area with longitude 106°49'–108°05' E and latitude 29°43'–30°53 N. The basin is bordered by Wanzhou City in the east, Fuling City, Fengdu City and Zhongxian County in the south, the districts of Yubei and Banan in the west, and the counties of Dazu and Kaijiang in the north. Longxi River is the primary tributary located at the north bank of Yangtze River. It originates at Liangpong District, traverses (from north to south) Dianjiang County and Changshou District, and finally flows into the Yangtze River. The river basin is topographically flat upstream and steep downstream with many surrounding rapid flows and waterfalls. The basin is rectangular with a total length of 229.8 km. The total catchment area is 3,280 km^2. The lengths of Longxi in Liangping, Dianjiang and Changshou are 60.2 km, 96.8 km and 72.8 km, respectively, with a river width of 35-70 m and depth of 3-6 m. In the 1950s, the Grade Large-1 type reservoir of Changshou Reservoir with the storage capacity of 1 billion m^3 was built in Changshou District along the Longxi River. This is the largest reservoir in Chongqing Municipality.

84. **Liangping District** is situated in the northeast valley area of Chongqing Municipality, with longitude 107°24'–108°05' E and latitude 30°25'–30°53 N'. The total area of the district is 1,889 km^2 including Longxi River basin area of 800 km^2 (42.35% of the total territory). The topography of the district is dominated by three parallel hill ranges ("east", "west", "central") oriented north to east. The major landforms are mountains (31.7% of the district area), hills (62.9%) and valleys (5.4%).

85. **Dianjiang County** is situated in the northeast valley area of Chongqing Municipality, with longitude 107°13'–107°40' E and latitude 29°58'–30°31 N'. The total area of the district is 1,518 km^2 including Longxi River catchment area of 1,491 km^2 (98.2% of the total territory). The three mountains, Jinhua Mountain, Huangcao Mountain and Mingyue Mountain, develop along northeast – southwest direction. The topography distributions of low-mountain and hill (including highland) are

[16] Established by the State Council: Western Development Leading Group (January 2000); Western Development 11th Five Year Plan (approved December 2006); Western Development 12th Five Year Plan (approved February 2012).

15.23% and 84.77%, respectively.

86. **Changshou District** is situated in the northeast arc-like fold hilly area of Chongqing Municipality, with longitude 106°49'–107°27' E and latitude 29°43'–30°12 N'. The total area of the district is 1,423 km^2 including Longxi River catchment area of 654 km^2 (45.96% of the total). The topography of district is Daba Mountain along the north bank of the Yangtze River, slope from northeast to southwest. The topographic distributions of the low-mountain, deep valley, shallow-hill and flatland landform are 18%, 35%, 42% and 5%, respectively.

87. **Soil in project area.** The project area has red soil, brown soil, limestone soil, and paddy soil. Red soil is distributed in elevations up to 2,500 m above sea level (ASL), and is the major soil where conifer forests, evergreen broad-leaved forests, and secondary forests occur. The potential for dryland cropping of these soils is high, and hillside cultivation occurs mainly in red soil areas. Brown soil is distributed across elevations from 1,500 to 2,100 m and supports mainly upland forests. Black limestone soil is distributed in limestone uplands with varying depths. The soil mass is sharply separated from the parent rock and has a thick humus layer rich in organic matter. Red limestone soil is more widespread, usually on gently rolling country with good drainage where its carbonates have been largely leached out leaving a good surface structure. Paddy soil is a special soil derived from naturally occurring floodplain soil sediments that have been repeatedly cultivated. The Seismic intensity in the project area is Grade VI and the earthquake acceleration is 0.05g.

88. **Soil erosion.** The project area is located on typical mountainous and hilly landforms of southwest PRC. Water and soil erosion in the project area is dominated by water erosion, of which the main erosion forms are surface erosion and gully erosion. The surface erosion mainly occurs in sloping fields, barren hills and sparse woodland, while the gully erosion mainly occurs on the slopes of the river and steep hill areas. The total soil erosion area in the Longxi River basin is 1,190 km^2, which accounts for about 40% of the total river basin area (2943 km^2) in the three county/districts. Among them, light, moderate, serious and extremely strong erosion areas are 260 km^2, 637 km^2, 171 km^2 and 122 km^2, respectively (Table IV-1).

Table IV-1: Soil, Soil Erosion and Seismicity of Project County/districts

Item	Project District/County		
	Liangping	Dianjiang	Changshou
Soil type	Moisture soil, purple soil, yellow soil, paddy soil		
Baseline Soil erosion intensity (t/km^2/a)	500	876	876
Seismic intensity	Grade VI	Grade VI	Grade VI
Earthquake acceleration (g)	0.05	0.05	0.05

(b) Meteorology and Climate

89. The project area, Longxi River basin, belongs to the subtropical humid monsoon climate, where has a moderate climate, rich heat, abundant rainfall, long frost-free period, four distinct seasons, less sunshine and harmony among light, heat and water. The climate parameters for each project district/county are shown in Table IV-2.

Table IV-2: Main Meteorological Parameters of Project Districts/County (/a = per annum)

Weather element	Liangping	Dianjiang	Changshou
Annual average temperature (°C)	16.6	17.0	17.4
Average temperature in July (°C)	27.3	27.5	27.8
Average temperature in January (°C)	5.4	6.1	6.8

Weather element	Liangping	Dianjiang	Changshou
Extreme maximum temperature (°C)	40.1	40.9	42.3
Extreme minimum temperature (°C)	-6.6	-4.4	-2.3
Average annual relative humidity (%)	82	81	80
Annually average precipitation (mm/a)	1300.7	1182.3	1158.8
Maximum annual precipitation (mm/a)	1878.1	1738.7	1490.8
Minimum annual precipitation (mm/a)	933.3	828.3	836.5
Average annual rainfall days	152	150	151
Average annual frost-free days	330	331	331
Mean annual wind speed (m/s)	1.27(NE)	1.0 (NE)	1.38 (NE)
Average annual evaporation (mm/a)	1102.1	1035.5	1079
Average annual sunshine hours (h/a)	1336.4	1162.9	1209.1
Average annual frost-free days (d/a)	269	350	331
Average annual wind speed (m/s)	0.9	1.0	2.0
Maximum annual wind speed (m/s)	9.69	15.0	12
Dominant wind direction	NE	NNE	NNE

90. **Climate change trend - temperature.** The annual mean temperature has increased 0.14℃ /10a in Longxi River basin during 1961-2015, which was lower than the warming rate for China average of 0.22℃/10a. The annual maximum and minimum temperature have increased at a warming rate larger than annual mean temperature with about 0.19℃/10a (Figure IV-1). The decadal changes showed cold 1980s compared with other decades. The warming after 2000s has been successively higher than any previous decades.

91. **Projected temperature change.** Modeling (RCP4.5) indicates that mean annual temperatures in the Longxi River basin will increase by 0.9℃ from 2020-2030 and 1.2℃ by 2050. The decadal mean temperature is projected larger than 1.5℃ since 2070s under RCP4.5, and larger than 2.0℃ since 2050s under RCP8.5 (Figure IV-2 and Table IV-4). In general, the greater temperature rises for decadal mean temperature, and less temperature rise for decadal maximum and minimum temperature for each decade are found.

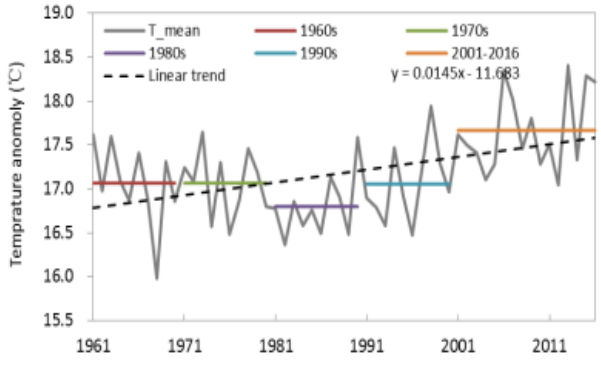


Figure IV-1: Annual and decadal temperature in Longxi River basin during 1961-2015

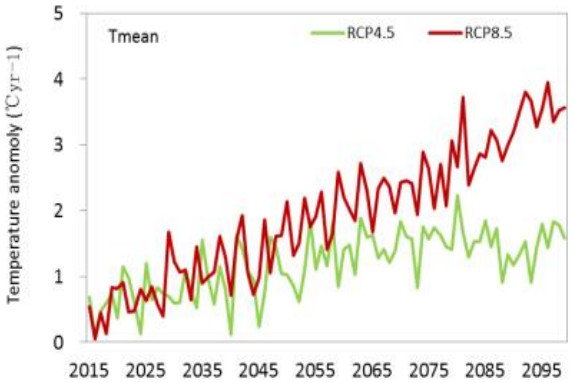


Figure IV-2: Projected annual mean temperature change in Longxi River basin for

2015-2099

Source: the TRTA consultants

Table IV-3: Projected decadal temperature changes in Longxi River Basin (baseline: 1986-2005)

Decade	T mean (℃)		T max (℃)		T min (℃)		PCP (%)	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
2020s	0.7	0.7	0.8	0.7	0.7	0.7	-2	2
2030s	0.9	1.3	0.9	1.2	0.8	1.0	-1	-4
2040s	1.0	1.4	1.1	1.3	1.0	1.2	2	-4
2050s	1.2	2.0	1.3	1.8	1.2	1.6	1	-3
2060s	1.4	2.6	1.5	2.3	1.3	2.0	-2	-8
2070s	1.5	2.6	1.8	2.4	1.4	2.2	-5	-1
2080s	1.6	3.2	1.7	2.9	2.1	2.7	-2	-4
2090s	1.5	3.8	1.5	3.5	1.8	3.2	1	-7

Source: the TRTA consultant

92. **Climate change trend - precipitation.** The changes in decadal precipitation showed that there is a dry period (2001-2015) with the decadal precipitation 6% less than the average precipitation during 1961-1990. There was a decreasing trend in annual rainfall days about 5.5 day/10a. There are consecutive three decades (1980s, 1990s and 2001-2015) with rainfall days less than the average rainfall days during 1961-1990, and there was 19 days less for 2001-2015.

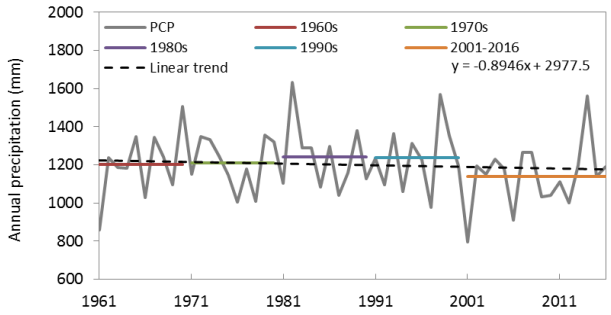


Figure IV-3 Annual and decadal precipitation in Longxi River basin during 1961-2015

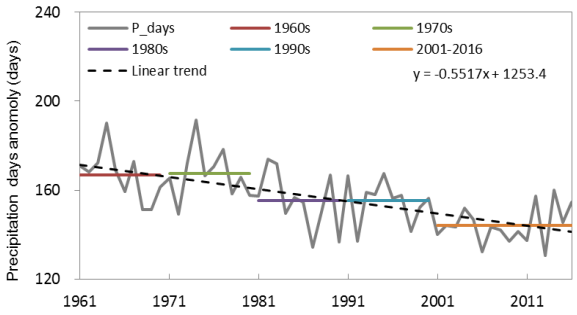


Figure IV-4 Annual and decadal rainfall days in Longxi River basin during 1961-2015

93. **Projected precipitation changes.** In Longxi River basin, the rainfall intensity will be changed due to climate change. The frequency analysis suggests that the maximum daily rainfall of 50 years return period will be increased by 3% (ranging from 9% to -5% based on girds) under RCP4.5 and increased by 1% (ranging from 8% to -5% based on girds) under RCP8.5 during the period of 2021-2050 (Table IV-4). While, the maximum daily rainfall of 20 years return period will be no clear changes in general. The projected storm will be slight increase in general, and direction and magnitude of projected changes in storm will be showed spatial heterogeneous.

Table IV-4: Projected daily rainfall changes in Longxi River Basin for 2021~2050
(baseline: 1986-2005, unit: %)

Probability of Exceedance (%)	Return Period (Year)	RCP4.5			RCP8.5		
		Mean	Max	Min	Mean	Max	Min
1	100	6	17	-7	4	14	-5
2	50	3	9	-5	1	8	-5
5	20	1	8	-2	1	7	-3
10	10	0	3	-3	0	2	-4
20	5	-2	0	-5	-2	2	-4

50	2	-4	0	-6	-6	-4	-9

Source: the TRTA Consultant

(c) Hydrology and Water Resources

94. The Longxi River contains numerous tributaries, which originate from Wenjia Gully in Liangping District, expands to 158 branches, flows through the towns of Mingda, Lirang, Renxian, Helin, Yunlong, Yinping, and finally runs into Dianjiang County at Chenjia Gully of Yinping Town. The two largest branches in the project area are the Huilong and Dasha Rivers. The Huilong originates in Pingjin Town (Liangping District), in the eastern region of Mingyue Mountain. It runs through Qinggang Town (Liangping District) and Shaping and Huilong Towns (Dianjiang County) then flows into Gaotan River. Dasha River originates in Huangyin Town, Zhong County in the east of Jinghua Mountain, runs through Huaqiao and Xianzhou in Zhong County. There are four tributaries with a catchment area larger than 100 km^2 which flow into Longxi River, including Qijian River in Liangping District, Guixi and Wudonggou Rivers in Dianjiang County, and Dayuxi River in Changshou District. The Qijian River is the main branch in the right bank of the Gaotan River. Its drainage area is 182.3 km^2 with a 51.8 km long mainstream and a 6.0‰ slope. The Huilong River is the primary tributary in the right bank of Longxi River. Its catchment area is 253 km^2 with a 29.4 km long channel and a 5.2‰ slope. In the 1950s, Changshou Reservoir, with a capacity of 1.1 billion m^3, was built in Changshou District along the Longxi River. It is one of the largest reservoirs in southwest PRC. Key data on the Longxi River is summarized in Table IV-5.

Table IV-5: Longxi River in Project Districts/County

Item	Liangping	Dianjiang	Changshou	Total
Section Length of Longxi River (km)	60.2	96.8	72.8	221
Catchment area of Longxi River (km^2)	800	1491	652	2943
Annual total runoff volume (million m^3)	432.68	808	1618	-
Annual average flow (m^3/s)	13.7	25.6	51.3	-
Number of main tributaries	12	6	6	24
Total reservoir volume (million m^3)	140	120	1440	1700

Source: *The Water Resource Management Plan of Longxi River Basin*

95. There are 18 main tributaries of Longxi River in the project areas including 7 in Liangping District, 5 in Dianjiang County and 6 in Changshou District (Table IV-6).

Table IV-6: The Tributaries of Longxi River in the Project Areas

Region	River	Headstream point	Confluence with Longxi River	Length (km)	Catchment area (km^2)
Liangping District	Baisha	Dongshan Village (Liangshan Town)	Jinping Village (Ansheng Town)	9.0	21.4
	Zhangingqiao	Anning Village (Shuanggui Sub-district)	Anfu Village (Ansheng Town)	8.0	13.9
	Longdong	Longdong Village (Liangshan Sub-district)	Shiyan Village (Jindai Town)	11.7	44.6
	Longtai	Sanlong Village (Helin Town)	Helin Village (Helin Town)	6.3	13.7
	Wanchang	Tiemen Village (Tiemen Town)	Fuhe Village (Helin Town)	7.5	16.2
	Ximao	Shun'an Village (Jukui Town)	Aiguo Village (Helin Town)	10.5	20.3
	Huilong	Longxi Village (Pingjin Town)	Hanling Village (Huilong Town)	29.4	137.7
Dianjiang County	Dasha	Maliu Village (Shaohe Town)	Gaodong Village (Baojia Town)	52.0	352.0
	Fangjiagou	Guanghui Village (Yongping Town)	Chunhun Village (Shenjia Town)	8.9	20.0
	Guixi	Qunshan Village (Guixi Town)	Suhe Village (Yong'an Town	43.2	165
	Huilong	Sanxi Village (Qixing Town)	Suhe Village (Yong'an Town)	30.2	18.0
	Xinmin	Shiziluokou Village (Guixi Town)	Gaoxing Village (Chengxi Town)	13.6	117

Region	River	Headstream point	Confluence with Longxi River	Length (km)	Catchment area (km^2)
Changshou District	Dayu	Longhua Village (Taiping Town)	Shiyan Town	36.4	79.9
	Jiaojia	Luowei Village (Shuanglong Town)	Dadu Town	17.2	10.1
	Gaodong	Huilong Village (Conglin Town)	Changshou Lake Town	17.9	49.7
	Shuanglong	Luowei Village (Shuanglong Town)	Longhe Town	19.5	57.2
	Zhangba	Zhoujiawan Village (Chengxi Town)	Yuntai Town	12.8	24.6
	Dandu	Sanlun Village (Shilong Town	Dandu Town	12.2	23.4

Source: The Study of Longxi River Watershed Planning

Figure IV-5 Longxi River (Liangping section)

Figure IV-6 Longdong River (Liangping)

Figure IV-7 Shizhu River (Liangping)

Figure IV-8 Xiaojia Stream (Liangping)

Figure IV-9 Upstream of Baisha River – rubbish on shore (Liangping)

Figure IV-10 Downstream of Baisha River – Bank failure (Liangping)

Figure IV-11 Dayu Stream – serous siltation (Dianjiang)

Figure IV-12 Xinmin River – farmland occupied river (Dianjiang)

Figure IV-13 Lanjia River – no protection banks (Changshou)

Figure IV-14 Shuanglong River - River weir obstructs flood discharge (Changshou)

Table IV-7: Water Resource of the Project Districts and County

Item	Changshou	Liangping	Dianjiang	Total	Chongqing Municipality	% of Chongqing
Average annual precipitation (million m^3)	1667.94	2322.64	1811.86	5802.44	87574.5	6.6
Average total annual water resource (million m^3)	696.44	1004.94	765.78	2467.16	56775.5	4.3
Average annual groundwater (million m^3/a)	112.56	153.87	123.59	390.02	9638.5	4
Average water resource per km^2 (m^3/km^2)	489,200	662,000	404700	510400	689000	74.1
Average per capita water resources (m^3/p)	770	1030	830	880	1898	46.4
Average groundwater resource per km^2 (m^3/km^2)	79,100	101,400	65,300	80,700	117,000	69
Average per capita groundwater resource (m^3/p)	125	158	134	139	322	43.2

Source: The Study of Longxi River Watershed Planning

(d) History of flood damage in the project area

96. In the PRC, flood-related damages account for more than 60% of total natural disasters. Since 1990, the average annual losses due to floods has accounted for about 2% of the national GDP. In the Longxi River basin, flood management is under-developed and requires strengthening. Many towns lack flood control facilities. About 40% of the Longxi River and its tributaries have flood control standards of only one in 2~5 years. There is frequent flooding in the basin and flood frequency and intensity is increasing. Existing levees are old and no longer capable of controlling frequent or large flood events as they were designed for 5-year returns.

97. In September and October 2017, the two project districts and county were severely affected by floods triggered by intensive rainfall over the entire basin. In Dianjiang County, fatalities and over 15,000 evacuees were reported. School buildings, roads, power stations, water supply network, dams, irrigation facilities and crops were damaged, resulting in CNY250 million direct economic losses. In Changshou District, about 20,389 people were affected, 24 houses collapsed, 270 houses were damaged, and 348.5 hectares of crops were affected. Highways, irrigation stations, and drainage facilities were damaged. Direct economic losses were CNY49.285 million.

98. Flood disasters occur frequently in the Longxi River basin. A summary of floods and damages is in Table IV-8.

Table IV-8: Summary of flood-related damages in the Longxi River basin

District /county	Year	Damaged farmland (mu)	Financial loss (CNY million)	Population affected
Liangping District	2012	12,600	38	35,600
	2013	35,700	35	91,600
	2014	1,900	46	63,700
	2015	500	2	2,900
	2016	84,300	105	151,800
	Subtotal	**135,000**	**226**	**345,600**
Dianjiang County	1979	320,700	94	400,000
	1989	246,000	112	384,000
	1998	249,500	155	335,000
	2005	56,200	21	230,000
	2007	202,000	47	396,000
	2010	413,200	740	458,000
	2014	39,700	59	69,000
	2017	8,200	102	15,000
	Subtotal	**1,535,500**	**1,330**	**2,287,000**
Changshou District	2005	120,000	86	-
	2007	215,000	58	229,000
	2009	92,000	33	118,000
	2010	61,000	49	89,600
	2014	60,300	566	11
	2017	5,227	49	20,389
	Subtotal	**553,527**	**842**	**457,000**
	Total	**2,224,027**	**2,397**	**3,089,600**

Source: the FSRs

Figure IV-15 Flood in Liangping District (September 2014)

Figure IV-16 Flood in Dianjiang County (September 2014)

Figure IV-17 & 18: Flood in Changshou District (September 2014)

(e) Flora and fauna

99. Ecological assessments for the project were conducted in the project county and two districts to assess the status of existing habitats and the presence of rare, threatened, restricted-range and/or protected species, and/or protected areas. The assessments focused on vegetation and flora and vertebrate fauna (birds, mammals, fish, reptiles, amphibians) and comprised: (i) habitat and site assessments by the TRTA wetland and ecological specialists (February 2018) for vegetation and avifauna (birds), supplemented by incidental observations for other species; (ii) site visits by the EIA institutes (October 2017–February 2018); and (iii) desktop review of literature and consultations by the TRTA specialists and DEIA institutes with local experts at the Chongqing University Faculty of Sciences. For vegetation, an estimate of vegetation cover along the project waterways was made, based on satellite imagery and site visits (Table IV-11).

100. **Vegetation communities.** The Longxi River Basin belongs to the "subtropical evergreen broad-leaved and needle forest biogeographic region", and historically supported extensive forest. However, the project area has supported over 2,000 years of human settlement and is now heavily modified, with a density of 445 people/km^2. Most original vegetation has been cleared and predominant land uses are farming (wheat, corn, fruits, vegetables), forestry, and settlements. Overall for Chongqing Municipality, the forest coverage rate is 43-45% and the vegetation coverage rate is over 80%.[17] Within the project county and two districts, the vegetation comprises 198,178 ha (2.98 million mu) agricultural land (40.6% of total lands, mainly in river valley areas) and 212,685 ha forest and grassland (44.0%, mainly on the mountainous area). A summary of habitats and

[17] The study report of Longxi River Watershed Planning (2016)

dominant flora in the project area is in Table IV-11.

101. **Flora.** Documented flora in the project county and two districts includes 68 families, 63 genera and 193 species, including pteridophytes (ferns; 9 species); gymnosperms (conifers; 3 species); and angiosperms (flowering plants; 181 species). (Tables IV-9 and IV-11).

Table IV-9: Flora in the Project Area

Types			Dominant Species
Ecological Type	arbor		*Ficus virens, Melia azedarach, Pterocarya stenoptera*
	shrub, subshrub		*Rhus chinensis, Ilex chinensis*, *Nandina domestica*
	liana		*Paederia scandena, Cayratia japonica, Pueraria lobate*
	herb		*Myosoton aquaticum, Cardamine hirsute, Vicia cracca*
Environmental Type	terrestrial plant		*Camptotheca acuminate, Sapium sebiferum, Dalbergia hupeana*
	wetland plant		*Triarrhena sacchariflora, Paspalum paspaloide, Mazus pumilus*
	hydrophyte	emergent plant	*Nelumbo nucifera, Acorus calamus, Zizania latifolia*
		floating plant	*Lemna minor, Eichhornia crassipes*
		submerged plant	*Potamogeton maackianus, Potamogeton distinctus, Potamogeton matans*
Resource Type	economic value	fibrous plant	*Salix matsudana, Morus alba, Miscanthus sinensis, Metasequoia glyptostroboides, Pteridium aquilinum var. latiusculum*
		fragrant plant	*Mentha haplocalyx, Perilla frutescens, Citrus reticulate*
		medicinal plant	*Artemisia argyi, Artemisia annua, Ixeridium chinense*
		crash crop	*Citrus maxima, Citrus reticulate, Citrus sinensis, Capsicum annuum, Zizania latifolia*
	ecological value	embankment-protecting plant	*Cynodon dactylon, Arthraxon hispidus, Eleusine indica*
	ornamental value	aquatic plant	*Phragmites communis, Arundo donax, Typha orientalis, Typha angustifolia*

Source: TRTA wetland and ecological specialists' survey report

102. There are 17 invasive flora species in the project county and two districts (Table IV-10), accounting for 8.81% of the total number of species recorded. All except one (*Eichhornia crassipes* Floating Water Lily) are terrestrial and most originate from North or South America. These species occur in the project sites on riverbanks, agricultural land, and in degraded secondary vegetation. They are characterized by ecological adaptability and are widespread in the PRC and other countries.

Table IV-10: Invasive Plant Species in the Project Area

No.	Species	No.	Species
1	*Erigeron annual* (L.) Pers.	10	*Alternanthera philoxeroides* (Mart.) Griseb
2	*Conyza candensis* (Linn.) Cronq.	11	*Amaranthus spinosus* L.
3	*Crassocephalum crepidioides* (Benth.) S. Moore	12	*Veronica arvensis* L.
4	*Bidens frondosa* L.	13	*Veronica didyma* Tenore
5	*Aster subulatus* Michx.	14	*Daucus carota* L.
6	*Soliva anthemifolia* (Juss.) R. Br.	15	*Lantana camara* L.
7	*Sonchus oleraceus* L.	16	*Phytolacca americana* L.
8	*Galinsoga parviflora* Cav.	17	*Eichhornia crassipes* (Mart.) Solms
9	*Setaria palmaefolia* (Koen.) Stapf		

Source: Ecological survey by the TRTA consultants

103. No wild populations of protected flora species are known from the project area. Cultivated plantings of two species listed in the PRC “National Protected Plants Directory”, *Metasequoia glyptostroboides* (National Cass I) and *Cinnamomum camphora* (Class II) occur in hilly areas, but are not wild populations and are commonly cultivated in the south-west PRC.

104. **Fauna.** Fauna habitats in the project area comprise fragmented and degraded riverine forest along the Longxi River and tributaries. This generally comprises a belt of 2–25 m wide of trees, shrubs, bamboo, grasses, and plantings (Table IV-11a). Although degraded and subject to human disturbance, these stands form a buffer between the waterways and adjacent agricultural lands and settlements. There are no records of rare or threatened fauna in the project area.

Table IV-11a: Summary of Ecological Survey along the Rivers

County/ District	River	Section/ Length	Vegetation status	
			Left bank	Right bank
Liangping District	Longxi River	Helin Town section, 3,300 m	Width: 5~12 m; area: 39 mu. vegetation: *Ficus virens* (25%); *Pterocarya stenoptera (*30%), Bamboo (15%) *Ilex chinensis and Nandina domestica* et al *(*15%)	Width: (2~10m); Area: 30 mu; vegetation: Ficus virens (20%), stenoptera (30%), Bamboo (20%), Ilex chinensis and Nandina domestica et al. (10%)
		Mingda Town section, 2,910 m	Width: 0~18m; area: 45 mu; vegetations: Dalbergia hupeana (15%), stenoptera (20%), Bamboo (15%), Ilex chinensis, Nandina domestica, et al. (15%)	Width: 2~12m; Area: 35 mu; vegetations: Dalbergia hupeana (25%), stenoptera (30%), Bamboo (10%), and Ilex chinensis, Nandina domestica et al. (15%)
		Jindai Town section, 2030 m	Width: 0~15 m; Area: 15 mu; vegetations: Dalbergia hupeana (25%), stenoptera (20%) Morus alba (15%), and Ilex chinensis, Nandina domestica, et al. (15%)	Width: 5~8 m; area: 25 mu; vegetations: Dalbergia hupeana (15%), Morus alba (20%), Pterocarya stenoptera (15%), and Ilex chinensis, Nandina domestica et al (10%)
	Huilong River	Pingjin Town section, 5,240 m	Width: 8~20 m; area: 85mu; vegetations: Ficus virens (15%), stenoptera (20%), Bamboo (15%), Ilex chinensis, Nandina domestica, et al. (15%)	Width: 0~12 m; area: 29 mu; vegetations: Ficus virens (15%), stenoptera (30%), Bamboo (15%), Ilex chinensis, Nandina domestica, et al. (20%)
	Baisha River	Liangshan Sub-district section, 3,300 m	Width: 5~15m; area: 45 mu; vegetations: Morus alba (15%), Pterocarya stenoptera (20%), sinensis (20%), bamboo (15%), and Ilex chinensis, Nandina domestica, et al. (15%)	Width: 3-10 m; area: 40 mu; vegetations: Morus alba, (10%), Pterocarya stenoptera (20%), sinensis (20%), bamboo (10%), and Ilex chinensis, Nandina domestica et al (15%)
Dianjiang County	Longxi River	Gaofeng Town section, 2,000 m	Width: 5~25 m; area: 45 mu; vegetations: Morus alba (20%), Pterocarya stenoptera (20%), sinensis (20%) bamboo (15%), and Ilex chinensis, Nandina domestica, et al. (15%)	Width: 5~15 m; area: 45 mu; vegetations: Morus alba (15%), Pterocarya stenoptera (25%), sinensis (20%), Bamboo10% Ilex chinensis, Nandina domestica, et al. 10%
		Gao’an Town section, 18,510 m	Width: 5~25 m; area: 45 mu; vegetations: Morus alba (20%), Pterocarya stenoptera (20%), sinensis (20%), bamboo (15%), and Ilex chinensis, Nandina domestica, et al. (10%)	Width: 5~15m; area: 40 mu; vegetations: Morus alba (20%), Pterocarya stenoptera (20%), sinensis (20%), bamboo (15%), and Ilex chinensis, Nandina domestica, et al. (15%)
Changshou District	Longxi River	Dandu Town section, 3,850	Width: 5~20 m; area: 80 mu; vegetations: Dalbergia hupeana (20%), Pterocarya stenoptera (20%) Metasequoia glyptostroboides (20%) bamboo (10%),	Width: 3~15m; area: 45 mu; vegetations: Dalbergia hupeana (10%), Pterocarya stenoptera (20%) Metasequoia glyptostroboides (20%),

			and Ilex chinensis, Nandina domestica, et al. (15%)	bamboo (15%), and Ilex chinensis, Nandina domestica, et al. (10%)
	Long River	Longhe Town section, 11,700 m	Width: 5~25 m; area: 45 mu; vegetations: Morus alba (20%) Pterocarya stenoptera (20%), Metasequoia glyptostroboides (20%), bamboo (15%), and Ilex chinensis, Nandina domestica, et al. (5%)	Width: 5~25 m; area: 45 mu; vegetations: Morus alba (20%), Pterocarya stenoptera (20%), Metasequoia glyptostroboides (20%), bamboo (15%), and Ilex chinensis, Nandina domestica, et al. (10%)
	Lanjia River	Linfeng Town section, 2,000 m	Width: 5~15m; area: 25 mu; vegetations: Dalbergia hupean (20%), Pterocarya stenoptera (15%), Metasequoia glyptostroboide (10%), bamboo (15%), Salix matsudana (10%), and Ilex.chinensis, Nandina domestica et al (15%)	Width: 5~25 m; area: 45 mu; vegetations: Morus alba (20%), Pterocarya stenoptera (10%), Metasequoia glyptostroboides (10%), Bamboo (10%), and Ilex chinensis, Nandina domestica, et al. (15%)

Source: TRTA consultants' ecological survey

105. For fish, available records[18] and consultation with a national fish expert[19] at the Chongqing University Faculty of Sciences confirmed that at least 30 species are known to occur in the Longxi River and tributaries, comprising seven genera: carpidae (22 species; 73.3% of documented species); Balitoridae (two species); Bagridae (two species); and Siluridae, Synbranchidae, Serranidae, and Channidae (one species each) (Table IV-11b). None of these species are protected or listed as threatened under national regulations or the IUCN Red List. Based on these results, site-specific sampling was not conducted because: (i) no dredging or other physical works will be conducted in the Longxi mainstream; and (ii) habitat assessments of the tributaries confirmed that the sections to be dredged are highly polluted and degraded.

Table IV-11b: Summary of Ecological Survey along the Rivers

Species	IUCN Red List	Endemic to PRC?
Anguilla japonica	Not Evaluated	No
Opsariichthys bidens	Not Evaluated	No
Zacco platypus	Not Evaluated	No
Ctenopharyngodon idellus	Not Evaluated	No
Mylopharyngodon piceus	Not Evaluated	No
Hypophthalmichthys molitrix	Not Evaluated	No
Carassiusauratus	Not Evaluated	No
Squaliobarbus curriculus	Not Evaluated	No
Ancherythroculter kurematsui	Not Evaluated	Yes (Yangtze River)
Culter alburnus	Not Evaluated	No
Onychostoma sima	Not Evaluated	No
Sinilabeo rendahli	Not Evaluated	Yes (Yangtze and Yuanjiang Rivers)
Abbottina rivularis	Not Evaluated	No
Coreius guichenoti	Not Evaluated	Yes (Changjiang River)
Hemibarbus maculatus	Not Evaluated	No
Rhinogobio cylindricus	Not Evaluated	Yes (Changjiang River)
Cyprinus carpio	Not Evaluated	No
Gobiobotia filifer	Not Evaluated	Yes (Changjiang River)
Botia superciliaris	Not Evaluated	No
Leptobotia rubrilabris	Not Evaluated	Yes

[18] Key sources: Tao et al. 2016. Comparative Analysis of Fish Distribution in Tributaries of the Yangtze River (Chongqing section). Pages 47-51. And, Xiong et al. 1993. Changes in the Number of Fish Resources in Chongqing. *Journal of Chongqing Normal University*: 15.

[19] Professor Guihua Liu, Ph.D., Chinese Academy of Science (Wuhan Botanical Garden, Wuhan China).

Parabotia bimaculata	Not Evaluated	Yes
Misgurnus anguillicaudatus	Not Evaluated	No
Lepturichthys fimbriata	Not Evaluated	Yes
Sinogastromyzon szechuanensis	Not Evaluated	Yes
Silurus meridionalis	Not Evaluated	No
Pelteobagrus vachelli	Not Evaluated	No
Pseudobagrus brevicaudatus	Not Evaluated	Yes
Monopterus albus	Not Evaluated	No
Siniperca kneri	Not Evaluated	Yes
Ophiocephalus argus	Not Evaluated	Yes

106. For birds, 64 species have been documented in the project area, including 44 species of resident birds (26.56%) and 20 species of migratory birds. Common resident and/or migratory bird species include *Tachybaptus ruficollis, Phalacrocorax carbo, Anas acuta, Anas crecca, Anas falcate, Anas poecilorhyncha, Phoenicurus auroreus, Rhyacornis fuliginosus, Lonchura striata, and Emberiza pusilla*. For mammals, records comprise small and medium sized fauna (weasels, rabbits, hedgehogs, rodents) which are widespread in south-west PRC.

(f) Social and economic status

107. The project county and two districts had a total registered population of 2.80 million people in 2016 (statistic yearbooks 2016). Social and economic indicators are in Tables IV-12 and IV-13a.

Table IV-12: Social and Economic Data for the Project Districts and County (2016)

Statistical data	Liangping District	Dianjiang County	Changshou District	Total
Total registered population	930,000	970,500	902,000	2,802,500
Total actual permanent population	664,000	676,700	825,700	2,166,400
Urban population	465,000	286,900	571,150	1,323,050
Total Area (km^2)	1,892.13	1518	1423.62	4,833.75
Urbanization rate (%)	50	42.4	63.32	-
Regional annual GDP (CNY billion)	27.1	23.98	45.4	96.48
Annual GDP per capita	35,442	35,367	55,033	-
Per capita disposable income (CNY, urban)	28,990	26,644	29915	-
Per capita disposable income (CNY, rural)	12,485	11,480	13252	-

Table IV-13a: Social and Economic Data for the Project Towns (2016)

District / County	Town/subdistrict	Location and distance to district town	Area (km^2)	Population	GDP (CNY million)
Lingping	Helin	Southwest, 13 km	58	26,000	339
	Pingjin	Southwest, 23 km	102	64,000	1199
	Mingda	Northwest, 21 km	589	30,764	487
	Jindai	Southwest 9 km	31.45	18,400	349.05
	Shuanggui subdistrict	Northwest 4 km	58	43,300	2,761
	Subtotal		**838.45**	**182,464**	**5135.05**
Dianjiang County	Gaofeng	Central, 14 km	48	33,666	146
	Gao'an	East, 14 km	2.65	29,000	130
	Guixi Subdistrict (Dianjiang county town)	The county town	45	100,000	1798
	Pushun	Northeast, 34 km	86	33,000	186.3
	Zhoujia	Northeast, 24 km	85	51,000	1,090
	Xinmin	North, 8 km	59	36,000	1,367
	Subtotal		**325.65**	**282,666**	**4,717.3**

District / County	Town/subdistrict	Location and distance to district town	Area (km^2)	Population	GDP (CNY million)
Changshou District	Dandu	Southeast, 4.7 km	57.4	16,654	280.96
	Haitang	North, 45 km	46	33,584	109.94
	Yuntai	North, 38 km	87.29	52,000	129.24
	Shiyan	North, 34 km	107.18	63,815	235.83
	Longhe	Northest 20 km	89.9	48,032	198,21
	Shuanglong	Northeast, 28 km	56.97	41,412	891
	Linfeng	East, 25 km	55.85	34,337	709.29
	Subtotal		**500.59**	**289,834**	**2,356.26**
Total			**1,664.69**	**754,964**	**12,208.61**

108. Within the project areas, surveys were conducted by the TA consulting team to document the presence of vulnerable households. A total of 48 households (120 residents) are classified as vulnerable, reflecting low levels of income, disability, and/or the presence of elderly family members. This breakdown is as follows: 12 households (24 persons) in Changshou District; 20 households (54 people) in Dianjiang County; and, 16 households (42 persons) in Lianping District (Table IV-13b).

Table IV-13b: Vulnerable Households Within the Project Area

Type	Criteria	Households	Persons
LIANPING DISTRICT			
Low-income	Local government classification standard	2	4
Five-guarantee household	Local government classification standard	10	20
	Subtotal	**12**	**24**
DIANJIANG COUNTY			
Five guarantee/low-income households	Local government classification standard	7	n/a
Households governed by women	Families without males 18-55 years old; women are the main earner	11	n/a
Families with ill members	Families who have lost their working capacity or with long-term medical expenses	1	n/a
Families with disabled members	Families with members identified as Level I or II disabled people	1	n/a
	Subtotal	**20**	
LIANPING DISTRICT			
Five guarantee/low-income households	Local government classification standard	2	4
Single-parent families	Single parent with children	3	7
Households governed by women	Families without males 18-55 years old; women are the main earner	4	13
Family with only old people	Persons more than 60 years old without kids	3	5
Family with disabled members	Families with members identified as Level I or II disabled people	2	7
Family with patients for long term	Families who have lost their working capacity or with long-term medical expenses	2	6
	Subtotal	**16**	**42**
	TOTAL	**48**	**120**

N/a = not available. Five-guarantee families = households classified by the PRC government as retired, unemployed, and/or suffering extended sickness. For such families, the government guarantees to provide resources for five basic needs: food, clothing, medical expenses, general living expenses, and the costs of burial.

C. Environmental Baseline for Changshou District

(a) Surface water quality

109. Baseline surface water quality of the Longxi River mainstream and its tributaries of Dayu Stream and Longdong River were monitored by the Environmental Monitoring Station (EMS) of

Changshou District. Six sampling points were selected (Table IV-14) and results are in Tables IV-15 and IV-16. The data of 16 times monitoring during the period of January–August 2017 (twice a month for eight months) was provided by the Changshou District EMS for the sampling No.1-4, while the monitoring for No.5 and No.6 were specific for the project conducted by the EMS on 19-20 January 2018. Geographic coordinates and maps of the sampling locations are described in Appendix 5.

Table IV-14: Monitoring Points for Baseline Monitoring of Surface Water Quality – Changshou

Sampling No.	Sampling point (location)	Water quality function	Remark
W1	Shizitan Reservoir section of Longxi mainstream (at outlet of the reservoir to the river)	Grade III, drinking water source	Water quality at upstream of drinking water source on Longxi mainstream
W2	Yanpo Village section of Longxi mainstream (at Yanpo Village of Dandu Town)		Water quality at the drinking water source of Longxi mainstream
W3	Zhangjiawan Section of Dayu Stream (Zhangjiawan Village of Haitang Town)	Assessed by Grade V standard, Irrigation, fishery	Water quality at upstream of Dayu Stream
W4	Kujian Bridge section of Dayu Stream (Kujian Bridge of Shiyan Town)		Water quality at downstream of Dayu Stream
W5	Wudong Bridge, Dayu Stream (at downstream of Yuntai Town WWTP)		Water quality at middle reach of Dayu Stream
W6	Longcheng-Lijing Bridge section of Yuntai River (at the bridge)		Water quality of Yuntai River

W = water sampling point, WWTP = wastewater treatment plant.

Table IV-15: Water Quality Monitoring Results of Longxi Mainstream – Changshou Section, January-August 2017. Unit: mg/L, except pH and fecal coliform)

		Sampling point W1		Sampling point W2	
Parameter	Grade III Standard	Monitored result	Standard compliance	Monitored result	Standard compliance
pH	6~9	7.14~8.89	met	7.11~8.51	met
CODcr	≤20	**13.9~20**	**exceeded**	10.4~19.1	met
BOD_5	≤4	2.5~3.9	met	1.9~3.8	met
NH3-N	≤1.0	0.12~0.672	met	0.112~0.308	met
TP	≤0.2	0.04~0.174	met	0.086~0.196	met
Petroleum	≤0.05	0.01L	met	0.01L	met
Fecal coliform	≤10000	**11000~14000**	**exceeded**	7900~9400	met
Sulfate	≤250	/	met	44.0~81.0	met
Chloride	≤250	/	met	13.6~19.3	met
Nitrate	≤10	/	met	0.495~3.29	met
Fe	≤0.3	/	met	0.03L	met
Mn	≤0.1	/	met	0.01L	met

110. Results (Table IV-15) show that the parameters at No. 2 point (Yanpo Village section of Longxi mainstream) and most of the parameter at the No.1 Point (Shizitan Reservoir section of Longxi mainstream) meet the Grade III of PRC Surface Water Quality Standards of GB3838-2002, except the two parameters of COD_{cr} and fecal coliform at the No.1 point, which exceeded standard due to the wastewater discharge from the surrounding towns and villages according to the DEIA.

Table IV-16: Water Quality Monitoring Results of the Tributaries – Changshou Unit: mg/L, except pH and fecal coliform)

	Jan.- Aug2017	Jan.- Aug 2017	19-20 Dec.2017	19-20 Dec.2017
Monitoring Point	**W3**	**W4**	**W5**	**W6 (Yuntai River)**

Parameter	Grade V Standard	Result	Standard compliance	Result	Standard compliance	Result	Standard compliance	Result	Standard compliance
pH	6~9	6.51~ 8.82	meet	7.47~ 8.83	meet	6.69~ 6.92	meet	6.58~ 6.76	meet
CODcr	≤40	**19~47**	**exceed**	15~ 29	meet	10~14	meet	**47~52**	**exceed**
BOD_5	≤10	3.8 ~9.3	meet	3.0~ 5.6	meet	3.3~3.7	meet	**15.1~ 16.1**	**exceed**
NH3-N	≤2.0	**2.03 ~10.4**	**exceed**	**0.11~ 2.73**	**exceed**	**4.35~ 4.42**	**exceed**	**12.0~ 12.1**	**exceed**
TP	≤0.2	**0.14 ~0.81**	**exceed**	**0.15~ 0.557**	**exceed**	0.17~ 0.18	meet	**0.97~ 0.99**	**exceed**
Petroleum	≤1.0	0.01~ 0.02	meet	0.01L	meet	0.01L	meet	0.01L	meet
Fecal coliform	10000	**18000 ~24000**	**exceed**	14000~ 18000	**exceed**	**3300~ 3400**	meet	4600	meet

111. The results in Table IV-16 show that the monitored parameters of COD_{cr}, NH_3-N, TP and fecal coliforms at W3 point, NH3-N, TP and fecal coliforms at W4 point, and NH3-N at W5 point (all on Dayu Stream) exceeded the Grade V Standard of GB3838-2002; and the parameters of COD_{cr}, BOD_5, NH_3-N and TP in Shuanglong River (point W6) exceeded the Grad V standard, indicating the poor water qualities in the tributaries due to the non-point pollution from the farmland and wastewater discharge from the surrounding towns and villages according to the DEIA.

(b) Quality of Sediment in Longxi Rivers – Changshou Section

112. Three sediment samples (Table IV-17) were taken by Chongqing Yijia Testing Technology Co. (the certificated environmental monitoring entity) on 19-20 December 2017. The results (Table IV-18) indicate that sediment qualities comply with the Standards for Pollutants in Sludge and Sediment for Agricultural Use (GB4284-84) and Grade II of the PRC Soil Quality Standard (GB15618-95). Geographic coordinates and maps of the sampling locations are described in Appendix 5.

Table IV-17: Monitoring Points for River Sediment - Changshou

No.	Sampling location	Remark
S1	Wudong Bridge, Dayu Stream, downstream from Yuntai Town WWTP	Quality of sediment
S2	Longcheng-Lijiang Section of Shuanglong River (Shaunglong Town)	Quality of sediment
S3	Dadu Bridge Section of Longxi River (Dandu Town)	Quality of sediment

WWTP = wastewater treatment plant.

Table IV-18: Baseline of River Sediment Quality - Changshou (Unit: mg/kg except pH**)**

Parameter	S1	S2	S3	Standard Value GB4284-84
pH	7.75	7.62	7.95	-
Cu	15	25	23	≤100
Zn	72.0	72.8	99.6	≤300
Pb	29.9	30.9	36.4	≤350
Cd	0.19	0.16	0.18	≤60
Ni	28	27	28	≤60
Hg	0.026	0.060	0.043	≤1.0
As	7.3	7.4	15.3	≤20
Cr6+	69	100	66	≤250
TP	252	682	499	-

TN	1,550	3,630	2,010	-

(c) Air Quality - Changshou

113. Baseline air quality in the two project districts and one county was assessed through: (i) compilation and review of available monitoring data for each of the three town centers, where the local EPBs have permanent monitoring stations to record up to six variables (NO_2, SO_2, CO, O_3, PM_{10}, $PM_{2.5}$); and (ii) sampling for seven consecutive days within the project sites, conducted by the domestic EIA institutes. The project sampling effort, although limited, was considered adequate for the project because air quality within the three town centers largely meets the required national standards (Table IV-19a). All project sites are at least 5 km from the town centers, within rural agricultural landscapes which do not include large sources of industrial or other emissions. It was considered a reasonable assumption that air quality in the project sites also meets the national standards. This is supported by the project sampling results.

114. **Ambient air quality in Changshou District Town.** The mean annual values for four of six recorded parameters in 2016 met the Grade II standard of the National Ambient Air Quality Standard (GB3095-2012) (Table IV-19a). Two parameters, PM_{10} and $PM_{2.5}$, exceeded the standard (Table IV-19a) due to the central location of the monitoring station within the town, near to industries, vehicles and other emission sources.

Table IV-19a: Ambient Air Quality in Changshou District Town in 2016

Pollutant	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	CO (mg/m^3)	O_3 ($\mu g/m^3$)
Annual Average	22.8	29.0	75.1	58.9	1.02	59.2
Grade II Standard	60	40	70	35	4	160
Standard compliance (Annual average)	meet	meet	Exceed	Exceed	meet	meet

Source: the DEIA Institute

115. **Project-specific sampling.** Daily ambient air qualities were monitored by Chongqing Yijia Testing Technology Co. for seven consecutive days, from 26 December 2017–1 January 2018. The three monitoring points at 30 m northwest of the construction sites (downwind direction) in the towns of Haitang, Shuanglong and Dayu were selected (Table IV-20). Geographic coordinates and maps of the sampling locations are described in Appendix 5. All parameters meet the Grade II of National Ambient Air Quality Standard (GB3095-1996) (Table IV-19b).

Table IV-19b: Daily Average Concentrations of Monitored Air Pollutants – Changshou. Unit: mg/m^3

Parameter	Sampling Location	Daily Average	Class II Standard of GB3095-1996
PM_{10}	A1 (Haitang Town)	0.076-0.116	0.15
	A2 (Shuanglong Town)	0.072-0.115	
	A3 (Dadu Town)	0.080-0,106	
SO_2	A1 (Haitang Town)	0.010-0.022	0.30
	A2 (Shuanglong Town)	0.010-0.019	
	No.3 (Dadu Town)	0.010-0.021	
NO_2	A1 (Haitang Town)	0.030-0.046	0.15
	A2 (Shuanglong Town)	0.032-0.046	

	A3 (Dadu Town)	0.030-0.046	

(d) Acoustic environment

116. Noise monitoring in the project area was conducted on 6-7 December 2017 at 12 locations (Table IV-20). Geographic coordinates and maps of the sampling locations are described in Appendix 5. Noise levels at all locations met both the PRC Environmental Quality Standard for Noise (GB3096-2008) – Grade II and the World Bank Group's EHS guideline values of 55 dB and 45 dB for day and night-time respectively (Table IV-21).

Table IV-20: Monitoring Location for Noise Baseline – Changshou

Sampling No.	Location	Purpose of Monitoring
N1	State point of Dayu Stream (Tuqiao Village, Haitang Town)	Ambient noise baseline
N2	Haitang Town (urban area)	Noise Baseline at sensitive point
N3	Liujiaba New Bridge of Yuntai Town	Ambient noise baseline
N4	Urban area of Yuntai Town	Noise Baseline at sensitive point
N5	The WWTP of Yuntai Town	Ambient noise baseline
N6	Jizi Bridge on Caijia River of Longhe Town (toll station)	Ambient noise baseline
N7	Zhujiadong Reservoir of Longhe Town	Ambient noise baseline
N8	Duanshi Bridge at Longtan Village of Shaunglong Town	Ambient noise baseline
N9	Urban area of Shuanglong Town	Noise Baseline at sensitive point
N10	Urban area (jiaojia) of Linfeng Town	Noise Baseline at sensitive point
N11	Urban area of Lingfeng Town	Noise Baseline at sensitive point
N12	Urban area of Dandu Town	Noise Baseline at sensitive point

Table IV-21: Baseline Noise Monitoring Data (dB(A)) – Changshou

Sampling No.	Tine	Monitoring Result		Grade II Standard of GB3096-2008	World Bank EHS Guideline	Standard compliance
		6 Dec. 2017	7 Dec. 2017			
N1	Day	46.1	45.2	60 (Grade II)	55	meet
	Night	36.4	35.3	50 (Grade II)	45	
N2	Day	51.3	50.7	60 (Grade II)	55	
	Night	40.7	41.4	50 (Grade II)	45	
N3	Day	45.9	44.3	60 (Grade II)	55	
	Night	36.6	37.8	50 (Grade II)	45	
N4	Day	51.8	51.1	60 (Grade II)	55	
	Night	41.7	40.8	50 (Grade II)	45	
N5	Day	46.5	46.1	60 (Grade II)	55	
	Night	36.8	36.3	50 (Grade II)	45	
N6	Day	47.5	49.5	60 (Grade II)	55	
	Night	37.8	38.3	50 (Grade II)	45	
N7	Day	41.8	43.2	60 (Grade II)	55	
	Night	32.4	32.2	50 (Grade II)	45	
N8	Day	46.2	49.3	60 (Grade II)	55	
	Night	37.6	36.5	50 (Grade II)	45	
N9	Day	51.0	50.0	60 (Grade II)	55	
	Night	41.1	39.6	50 (Grade II)	45	
N10	Day	52.9	52.6	60 (Grade II)	55	

	Night	41.8	41.8	50 (Grade II)	45	
N11	Day	52.6	53.8	60 (Grade II)	55	
	Night	41.5	44.5	50 (Grade II)	45	
N12	Day	48.7	51.4	60 (Grade II)	55	
	Night	40.1	40.8	50 (Grade II)	45	

D. Environmental Baseline for Dianjiang County

a) Surface Water Quality

117. The assigned environmental function of Longxi River (Dianjiang section) is Class III of PRC Environmental Quality Standards for Surface Water (GB3838-2002), based on the Chongqing Municipality Surface Water Functional Map. The Dianjiang County EMS conducted the surface water baseline monitoring on 19-20 December 2017, at five sampling locations (Table IV-22). Geographic coordinates and maps of the sampling locations are described in Appendix 5. The monitoring results are shown in Table IV-23.

Table IV-22: Monitoring Points for Surface Water Quality Baseline – Dianjiang

Sampling No.	Sampling point (location)	Water quality function	Remark
W1	Dianjing No.4 Middle school section on Banqiao River	Grade V Irrigation, fishery	Water quality of section of Banqiao River prior flows into Longxi River
W2	The starting point of embankment work on Xinmin River in Xinmin Town	Grade III drinking water source, Irrigation	Water quality of Xinmin River
W3	Dianjiang No.3 Middle School Section on Longxi mainstream in Gao'an Town		Water quality at middle-stream of Longxi River (Dianjiang Section)
W4	Banjie Bridge section of Longxi River		Water quality at upstream of Longxi mainstream (Dianjiang section
W5	Bajiantan section of Longxi River		Water quality at downstream of Longxi mainstream (Dianjiang section)

Table IV-23: Water Quality Monitoring Results of Longxi River and Tributaries – Dianjiang. Unit: mg/L, except Ph and fecal coliform

Sampling. No.	Item	pH	CODcr	BOD_5	NH3-N	TP	Petroleum	Fecal coliform
	Grade V Standard	**6~9**	**≤40**	**≤10**	**≤2.0**	**≤0.2**	**≤1.0**	**≤10000**
W1 (Banqiao River)	Result	7.21~ 7.36	15~18	4.0~ 4.4	1.24 ~ 1.26	**0.39~ 0.42**	0.01L	2700~ 3300
	Standard compliance	meet	meet	meet	meet	**exceed**	meet	meet
	Grade III Standard	**6~9**	**≤20**	**≤4**	**≤0.5**	**≤0.2**	**≤0.05**	**≤10000**
W2 (Xinmin River)	Result	7.07~ 7.11	7~ 10	1.9~ 2.2	0.125~ 0.136	0.04~ 0.05	0.01L	3400~ 4300
	Standard compliance	meet	meet	meet	meet	meet	meet	meet
W3 (Longxi River)	Result	6.83~ 6.98	16~ 17	1.6~ 2.1	0.818~ 0.826	**0.23~ 0.25**	0.01L	2200~ 2700
	Standard compliance	meet	meet	meet	meet	**exceed**	meet	meet
	Result	7.41	12	2.9	0.46	0.19	0.01L	——

W4 (Longxi River)	Standard compliance	meet	meet	meet	meet	meet	meet	——
W5 (Longxi River)	Result	——	9	2.9	0.48	0.08	0.01L	——
	Standard compliance	——	meet	meet	meet	meet	meet	——

118. The results in Table IV-23 show that all the monitored parameters in both the upstream and downstream of Longxi River – Dianjiang section (No. W4 and W5) meet the Grade III Standard of GB3838-2002, while only the TP in the middle reach of Longxi River (No. W3) exceeds the standard due to non-point pollution from the nearby farmland according to the DEIA; the monitored parameters of TP in Banqiao River (No. W1) exceed the Grade V standard; and all the monitored parameters in Xinmin River (No. W2) meet the Grade III standard.

(e) Quality of Sediment in Rivers – Dianjiang

119. Three sediment samples (Table IV-24) were taken by Chongqing Yijia Testing Technology Co. on 20 December 2017. Geographic coordinates and maps of the sampling locations are described in Appendix 5. Results (Table IV-25) indicate that sediment qualities comply with the Standards for Pollutants in Sludge and Sediment for Agricultural Use (GB4284-84) and Grade II of the PRC Soil Quality Standard (GB15618-95).

Table IV-24: Monitoring Points for River Sediment - Dianjiang

No.	Sampling location	Remark
S1	Under the Bridge of Motan Power Station in Pushun Town (Longxi River)	Quality of sediment
S2	Under the Huatan Bridge in Gao'an Town (Longxi River)	Quality of sediment
S3	The end-point of embankment in Wudong Town (Longxi River)	Quality of sediment

Table IV-25: Baseline of River Sediment Quality - Dianjiang (Unit: mg/kg except pH**)**

Parameter	Sampling No.			Standard Value GB4284-84
	S1	S2	S3	
pH	7.75	8.11	7.74	-
Cu	50	15	14	≤100
Zn	102.3	78.0	66.0	≤300
Pb	36.3	29.4	29.6	≤350
Cd	0.63	0.20	0.16	≤60
Ni	28	29	26	≤60
Hg	0.030	0.036	0.058	≤1.0
As	12.5	12.8	11.1	≤20
Cr6+	52	98	84	≤250
TP	1190	641	761	-
TN	2000	755	3510	-

b) Air Quality - Dianjiang

120. **Ambient air quality in Dianjiang County Town.** For air quality parameters are measured at the Dianjiang monitoring station within the county town and data are available for three years (2015–2017). Mean annual levels of SO_2 and NO_2 met the Grade II Standard of GB3095-2012 in all years. Two parameters, PM_{10} in 2015 and $PM_{2.5}$ in 2016 and 2017, exceeded the standards (Table IV-26a), due to the central location of the monitoring station within the town, near to industries, vehicles and other emission sources.

Table IV-26a: Ambient Air Quality in Dianjiang County Town 2015–2017 (unit: μg/m^3)

Pollutant	SO_2	NO_2	PM_{10}	$PM_{2.5}$
2015	14	48	74 (exceed standard)	-
2016	10	29	66	57 (exceed standard)
2017	12	26	57	47 (exceed standard)
Grade II Standard (Annual average)	60	40	70	35

121. **Project-specific sampling**. Daily ambient air qualities were monitored by the Dianjiang County EMS for seven consecutive days, from 26 December 2017–1 January 2018. The three monitoring points in the towns of Pushun, Gao'an and Gaofeng were selected. Geographic coordinates and maps of the sampling locations are described in Appendix 5. The monitored data are shown in Table IV-26b. All the monitored parameters of Pm_{10}, SO_2 and NO_2 meet the Grade II of National Ambient Air Quality Standard (GB3095-1996).

Table IV-26b: Daily Average Concentrations of the Monitored Air Pollutants – Dianjiang. Unit: mg/m^3

Parameter	Sampling Location	Daily Average	Class II Standard of GB3095-1996
PM_{10}	A1 (The government building in Pushun Town)	0.080-0.112	0.15
	A2 (Dianjiang No. 3 Middle School in Gao'an Town)	0.080-0.109	
	A3 (Fuli Building of Fengshan Park in Dianjiang County Town)	0.057-0,106	
SO_2	A1 (The government building in Pushun Town)	0.010-0.021	0.30
	A2 (Dianjiang No. 3 Middle School in Gao'an Town)	0.009-0.021	
	A3 (Fuli Building of Fengshan Park in Dianjiang County Town)	0.012-0.019	
NO_2	A1 (The government building in Pushun Town)	0.029-0.045	0.15
	A2 (Dianjiang No. 3 Middle School in Gao'an Town)	0.030-0.046	
	A3 (Fuli Building of Fengshan Park in Dianjiang County Town)	0.026-0.040	

(a) Acoustic environment – Dianjiang

122. Noise monitoring in the project area was conducted on 4 - 5 December 2017 at 15 locations (Table IV-27) by Chongqing Jiayi Testing Technology Co. Geographic coordinates and maps of the sampling locations are described in Appendix 5. The noise levels at all locations met both the PRC Environmental Quality Standard for Noise (GB3096-2008) – Grade II and the World Bank Group's EHS guideline values of 55 dB and 45 dB for day and night-time respectively (Table IV-28).

Table IV-27: Monitoring Location for Noise– Dianjiang

Sampling No.	Location	Purpose of Monitoring
N1	Banjie Bridge in Pushun Town	Ambient noise baseline

N2	The Government Building in Pushun Town	Noise Baseline at sensitive point
N3	Dianjiang No.4 Middle School nearer Banqiao River (Zhoujia Town)	Ambient noise baseline
N4	The government Building of Zhoujia Town	Noise Baseline at sensitive point
N5	The stating point of Enbankment work on Xinmin River	Ambient noise baseline
N6	Zhenshang Bridge in Xinmin Town	Ambient noise baseline
N7	Pingtan Bridge in Gao'an Town	Ambient noise baseline
N8	Laoyuan residental community in west urban area	Ambient noise baseline
N9	Dianjiang No.3 Middle School	Noise Baseline at sensitive point
N10	The Government Building in Gaofeng Town	Ambient noise baseline
N11	The proposed emergency bridge location	Ambient noise baseline
N12	Longtan Village of Wudong Town	Ambient noise baseline
N13	Wujia Bridge of Chengxi Town	Ambient noise baseline
N14	Dancheng Lake of Chengxi Town	Ambient noise baseline
N15	The dam of Sanhe Reservoir	Ambient noise baseline

Table IV-28: Baseline Noise Monitoring Data (dB(A)) – Dianjiang

Sampling No.	Tine	Monitoring Result	Grade II Standard of GB3096-2008	World Bank EHS Guideline	Standard compliance
N1	Day	44.6~46.2	60 (Grade II)	55	meet
	Night	37.2~38.0	50 (Grade II)	45	
N2	Day	51.0~53.0	60 (Grade II)	55	
	Night	42.6~42.7	50 (Grade II)	45	
N3	Day	48.1~49.8	60 (Grade II)	55	
	Night	39.7~40.6	50 (Grade II)	45	
N4	Day	52.5~54.4	60 (Grade II)	55	
	Night	43.1~44.7	50 (Grade II)	45	
N5	Day	41.0~41.6	60 (Grade II)	55	
	Night	33.4~38.5	50 (Grade II)	45	
N6	Day	42.6~44.6	60 (Grade II)	55	
	Night	37.0~37.5	50 (Grade II)	45	
N7	Day	45.3~47.0	60 (Grade II)	55	
	Night	37.9~38.2	50 (Grade II)	45	
N8	Day	57.3~58.3	60 (Grade II)	55	
	Night	45.8~46.3	50 (Grade II)	45	
N9	Day	47.8~48.5	60 (Grade II)	55	
	Night	39.4~39.9	50 (Grade II)	45	
N10	Day	50.7~51.3	60 (Grade II)	55	
	Night	42.6~43.8	50 (Grade II)	45	
N11	Day	47.6~49.8	60 (Grade II)	55	
	Night	37.9~40.6	50 (Grade II)	45	
N12	Day	50.9~51.4	60 (Grade II)	55	
	Night	42.6~42.9	50 (Grade II)	45	
N13	Day	48.1~48.9	60 (Grade II)	55	
	Night	38.3~41.7	50 (Grade II)	45	
N14	Day	48.2~49.2	60 (Grade II)	55	

	Night	40.0~42.6	50 (Grade II)	45	
N15	Day	37.9~39.1	60 (Grade II)	55	
	Night	32.2~32.8	50 (Grade II)	45	

E. Environmental Baseline of Liangping District

c) Surface Water Quality

123. The assigned functions of the Longxi River mainstream and Shuanggui Lake (W1-W4) in Liangping District are Grade III of GB3838-2002 based on Chongqing Municipality Surface Water Functional Map. The official water zoning functions of the tributaries of Longdong River, Shizhu River, Baisha River, Xiaojia Stream, Huashi Stream (W5-W13) have not yet been defined by the local EPB; after consultation with the EPBs, the water qualities of the tributaries were assessed based on the Grade V Standard in the DEIA. Thirteen points were sampled (Table IV-29). Geographic coordinates and maps of the sampling locations are described in Appendix 5.

Table IV-29: Monitoring Points for Surface Water Quality Baseline – Liangping

Sampling No.	Sampling point (location)	Water quality function	Remark
W1	500 m upstream of Baihe Bridge on Longxi mainstream (Liangping section)	Grade III, drinking water source	Water quality at upstream of Longxi mainstream
W2	1200 m upstream from Baihe Bridge (Longxi mainstream)		8-10 Jan
W3	1000 m downstream from the confluence point of Sandengpo Tributary and Loangxi mainstream (Longxi mainstream)		8-10 Jan
W4	The wharf of Shuanggui Lake		Water quality of Shuanggui Lake
W5	500 m upstream on Longdong River at the confluent point with Longxi River	Grade V Irrigation, fishery	Water quality of Longdong River
W6	500 m upstream of Shizhu River at Tangjiayuanzi Village		Water quality of Shizhu River
W7	100 m upstream at Yu-sui Highway (Longtong River)		Water quality of Longdong River (Phase I)
W8	500 m upstream at the Bridge on No. 303 Provincial highway (Xiaojiagou stream)		Water quality of Xiaojia Stream
W9	500 m upstream of Huashigou Stream at the confluent point with Shizhu River		Water quality of Huashigou Stream
W10	500 m upstream of Baisha River at the confluent point with Da River		Water quality of Baisha River
W11	100 m downstream of Xiaosha River at the confluent point with Zhangxingqiao River		Water quality of Xiaosha River
W12	1000 m downstream from Pingjin Town (Huilong River)		Water quality of Huilong River
W13	500 m upstream from the confluence point of Sandengpo Tributary and Loangxi mainstream (Sandengpo Tributary)		Water quality of Sandengpo Tributary

Table IV-30: Water Quality Monitoring Results of Longxi River and tributaries – Liangping. Unit: mg/L, except Ph and fecal coliform)

Sampling. No.	Item	pH	CODcr	BOD_5	NH3-N	TN	TP	Petroleum
Grade III Standard		**6~9**	**≤20**	**≤4.0**	**≤0.5**	**≤1.0**	**≤01**	**≤0.05**
W1 (Longxi River)	Result	8.17	**24**	**4.0**	**2.25**	**5.83**	**0.54**	**0.73**
	Standard compliance	meet	**exceed**	**exceed**	**exceed**	**exceed**	**exceed**	**exceed**
W2 (Longxi River)	Result	7.8	14.7	3.5	**3.78**	**5.06**	**0.39**	0.04
	Standard compliance	meet	meet	meet	**exceed**	**exceed**	**exceed**	meet
W3(Longxi River)	Result	8.2	6.7	2.3	**0.72**	0.88	0.063	0.04
	Standard compliance	meet	meet	meet	**exceed**	meet	meet	meet
W4 (Shuanggui Lake)	Result	8.06	15.0	2.6	0.228	0.727	0.05	0.08
	Standard compliance	meet	meet	meet	meet	meet	meet	meet
		pH	**CODcr**	**BOD_5**	**NH3-N**	**TN**	**TP**	**Petroleum**
Grade V Standard		**6-9**	**≤40**	**≤10**	**≤2.0**	**≤2.0**	**≤0.2**	**≤1.0**
W5 (Longdong River)	Result	8.24	14.33	3.27	**2.16**	**3.24**	**0.35**	**1.87**
	Standard compliance	meet	meet	meet	**exceed**	**exceed**	**exceed**	**exceed**
W6 (Shizhu River)	Result	8.50	4.67	2.53	0.05	0.88	0.05	0.22
	Standard compliance	meet	meet	meet	meet	meet	meet	meet
W7 (Longdong River)	Result	8.84	15.0	1.97	0.11	1.1	0.06	0.13
	Standard compliance	meet	meet	meet	meet	meet	meet	meet
W8 (Xiaojia Stream)	Result	8.48	13.0	2.53	0.91	1.87	0.14	0.14
	Standard compliance	meet	meet	meet	meet	meet	meet	meet
W9 (Huashi Stream)	Result	8.56	4.0	2.5	0.09	0.49	0.04	0.10
	Standard compliance	meet	meet	meet	meet	meet	meet	meet
W10 (Baisha River)	Result	7.07	128.3	46.9	19.2	21.6	2.31	0.18
	Standard compliance	meet	exceed	exceed	exceed	exceed	exceed	exceed
W11 (Xiaosha River)	Result	7.37	45.5	8.0	7.54	-	-	0.023
	Standard compliance	meet	exceed	meet	exceed	exceed	exceed	meet
W12 (Huilong River)	Result	7.7	6.0	2.4	3.47	4.38	0.33	0.04
	Standard compliance	meet	meet	meet	exceed	exceed	exceed	meet
W13 (Sandengpo Tributary)	Result	8.1	5.5	2.3	0.49	0.71	0.033	0.04
	Standard compliance	meet	meet	meet	meet	meet	meet	meet

124. The results (Table IV-30) show that: (i) water quality of the Longxi River mainstream did not meet the Grade III Standard of GB3838-2002; exceeded parameters were NH_3-N (W1, W2 and W3); TN and TP (W1 and W2), and COD_{cr}; BOD_5 and Petroleum (W1); (ii) the monitored parameters at Shaunggui Lake (W4) all met the Grade III Standard; (iii) the water quality of Longdong River (W5) exceeded the Grade V Standard, with the exceeded parameters of NH_3-N, TN, TP and petroleum; (iv) the water qualities of Shizhu River (W6), Longdong River (W7), Xiaojia Stream (W8) and Huashi Stream (W9) meet the Grad V standard; (v) The water quality of Baisha River (W10) significantly exceeded the Grade V standard, the exceeded parameters are CODcr, BOD_5, NH_3-N, TN, TP and petroleum; (vi) the water quality of Xiaosha River (W11) could not meet the Grade V standard with the exceeded parameters of CODcr, NH_3-N, TN and TP; (vii) the water quality of Huilong River (W12) exceeded the Grade V standard, and the exceeded pollutants are NH_3-N, TN, and TP; and (viii) the water quality of Sandengpo tributary meet the Grade V standard. The reasons for the exceedances

in the Longxi mainstream and its tributaries are wastewater discharge from the surrounding towns and villages and non-point pollutions from surrounding farmlands.

d) Sediment Quality in Longxi River and Tributaries

125. Sediment sampling was conducted on 14 January 2018 in 12 sites, comprising two points on Longxi River and 10 points for the tributaries, by the Chongqing Mineral Resources Testing Center on 14 January 2018 (Table IV-31). Geographic coordinates and maps of the sampling locations are described in Appendix 5. The results (Table IV-32) indicate that sediment quality complies with the Standards for Pollutants in Sludge and Sediment for Agricultural Use (GB4284-84) and Grade II of the PRC Soil Quality Standard (GB15618-95).

Table IV-31: Monitoring Points for River Sediment - Liangping

No.	Sampling Location
S1	Longxi mainstream; 500 m upstream of Baihe Bridge (Liangping)
S2	Longdong tributary; 500 m upstream from confluence with Longxi River
S3	500 m upstream of Shizhu River at Tangjiayuanzi Village
S4	100 m upstream at Yu-sui Highway (Longtong River)
S5	500 m upstream at the Bridge on No. 303 Provincial highway (Xiaojiagou stream)
S6	500 m upstream of Huashigou Stream at the confluent point with Shizhu River
S7	500 m upstream of Baisha River at the confluent point with Da River
S8	At Shuanggui-Yayuan Residential Comunity in Zhangxingqiao River
S9	1200 m upstream from Dingjia Bridge on Longxi River
S10	1000 m downstream of Huilong River from the urban area of Pingjin Town
S11	500 m upstream of Sandengpo tributary from the confluent point with Longxi River
S12	1000 m downstream of Sandengpo tributary from the confluent point with Longxi River

Table IV-32: Baseline of River Sediment Quality - Liangping (Unit: mg/kg except pH**)**

Sampling No.	Sampling Date	Parameter								
		pH	Cu	Zn	Ni	As	Cr	Hg	Cd	Pb
S1	14 January 2018	7.58	11.2	38.5	29.5	4.40	129	0.189	0.094	16.5
S2		6.50	24.6	82.3	52.8	7.86	180	0.454	0.42	27.2
S3		6.60	27.3	54.9	26.1	2.67	121	0.174	0.18	21.1
S4		6.93	5.66	17.0	32.2	0.73	139	0.022	0.088	17.5
S5		6.84	8.98	30.3	39.1	2.10	139	0.012	0.21	21.8
S6		6.82	13.9	43.9	52.4	2.56	187	0.062	0.17	22.8
S7		6.50	52.0	186	63.2	2.59	233	0.755	0.52	40.6
S8		7.27	25.3	77.6	69.6	3.61	222	0.024	0.12	23.6
S9	8 January 2018	6.85	18.5	26.7	26.4	1.56	0.02	0.112	0.1	3.5
S10		7.01	22.1	67.4	67.4	11.3	0.01	0.112	0.35	7.1
S11		6.97	31.7	80.5	80.5	4.11	0.01	0.096	0.3	6
S12		6.93	20.2	81.3	81.3	3.28	0.02	0.083	0.21	5.6
Standard Value GB4284-84		≧ 6.5	≤500	≤1000	≤200	≤75	≤1000	≤15	≤20	≤1000

(a) Air Quality

126. **Ambient air quality in Lianping District Town.** Air quality parameters are measured at the Lianping monitoring station within the district town and data are available for three years (2015–2017). Mean monthly levels of SO_2, NO_2 and PM10 met the Grade II Standard of GB3095-2012 in all months (Table IV-33a). One parameter, $PM_{2.5}$ in January and December 2017, exceeded the standard (Table IV-33a), due to: (i) the central location of the monitoring station within the town, near to

industries, vehicles and other emission sources; and (ii) few winds in winter to disperse the pollutants.

Table IV-33a: Ambient Air Quality in Liangping District Town 2015–2017 (Unit: mg/m^3)

Year	Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Grade II Standard (daily average)
2015	Days of good air quality	25	28	30	30	31	30	31	31	30	31	30	31	
	Major Pollutant	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	
	SO_2（mg/m^3）	0.014	0.015	0.013	0.012	0.012	0.01	0.011	0.013	0.012	0.013	0.01	0.011	**0.15**
	NO_2（mg/m^3）	0.031	0.024	0.018	0.013	0.012	0.009	0.008	0.014	0.013	0.025	0.02	0.03	**0.08**
	PM_{10}（mg/m^3）	0.108	0.061	0.07	0.054	0.048	0.032	0.042	0.044	0.047	0.068	0.04	0.074	**0.15**
2016	Days of good air quality	30	29	31	30	31	30	No data for this period as equipment being updated		30	30	29	15	
	Major Pollutant	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}			$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	
	SO_2（mg/m^3）	0.013	0.012	0.016	0.012	0.012	0.009			0.01	0.008	0.008	0.011	**0.15**
	NO_2（mg/m^3）	0.031	0.031	0.025	0.022	0.016	0.016			0.02	0.016	0.031	0.025	**0.08**
	PM_{10}（mg/m^3）	0.09	0.081	0.069	0.043	0.041	0.032			0.072	0.052	0.064	0.066	**0.15**
	$PM_{2.5}$（mg/m^3）	/	/	/	/	/	/			0.046	0.027	0.039	0.047	**0.075**
2017	Days of good air quality	15	22	31	28	28	30	31	31	30	31	30	19	
	Major Pollutant	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	
	SO_2（mg/m^3）	0.011	0.01	0.011	0.01	0.009	0.009	0.01	0.012	0.012	0.011	0.014	0.017	**0.15**
	NO_2（mg/m^3）	0.03	0.029	0.029	0.019	0.017	0.017	0.013	0.013	0.014	0.019	0.032	0.039	**0.08**
	PM_{10}（mg/m^3）	0.112	0.078	0.066	0.051	0.061	0.053	0.034	0.035	0.039	0.042	0.076	0.125	**0.15**
	$PM_{2.5}$（mg/m^3）	0.083	0.056	0.038	0.027	0.037	0.035	0.015	0.018	0.02	0.022	0.047	0.082	**0.075**

Source: DEIA Institute

127. **Project-specific sampling**. Ambient air quality was monitored at eight locations (Table IV-33b). Geographic coordinates and maps of the sampling locations are described in Appendix 5. Standards for SO_2, NO_2, PM_{10} and $PM_{2.5}$ met Grade II of National Ambient Air Quality Standard (GB 3095-1996) (Table IV-33a).

Table IV-33b: Monitoring Location for Ambient Air Quality – Liangping

No.	Sampling location	Date
A1	Songzu Village (708 m west of Baisha River)	23-29 May 2016
A2	C-block of Shuangguijiayuan Residential Community (200 m north of Shuanggui Lake)	11-17 April 2016
A3	Bai'an Village (80 m south of the confluence of Longdong River and Longxi River	11-17 January 2018
A4	Wenjiahe Dam (100 m south of the confluence of Longdong River and Xiaojia Stream	
A5	Dingjiayan Village (20 m east of Longxi River)	5-12 January 2018
A6	Urban area of Pingjin Town (1000 m east of Huilong River downstream)	
A7	Daoshiqiao Village (20 m east of Longxi River	
A8	East Renmin Road in Liangping District Town	18-24 January 2018

Table IV-34: Daily Average Concentrations of the Baseline Air – Liangping (unit: mg/m^3)

Parameter	Sampling No.	Daily Average	Class II Standard of GB3095-1996
PM_{10}	A1	0.057~0.082	0.15

	A2	0.051~0.065	
	A3	0.078~0.086	
	A4	0.079~0.088	
	A5	0.043~0.047	
	A6	0.054~0.059	
	A7	0.043~0.053	
PM2.5	**A8**	**10-15**	**75**
SO_2	A1	0.012~0.021	0.15
	A2	0.019~0.025	
	A3	0.007~0.009	
	A4	0.007~0.009	
	A5	0.014~0.017	
	A6	0.017~0.019	
	A7	0.016~0.019	
NO_2	A1	0.020~0.034	0.08
	A2	0.019~0.023	
	A3	0.032~0.033	
	A4	0.032~0.033	
	A5	0.021~0.027	
	A6	0.031~0.038	
	A7	0.027-0.035	

(b) Acoustic environment

128. Noise monitoring was conducted in 16 locations on 11-12 January 2018, at and near the project construction sites (Table IV-35). Geographic coordinates and maps of the sampling locations are described in Appendix 5. Noise levels met the PRC Environmental Quality Standard for Noise (GB3096-2008) – Grade II and World Bank Group's EHS guideline values (Table IV-36).

Table IV-35: Monitoring Location for Noise – Liangping

No.	Location	Purpose of Monitoring
N1	30 m from east bank of Longxi River (Liangjiaba Village, at intersection of No.10 Road and No.19 Road	Ambient noise baseline
N2	29 m from south bank, Longdong River-Phase I (Mopan Village)	Baseline at sensitive receptor
N3	14 m from south bank of Shizhu River (nearby the G20 Hightway	Ambient noise baseline
N4	98 m from south bank, Huashi Stream (near Shanshuwan Village)	Baseline at sensitive receptor
N5	39 m from north bank, Longdong River Phase II (near the Second Ring Road	Ambient noise baseline
N6	117 m from north bank, Xiaojia Stream (near G55 Highway)	Ambient noise baseline
N7	98 m from north bank, Shuanggui Lake (Shuanggui Water Supply Co.)	Ambient noise baseline
N8	Northwest bank, Shuanggui Lake (the nursing home)	Baseline at sensitive receptor
N9	62 m from north bank, Zhangxingqiao River (Zhide Primary School)	Baseline at sensitive receptor
N10	72 m from west bank, Shuanggui Lake (West entrance of the park)	Ambient noise baseline

N11	53 m from east entrance of Shuanggui Lake Park	Ambient noise baseline
N12	149 m from north bank, Baisha River (Chenjiaqiao Village)	Baseline at sensitive receptor
N13	40 m from east bank, Longxi River (at police station)	Baseline at sensitive receptor
N14	50 m from north bank, Huilong River (S102 residential community)	Baseline at sensitive receptor
N15	20 m from south bank, Huilong River (Pingjin Middle School)	Baseline at sensitive receptor
N16	10 m from east bank, Longxi River (Daoshiqiao Village)	Baseline at sensitive receptor

Table IV-36: Baseline Noise Monitoring Data (dB(A)) – Dianjiang

No.	Tine	Monitoring Result		Grade II Standard of GB3096-2008	World Bank EHS Guideline	Standard compliance
		11 Jan 2018	12 Jan 2018			
N1	Day	41.5	41.9	60 (Grade II)	55	meet
	Night	39.2	39.8	50 (Grade II)	45	
N2	Day	42.6	42.1	60 (Grade II)	55	
	Night	39.8	38.3	50 (Grade II)	45	
N3	Day	45.2	44.5	60 (Grade II)	55	
	Night	41.2	40.2	50 (Grade II)	45	
N4	Day	43.7	44.6	60 (Grade II)	55	
	Night	39.7	39.2	50 (Grade II)	45	
N5	Day	42.3	43.5	60 (Grade II)	55	
	Night	40.2	39.6	50 (Grade II)	45	
N6	Day	46.3	45.5	60 (Grade II)	55	
	Night	39.2	39.8	50 (Grade II)	45	
N7	Day	44.9	44.3	60 (Grade II)	55	
	Night	43.1	42.4	50 (Grade II)	45	
N8	Day	47.6	48.3	60 (Grade II)	55	
	Night	40.8	41.4	50 (Grade II)	45	
N9	Day	44.1	45.3	60 (Grade II)	55	
	Night	41.4	40.7	50 (Grade II)	45	
N10	Day	50.7	50.1	60 (Grade II)	55	
	Night	44.3	42.2	50 (Grade II)	45	
N11	Day	42.9	43.5	60 (Grade II)	55	
	Night	39.7	39.2	50 (Grade II)	45	
N12	Day	42.2	43.2	60 (Grade II)	55	
	Night	40.3	39.0	50 (Grade II)	45	
N13	Day	46.7	46.2	60 (Grade II)	55	
	Night	38.5	39.8	50 (Grade II)	45	
N14	Day	67.1	66.6	60 (Grade II)	55	
	Night	61.6	53.1	50 (Grade II)	45	
N15	Day	46.7	46.7	60 (Grade II)	55	
	Night	39.1	39.8	50 (Grade II)	45	
N16	Day	39.7	41.8	60 (Grade II)	55	
	Night	33.4	37.4	50 (Grade II)	45	

V. ANTICIPATED IMPACTS AND MITIGATION MEASURES

A. Project Area of Influence and Sensitive Receptors

129. To define the geographic scope of the impact assessment, the "project area of influence" and "sensitive receptors" were identified. The project area of influence was defined as the total area which might be subject to adverse impacts of the project. This was based on the locations of sensitive receptors, defined as settlements and/or environmental values that might be affected by the project construction and/or operation. The receptors (Tables V-1 to Table V-3) comprise: (i) villages, communities and/or public buildings (e.g. schools, offices) potentially subject to construction- or operational- noise and/or vibration, air pollution, altered water quality or supply, and/or environment-related social impacts; (ii) public service facilities vulnerable to disturbance or pollution e.g. water source protection areas and reservoirs; (iii) vegetation, fauna habitats, and agricultural lands within 200 m of the waterways targeted for construction works, including the Longxi River main channel, tributaries and riverbank habitats; and (iv) the Longxi mainstream and riverbank habitats downstream of the project area e.g. in the event that downstream communities might be affected by increased flood risk or altered water supply as a result of the project.

130. The following distances were applied to identify the sensitive receptors: (i) for construction and/or operational noise – receptors within 200 m of the noise-generating source; (ii) for construction-related air quality impacts (e.g. odor from dredging) – receptors within 200 m of the source; (iii) for potential downstream changes in hydrology or environment-related social impacts on the Longxi River mainstream and its tributaries, 2,000 m downstream from the furthest downstream construction works, based on hydrological modeling. These distances, combined with the direct construction sites, were assumed to encompass the total project area of influence.

Table V-1: Environmentally Sensitive Receptors – Liangping District

Subproject	No.	Sensitive Receptor	Description	Households (HH) and # people	Impact
L1.2 Ecological and Environmental Improvement of Longxi Upstream at Liangping Urban and Surrounding Area (Shuanggui Lake Wetland Area)	1	The nursing home	North bank, Shuanggui Lake	50 aged people (a 1,355 m2 building)	Noise, air pollution, odor from sediment dredging
	2	The scattered residents	West bank, Shuanggui Lake	7 HH (25 persons)	
	3	Zhide Primary School	10 m from the west bank of Shuanggui Lake	Eight buildings (800 students, 21,200 m^2	
	4	The residential community	15 m from the north bank of Shuanggui Lake	400 HH (1,250 persons, 30 buildings)	
	5	Shuanggui-Yayuan Residential Community (II-B)	13 m from the east bank of Shuanggui Lake	17 buildings; 360 HH (1,368 persons)	
	6	Shuanggui Lake	In the park	Water for industry, agriculture and, landscaping)	Wastewater
L1.3 Jindai Town Longxi River and tributary comprehensive treatment	7	Liangjiaba Village	31 m from west bank, Longxi River (at intersection of Roads 018 and 019	12 HH (39 Persons)	Noise, air pollution
	8	Xinglongzai Village	69 m from the east bank of Longxi River	9 HH (29 persons)	
	9	The scattered residents	24 m from the west bank of Longxi River	6 HH (20 Persons)	
	10	Ma'anshan Village	79 m from the east bank of Longxi River	12 HH (39 persons)	

Subproject	No.	Sensitive Receptor	Description	Households (HH) and # people	Impact
	11	Tuqiao Village	22 m from west bank Longxi River	8 HH (26 persons)	
	12	Mopanzai Village	29 m from the north bank of Longdong River (Phase II)	9 HH (29 persons)	
	13	Scattered hoodhoods of Shizhu Village	28 m from the north bank of Shizhu River	15 HH (49 persons)	
	14	Shanshuwan Village	98 m from the south bank of Huashi Stream	16 HH (56 persons)	
	15	Shuangguitang Village	39 m from south bank of Longdong River (Phase I)	26 HH (84 persons)	
	16	Scattered hoodhoods of Rende Village	117 m from south bank of Xiaojia Stream	3 HH (10 persons)	
	17	Yangjiayan Village	168 m from south bank of Xiaojia Stream	7 HH (23 persons)	
	18-22	Longxi River, Longdong River, Shizhu River, Xiaojia Stream and Huashi Stream	Surface water for irrigation, industry, landscaping and flood discharge	-	Wastewater
L1.1 Longxi River and Tributary Improvement for the towns of Helin, Pingjin, Mingda, and Liangshan	23	Scattered hoodhoods of Xinyi Village, Chenjia Village and Huangjia Village (Mingda Town)	60 m from east bank of Longxi River	45 HH (135 persons)	Noise, air pollution and odor from dredging
	24	Scattered hoodhoods of Tianjia Village (Mingda Town)	10 m from north bank of Sandengpo tributary	40 HH (120 persons)	
	25	Helin Town	40 m from east bank of Longxi River	200 HH (600 persons)	
	26	Scattered hoodhoods of Wan'an Village and Tangjiaba Village (Helin Town)	30 m from the west bank of Longxi River	25 HH (75 persons)	
	27	Scattered hoodhoods of Aiguo Village	90 m from east bank of Longxi River (Aiguo Power Station)	10 HH (30 persons)	
	28	The residential community of Xingping Street (Pingjin Town)	5 m from the south bank of Huilong River	1000 HH (3500 persons)	
	29	No. 3 Pingjin Primary School	20 m from south bank of Huilong River	50 teachers and students	
	30	Pingjin Middle School	10 m from the south bank of Huilong River	3,000 teachers and students	
	31	Scattered hoodhoods of Sungou Village and Tangyao Village	85 m from south bank of Huilong River	180 HH (650 persons)	
	32	Scattered hoodhoods of Xinhe Village, Wangjia Village and Gaojia Village	100 m from north bank of Huilong River	70 HH (250 persons)	
L1.4 Connection between Yanjingkou	33	Chenjaqiao Village	120 m from the east bank of Xiaosha River	7 HH (23 persons)	Noise and air pollution
	34	Liujia Village	23 m from east bank of the connection channel	40 HH (128 persons)	

Subproject	No.	Sensitive Receptor	Description	Households (HH) and # people	Impact
Reservoir and Xiaosha River	35	Yahaoyuan Residental Comunity	20 m from west bank of the connection channel	200 HH (1000 persons)	
	36	Zhongying-xingcheng Residential Community	20 m from east bank of the connection channel	160 HH (800 persons)	
	37	Baisha River	Surface water	Irrigation, industry and flood discharge	

Table V-2: Environmentally Sensitive Receptors – Changshou District

No.	Subproject	Sensitive Receptor	Description of Receptor	Location of construction sites	Impact
A. Surface water					
C1.1	**C1.1 Dandu Town Flood Control and Water Resource Protection;**	Longxi River (Dandu Town Section)	The raw water intake of Dandu Water Supply Plant is 200 m upstream from Dandu Bridge on Longxi River. The scope of Grade I protection zone of drinking water source is 1000 m upstream to 100 m downstream from the water intake point	Embankments on both banks of Longxi river (Dandu Section)	Wastewater during construction
2	**C1.2 Dayuxi Tributary Comprehensive Treatment**	Dayu Stream	The first tributary of Longxi River, the functions of river are agricultural irrigation, fishery and flood discharge for Haitang and Yuntai towns; there is no drinking water intake	Both banks (in Haitang and Yuntai Towns)	
3	**C1.3 Longxi River Tributary Comprehensive Treatment**	Shuanglong River	The first tributary of Longxi River, the functions of river are agricultural irrigation and flood discharge; there is no drinking water intake.	Embankment on both banks	
4		Longhe River	The secondary tributary of Longxi River, the functions of river are agricultural irrigation and flood discharge; there is no drinking water intake.	Embankment on both banks	
5		Jiaojia River	The first tributary of Longxi River, the functions of river are agricultural irrigation and flood discharge; there is no drinking water intake	Embankment on both banks	
6		Lanjia River	The first tributary of Longxi River, the functions of river are agricultural irrigation and flood discharge; there is no drinking water intake	Embankment on both banks	
B. Ambient air and acoustic environment					
1	**C1.1 Dandu Town Flood Control and Water Resource Protection**	Urban Area of Dandu Town	Residential communities (1600 permanent residents)	200m from east bank of Longxi River	Noise, dust and emission from construction activates
2	Flood control for Dayu stream	Tuqiao Village of Haitang Town	Residential community (500 residents)	430m from right bank of Dayu Stream	

No.	Subproject	Sensitive Receptor	Description of Receptor	Location of construction sites	Impact
3		Shiqiaoba Village of Haitang Town	Residential community (600 residents)	480 m from right bank of Dayu Stream	
4		Urban area of Haitang Town	Residential community (2,000 residents)	180 m from right bank of Dayu Stream	
5		Urban area of Yuntai Town	Residential community (2,500 residents)	Both banks of Dayu Stream	
6	Environmental comprehensive renovation works for the tributaries of Longxi River	Hexingchang Village of Longhe Town	Residential community (3,400 residents)	520 m from east bank of Caijia River	
		Longhe Village of Longhe Town	Residential community (600 residents)	130-550 m from east bank of Caijia River	
		Urban area of Shuanglong Town	Residential community (4,000 residents)	On the two sides of Shuanglong River	
		Jiaojiachang Village of Linfeng Town	Residential community (300 residents)	On the two sides of Jiaojia River	
7		Urban Area of Lingfeng Town	Residential community (1,950 residents)	150 m to the west bank of Lanjia River	
C. **Ecological Environment**					
1	Proposed river and stream sections		Flora, fauna, soil and crops within 200m scope from two banks of the rivers and streams		Soil and water conservation and ecology
2	Changshou Lake scenic spot		Changshou Lake, the biggest reservoir in Chongqing Municipality, with the water surface area of 65 km2 and the total capacity of 1.027 billion m3, which is the raw water intake for the water supply plant of Changshou Town		Scenic Area
D. Groundwater					
1	No environment sensitive spot such as drinking-water source				Wastewater

Table V-3: Environmentally Sensitive Receptors – Dianjiang County

No.	Subproject	Sensitive Receptor	Description of Receptor	Location of embankment	Impact
A. Surface water					
1	Comprehensive flood control of Longxi River	Pushun Town section of Longxi River	The functions of Longxi River are agricultural irrigation, fishery and flood discharge for the two towns of Haitang and Yuntai, there is no drinking water intake	Embankment on both sides of longxi River (Pushun Town Section)	Wastewater during construction
2		Gao'an Town section	The functions of Longxi River are agricultural irrigation, fishery and flood discharge; there is no drinking water intake.	Embankment on both sides of Longxi River (Gao'an Town Section)	
3		Gaofeng Town section	As above	Embankment on both sides of Longxi River (Gao'an Town Section)	

No.	Subproject	Sensitive Receptor	Description of Receptor	Location of embankment	Impact
6	Flood control for tributary of Longxi River	Xinmin River	The functions of Xinmin River are agricultural irrigation and flood discharge; there is no drinking water intake.	Embankment on both sides of Xinmin River	
8	Sanhe Reservoir (Grade: "Small-I")	Guixi Sub-district	Agricultural irrigation and flood discharge (storage capacity is 1.5248 million m^3, and irrigation for 2,900 mu farmland)	Water quality of reservoir	Wastewater
B. Ambient air and acoustic environment					
1	Environmental comprehensive renovation works for Longxi River	Urban area of Pushun Town	Communities with 1,000 residents (2-500 m from the two banks of Longxi River	Urban area on east bank; rural households on west bank	Dust emission and construction noise
2		Urban area of Gao'an Town	Communities with 10,000 residents (5-500 m from the two banks of Longxi River	Urban area on east bank; rural households on west bank	
3		Gaofeng Town section	Communities with 20,000 residents (3-500 m from the two banks of Longxi River	Urban area on west bank; rural households on east bank	
	Flood control, tributary of Longxi	Xinmin River	Community of Zhoujia Town (1500 residents)	Rural households on both banks of river	
C. Ecosystem					
1	Proposed River sections		Flora, fauna, soil and crops within 200 m scope from two banks of the rivers		Soil and water conservation and ecology
C. Groundwater					
1	No environment sensitive spot such as drinking-water source				Wastewater

B. Anticipated Project Benefits and Positive Impacts

131. The project is intended to significantly contribute to achieving municipal targets for environmental and social improvement, as follows.

132. **Improved water quality.** The project will contribute to the following targets in the Chongqing Master Plan: by 2020, water quality in the Longxi mainstream improved from Grade IV to Grade III, and for tributaries, from Grade V (or worse) to Grade IV. The project designs to help address these targets include: (i) construction of 77.89 km sewer pipelines along the river and tributaries for improved wastewater interception, which is estimated to increase the rate of wastewater collection from 42-47% to 80% (based on survey data of current collection rates); (ii) dredging of 7.85 km of river channels, to remove 215,000 m^3 of polluted sediment; and (iii) establishment of about 354 ha (5,314 mu) of vegetated green belts along the river, tributaries, and two reservoirs (Shanggui and Sanhe), comprising "ecological buffer strips", constructed wetlands, and green landscaping, which are collectively estimated to reduce pollutant loads in the intercepted runoff by 40% to 70% (Section III.C).

133. **Improved flood control and reduced siltation in the Yangtze River.** The project will contribute to the following targets in the Chongqing Master Plan: (i) raise the flood protection standard of the Longxi River mainstream and the tributaries from the current 1 in 2-5 years to 1 in 20 years; (ii) reduce siltation input to the Yangtze River by 18,600 m^3/a; and (iii) increase flood

retention capacity in the Longxi River basin by 33% or 2.27 million m^3, from 6.86 million m^3 in 2017 to 9.13 million m^3 in 2023. These measures are expected to avoid about CNY85.8 million ($13.2 million) per year in flood damages. The project designs to help address these targets include: (i) the construction of 158.08 km of embankments along the Longxi mainstream and tributaries; (ii) improved water retention and filtration capacity through the greenbelts to be established (see previous paragraph); and (iii) improved water resources management, including new flood forecasting and warning systems, for the Longxi River basin. These benefits will contribute to reduced flood risks to downstream populations in Chongqing Municipality and along the Yangtze River mainstream, as well to reduced silt load to the downstream catchment area of the Three Gorges Reservoir.

134. **Climate change adaptation.** The project will support afforestation and re-vegetation of 209 ha, comprising 198.3 ha terrestrial vegetation and 10.7 ha aquatic vegetation. Of this total, 70.1 ha (Table V-18) will comprise woody plants (trees and shrubs). In the PRC, annual carbon sequestration capacity of forest is estimated to be 0.3-12 t C/ha[20] depending on forest type, species and age, as well as soil, water and weather (average annual sunshine hours, rainfall, and temperature). A carbon sequestration rate of 3.32 t/ha.yr[21] (Table V-18) was applied to the project based on consideration of the soil and weather conditions of in the project area, and only the area of woody plants (70.1 ha) was assumed to provide a significant function for carbon sequestration. Based on these assumptions, the revegetation component of the project is estimated to achieve 232.7 tons of carbon sequestration per year. Project design features relevant to climate resilience include: (i) the storage capacity of Shaunggui Lake will be increased, strengthening resilience against drought and flood; (ii) river dredging and removal of excess sediments will increase flow capacity and buffer against increased unpredictability of floods; and (iii) improved efficiency of water transfer between Longxi River and its tributaries will strengthen resilience against uneven rainfall in different areas; and (iv) strengthening overall river management including river-chief system will benefit the flood control and water resource utilization efficiency.

135. **Long-term integrated river basin management.** The project will pilot an integrated river basin management approach for the Longxi River, which will gradually replace the historical approach of many small and fragmented projects in the basin. The national and municipal governments are already moving toward more centralized approaches for river basin management, including the appointment of “river chiefs” (officials accountable for river-related targets for quality and flood control). Through output 4, the project will help consolidate this approach, by focusing on non-structural measures, including improved government capacity for flood forecasting and warning, monitoring of water quality, improved community involvement in flood management, and capacity building for stakeholders.

136. **Social and economic benefits.** The total population of the project county and two districts was 2.80 million in 2016. The project will directly benefit about 895,000 residents in 19 towns, including 563,000 (62.9%) rural residents, 20,718 (2.3%) low-income residents [of which 1,250 (0.14%) are below the PRC poverty line; defined as annual net income per capita of CNY2,300], and 436,000 (48.7%) are female. These benefits comprise: (i) reduced flood risks, resulting in reduced annual loss of life and damage to land and property; (ii) improved sanitation, due to the improved systems for wastewater and solid waste collection and disposal, which will contribute to improved health and reduced medical costs. The project facilities are public services and will have equitable social and gender benefits. The project will also promote the employment of women for

[20] Carbon sequestration capacity comparison. May 2011. http://www.carbontree.com.cn/News show asp ?bid=5725

[21] C-D. Huang, J. Zhang et al. Dynamics on forest carbon stock in Sichuan Province and Chongqing City. Acta Ecological Sinica, 2008, 28(3):0966-0975.

project construction and operation, such as for tree planting, landscaping, and/or sanitation services. The project will also indirectly benefit the other 1.91 million residents in the project area.

137. **Alignment with development strategies and plans.** The project is aligned with the PRC Thirteenth Five Year Plan (2016–2020), which promotes environmentally friendly and resource-efficient development, reduction of natural disasters, improvement of residents' living standard and construction of all-around well-off society. The project is also consistent with ADB's Strategy 2020, which supports innovation and inclusive growth, by being designed to remove economic constraints, address climate change abatement and environmental concerns, promote sustainable social and economic growth, and support policy and institutional reforms.

C. Pre-Construction Phase

138. Prior to construction, the following measures will be implemented.

i) **Institutional strengthening.** (a) The Chongqing project management office (CPMO) will assign at least one full-time, qualified environment officer to the CPMO team. This officer will lead the coordination of the EMP; (b) the three implementing agencies will each assign one full-time, qualified environment officer as part of the three PMO teams; and (c) under the loan consulting services, the CPMO will hire a loan implementation environment specialist (LIEC) to provide external support.

ii) **Second round of water and sediment sampling.** During the detailed design stage, a second round of water and sediment sampling will be conducted, specifically to test the presence of pesticides, heavy metals and persistent organic pollutants (POPs) in the sections of the tributaries to be dredged. If the presence of these pollutants in the sediments is confirmed, the mitigation measures for the dredging (Section V.D.3) will be reviewed and updated as needed to minimize the risk of water-borne dispersal of these pollutants. These actions are also included in a project assurance (Section X).

iii) **Updating the EMP.** The EMP will be updated as needed, including mitigation measures and monitoring. This will be the responsibility of the CPMO, PMOs and LIEC.

iv) **Training in environmental management.** The LIEC and personnel from Chongqing municipal environment protection bureau (CEPB) and district/county EPBs will give training in implementation and supervision of environmental mitigation measures to contractors and the construction supervision companies (CSCs).

v) **Grievance Redress Mechanism (GRM).** The CPMO and PMOs will implement the project GRM at least two months before the start of construction, to ensure that the project communities and public services (e.g. schools and nursing homes) are well informed and provided the opportunity to discuss any concerns. This is further to the public consultations already conducted during project preparation (Section VII).

vi) **Bidding document and contract documents.** The project environment management plan (EMP; Appendix 1) 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.** Contractors, in their bids, will respond to the environmental clauses in the bidding documents for EMP requirements. Prior to construction, each contractor will

develop a site EMP, based on the attached project EMP, and assign at least one person responsible for environment, health, and safety (EHS). The site EMP shall include the following: (a) surface water protection (especially, to avoid or minimize impacts to the Longxi and Yangtze rivers); (b) spill control and management; (c) site drainage and soil erosion protection; (d) health and safety; (e) temporary traffic management; (f) construction site access control; (g) specific mitigation measures at the sites where the risks of high noise levels (281 housholds) and/or odor from sediment dredging have been identified; and (h) contractor performance targets, which are listed in Tables EMP-2 and EMP-5, to strengthen the implementation of the mitigation measures. The site EMPs will be submitted to the environmental officer of each PMO for approval, with support of the local EPBs.

D. Construction Phase

(1) Geology and Soil

139. Without management, the construction works may cause soil erosion and/or contamination. Soil erosion may be caused by excavation of the wastewater pipe trenches, unprotected stockpiles of soil and spoil, and exposed surfaces from construction of the embankments, sediment dredging, and road re-laying after pipeline construction. Embankment construction may contribute to bank erosion and excessive suspended particles (SS) and sedimentation of the Longxi Rivers and/or tributaries. Erosion could also occur after completion of construction where site restoration is inadequate. Soil contamination could result from inappropriate transfer, storage, and/or disposal of dredged sediment, chemicals, (e.g. gasoline, diesel, acetylene and lubricant), and solid wastes.

140. **Soil erosion.** The project area is located in hilly landforms typical of southwest PRC. The natural soil erosion intensity in the project areas is 500–876 tons per square kilometer per year (t/km^2.a), which is categorized as a “light erosion intensity area” [500–2,500 t/(km^{2}a)] in accordance with the PRC Standard for Grading of Soil Erosion Intensity of SL190-2007 (Table II-15). Soil erosion rates are expected to increase during construction when the banks and sites nearby rivers are disturbed and surface vegetation and soil are damaged or disturbed. The most vulnerable soil erosion areas for the project are the embankments and sewer pipeline construction activities along the rivers, construction sites, spoil sites, temporary construction roads, and other areas where surface soil is disturbed, especially on rainy days. Soil erosion amounts during th periods of construction and recovery (generally 1-2 years after the construction completed) were estimated based on the following formula:

$$W = \sum_{j=1}^{2} \sum_{i=1}^{n} (F_{ji} \times M_{ji} \times T_{ji})$$

$$\triangle W = \sum_{j=1}^{2} \sum_{i=1}^{n} (F_{ji} \times \triangle M_{ji} \times T_{ji})$$

Where, W is soil erosion amount (t); ⊿W is newly increased soil erosion amount (t), Fji is the predicted area at certain period and unit (km^2); Mji is the soil erosion intensity at certain period and unit (t/km^2.a); ⊿Mji is newly increased soil erosion intensity at certain period and unit (t/km^2.a); Tji is the prediction period for a certain unit (a); j is the prediction period (j = 1, 2, 3, including the construction and recovery periods; and i is prediction period (i=1, 2, 3, n);

141. **Soil erosion intensity before and after soil disturbance.** Based on the site surveys and the current soil erosion situation, in combination with the factors of rainfall, soil type, landform, physiognomy and vegetation on the project sites, against the Grading Standard of Soil Erosion Intensity of SL190-2007, the identified baseline soil erosion intensities of Liangping, Changshou and Dianjiang are 500 t/(km^2.a), 876 t/(km^2.a) and 876 t/(km^2.a), respectively (Table V-4). Projected soil

erosion intensities *after* disturbance (i.e. during construction) were derived by comparison with a similar construction along the nearby Yangzte River ("Flood Control and Environment Improvement for Chongqing Banan District Section of the Yangtze River Project)" which was completed in 2016 with environmental certification. Soil erosion factors of the two projects were compared and a correction coefficient applied to estimate soil erosion intensities during both the construction and recovery periods were determined (Table V-4).

Table V-4: Estimated Soil Erosion Intensities during Site Construction and Rehabilitation.

Unit: t/(km^2.a)

No.	Soil erosion intensity	Liangping	Changshou	Dianjiang
1	Baseline soil erosion intensity	500	876	876
2	Before soil disturbance, during construction period	500	876	876
3	After soil disturbance, during construction period (for embankment and other construction sites)	4500	7000	7000
4	After soil disturbance, during construction period (for temporary paths and roads)	4500	5800	5800
5	After soil disturbance, during recovery period (for embankment and other construction sites)	1000	900	900
6	After soil disturbance, during recovery period (for temporary paths and roads)	1000	1000	1000

142. The total soil disturbance area in the project county and two districts during construction is estimated to be 344.94 ha. The increased soil erosion amount during the 4-5 years construction period will be 22,405 tons, which is categorized as a "light soil erosion impact" in comparison with other similar projects in Chongqing Municipality (Table V-5).

Table V-5: Estimated Soil Erosion Amounts

Area	Period	Baseline of erosion (t/km^2·a)	Erosion after disturbance (t/km2·a)	Area of soil disturbance (ha)	Erosion period (yr)	Baseline erosion amount (t)	Estimated erosion amount (t)	Increased erosion amount (t)
Liangping District								
Upstream of Longxi River	Construction	500	4500	56.45	3.0	846.8	7,620.8	6,774.0
	Recovery	500	1000	49.64	2.0	496.4	992.8	496.4
Jindai Town	Construction	500	4500	37.51	1.5	281.3	2,531.9	2,250.6
	Recovery	500	1000	26.34	2.0	263.4	526.8	263.4
Towns of Helin, Pingjin and Mingda	Construction	500	4500	56.32	1.5	422.4	3,801.6	3,379.2
	Recovery	500	1000	39.54	2.0	395.4	790.8	395.4
Subtotal				**150.28**		**2,705.7**	**16,264.7**	**13,559.0**
Dianjiang County								
Construction site	Construction	876	7,000	75.64	1.3	861.4	6,883.2	6,021.9
	Recovery	876	900	75.64	1	662.6	680.8	18.2
Temporary paths and roads	Construction	876	5800	12.21	1.7	181.8	1,203.9	1,022.1
	Recovery	876	1000	12.21	1	107.0	122.1	15.1
Subtotal				**87.85**		**1,812.8**	**8,890.0**	**7,077.2**

Changshou District								
Construction site	Construction	876	7,000	94.55	1.3	1076.74	8,604.05	7,527.3
	Recovery	876	900	94.55	1	828.26	850.95	22.7
Temporary paths and roads	Construction	876	5800	15.26	1.7	227.25	1504.64	1277.4
	Recovery	876	1000	15.26	1	133.68	152.60	18.9
Subtotal			**14,700**	**106.81**		**2,265.93**	**11,112.24**	**8,846.3**
Total				**344.94 (in construction)**		**6,784.4**	**36,266.9**	**22,405.3**

143. **Earthworks.** The early draft FSR included a surplus of 1.2 million m^3 with no clear disposal mechanism. Following discussions by the TRTA team, FSR institute and DEIA institutes, the excavation plans were improved and the surplus earth was reduced to 0.527 million m^3 in the updated FSR (Table V-6). The surplus earth will be reused within the district or county for filling the roadbed and construction sites.

Table V-6: Earth Balance for Each Project Component (m^3)

District/ County	Town/ subproject	Excavation Earth/stone	Filling earth/ stone	Borrow earth and stone	Surplus earth	Surplus earth balance and reuse
Liangping District	Longxi River upstream	119,200	119,200	0	0	-
	Connection between	182,800	111,800	33,400	104,400	23,500 m^3 for filling Dahe River embankment (0.5-1.0 km distance), and 80,900 m^3 for filling the construction site in Liangping industrial park (2-4 km distance)
	Longxi River (Jindai Tow)	297,600	284,800	0	12,800	Filling the roadbed in Qianhe Village (6 km distance)
	Longdong River (Phase II)	93,600	28,800	0	64,800	Filling the roadbed in Liujia Village (1.5 km distance)
	Helin Towm (Longxi River	188,100	135,900	0	52,200	Filling in the roadbed in Fuhe Village in Helin Town
	Pingjin	126,300	91,700	0	34,600	Filling the roadbed in Nanmu Village
	Mingda	120,100	155,000	34,900	0	-
	Subtotal	**1,127,700**	**927,200**	**68,300**	**268,800**	**-**
Dianjiang County	Gao'n Town	558,300	425,500	0	132,800	Filling the roadbed in the villages of Hexing, Helong and Dongqiao (5-10 km distance)
	Gaofeng Town	114,300	82,700	0	31,600	Filling the roadbed in Minzhu Village (6 km)
	Pushun Town	110,700	82,500	0	28,200	Filling the roadbed in Changbai Village (7 km)
	Xinmin Town	38,300	33,200	16,800	21,900	Filling the roadbed in Qiqiao Village (3 km)
	Zhoujia Town	2,100	1,800	0	300	Filling the roadbed in Jinqiao Village
	Subtotal	**823,700**	**625,700**	**16,800**	**214,800**	
Changshou District	Dando Town	117,277	505,458	388,181	0	-
	Haitang Town	67,397	351,804	284,407	0	-

District/ County	Town/ subproject	Excavation Earth/stone	Filling earth/ stone	Borrow earth and stone	Surplus earth	Surplus earth balance and reuse
	Yuntai Town	107,467	423,384	315,916	0	-
	Shiyan Town	2,440	2,397	1,826	1,869	Filling in construction site in Yuntai Tow (7-8 km distance)
	Shuanglong Town	232,603	436,167	203,564	0	-
	Longhe Town	395,767	1,209,797	814,030	0	
	Lingfeng Town	181,887	188,871	48,892	41,908	Filling the embankment in Shuanglong Tow (9-10 km distance)
	Subtotal	**1,104,838**	**3,117,878**	**2,056,816**	**4,3777**	**-**
Total		**3,056,238**	**4,670,778**	**2,141,916**	**527,377**	**Zero balance (no surplus)**

144. **Measures for soil erosion control.** Before construction, contractors will each prepare Site Drainage and Soil Erosion Management Plans for their specific work sites, to prevent soil erosion. The plans will include the following measures.

(i) During embankment construction: (a) maintain slope stability at cut faces by implementing erosion protection measures such as terraces and silt barriers; (b) construct berms or drainage channels around the perimeter of the construction site to capture soil runoff and direct rainwater away; and (c) plan and implement construction in staged sections, with one section completed and stabilized before beginning the next.
(ii) Stabilize all cut slopes, embankments, and other erosion-prone working areas.
(iii) Stabilize all earthwork disturbance areas within 15 days after earthworks are completed.
(iv) Minimize open excavation areas during trenching and river embankment activities (≤300 m)).
(v) Use appropriate compaction techniques for pipe trench construction.
(vi) Provide temporary detention ponds or containment to control silt runoff.
(vii) Construct intercepting channels and drains to prevent runoff entering construction sites and divert runoff from sites to existing drainage or open ground for watering the vegetation.
(viii) Strip and stockpile topsoil, and cover (by geotechnical cloth) or seed temporary soil stockpiles.
(ix) Limit construction and material handling during periods of rains and high winds.
(x) Properly slope or re-vegetate disturbed surfaces e.g. pipeline trenches and cut banks.
(xi) Protect slopes on both sides of embankment.
(xii) All dredged sediment, channel soil and spoil disposal sites, embankments, and revetments, will be rehabilitated once they are completed (or full in the case of the disposal sites).
(xiii) Landscaping will only use native plant species.
(xiv) Construction camps and storage areas will be located to minimize land area required.

145. **Measures for soil contamination.** To reduce the risk of soil contamination from construction machinery, contractors will do the following.

(i) Store petroleum products, hazardous materials and wastes on impermeable surfaces in secured and covered areas.
(ii) Remove all construction wastes from the site to approved waste disposal sites.
(iii) Establish emergency preparedness and response actions.
(iv) Provide spill cleanup measures and equipment at each construction site.
(v) Train contractors and crews in emergency spill response procedures.

146. **Inspection and monitoring.** Site inspections and monitoring will be conducted by the contractors, CSCs, PMOs, LIEC, and external monitoring agency and is described in the EMP

(Appendix 1).

(2) Water Quality, Wastewater Management and Hydrology

147. **Water quality and wastewater management.** Excavation of pipeline trenches, embankment and dredging constructions could result in soil runoff to Longxi River and its tributaries, while inappropriate storage and handling of fuel, accidental spills, domestic wastewater discharge from construction camps, and wash-down water for machinery and vehicles, could contaminate the rivers. Construction wastewater will come from washing aggregates, pouring and curing concrete, cleaning of construction machineries and vehicles, and human wastes.

148. **Construction wastewater.** Construction wastewater will be produced from the maintenance and cleaning of mechanical equipment and vehicles, water from mixing and curing concrete, and lost water and soil during the construction period which is discharged as pollutants. During construction there will be a total of 77 construction sites, over 4 to 5 years, with an average of 19.2 construction sites per year. Each site will generate an estimated 5 m^3/d construction wastewater, with suspended solids (SS) (about 300 mg/L) and petroleum (20 mg/L) (based on rates applied in the DEIAs). If discharged in an improper manner, this has the potential to impact the existing water bodies. Construction wastewater will not be discharged onto the surrounding soil or into the river. Sedimentation tanks will be held on site and, after settling out of solids, the upper clear liquid will be recycled for spraying the construction site (dust control), and the waste residue in the tank will be cleared and transported to the construction spoil disposal sites. Oily wastewater will require the installation of oil-water separators before the sedimentation tank. After site treatment, construction wastewater will comply with the Integrated Wastewater Discharge Standard (GB8978-1996). This The standard provides the limit for pollutant concentrations and the total allowed wastewater discharge from industries and construction sites. The indicative pollution parameters are total SS and oil/petrochemical residues. These will be monitored as part of the EMP.

149. **Domestic wastewater and rubbish from construction workers.** Peak work forces are estimated to be 300, 200, and 300 workers in Liangping, Dianjiang and Changshou respectively. Daily domestic wastewater discharge and municipal solid waste (MSW) production is estimated as 0.1 m^3 and 0.5 kg respectively per worker per day. The pollutant concentrations of CODcr, BOD_5 and NH_3-N in the domestic wastewaters from the construction workers are assumed to be 300 mg/L, 150 mg/L and 40 mg/L respectively. Estimated volumes of construction and domestic wastewater are shown in Table V-8. About 80% of the workers will live in rented apartments in the towns, therefore the majority of domestic sewage and solid waste will be discharged and disposed through the existing municipal sanitation systems. For the 20% of workers that will reside in worker camps, camp management will include waste disposal systems (see Section V.D.7).

Table V-8: Wastewater Generated during Construction

No.	Item	Liangping	Dianjiang	Changshou	Total
1	Total construction sites	33	15	29	77
2	Average numbers of construction sites per year	9.4	3.3	6.4	19.2
3	Construction wastewater generated (m3/d)	47	16.5	32	95.5
4	Pollutant generation from construction wastewater (SS kg/d)	14.1	4.95	9.6	28.65
5	Pollutant generation from construction wastewater (petroleum kg/d)	0.94	0.33	0.64	1.91
6	Number of workers at peak construction	300	200	300	800
7	Domestic wastewater (m^3/d)	30	20	30	80
8	Pollutant generation from domestic wastewater (CODcr, kg/d)	9	6	9	24
9	Pollutant generation from domestic wastewater (BOD_5, kg/d)	4.5	3	4.5	12
10	Pollutant generation from domestic wastewater (NH_3-N, kg/d)	1.2	0.8	1.2	3.2

150. **Water-borne dispersal of pollutants from dredged sediment.** The project tributaries are located in an agricultural landscape where pesticides are frequently used. It is possible that the project dredging will result in the release of pesticides or other pollutants which will be dispersed in the water column and downstream, potentially causing impacts to the environment or people.

151. The following measures will be implemented to minimize water pollution.

(i) During the detailed design stage, a second round of water and sediment sampling will be conducted, specifically to test the presence of pesticides, heavy metals and persistent organic pollutants (POPs) in the sections of the tributaries to be dredged. If the presence of these pollutants in the sediments is confirmed, the mitigation measures for the dredging (Section V.D.3) will be reviewed and updated as needed to minimize the risk of water-borne dispersal of these pollutants. These actions are also included in a project assurance (Section X).
(ii) During embankment and dredging, contractors will pump slurry to designated sites along the tributary banks and properly dispose dredged sediment and other spoil. This will reduce the impact to water quality of the rivers and lakes.
(iii) Contractors will develop actions for control of oil and other dangerous substances as part of their site EMPs.
(iv) Wastewater from construction activities will be collected in sedimentation tanks, retention ponds, and filter tanks to remove silts and oil.
(v) All sites for washing of construction equipment will be equipped with water collection basins and sediment traps.
(vi) Fuel storage, machinery maintenance workshop and vehicle cleaning areas must be stationed at least 500 m away from the waterbody.
(vii) Storage facilities for fuels, oil, and other hazardous materials will be within secured areas on impermeable surfaces and provided with bunds and cleanup installations.
(viii) Contractors' fuel suppliers must be properly licensed. They shall follow proper protocol for transferring fuel and the PRC standard of JT3145-91 (Transportation, Loading and Unloading of Dangerous or Harmful Goods. revised).
(ix) Earthworks along rivers, reservoirs and wetlands will be accompanied by measures to minimize sediment runoff into the water bodies, including sediment traps.
(x) Labor camps will be located at least 500 m from waterbody.
(xi) Portable toilets and on-site wastewater pre-treatment systems will be installed at construction camps along with proper maintenance protocols.
(xii) Water quality will be monitored by local EMAs during construction as per the EMP.
(xiii) River embankment and dredging works shall be conducted in the dry season. Construction during the high-flow season (May to September) is prohibited.
(xiv) Coffer dams will only be constructed on one side of the river channel at a time, to maintain an uninterrupted water flow to downstream areas.

152. **Hydrology and water availability.** There will be neither dredging work nor flow diversion and interruption on the Longxi mainstream. Embankment along the Longxi mainstream and its tributaries, and dredging in the tributaries, may temporarily impact river flows. This risk will be avoided and/or minimized by: (i) the use of coffer dams and temporary diversion channels along the tributaries, to maintain continued water flow while works are conducted; (ii) prior to any works along waterways, the contractor, construction supervision company (CSC), PMO Environment Officer, and district/county EPB, will collectively re-confirm the planned construction schedule and site EMP actions; and (iii) dredging will take place section-by-section, to minimize the extent of the disturbance area at any one time.

(3) Sediment dredging

153. The proposed dredging works will be located on five tributaries of the Longxi River. No dredging will be conducted on the Longxi mainstream. The total distance of dredging will be about 7.85 km, in discrete sections 0.4 to 2.45 km long, which represent 20–50% of the total length of the individual tributaries where the dredging will occur. The tributaries to be dredged are all small, second- or third-order streams of the Longxi River, about 3–25 m wide. The channels are highly polluted: water qualities are Grade V or worse (Section IV) and sediment qualities meet the PRC Standards for Pollutants in Sludge and Sediment for Agricultural Use (GB4284-84) and Grade II of the Soil Quality Standard (GB15618-95) (Section IV). Some channels are partly clogged by excessive sediment and/or plant growth and contain solid waste. All the channels are in agricultural lands and are adjacent to fields and villages. Some sections have scattered stands of degraded vegetation. The dredging will be conducted to a depth of 0.5–0.7 m, to achieve the project objectives for flood control and removal of polluted sediments. The total volume of sediments to be dredged, including dry earth excavation, is about 215,400 m^3 (Table V-9). Dredging will be staged over three years.

Table V-9: Summary of Sediment Dredging

Site	Volume (m^3)	Length (km)	Mean width (m)	Mean dredging depth (m)	Dredging Method	Sediment quality*	Disposal method	Odor from dredging?
Liangping District								
Huilong River	840	0.4	3.0	0.7	Ecological dredging	Meet standard	Landscaping	No
Dianjiang County								
Ximin River	6,860	2.45	4.0	0.7	Ecological dredging	Meet standard	Landscaping	No
Sanhe Reservoir	172,800	34.6 ha		0.5	Ecological dredging	Ecological dredging	Fill for embankment	No
Subtotal	**179,660**							
Changshou District								
Dayu Stream	7,500	2.0	7.5	0.5	Ecological dredging	Meet standard	Landscaping	No
Yuntai River	2,450	1.0	3.5	0.7	Dry excavation	Meet the standard	Landscaping	Yes
Jiaojia River	25,000	2.0	25.0	0.5	Ecological dredging	Meet standard	Landscaping	No
Subtotal	**34,950**	5.0						
Total	**215,400**	**7.85**						

*Based on the results of sediment sampling (Section IV).

154. The dredging will cause short-term, localized disturbance and exposure of sediments. This may cause the following: (i) temporary increases in the levels of nutrients and SS, leading to sediment plumes downstream, reduced water transparency and dissolved oxygen, and algal blooms. Low light, reduced oxygen, and smothering or abrading by silt may reduce plant growth and cause mortality of fish and sediment-dwelling (benthic) organisms; (ii) removal of habitats for fish, invertebrates, and other aquatic fauna; and/or (iii) release of pollutants and/or odor (hydrogen sulfide and ammonia) from the dredged sediments, since some sediments are anoxic with high organic content. Modeling conducted for the project estimated the odor dispersion distances to be up to 200 m around and/or downwind of the dredging sites and/or temporary dredge storage and dewatering sites. Based on the locations of sensitive receptors (Section V.A), about four villages and one residential community (total population 4,900) occur within 200 m of the dredging locations; and (iii)

inadequate management of dredging procedures and machinery could cause leakage or spill of sediments or fuel into waterways, along transport routes, and/or at disposal sites, leading to soil or water pollution.

155. These risks will be minimized as follows.

i) **Second round of water and sediment sampling.** During the detailed design stage, a second round of water and sediment sampling will be conducted, specifically to test for the presence of pesticides, heavy metals and persistent organic pollutants (POPs) in the sections of the tributaries to be dredged. The sampling and analysis will be conducted by the Chongqing Municipal Ecological and Environmental Monitoring Center (http://www.cqemc.cn/), an agency that is nationally-certified to analyze sediment and soil quality including organochlorine pesticides (including HCH and DDT), organophosphorus pesticides, and polycyclic aromatic hydrocarbons (a type of POP). The report from the agency will include: (a) historical analysis of the general landscape in the context of pesticides, heavy metals, and POPs; (b) a detailed map of the sampling sites; (c) a list of the potential toxicants measured; and (d) description of methodology for the sampling and analysis.

ii) If the presence of these pollutants in the sediments is confirmed, the following procedures will be taken: (a) the level of risk to people and the environment will be re-assessed, based on the level of toxicity and extent of contamination in the sections of tributaries to be dredged; (b) sediment tested positive for pollutants listed as hazardous under PRC regulations, the World Health Organization, and/or the World Bank's EHS, will not be used for landfill. Instead, these sediments will be disposed at the Bishan Hazardous Waste Disposal Center (for the project sites in Dianjiang County and Lianping District) or the Changshou Hazardous Wastes Disposal Plant (for Changshou District). Both sites are certified to transport, manage, and dispose hazardous materials;[22] (c) for sediments that are not classified as hazardous: first, the volumes of remaining sediment for disposal in landscaping (Table V-9) will be revised, and then the final locations for disposal will be assessed, based the guidelines for *Assessment Levels for Soil, Sediment and Water* (2010) of Western Australia (including Table 2 of the *guidelines*: see Appendix 2 of this EIA). The *guidelines* provide a safe approach for the disposal of sediment for different land uses based on the sampling results.[23] These actions are also included in a project assurance (Section X).

iii) **Planning.** Base on the approved FSR and the results of the second round of sampling, the design institutes, in their detailed engineering design, will further develop a detailed dredging plan, emergency preparedness and response plan prior to commencement of dredging activities, to be approved by the local EPBs and the Water Resources Bureaus (WRBs).

iv) The technical requirements and mitigation measures for dredging will be included in the bidding documents and construction contracts. The contractor will be required to develop a sound environmental management plan, including dredging machinery maintenance,

[22] The Bishan Hazardous Waste Disposal Center has an approved capacity for hazardous waste disposal of 30,600 tons/year. The site was approved on 29 December 2017 by the Chongqing Municipal EPB. It is located in Bishan District in Chongqing Municipality. The Changshou Hazardous Wastes Disposal Plant has an approved disposal capacity of 3,300 tons/year. The site was approved on 31 May 2016 by Chongqing Municipal EPB (Permit G5001150031). The site is operated by the Chongqing Tianzhi Environment Protection Company and is located in the Chaoshou Economic Development Zone. Details for both sites available at the Chongqing EPB website: http://www.cepb.gov.cn/doc/2017/12/29/171726.shtml

[23] Department of Environment and Conservation. 2010. Contaminated Sites Management Series. Assessment levels for Soil, Sediment and Water

dredged material dewatering site management, internal monitoring procedures, emergency preparedness and response mechanism.

v) **Timing.** Dredging will only be conducted in the dry season (November to March), the time of lowest water depth and slow flow. Dredging will be completed by late February/early March, to allow at least one month for the disturbed bottom sediments to settle and stabilize before the wet season (April–October).

vi) **Restricted extent of dredging at any one time.** Dredging will be limited to short (≤300 m) sections of channel at any one time to minimize disturbance.

vii) **Dredge method in sensitive sites.** For four of the five channels to be dredged (Table V-9), the "ecological dredge method" will be applied. This method is implemented in two stages: dredging of the top layer of the sediments (about 0.5 m), then, dredging to target depth. For these four channels, the dredging equipment to be used will include a specialized 'cutter head', which sucks up sediment and limits dispersion and therefore turbidity impacts. For one channel, Yuntai River (the most highly polluted of the five channels) in Changshou District, the channel is seasonal and dredging will be dry excavation rather than wet dredging, as the works will be done in the dry season. This will be much less impacting than wet dredging.

viii) In each dredge site, temporary silt traps and fences will be placed at the downstream end of each section being dredged, and along the nearby channel banks, to further reduce the risk of high silt loads being dispersed downstream.

ix) After removal from the channel, the top layer of sediment will be transferred to existing cleared land on the channel banks adjacent to the dredge sites, where it will be placed on top of a simple textile layer (to protect the ground) for dewatering and drying. If necessary, flocculants will be applied to the sediment to speed up the dewatering process. This will reduce the sediment volume by up to 70%. A small temporary earth drain will be established around each drying site to drain the water into a small sedimentation pond, to further increase settling and sedimentation. This supernatant water will further be treated with flocculants to assist settling and to meet PRC Integrated Wastewater Discharge Standard (GB 8978-2015) prior to draining back into the channel. Final disposal of the dredged sediment will be subject to the results of a second round of sediment and water sampling.

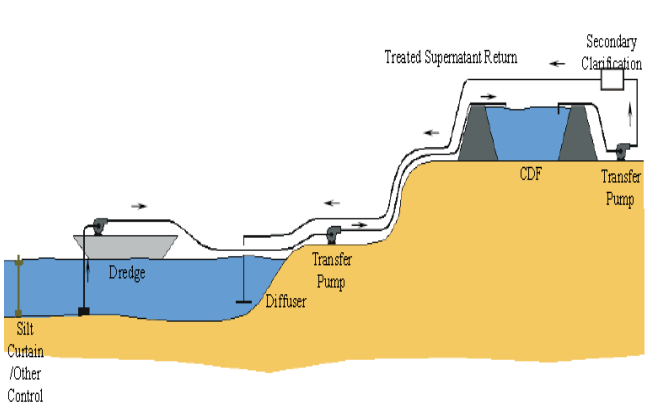


Figure V-1 and V-2: Ecological River Sediment Dredging

x) **On-site storage limited.** Earth berms or drainage channels will be constructed around the perimeter of the dredge sediment storage and disposal sites to prevent washing away from rainfall. On-site storage will be limited to de-watering; the sediment will then be transported to the disposal sites.

xi) **Managing odor.** Impacts will be minimized by: (i) timely community consultations to ensure awareness of the issue prior to dredging; (ii) rapid on-site treatment of dredge spoil to minimize time near communities; (iii) transport in sealed containers to avoid odor; (iv) minimizing the release of odors by dredging in short sections (⩽300 m) at any one time. Impacts will also be temporary as odors are dispersed (Section V.D.4).

xii) **Transport to disposal sites.** Except for any sediment to be used for construction purposes, the de-watered sediment will be transported off-site, in sealed containers to prevent leakage and minimize odor.

xiii) **Disposal and re-use of the de-watered sediment.** Sediment sampling during the design phase indicated that pollutant concentrations in the sediments meet the PRC Control Standards for Pollutants in sludge for Agricultural Use (GB4284-84) and Grade II of the PRC Soil Quality Standard (GB15618-2008, revised). This indicates that the dewatered sediment could be re-used as topsoil and fertilizer for landscaping and agriculture. However, the sampling did not test for the presence of pesticides, heavy metals, and/or POPs. A second round of water and sediment sampling will be conducted during the detailed design stage to provide final guidance on disposal techniques and locations for the dredged sediment (see point [i] of this paragraph).

156. Overall, except for odor released by dredging, the environmental risks of the planned dredging are considered to be low, due to: (i) the degraded and polluted condition of the tributaries; (ii) the dynamic nature of the tributaries, which are subject to regular flooding (it is likely that surface sediments and habitats are regularly replaced, suggesting the short-term removal of surface materials would not cause permanent losses of habitat for local fauna); (iii) the location of the dredging, which will be restricted to small tributaries and not the Longxi mainstream; and (iv) the safeguard measures to be implemented. For analysis of odor, see Section V.D.4.

(4) Air Quality

157. Air pollution sources include: (i) dust from earth excavation, filling, loading, hauling, bare earth surfaces, uncovered construction areas, and vehicle movements on unpaved roads, especially in windy days; (ii) aggregate preparation and concrete-mixing; (iii) vehicle and machinery emissions (gaseous CO, CH and NO_2); and (iv) odor from dredging of sediments. The project includes the components of flood emergency roads and sewer pipeline constructions, repaving roads after pipe laying will also produce emissions. During the asphalt heating and mixing process, the fuel burning will produce smoke, and the asphalt will produce flue gas. Modern asphalt mixing equipment used in the PRC releases typical flue gas emission concentrations of 30 mg/m^3, which complies with discharge requirements of 80-150 mg/m^3 of the PRC Atmospheric Pollutant Emission Standard (GB16297-1996) and PRC Ambient Air Quality Standard (GB3095-2012), which limits the concentration of benzopyrene at 0.0025 μg/m^3 (daily average, at 100 m downwind from the asphalt mixing station). These various sources of air pollution could affect nearby sensitive receivers, including villages, and residential areas identified in Section V.

158. The quantity of dust generated will depend on wind, humidity of the material and earth, and state of site. For the project area it was estimated that under general on-site conditions (average

wind speed 2.5 m/s, and average humidity of 80%) dispersion distance is 100 m downwind. For dust generated by transporting earth and other construction materials, the impact zone may exceed 60 m each side of the route. Based on the locations of sensitive receptors (Section V.A), about 14 villages and three residential communities (total population 16,000) occur within 100 m of the construction sites and may be subject to dust-related disturbance.

159. **Odors from sediment.** The project dredging (Section V.D.3) may cause the release of odor (hydrogen sulfide and ammonia) from the dredged sediments, since the channel sediments are anoxic with high organic content and are polluted. To estimate the total number of communities that may be affected by odor, the dispersion distance of 100 m downwind was doubled to 200 m. Five settlements (total population 4,900) occur within 200 m of the dredge locations, and odors released from dredging and dewatering may cause short-term disturbance to residents.

160. Mitigation measures to reduce impacts on air quality are as follows.

(i) Spraying water daily on construction sites where fugitive dust is being generated.
(ii) Locating asphalt plants and mixers >500 m downwind from the nearest residential areas and other sensitive receptors.
(iii) Dust suppression near sensitive receptors e.g. schools, hospitals, residential areas.
(iv) Storing petroleum or other harmful materials in appropriate places and covering to minimize fugitive dust and emission.
(v) Covering materials during truck transportation, in particular, fine material, to avoid spillage or dust generation.
(vi) Ensure vehicle and machinery emissions comply with PRC standards of GB18352-2005, GB17691-2005, GB11340-2005, and GB18285-2005.
(vii) **Odor.** Impacts will be minimized by: (a) timely community consultations to ensure awareness of the issue prior to dredging; (a) rapid on-site dewatering of dredge spoil to minimize time near communities; (b) transport in sealed containers to avoid odor; (c) no on-site storage of sediments; and (d) minimizing the release of odors by dredging in short sections (⩽300 m) at any one time.
(viii) Timely monitoring of air quality and inspections during construction, as defined in the project EMP (Tables EMP-6 and EMP-7).

161. Overall, the potential impacts of disturbance related to air quality are considered to be low, due to: (i) the local weather regime, which is generally rainy rather than windy, with high relative humidity (average annual relative humidity of 80-82%) – this reduces dispersion distances; (ii) high ground soil moisture and high vegetation coverage (Section IV), which will reduce the dispersons of fugitive dust; (iii) since January 2017, the PRC has implemented increased controls on vehicle/machinery emissions, to protect ambient air quality: all vehicles and construction machinery must comply with the PRC Grade IV or higher emission standard; and (iv) the temporary duration of the project works.

(5) Noise

162. Construction will involve excavators, bulldozers, scrapers, dredgers, concrete-mixer, trucks and other heavy machinery. Noise during pipeline construction will be generated by trench excavators, rollers and compaction machine. Noise emissions will not include rock-crushing, as any rock materials will be purchased off-site by contractors and transported to the sites. Noise will be temporary and localized. Construction materials, surplus spoil and construction wastes will be transported to and from the construction sites during an average 10-hour work-day for the construction season of about 300 days per year, for about 4-5 years. Estimated construction noise

values (at 5 m distance from the machineries and vehicles) are shown in Table VI-10.

Table VI-10: Testing Values of Construction Machinery Noise

No.	Machine Type	Maximum Sound Level Lmax (B)
1	Excavator	85-95
2	Concrete mixer	86
3	Bulldozer (100 horse-power)	78-96
4	Scraper	85-95
5	Heavy truck	88-93 (speed up), 84-89 (steady speed)
6	Medium-duty truck	85-91 (speed up), 79-85(steady speed)
7	Drilling machine	96
8	Wheel loader	85-92
9	Vibrating roller	86
10	Two-wheeled two-vibrating roller	81
11	Asphalt concrete paver	82
12	Generating set	88-92

163. Estimating noise levels. Construction equipment is a point sound source. The predictive model applied in this project is:

$$L_i = L_0 - 20 \lg \frac{R_i}{R_0} - \Delta L$$

Where, L_i and L_0 are equipment noise sound levels at R_i and R_0 respectively. ΔL is additional diffusion attenuation produced by barriers, vegetation and air.

As for the impact of multiple construction machineries on a certain future position, sound level superposition is needed:

$$L = 10 \lg \Sigma 10^{0.1 \times L_i}$$

164. **Prediction results.** Noise levels at different distances were derived after calculating the impact scope of equipment noise during construction as defined in Table VI-10. The PRC Standard of Noise Limits for Construction Sites (GB12523－2011, revised) specifies the noise limit in Class II areas as 70 dB (A) during daytime and 55 dB (A) during nighttime. The standard compliance noise impact scope (m) of different machineries is listed in Table VI-11a.

Table VI-11a: Noise Values of Construction Machineries at Different Distances dB (A)

Machinery Name	Distance to Machinery								
	15m	20m	40m	60m	80m	100m	130m	150m	200m
Excavator	71	69	63	59	57	55	53	51	49
Bulldozer	72	70	64	60	57	56	54	52	50
Loader	61	59	53	49	47	45	43	41	39
Heavy truck	69	67	61	57	55	53	51	49	47
Drilling machine	72	70	64	60	57	56	54	52	50
Concrete-mixer	71	69	63	59	57	55	53	51	49
Applicable Standard (GB12523－2011, revised)	70 (daytime)								
	55 nighttime)								

165. These values were compared with the locations of the sensitive receptors (Section VI.A) to

see which communities would be within 40 m of construction works which exceed daytime noise levels of 70 dB(A), the threshold applied to this project under PRC standard GB12523－2011 (Table VI-11). To be conservative, no attempt was made to distinguish between noise emissions from different types of construction activity i.e. any works within 40 m of residences were assumed to generate noise levels exceeding the threshold and so require management. A total of 281 households (about 844 people) are situated within 40 m of planned works (Table VI-11b). These communities may experience day-time noise levels up to 70 dB(A) in the audible scale. Extended exposure to such noise levels could cause physical hearing injury to residents and workers, in addition to general stress and disturbance.

Table VI-11(b): Households within 40 m of Construction Works

Region	Towns	Households	Persons
Changshou District	1 (Yuntai Town)	101	320
Dianjiang County	4 (Gao'an, Gaofenng, Pushun, Xinmin)	118	372
Liangping District	3 (Jindai, Helin, Pingjin	62	192
Total	**8**	**281**	**884**

166. Mitigation measures. The following measures will be implemented to comply with PRC construction site noise limits and to protect sensitive receptors (see Section IV).

(i) Ensure that noise levels from equipment and machinery conform to PRC standard of GB12523-2011 (revised). Properly maintain construction vehicles and machineries to minimize noise.
(ii) Apply noise reduction devices and methods for high noise equipment operating within 200 m of the sensitive sites e.g. schools, villages, residential areas (Tables IV-53 to IV-57).
(iii) Locate high-noise activities (e.g. rock crushing, concrete-mixing) >1 km from sensitive areas.
(iv) Prohibit operation of high-noise machinery, and movement of heavy vehicles along urban and village roads, between 20:00 and 07:00, in accordance with Chongqing municipal regulations.
(v) Take special caution at construction sites that are close to such sensitive sites as schools and hospitals. When construction activities are unavoidable during the school seasons, the use of heavy equipment will be restricted to weekends and non-class hours.
(vi) Place temporary hoardings or noise barriers around noise sources during construction.
(vii) Monitor noise at sensitive areas at regular intervals (EMP Tables 6 and 7). If noise standards are exceeded, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation.
(viii) Conduct regular interviews with residents/villagers adjacent to construction sites to identify noise disturbance. Community feedback will be used to adjust work hours of noisy machinery.
(ix) For the 281 households that will be within 40 m of construction works, particular attention will be provided. This will include: (a) follow-up consultations with all of these households prior to the start of any works, to specify the exact planned dates and schedule of works, nature of works, equipment to be used, safety measures, and public access around the works during construction; (b) installation of noise barriers to reduce as much of the emissions as possible, and/or installation of additional layers on the windows of the affected homes, pending assessment of the most technically effective method and feedback from the community consultations; (c) agreement on the duration of daily works; and (d) provision of temporary housing if required.

167. Based on effective implementation of these measures, the net impact of noise disturbance is expected to be manageable, due to: (i) stone material is commercially available, and there will be no on-site stone crushing; (ii) all the emergency bridges are small simply-supported girder structures which will not require the use of pile hammers; (iii) the sewer pipes are small diameters (<300 mm), using small rollers is enough for road repaving after the pipe laying; and (iv) the extent of noise

disturbance to individual communities will be shorter than the total construction time for the project, as the scope of works within individual sites is relatively small compared to the total cumulative works. Overall, noise management will require close attention during the project implementation.

(6) Vibration

168. Vibration impacts are expected during constructions. Mechanical vibration may be sudden and discontinuous, which can cause stress among workers and communities. To address these issues: (i) high noise activities, such as 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. The Japanese Handbook of Environmental Impact Assessment provides measures of vibrations caused by construction machinery (Table V-12).

Table V-12: Vibration Levels of Construction Machinery (Unit: dB)

Equipment	At 5 m	At 10 m	At 20 m	At 30 m
Vibratory hammer	75	67	48	44
Roller	58	53	50	48
Diesel truck	62	58	54	51

169. Table V-12 shows that the requirements for residential and cultural areas as specified in Environmental Vibration Standard for Urban Areas (GB10070-88) (see Section II) is met at a distance of >10m from the vibration source. Mitigation measures include prohibition of pilling and compaction operations at night, which will effectively reduce the vibration impact. No sensitive receptor site is closer than 20 m from a construction area, although some residential areas are between 20 m and 100 m of construction areas. Overall, the impact of vibration is considered to be low, due to: (i) stone material is commercially available, and there will not be any on-site stone crushing; and (ii) the emergency bridges to be built are small simply-supported girder structures for which pile hammers (high noise and vibration) will not be used.

(7) Solid Waste

170. **Construction spoil.** About 4,000 m^3 of construction spoil cannot be reused as filling earth, comprising 1,500 m^3 for Liangping, 1,500 m^3 for Changshou and 1,000 m^3 for Dianjiang. This spoil will be regularly transported off-site by the contractor for disposal at designated spoil disposal sites (Table V-13) that have been approved by the local environment protection bureaus (EPBs) in compliance with PRC Law on Prevention and Control of Environmental Pollution by Solid Waste. All sites are confirmed to have adequate capacity to receive the spoil generated during construction, have soil erosion protection plans, and will be rehabilitated once filled.

Table V-13: Approved Spoil Disposal Sites

Item	Liangping	Changshou	Dianjiang
Name	Duliang Construction Wastes Treatment Plant	Official construction waste disposal site at Gufo Village	Construction spoil for Dianjiang will also be transported to the Gufo Village waste disposal site (official agreement between Dianjiang IA and the disposal site)
Location	Shaoxing Village (Yuansi Town)	Gufo Village	
Design capacity	100 t/d	1.2 million m^3	
Available capacity	0.3 million m^3	0.2 million m^3	
Distance from project construction site	5-25 km	5-25 km	10-35 km

Total area	4.6 ha	9.4 ha	-
Approval date	June 2014	June 2015	-
Approval authority	Liangping District EPB	Changshou District EPB	-
Rehabilitation plan	Yes	Yes	-
Soil erosion control action plan	Yes	Yes	-

IA = implementing agency.

171. **Domestic wastewater and rubbish from construction workers.** The peak work forces are estimated at 300, 200, and 300 workers in Liangping, Dianjiang and Changshou, respectively. Daily domestic solid wastes production is estimated as 0.5 kg per worker per day (0.4 t/d in total) (Table V-14). About 80% of the workers will live in rented apartments in the towns, and 20% will live in worker camps. For the workers living in rented apartments, their daily rubbish (about 0.32 t/d) will be collected and disposed through the existing municipal rubbishes collection systems in the towns. For the rubbish from the worker camps (0.08 t/d), covered garbage bins will be installed in the camps, which will be the responsibility of the construction contractors to provide sufficient garbage bins at proper locations and ensure they are protected from birds and vermin and emptied regularly, and transport to the local sanitation landfills for disposal. The landfill sites are confirmed to have sufficient capacity to receive the waste and have approved soil control plans (Table V-15).

Table V-14: Summary of Solid Waste Generated during Construction

No.	Item	Liangping	Dianjiang	Changshou	Total
1	Total construction sites	33	15	29	77
2	Average numbers of construction sites per year	9.4	3.3	6.4	19.2
3	Number of workers at peak construction	300	200	300	800
4	Domestic solid wastes (t/d)	0.15	0.1	0.15	0.4
5	Total construction wastes (m3)	1,500	1,000	1,500	4,000

Table V-15: Approved Sanitation Landfills

Item	Liangping	Changshou	Dianjiang
	Liangping Chengbei Sanitation Landfill	Changshou Majiagou Sanitation Landfill	Dianjiang County Nanyinsi Sanitation Landfill
Location	Gaodong Village of Chengbei Town in Liangping District	Majiagou Village of Yanjia Town in Changshou District	Nanyinsi Village of Xinmin Town in Changshou County
Total capacity	0.95 million m3	2.44 million m3	1.93 million
Design daily capacity	80 m3/d	170 m3/d	100 m3/d
Available capacity	0.51 million m^3	1.5 million m3	1.1 million m3
Average transport distance from the towns and villages	10 km	15 km	12 km
Total area	10.0 ha	21.3 ha	16.0
Approval date	July 2004	November 2004	November 2004
Approval authority	Liangping District DRC	Chongqing Municipal EPB	Chongqing Municipal EPB
Rehabilitation plan	Yes	Yes	Yes
Soil erosion control action plan	yes	yes	yes

(8) Ecology

172. Impacts comprise: (i) clearance of about 6.12 mu (0.41 ha) of existing vegetation for embankments along the Longxi River and dredging along tributaries; and (ii) temporary noise and/or visual disturbance to fauna within and near the construction sites. Ecological impacts are considered low as: (i) species richness is low and comprises widespread species (Section IV); (ii) the areas to be cleared are relatively small; (iii) most existing vegetation is secondary, planted, and/or degraded; (iv) there are no rare, threatened, or protected flora or fauna species, critical habitats, or protected areas, in or near the construction sites; and (v) the project will result in a net increase in vegetation, from the planned afforestation of 209 ha, and, the compensatory plantings that will be required for the cleared sites. In accordance with Chongqing municipal regulations, double the area cleared will be replanted i.e. 0.82 ha, to ensure a minimum survival rate of 80%. The ecological resource protection measures in the EMP are as follows.

(i) Clearance of vegetation will be restricted to specific construction sites.
(ii) Prior to construction, vegetation and habitats will be clearly demarcated, as no-go zones for workers and machinery.
(iii) In compliance with the Chongqing Regulation for Landscaping Management: (a) the area of compensatory plantings will be double that of the area of vegetation that is cleared; and (b) a minimum survival rate of 80% of the planted vegetation is required. The Chongqing regulatory requirement for the area of replanting builds on the PRC Forestry Law, which states that compensatory planting will be of “an equivalent or larger area of affected trees and vegetation”.
(iv) Cleared sites will be immediately re-vegetated afterward.
(v) All re-vegetation will use native plant species of local origin, to maintain genetic fitness and reduce the risk of introducing non-local and invasive species.

173. It is possible that increased impoundment at Shaunggui and Sanhe reservoirs may: (i) impact native species which rely on seasonal changes in water levels; (ii) encourage disease vectors which thrive in flooded conditions; and/or (iii) support the spread of invasive species. These risks are assessed to be low, because the sites are already permanently inundated and have been in operation for many years.

(9) Social Issues

174. Most of the embankment and sewer pipeline construction sites are located close to villages, residential communities and towns, and the comprehensive scope of the project works will render some social impacts unavoidable. Construction may cause unexpected interruption in municipal services in the case of unintended damage to pipelines or transmission lines for water, drainage, gas, and/or electricity. This risk will be managed through: (i) frequent inspection of the facilities during construction; and (ii) consultations with nearby communities before and during construction, as part of the ongoing consultation and information disclosure (Section VI). The project will also involve temporary and permanent land acquisition and house demolition. These issues, including resettlement, compensation, and public consultations, are described in the TRTA documents of Land Acquisition and Resettlement Plan (LAR) and Poverty and Social Assessment Report (PSAR).

(10) Community and worker health and safety

175. Traffic congestion and risk of accidents in the project districts and county will increase with construction traffic, causing temporary inconvenience to traffic, residents, commercial operations, and institutions. Construction may cause unexpected interruptions in municipal services and utilities because of damage to pipelines for water supply and drainage, as well as to underground power

cables and communication cables (including optical fiber cables). Contractors will implement the following EMP measures to reduce risks to community health.

(i) Traffic management. A traffic control and operation plan will be prepared by contractor, to be approved by the local traffic management administrations before construction. The plan will include provisions for diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at road crossings, selecting transport routes to reduce disturbance to regular traffic, reinstating roads, and opening them to traffic as soon as the construction is completed.
(ii) Underground facilities survey and protection. Pipeline construction activities will be planned so as to minimize disturbances to utility services.
(iii) Information disclosure. Villagers, residents and businesses will be informed in advance through media and information boards at construction sites of the construction activities, given the dates and duration of expected disruption.
(iv) Construction site protection. Clear signs will be placed at construction sites in view of the public, informing people about the project GRM, and warning people against potential dangers such as moving vehicles, hazardous materials, and excavations, and raising awareness on safety issues. Heavy machinery will not be used at night. All sites will be secured, disabling access by the public through appropriate fencing whenever appropriate.

176. The construction industry is considered to be one of the most hazardous industries. Intensive use of heavy construction machinery, tools, and materials present physical hazards including noise and vibration, dust, handling heavy materials and equipment, falling objects, work on slippery surfaces, fire hazards, and chemical hazards such as toxic fumes and vapors. Contractors will each prepare an environmental, health and safety management plan (Table EMP-2 of Appendix 1), which will include the following.

(i) Provide a clean and sufficient supply of fresh water for construction sites and camps.
(ii) Provide adequate number of latrines at construction sites and work camps and ensure that they are cleaned and maintained in a hygienic state.
(iii) Garbage receptacles at construction sites and camps will be set up, which will be periodically cleared to prevent outbreak of diseases.
(iv) Provide personal protection equipment to comply with PRC regulations e.g. safety boots, helmets, gloves, protective clothing, goggles, ear plugs.
(v) Emergency preparedness and response plan for accidents and emergencies, including environmental and public health emergencies associated with hazardous material spills and similar events. These plans will be submitted to the local EPBs for review and approval. Emergency phone link with hospitals in the project towns will be established. A fully equipped first-aid base in each construction camp will be organized.
(vi) A records management system that will store and maintain easily retrievable records against loss or damage will be established. It will include documenting and reporting of occupational accidents, diseases, and incidents. The records will be reviewed during compliance monitoring and audits.
(vii) Occupational health and safety matters will be given a high degree of publicity to all work personnel and posters will be displayed prominently at construction sites.
(viii) All workers will be given basic training in sanitation, general health and safety matters, and work hazards. An awareness program for HIV/AIDS and other communicable diseases will be implemented for workers and the local communities.
(ix) Core labor standards will be implemented. 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 pay women’s wages directly to them; and (iv) not

employ child or forced labor. Specific targets for employment have been included in the project gender action plan.

177. It is expected that these risks can be effectively managed through implementation of the EMP, including the mitigation measures, capacity building, inspection, supervision, and reporting.

(11) Physical Cultural Resources

178. No cultural heritage or archaeological sites are known within 1 km of the project areas. One temple, Shuangguitang (located in Jindai Town in Lianping District). The temple was built in the Qing Dynasty (1661) and has a total area of 70,000 m^2. It is among the most famous Buddhist temples in southwest PRC. The nearest construction works will be 2.5 km away from the temple, well outside the zone of noise, vibration or other disturbance. No impacts are expected. 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. The local Cultural Heritage Bureau, CPMO, and PMO 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.

E. Operational Phase

(1) Changes in hydrology and flow regime

179. There is a risk that the project embankments (158.08 km; 58.36 km along the mainstream and 99.72 km along tributaries) and dredging (7.85 km; only along five tributaries) may result in higher water velocities and/or volumes moving downstream, posing risks to downstream communities and lands and/or changes in river morphology. Climate change may further increase this impact. To assess these potential impacts: (i) modeling of mean annual flood speed before and after the project was conducted for the Longxi River mainstream in the project sections (Appendix 3); (ii) changes in river gradient due to the dredging (which will remove 0.5–0.7 m of surface sediments) were considered; (iii) the range of embankment types to be developed by the project (and their contribution to higher flow velocity through smooth-sided channels) was considered; and (iv) the results of climate change analyses were included in the assessment.

180. Based on this analysis, it is concluded that: (i) the project will result in small velocity increases (0.05-0.1 m/s) to mean annual flood velocities downstream of Longxi River; (ii) the channel gradient of the river and tributaries will not be changed by the construction, as there will be no dredging in the mainstream of Longxi River and the dredging in the tributaries will maintain the existing gradient; (iii) the “green” designs for the embankments will contribute to water retention and reducing flow speeds; and (iv) under climate change, mean annual precipitation is predicted to increase by only 1% under RCP8.5 modeling during the period of 2021-2050 (Section IV).

(2) Operation of pump stations

181. Two sewage pumping stations in Changshou District will be constructed. Operation of the pumping stations will generate noise and odor (ammonia and hydrogen sulfide). To reduce noise, each station will install low-noise equipment, submerged pumps, and thick walls. The pump stations have been situated to be at least 100 m from the nearest sensitive receptor (villages, household, school or other). Station operators will maintain the equipment in good working condition as part of standard operating procedures. With these measures, noise levels at the boundaries of the pump

stations were modeled to be 54 dB(A) in the day time and 45 dB(A) at night: these levels comply with Grade II noise standards [60 dB(A) in the day time and 50 dB(A) at night] of PRC Noise Standards at the Boundary of Industries and Enterprises (GB12348-2008). For odor, levels of ammonia and hydrogen sulfide emission were modeled and will be less than 1.2 mg/m^3 and 0.05 mg/m^3 respectively at the boundaries of the pump stations. This complies with Grade II of PRC Emission Standards for Odor Pollutants (GB14554-93).

(3) Operation and maintenance of project facilities

182. Inadequate maintenance of built structures, will lead to damaged embankments, river channel sedimentation, blocked pipelines, and surface water degradation. The project facilities will be integrated into the existing work programs and budgets of the local water resources bureaus (WRBs). Maintenance will include: regular inspection of the embankments for stability; the condition of habitat features and vegetation plantings; and the presence of illegal structures (which would be removed). During the project preparation, extensive discussions were held with the Chongqing Municipal WRB, Hydrological Information Station, headquarters for Flood Control and Drought Relief, and Management Office of the River-Chief System. Roles and responsibilities for operation and maintenance of the project facilities, and training requirements, were clarified and are included in the project design and EMP (Appendix 1).

F. Indirect, Induced and Cumulative Impacts

183. Indirect impacts are adverse and/or beneficial environmental impacts which cannot be immediately traced to a project activity but can be causally linked. Induced impacts are adverse and/or beneficial impacts on areas and communities from unintended but predictable developments caused by a project which may occur later or at a different location. Cumulative impacts are the combination of multiple impacts from existing projects, the proposed project, and anticipated future projects that may result in significant adverse and/or beneficial impacts that would not be expected in case of a stand-alone project.[24]

184. **Indirect impacts.** A potential indirect impact is that the hydrology and ecology of river sections downstream of the project facilities are affected, either due to the new project facilities, and/or changes in flow allocations which occur after the project. The physical connection of Yanjingkou Reservoir and Xiaosha River (Liangping District) will result in water mixing, which might cause the spread of invasive species or disease vectors. Reduced seasonal water allocation might create impacts for downstream environment-related livelihoods e.g. seasonal water requirements for agriculture. These risks are considered minimal because: (i) the flow regimes of all rivers and channels in the project area are already highly regulated, due to upstream dams and numerous culverts and gates along the Longxi River and its tributaries; (ii) the modified nature of the waterbodies, which are already subject to high levels of human use; (iii) downstream flow allocations will not be reduced, in any seasons; (iv) improved storage capacities of Sanhe and Shaunggui reservoirs will enable improved flood control and reduce the incidence of downstream flooding; (v) the 17 exotic plant species recorded in the project sites (Section IV.B.E) are already widespread and well established in the region, and the project does not present a risk of further spread these species;[25] and, (vi) the Longxi River Watershed is not an isolated ecological system, and overland flow and water mixing occurs, at least occasionally, during floods.

185. **Induced impacts.** The project will result in increased water storage capacity of Shuanggui

[24] ADB. 2011. *Sourcebook for Safeguard Requirement 1: Environment.* ADB, Manila.
[25] Hao et al. 2012. *Biological Invasion: Chinese Alien Invasive Plant Map.* Science Press, Beijing.

Lake, which will increase dry-season surface water availability. This will benefit agriculture and domestic use around the lake.

186. **Cumulative impacts.** For the consideration of embankments, the project-funded embankments will encompass 31.4 km of the combined length (both banks) of the Longxi mainstream (430 km). This represents a conversion of 7.3% of the river banks from a state of "natural" to "artificial". This is not anticipated to affect the hydrological regime of the river (see assessment of indirect impacts above). It is possible that the progressive replacement of other sections of the river banks by artificial embankments, under future projects, could cumulatively alter the river flow regime. Such risks are unclear, but appear low as: (i) although it seems likely that small embankments may be built in other locations in the future, there are no other large-scale embankment projects planned for the Longxi River that are similar in scope to the current project; and (ii) the assumption that conversion of existing river banks will cause negative changes to hydrology is overly simplistic, as many sections of riverbanks are already degraded or modified; in comparison, the green design of embankments now commonly applied to rivers in the PRC (i.e. porous latticework structures with planted vegetation) are intended to increase water retention and reduce runoff and river velocity i.e. have positive effects for flood control.

187. For the consideration of cumulative levels of development, numerous, separate and small construction projects are being conducted or planned in the project area, in accordance with municipal development plans. Together with the ADB-funded project, cumulatively larger effects of construction and operation will occur, including levels of noise and dust, wastewater discharge, solid waste disposal, and traffic congestion. The exact locations of other planned construction projects over the next several years (during the construction phase of the ADB-funded project) are unknown. However, as and when these other projects begin, and should they overlap closely with the proposed project, the following mitigation measures will be implemented to minimize cumulative impacts: (i) coordination between projects to share road access and borrow and disposal sites; (ii) sharing of any associated facilities (e.g. pipelines, easements) to avoid repeated excavation of the same alignments; (iii) coordinated traffic management plans; (iv) participatory planning with local villages and communities; and (v) training of workers to minimize social disturbance.

G. Climate Change and Greenhouse Gas Emissions

188. **Greenhouse gas (GHG) emissions, carbon sequestration, and net emissions.** Project GHG emissions will be generated during construction (vehicles, machinery, workers) and operation (electricity use at the two pump stations, emissions of station vehicles, and emergency generators during power black-outs). Electricity will be supplied through the municipal grid. A course estimate of the project GHG emissions was derived using the following assumptions: construction – full-time three-year schedule (the project is five years but peak construction intensity will be less) employing 800 full-time workers, construction vehicles, and generation of construction waste; and operation – electricity use of the pump stations and emissions of five commercial vehicles, for the first 10 years of operation (Table V-16). This is not a detailed project GHG inventory and almost certainly under-estimates total project GHG emissions. Nonetheless, after 10 years of construction and operation, the total estimated emissions are only one-third of the level defined by ADB as significant ($\geq$100,000 t CO_{2e}) (SPS, 2009), and are small compared with the annual emission of high-risk projects listed by the ADB Environment Safeguards Good Practices handbook (ADB 2012, pp.59–62).

Table V-16: Course Estimation of GHG Emission by the Project

Construction period	CO_2 equivalent (t CO2e)
Workers (800) – consume 1 kg meat/d for 4.5 years	6,760
Articulated truck (100 t) – total100,000 km	2,000

Light commercial truck (10t) – total100,000 km	13.0
Construction wastes (4,000 t)	800
Operation (first 10 years)	
Pump electricity consumption (assume 200,000 kWh/pump/year)	2,120
Pumping station vehicles (10 light vehicle ×10,000 km/year)	282
Total GHG emissions for 10 years	**11,975**
Total GHG emissions per year	**1,198 CO_2 (326.7 Carbon)**

Estimated using online GHG calculator (www.carbonneutral.au).

189. **Carbon sequestration and net project GHG emissions.** The total proposed afforestation and re-vegetation area in the project county and two districts is about 209 ha, comprising about 198.3 ha terrestrial vegetation and 10.7 ha aquatic vegetation. National estimates are not available for carbon sequestration by grasslands and aquatic vegetation, and for the current calculation, only the replanting area for woody plants (i.e. trees and bushes) was used, which is 70.1 ha (Table V-18). In the PRC, annual carbon sequestration capacity of forest is estimated to be 0.3-12 t C/ha[26] depending on forest type, species, and age, as well as soil, water and weather (average annual sunshine hours, rainfall and temperature). Considering the weather conditions of Chongqing Municipality, the value of 3.32 t/ha.yr[27] was applied for the calculation of carbon sequestration for the project. It is estimated the project tree and shrub plantings will achieve 232.7 tons of carbon sequestration per year (Table V-17). Assuming project GHG emissions of 1,198 t CO_2e (326.7 Carbon) per year (Table V-16), the project will result in net GHG emissions of **344.8 tons** CO_2e per year i.e. (326.7-232.7) x CO_2(44)/C(12). This is a coarse estimate and the subtraction of carbon sequestration does not account for other, more harmful GHG emissions from construction and operation. Nonetheless, these figures are magnitudes of scale much lower than the SPS threshold of concern of 100,000 t CO_2e per year.

Table V-17: Preliminary Calculation of Carbon Sink from Re-vegetation

County / District	Area of trees (ha)	Area of bushes (ha)	Total area (ha)	Carbon Sink factor (t/ha/yr)	Carbon Sequestration Potential (t/year)
Liangping	17.9	8.9	26.8	3.32	89.0
Dianjiang	13.8	8.3	22.1		73.4
Changshou	6.9	14.3	21.2		70.4
Total	**38.6**	**31.5**	**70.1**		**232.7**

190. **Climate change adaptation.** A climate risk vulnerability assessment (CRVA) was conducted by the TRTA consultant to identify the risk climate change presents to project viability, assuming a design life of 30-40 years. The annual mean temperature has increased 0.14℃/10a in Longxi River basin during 1961-2015, which was lower than the warming rate for the PRC average (about 0.22℃/10a). Modeling (RCP4.5) indicates that mean annual temperatures will increase by 0.9℃ from 2020-2030 and 1.2℃ by 2050. In Longxi River basin, the rainfall intensity will be changed due to climate change. The frequency analysis suggests that the maximum daily rainfall of 50 years return period will be increased by 3% during the period of 2021-2050. variability in precipitation will increase, and storm severity may increase. Increasing flood volumes could exceed the flow capacity of embankments, channels, pipelines, and pump stations. To accommodate this, all structures will be constructed to a flood protection standard of once in 20 years, and embankments have been designed to be porous for improved infiltration. Overall, the existing project design, which is focused on water conservation and management, is strongly oriented to achieve resilience to climate impacts.

[26] Carbon sequestration capacity comparison. May 2011. http://www.carbontree.com.cn/News show asp ?bid=5725

[27] C-D. Huang, J. Zhang et al. Dynamics on forest carbon stock in Sichuan Province and Chongqing City. Acta Ecologica Sinica, 2008, 28(3):0966-0975.

Increased storm water retention and improved water monitoring and allocation will strengthen water security; channel rehabilitation will improve water flows and reduce flood risk; increased water storage in Shaunggui Lake will increase resilience to drought; and, training will be given under the project in natural disaster (flood) reduction and Longxi River watershed integrated management.

VI. ALTERNATIVE ANALYSIS

191. The major construction contents of the proposed project are river embankment, sediment dredging and sewer pipeline laying. During the TRTA and preparation of the FSRs and DEIAs, alternative designs and construction methods were assessed and compared against technical, economic, environmental, and social criteria for each project component. The primary objective with respect to environmental criteria were to identify options with the least adverse environmental impacts and maximum environmental benefits. The following environmental and socio-economic factors were used in the analysis: (i) balanced flood control and water quality improvement; (ii) impacts related to land acquisition and resettlement (LAR); (iii) minimization of village and community disturbance; and (iv) adaptation to local context (flood control, ecological preservation, water quality improvement for Longxi River and its tributaries, and climatic constraints). Alternative analyses for embankment designs, pipe materials for sewer pipeline laying, methods for sediment dredging, dredged sediment dewatering process and disposal are described below.

A. Without-Project Alternative

192. Without the project, about 895,000 residents in Longxi River watershed will continue to suffer from flood disasters annually and polluted water will continue to flow into the Yangzi River and the three Gorge Reservoir from Longxi River and its tributaries, due to point and non-point pollution sources in the river basin.

B. River Embankment

193. Two embankment designs were assessed for the river embankment constructions: traditional concrete embankment and ecological embankment. The reinforced concrete river banks used to be widely constructed in the PRC, but has high ecological impacts, while the ecological embankment method reduces such impacts due to the use of permeable structures and materials and plantings with native species. For all the embankments under this project, ecological embankment will be adopted.

C. River sediment dredging method

194. Two options were assessed for sediment dredging: conventional dredging and ecological dredging. Conventional dredging was conducted in the PRC for many years and focuses on speed and cost effectiveness; while ecological dredging is a more environmentally friendly method for removal of pollutants, as it incorporates measures to minimize disturbance and to restore the river condition. Environmental dredging removes the upper layer of polluted sediment, while maintaining the lower substrate to retain aquatic organisms and microbes. Environmental dredging can reduce 40-60% of pollutants in sediment.[28] Based on the conditions of the five tributaries to be dredged, environmental dredging will be used at Huilong River, Xinmin River, Dayu Stream and Jiaojia River with ecological values (water quality is Grade V or better, with aquatic animals and plants); for the degraded seasonal channel, Yuntai River (water quality is worse than Grade V and severe silted), conventional dredging will be applied. No dredging will be conducted in Longxi mainstream.

D. Dewatering Processes for Dredge Sediment

[28] Dredging and silt treatment technology for small and medium rivers: channelshttp://www.360doc.com/content/15/0515/20/20625683_470752063.shtml

195. Three alternatives of dredged sediment dewatering were assessed: natural drying, geotextile tube bag process, and mechanical dewatering (Table VII-1). Natural drying requires a larger area of space, longer time for dewatering, and release of odor from the drying sediments, but does not require any power and is the least cost option, and was selected.

Table VI-1: Dewatering Process for Dredged Sediment

Option	Option I - Natural Drying	Option II - Geotextile Tube	Option III - Mechanical dewatering
Advantage	• No power consumption • Low cost	• Low power consumption • Medium dewatering efficiency • Low cost	• High water content reduction (35%) • Short dewatering period; • Less land occupation; • Less odor impact
Disadvantage	• Low dewatering efficiency • Long drying period • High water content • Large land occupation • Odor impact	• Low dewatering efficiency; • Long drying period; • High water content • Large land occupation	• High power consumption; • Need flocculant dosage

E. Disposal of Dredged Sediment

196. The disposal of dewatered dredge sediment can be used as topsoil and fertilizer for landscaping and agriculture. Based on the sediment baseline quality monitoring, all the sediment qualities meet the Standards for Pollutants in Sludge and Sediment for Agricultural Use (GB4284-84) and Grade II of the PRC Soil Quality Standard (GB15618-95), so the dewatered sediment will be transported to the nearby towns for landscaping.

F. Alternatives for Sewer Pipe Material

197. Two types of pipe materials were compared: high-density polyethylene (HDPE) double-wall corrugated pipe, and reinforced concrete pipe. Reinforced concrete pipe was adopted for drainage pipes with diameter $\geq$500 mm due to lower cost. For drainage pipes with diameter $\leq$ 500 mm, HDPE double wall corrugated pipe was selected due to ease of construction, less scale formation, flexibility, and high resistance to shock, pressure and corrosion.

Table VI-2: Comparison of Sewer Pipe Material Alternatives

Item	HDPE Double Wall Corrugated Pipe	Reinforced Concrete Pipe
Roughness Coefficient	0.009	0.013
Corrosion Resistance	Good	Medium
Quality of Pipe Works and Maintenance Cost	Hot melt used for pipe connection – less subject to damage, quality of pipe installation improved. Maintenance cost relatively low.	The joint is subject to damage; impermeability is poor. The quality of whole works cannot be guaranteed. Maintenance cost relatively high.
Length of Unit Pipe	＞6 m	3-5m
Unit Price	High	Low
Weight	5% of reinforced concrete pipe	Very heavy
Environmental Impact	Good for groundwater due to less seepage	Leakages more likely, resulting in groundwater pollution
Service Life	60 years	60 years

VII. PUBLIC CONSULTATION, PARTICIPATION AND INFORMATION DISCLOSURE

198. Meaningful public participation and consultation during project feasibility study, design and implementation are important safeguard requirements. The PRC Environmental Protection Law and Regulations on the Administration of Construction Project Environmental Protection (Order No. 253 of the State Council) require that a DEIA solicits the opinions of organizations concerned and villagers 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.

199. 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.

200. This section describes the public consultations for the environmental assessment, undertaken by the DEIA institutes and implementing agencies. Consultation included: (i) information disclosure; (ii) questionnaire surveys; (iii) informal visits to villages and households in the project areas; and (iv) public meetings attended by representatives of the affected public and other concerned stakeholders, including a questionnaire survey after the meeting. A social and poverty analysis was also conducted by the TRTA social and resettlement experts based on group discussions with key agencies, beneficiaries, and adversely affected communities, with emphasis on poverty villages and potential gender issues. 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

201. Two rounds of information disclosure for the project were conducted by the DEIA institute in each project county/district. Information was distributed through local government websites (Table VII-1, Figure VII-1). The first round was carried out during DEIA preparation and a total of three disclosure documents (one for each of the project districts and county) was prepared and released on the local EPB websites. Each disclosure comprised: (i) description of Longxi River and environmental issues (floods and pollution); (ii) summary description of the project components and site, including the specific quantities of embankments, dredging, roads, bridges, and other planned facilities; (iii) a summary of the national laws and regulations ensuring the rights of communities to express their views; (iv) procedures and scope of the domestic EIAs; (v) avenues for public feedback; and, (vi) contact details of the CPMO, IAs, PMOs, DEIA Institutes and local EPBs. People from areas where potential impacts might occur were consulted, as well as the appropriate representatives of age, gender, education, poverty, and occupations.

202. The second round of information disclosure was undertaken after preparation of the FSRs and DEIAs to seek public feedback on the findings, including potential impacts and updated mitigation measures, and included consultations with communities and villages in and near project sites.

Table VII-1: Summary of Information disclosure.

District/	1st Information Disclosure	2nd Information Disclosure

county	Date	Media Posted	Date	Media Posted
Liangping	16 Jan. 2018	Liangping District Government's website	7 Feb. 2018	Liangping District Government's website
Dianjiang County	7 Dec. 2017	Dianjiang County DRC's website http://fgw.cqsdj.gov.cn/Html/21/fgwxx/tzgg/2018-2/170440.html	23 Jan. 2018	Dianjiang County DRC's website, http://www.cqsdj.gov.cn/Html/21/fgwxx/tzgg/2018-2/171461.html
Changshou District	20 Dec. 2018	Changshou District Government's website: http://cs.cq.gov.cn	23 Jan.- 5 Feb. 2018	Changshou District Government's website: http://cs.cq.gov.cn

Source: the DEIA

Webpage of 1st Information Disclosure for Liangping District

Webpage of 2nd Information Disclosure for Liangping District

Webpage of 1st Information Disclosure for Dianjiang County

Webpage of 2nd Information Disclosure for Dianjiang County

Webpage of 1st Information Disclosure for Changshou District

Webpage of 2nd Information Disclosure for Changshou District

Figure VII-1: Project information disclosed on the websites

203. **Future information disclosure.** Further disclosure will be as follows:

(i) The summaries of the five DEIAs in Chinese will be disclosed on the district/county EPB websites for at least 10 days before DEIA approval;
(ii) Copies of the DEIAs in Chinese are available on request in both the Municipal EPB and the EPBs of three project county/districts;
(iii) This project EIA was disclosed on the ADB website on 20 March 2018, four months before ADB Board consideration of the loan (see: https://www.adb.org/projects/documents/prc-51005-002-eia); and,
(iv) Environment progress and monitoring reports will be prepared on a semi-annual basis and will be disclosed on the ADB public website.

B. First Round of Consultation

204. The first round of public consultations for the project were conducted in the project county/districts, between December 2017 to February 2018. The consultation scope included the villages and within 300 m from the construction sites of embankment, where people more likely to be impacted by noise, dust, and odor from dredged sediment during construction, for the components of sediment dredging, villages and residential communities within 500 m upstream and 1,000 m downstream of proposed river sections were included. The consultations consisted of villagers/residents from 36 villages and residential communities. In total for the three county/districts, 370 questionnaires were distributed by the four EIA Institutes, together with the implementing agencies and 336 (90.8%) were completed and returned. Respondents from different age groups, gender, educational backgrounds and occupations are summarized in Table VII-2 and the results are in Table VII-3.

Table VII-2: Respondents of 1st Round of Questionnaire Survey

Information of Consulted APs		Liangping		Dianjiang		Changshou	
		22-25 Jan. 2018		17-18 Dec. 2018		14-16 Dec. 2017	
		127 Resp. (total 127)	%	91 Resp. (total 100)	%	118 Resp. (total 118)	(%)
Gender	Male	104	81.9%	75	82.4%	81	68.6%
	Female	23	18.1%	16	17.6%	37	31.4%
Age Group	<30	4	3.1%	1	1.1%	7	5.9%
	31-50	40	31.5%	34	37.4%	40	33.9%
	≥50	72	56.7%	53	58.2%	71	60.2%
	Not filled	11	8.7%	1	1.1%	0	0.0%
Education	Below junior high school	104	81.9%	67	73.6%	83	70.3%
	Senior high & vocational school	13	10.2%	16	17.6%	28	23.7%
	College and above	0	0.0%	4	4.4%	7	5.9%
	Not filled	10	7.9%	4	4.4%	0	0.0%
Occupation	Worker	4	3.1%	6	6.6%	3	2.5%
	Peasant	92	72.4%	76	83.5%	98	83.1%
	Cadre	7	5.5%	0	0.0%	7	5.9%
	Member of local People's Congress	8	6.3%	0	0.0%	0	0.0%
	Others	6	4.7%	8	8.8%	5	4.2%
	Not filled	0	0	1	1.1%	5	4.2%
Number of consulted towns/villages		People from 11 villages/residential communities		People from 5 villages		18 villages/residential communities in 7 towns	

Table VII-3: Results of 1st Round of Questionnaire Survey

No.	Question	Option	Liangping		Chaoshou		Dianjing	
			127 Resp.	(%)	118 Resp.	(%)	91 Resp.	(%)
1	Do you know the project construction?	Know very well	47	37.0	23	19.5	60	65.9%
		Basically know	59	46.5	74	62.7	30	33.0%
		Know a little	21	16.5	21	17.8	1	1.1%
2	What do you think is the possible environment impact during construction of the project? (multiple-choice)	Dust, noise, wastewater and solid wastes	103	81.1	92	78	69	75.8%
		Soil erosion	49	38.6	23	19.5	11	12.1%
		Impact to landscape	27	21.3	19	16.1	5	5.5%
		Impact to ecosystem	41	32.3	26	22.0	6	6.6%
3	What do you think is the possible environment impact during operation of the project? (multiple-choice)	Noise	54	42.5	48	40.7	48	52.7%
		Air pollution	32	25.2	11	9.3	27	29.7%
		Wastewater	97	76.4	64	54.2	11	12.1%
		Solid wastes	65	51.2	43	36.4	5	5.5%
4	What do you think is the impact on the environment after the implementation of the project?	Positive impacts	119	93.7	58	49.2	50	54.9%
		No impact	5	3.9	34	28.8	26	28.6%
		Some impacts, but acceptable	3	2.4	23	20.3	15	16.5%
		Negative, not acceptable	0	0	0	0	0	0.0%
5	Are you satisfied with the current situation of environmental quality?	Very satisfied	82	65	81	68.6	41	45.1%
		Satisfied	25	20	26	22.0	38	41.8%
		Dissatisfied	16	13	11	9.3	12	13.2%
		Very dissatisfied	4	2	0	0.0	0	0.0%
6	Do you agree with the plan and sites of the proposed project	Agree	118	93	107	90.7	52	57.1%
		Largely agree	7	5	11	9.3	38	41.8%
		Disagree	0	0	0	0	0	0.0%
		No difference	2	2	0	0	1	1.1%
7	If the project involves land acquisition, do you agree?	agree	123	97	115	97.5	81	89.0%
		disagree	0	0	0	0	0	0.0%
		No difference	4	3	3	2.5	10	11.0%
8	If the project involves your resettlement, do you agree?	agree	125	98	117	99.2	72	79.1%
		disagree	1	2	0	0.0	1	1.1%
		No difference	1	1	1	0.8	18	19.8%
9	What do you think the project for improvement of local social-economic development?	Great	113	88	116	98.3	68	74.7%
		Small	2	2	1	0.8	5	5.5%
		Ordinary	10	8	1	0.8	18	19.8%
		No	0	0	0	0.0	0	0.0%
10	If all the environmental mitigation measures are properly implemented, do you support the project	Support	126	99	118	100	91	100.0%
		Not support	0	0	0	0	0	0.0%
		No difference	1	1	0	0	0	0.0%

205. **Results of the first round of public consultation.** All respondents (100%; N=336) in the project county and two districts supported the project and the anticipated benefits for social and economic development, improved flood control, river ecological management, and landscaping. Feedback by the respondents included: (i) improve the flood control capacity of rivers as far as possible; (ii) increase the landscaping area as much as possible along the rivers to improve scenic beauty; (iii) minimize odor and pollution from dredged sediment; (iv)

conduct water spraying on construction sites to minimize dust generated by construction activities; (v) guarantee resident safety from construction activity; and (vi) for the sewer pipeline subprojects, residents expressed that sound construction planning is needed during the engineering designs to avoid repeated excavation of easements. These considerations have been included as mitigation and management measures in the updated FSRs and the DEIAs.

C. Second Round of Consultation

206. The second round of public consultations were undertaken in the project county and two districts in the form of consultation meetings followed by questionnaire surveys, in January and February 2018, after the second round of information disclosure. The public meetings were used as an opportunity to: (i) present the main anticipated impacts and the final proposed mitigation measures as defined in the updated FSRs and the DEIAs; and (ii) introduce the project grievance redress mechanism (GRM). After the meetings, 300 follow-up questionnaires were distributed and 283 (94.3%) were returned. The questionnaires focused on public understanding of the project components, and local opinions on the potential environmental, social and economic impacts of the project. The breakdown of participants and the results of questionnaire survey are listed in Tables VII-4 and VII-5 respectively.

Table VII-4: Respondents of 2nd Round of Questionnaire Survey

No.	Question	Option	Liangping		Chaoshou		Dianjing	
			Total 124 Resp.	(%)	Total 77 Resp.	(%)	Total 82 Resp.	(%)
1	Do you know the mitigation measures proposed in the DEIAs?	Know very well	12	9.7	2	2.6	52	63.4%
		Basically know	89	71.8	50	64.9	10	12.2%
		Know a little	23	18.5	25	32.5	20	24.4%
2	Do you think the proposed mitigation measures are feasible?	Sound and manageable	57	46.0	21	27.3	52	63.4%
		Basically feasible	67	54.0	56	72.7	30	36.6%
		Not feasible	0	0	0	0	0	0.0%
3	What do you think is the possible environment impact during construction of the project? (multiple-choice)	Dust	27	21.8	67	48.1	28	34.1%
		noise	32	25.8	52	67.5	18	22.0%
		Wastewater	51	41.1	33	42.9	8	9.8%
		Odor impact	27	21.8	27	35.1	22	26.8%
		Soil erosion	98	79.0	4	5.2	18	22.0%
		Impact to landscape	28	22.6	10	13.0	12	14.6%
		Impact to ecosystem	57	46.0	13	16.9	5	6.1%
4	What do you think is the possible environment impact during operation of the project? (multiple-choice)	Noise	12	9.7	21	27.3	32	39.0%
		Air pollution	37	29.8	35	45.5	26	31.7%
		Wastewater	78	62.9	62	80.5	15	18.3%
		Solid wastes	56	45.2	57	74.0	54	65.9%

No.	Question	Option	Liangping		Chaoshou		Dianjing	
			Total 124 Resp.	(%)	Total 77 Resp.	(%)	Total 82 Resp.	(%)
5	Do you think the project will benefit the environment and flood control?	Substantial improvement	103	83.1	68	88.3	76	92.7%
		Improvement	19	15.3	9	11.7	6	7.3%
		No improvement	2	1.6	0	0.0	0	0.0%
4	What's your attitude to the project?	Support	119	96.0	75	97.4	82	100.0%
		Not sure	5	4.0	2	2.6	0	0.0%
		Not support	0	0	0	0	0	0.0%

207. All (100%, N=283) of the consulted persons supported the project, and believed it will improve the local flood control, river water restoration and livelihoods improvement. Almost all (98.3% to 100%) of respondents thought the mitigation measures proposed in the DEIAs are adequate and realistic; 21.8% to 35.1% felt that the odor from dredged sediment is the major impact during construction, but after introduction of the subproject (only the dredging in Yuntai River has odor-related risks; see Section V.D.5) and the mitigation measures for the dredging proposed in the FSRs and DEIAs, most respondents believed that the mitigation measures for the risk of odor are adequate.

D. Third Round of Consultation

208. The first two rounds of consultation were conducted close together and had relatively low female participation. At the time of the consultations, some of the impact analyses had not yet been completed. To address these limitations, and to ensure gender-inclusive consultations are achieved and which fully inform the communities of potential issues during construction and operation, a third round of community consultation is planned. The consultations will be completed by **April 2018** and will: (i) be arranged at times and locations to ensure equal opportunity for women to attend; and (ii) focus especially on households that may be affected by construction noise, dust, and/or odor from sediment. This EIA will be updated with the results of the consultations.

E. Future Consultation

209. Dialogue will be maintained with project communities throughout implementation. Future consultation will be undertaken by the CPMO and PMO Environment and Social Officers, via questionnaire surveys, household visits, workshops, and public hearings (see attached EMP).

VIII. GRIEVANCE REDRESS MECHANISM

210. During the DEIAs and project EIA preparation, the grievance redress mechanism (GRMs) was developed in the project districts and county in compliance with ADB's SPS (2009) requirement to address environmental, health, safety, and social concerns associated with project construction, operation, and land acquisition. The GRM is designed to achieve the following objectives: (i) provide channels of communication for local villages and communities to raise concerns about environmental and social-related grievances which might result from the project; (ii) prevent and mitigate adverse environmental and social impacts to villages and 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 villages and communities; and (iv) build village and community acceptance of the project. The GRM is accessible to all members of the villages and communities, including women, youth, minorities and poverty-stricken villagers and residents. Multiple points of entry are available, including face-to-face meetings, written complaints, telephone conversations, e-mail, and social media.

211. 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 by embankment, inappropriate disposal of construction wastes, damage to private houses, safety measures for the protection of the public and construction workers, and/or water quality deterioration. Grievances related to involuntary resettlement may relate to the lack, or untimely payment of, compensation monies, other allowances, and/or lease monies as per entitlements described in the resettlement plan and associated documents.

212. Currently in Chongqing Municipality (and generally in the PRC), when residents or organizations are negatively affected by a construction or development, they may complain, by themselves or through their village or community committee, to the contractors, developers, the local EPB, or by direct appeal to the local courts. The weaknesses of this system are: (i) the lack of dedicated personnel to address grievances; and (ii) the lack of a specific timeframe for the redress of grievances. This project GRM addresses these weaknesses.

213. The GRM meets the regulatory standards of the PRC that protect the rights of citizens from construction-related environmental and/or social impacts. Decree No. 431 Regulation on Letters and Visits, issued by the State Council of PRC in 2005, codifies a complaint acceptance mechanism at all levels of government and protects the complainants from retaliation. Based on the regulation, the Ministry of Environmental Protection (MEP) published updated Measures on Environmental Letters and Visits (Decree No. 15) in December 2010.

214. The GRM will be accessible to diverse members of the villages and community, including more vulnerable groups such as women, minority and poor. Multiple points of entry, including face-to-face meetings, written complaints, telephone conversations, or e-mail, will be available.

215. The details of the GRM, including a time-bound flow chart of procedures, are included in the project EMP (Appendix 1 of this EIA).

IX. ENVIRONMENTAL MANAGEMENT PLAN

216. A project environmental management plan (EMP) has been prepared (Appendix 1). Development of the EMP drew on the five DEIA reports, discussions with the CPMO, PMOs and IAs, and consultations with the local 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.

X. PROJECT ASSURANCES

217. All ADB-funded projects are required to comply with a standard set of loan assurances for environmental safeguards, which focus on compliance with national laws and the project EMP. In addition, the following project-specific assurances are included in the project agreement between ADB and the CMG.

(i) CMG will and will cause the IAs and project implementation units (PIUs – the companies that will conduct the works on behalf of the IAs) to ensure that: (i) during the detailed design stage, a second round of water and sediment sampling will be conducted, to test for the presence of pesticides, heavy metals and persistent organic pollutants (POPs) in the sections of the tributaries to be dredged. If the presence of these pollutants in the sediments is confirmed, the procedures for impact assessment, mitigation, and sediment disposal described in Section V.D.5 of the EIA, and Table EMP-2 of the EMP, will be implemented; (ii) no proceeds of the Loan will be used to fund any dredging along the Longxi River mainstream; and (iii) any river dredging required for the Project will only be conducted between the calendar months of November to March each year (the dry season).

(ii) CMG will and will cause the IAs and PIUs to ensure that (i) any existing water and wastewater services will continue to be provided to communities during the civil works for the Project; (ii) any interruptions to such services are as limited as possible; and (iii) prior to any such interruptions, consultations are held with all affected communities.

(iii) CMG will and will cause the IAs and PIUs to ensure that all planting activities under the Project, including re-vegetation, embankment construction, wetlands, landscaping, and rehabilitation of construction sites, will only use plant species which are (i) native (i.e. naturally occurring) to the Longxi River basin, and (ii) are sourced from local stock within Chongqing Municipality. In the event that non-native seedlings are required for rapid stabilization of exposed soils and sites, CMG will and will cause the IAs and PIUs to ensure that only sterile seedlings are used to prevent the spread of weeds.

(iv) CMG will and will cause the IAs and PIUs to ensure that all re-vegetation activities under the project, including for the wetlands, landscaping, and embankments, will be subject to operation and maintenance procedures after planting, to ensure the planted vegetation is adequately protected and maintained.

(v) CMG will and will cause the IAs and PIUs to ensure that to avoid pollution of the Longxi River and Shanggui Lake, no pesticides and no top-dressing fertilizers will be used for any of the re-vegetation, planting, or landscaping activities under the Project.

(vi) CMG will and will cause the Changshou District Government to ensure that if any changes are made to the Associated Facilities[29] which will significantly impact their capacity or function and as a result the viability of the Project, ADB is immediately advised of such changes. The Changshou District Government will assess the Project impact and prepare a corrective action plan, if necessary, to be agreed with ADB.

XI. CONCLUSION

218. The project will bring significant benefits to residents in the project county and two districts by significantly contributing to improved flood control, wastewater collection, and improved water quality of the Longxi River and its tributaries. These benefits will also reduce the pollution and silt loads entering the Yangtze River and downstream catchment of the Three Gorges Reservoir.

219. Key environmental risks during construction are from the proposed dredging and construction of embankments. Dredging works will be conducted in the tributaries, and Sanhe Reservoir (Dianjiang County). This may cause increase the water turbidity, pollutants and odor to be released from the dredged sediments, cause temporary, elevated increases in sediment levels, and may result in loss of breeding habitat for fish and aquatic invertebrates. Other risks include soil erosion, noise, air pollution (mainly fugitive dust), soil erosion from uncontrolled earthworks, uncontrolled solid waste disposal, interference with traffic and municipal services during wastewater pipeline construction, permanent and temporary acquisition of land, involuntary resettlement, and occupational and community health and safety. Measures to avoid, minimize, and mitigate potential project impacts have been developed within the EMP (Appendix 1), which is the key document to manage, monitor and report on environmental impacts of the project. A project-specific GRM has been developed, and will be implemented at the municipal, county/district, and site levels.

220. Project assurances have been developed to strengthen confidence in the implementation of key measures in the project EMP, and, to address potential issues that are beyond the project scope. The assurances have been agreed between the CMG and ADB, and are described in Section X.

221. 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 project EIA.

[29] To be defined as the wastewater treatment plants located in each of (1) Dandu Town, (2) Linfeng Town, (3) Longhe Town, (4) Shiyan Town, (5) Yuntai Town, (6) Shuang-long town and (7) Haitang Town, of Changshou District.

APPENDIX 1. ENVIRONMENTAL MANAGEMENT PLAN

TABLE OF CONTENTS

A. Objectives

1. This Environmental Management Plan (EMP) is for the Chongqing Longxi River Environment Comprehensive Treatment and Ecological Protection Demonstration Project (the Project). The EMP is to be implemented in all phases of the project – design, pre-construction, construction, and operation. The EMP is to ensure project compliance with PRC environmental laws and ADB's Safeguard Policy Statement (SPS 2009). The EMP describes: the roles and responsibilities of all project agencies to implement this EMP; anticipated impacts and mitigation measures; inspection, monitoring, and reporting arrangements; training and institutional strengthening; grievance redress mechanism (GRM); and future public consultation.

2. In the engineering design stage the Chongqing Municipal Project Management Office (CPMO) will pass this EMP to the design institutes for incorporating mitigation measures into the detailed engineering 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 CPMO and the PMOs of the project county and two districts will prepare and provide the specification clauses for incorporation into the bidding documents: (i) a list of environmental management requirements to be budgeted by the bidders in their bids; (ii) environmental clauses for contractual terms and conditions; and (iii) the project EIA and updated EMP.

B. Organizations and Their Responsibilities for EMP Implementation

3. The Chongqing Municipal Government (CMG), represented by the Municipal Development and Reform Commission (CDRC), is the executive agency (EA) of the project. At the municipal-level, CMG has established the Chongqing Municipal Project Leading Group (CMPLG) to provide policy guidance and coordination, and the Chongqing Municipal Project Management Office (CPMO) to manage, supervise and coordinate overall project implementation. The CPMO comprises representatives from the CDRC, Chongqing Finance Department (CFD), Chongqing Water Resource Bureau (CWRB), and other relevant agencies. The county and district governments will be the implementing agencies (IAs), of which each has established a project management office (PMO) to implement their project components and subprojects. The EMP implementation arrangements and responsibilities of governmental organizations are summarized in Table EMP-1.

Table EMP-1: Institutional responsibilities for EMP implementation

Agency	Environmental Management Roles and Responsibilities
Executing Agency (EA) – Chongqing Municipal Government (CMG) and Chongqing Municipal Project Leading Group (CMPLG)	• Coordination with municipal and district/county governments; • Coordinate project preparation and implementation; • Facilitate inter-agency coordination; • Liaison with ADB.

Agency	Environmental Management Roles and Responsibilities
Chongqing Municipal Project Management Office (CPMO)	• Supervise and manage project implementation; • Daily management work in project preparation and implementation; • Assign CPMO Environment Officer and Social Officer; • Coordinate with ADB on project progress and monitoring reports; • Submit bidding documents, bid evaluation reports and other necessary documentations to ADB for necessary approval; • Procure project implementation consulting services (PIC), including a loan implementation environmental consultant (LIEC); • Consolidate environmental monitoring reports prepared by district/county PMOs and environmental monitoring agencies (EMA) and submit them to ADB for disclosure; • Engage a procurement agency which supports the implementation agencies and three PMOs
Implementing Agencies (IAs) – the three county/districts, and their respective Project Management Offices (PMO)	• Implement project components in their jurisdiction, including finance and administration, technical and procurement matters, monitoring and evaluation, and safeguard compliance. • Coordinate with CPMO for project management and implementation; • Assign PMO environment officer as EMP coordinator; • Incorporate EMP into bidding documents; • Establish GRM; • Supervise and monitor EMP implementation and annual reporting to the CPMO (with support of LIEC); • Participate in capacity building and training programs; • On behalf of IAs, submit bidding documents, bid evaluation reports and other necessary documentations to CPMO and ADB for approvals; • Submit withdrawal applications to Chongqing Municipal and local finance bureaus; • Engage design institute to complete engineering designs; • Tendering contractors and equipment with assistance of the international tendering agency; • Administer and monitor contractors and suppliers; • Construction supervision and quality control; • Contract local EMA to conduct environmental monitoring; • Procure and manage construction supervision companies (CSC) for subproject implementation; • Commission the constructed facilities.
Project Facility Operators: The local towns or district/county WRBs	• With PMOs, commission the constructed facilities; • Operate and maintain completed facilities, including environmental management, monitoring and reporting responsibilities.

4. **Environment staff within CPMO and PMOs.** The CPMO will have main EMP coordination responsibility. The CPMO has designated an Environmental Officer to be responsible for the environmental issues during the project implementation. The officer will be assigned on a full-time basis for the entire duration of the project, and will take charge of: (i) coordinating the implementation of the EMP and developing implementation details; (ii) supervising the implementation of mitigation measures during project design, construction and operation; (iii) ensuring that environmental management, monitoring, and mitigation measures are incorporated into bidding documents, construction contracts and operation management manuals; (iv) submitting semi-annual EMP monitoring and progress reports to ADB; (v) coordinating the GRM; and (vi) responding to any unforeseen adverse impacts beyond those mentioned in this EMP. The CPMO Environmental Officer will be technically supported by the loan implementation environment consultant (LIEC). Each of the three PMOs will nominate one environmental officer and one social officer to check the overall

implementation of environmental management provisions of the EMP, and to work in close coordination with the CPMO Environmental Officer.

5. **Loan Implementation Environment Consultant (LIEC).** A LIEC will be hired under the loan implementation consultant services. The LIEC will advise the CPMO, PMOs, contractors and CSCs 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) on behalf of the PMOs and CPMO, prepare the annual EMP monitoring and progress reports in English and submit it to ADB; (iv) provide training to the CPMO, PMOs, CSCs, on the PRC's environmental laws, regulations and policies, ADB SPS 2009, EMP implementation, and GRM in accordance with the training plan defined in Table EMP-6; (v) identify any environment-related implementation issues, and propose necessary corrective actions; (vi) undertake site visits for EMP inspection as required.

6. Draft terms of reference for the positions of CPMO Environment Officer, the three PMO Environment Officers, and the LIEC, are described in Appendix 4.

7. **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 PMOs. Contractors will develop site-specific EMPs based on this EMP, including the specific contractor performance targets listed in Table EMP-2. CSCs will be selected through the PRC bidding procedure by the PMOs. 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; (ii) undertake simple and cost-effective on-site quantitative measurements to regularly check that the construction complies with the environmental monitoring standards and targets, especially for noise, and water turbidity (during the dredging and embankments), using a basic hand-held meter; and (iii) prepare the contractor's environmental management performance section in monthly project progress reports submitted to the PMOs and CPMO.

8. **External Environmental Monitoring Agency (EMA)**. External environmental monitoring is required by ADB for projects which are Category "A" for environment. The external environmental monitoring (Table EMP-5) will be conducted by a certified agency, that will be engaged through a public tendering process. The PMOs will appoint the EMA of each project county/district to conduct periodic environmental monitoring during construction and operation in accordance with the monitoring plan (Table EMP-5), and the EMA will report the results of the monitoring to the CPMO, the PMOs and ADB.

C. Potential Impacts and Mitigation Measures

9. **Tables EMP-2 and EMP-3** list the potential impacts of the project components in the project county and two districts during project preparation, design, construction and operation, and proposed mitigation measures. The mitigation measures will be incorporated into detailed design, bidding documents, construction contracts and operational management manuals, by the design institutes (during detailed design) and contractors (during construction), under the supervision of CSCs and PMOs, with technical support from the LIECs. The effectiveness of these measures will be evaluated based on environmental inspections and monitoring to determine whether they should be continued, improved or adjusted.

Table EMP-2: Potential Impacts and Mitigation Measures during Pre-construction and Construction Phases

Item	Potential impacts / issues	Mitigation measures	Who implements	Who supervises
A. DESIGN AND CONSTRUCTION PHASES				
Detailed design stage	Institutional strengthening for EMP Implementation and supervision	• At least 1 month before construction: (i) reconfirm the full-time status of the CPMO Environmental Officer for the project; (ii) appoint at least one Environment Officer in each of the three PMOs. • At least 2 months before any construction, CPMO engages LIEC. • At least 2 months before any construction, provide training to all environmental staff for EMP implementation and supervision. • Confirm that at least one certified environmental monitoring agency has been recruited for the project **at least 2 months before any construction**. • Organize and conduct training on the project EMP for appropriate staffs of the CPMO, IAs, PMOs, contractors, and CSCs.	CPMO, PMOs	EA, ADB
	Second round of water and sediment sampling	• Conduct second round of water and sediment sampling to test for the presence of pesticides, heavy metals and POPs in the dredge sections. • Sampling and analysis will be conducted by the Chongqing Municipal Ecological and Environmental Monitoring Center (http://www.cqemc.cn/). • The agency's report will include: (a) historical analysis of the general landscape in the context of pesticides, heavy metals, and POPs; (b) a detailed map of the sampling sites; a list of the potential toxicants measured; and (c) description of methodology for the sampling and analysis, including a list of ecotoxicological tests to be undertaken. • If the presence of such pollutants in the sediments is confirmed, the following procedures will be taken: (a) the level of risk to people and the environment will be re-assessed, based on the level of toxicity and extent of contamination in the sections of tributaries to be dredged; (b) sediment tested positive for pollutants listed as hazardous under PRC regulations, the World Health Organization, and/or the World Bank's EHS, will not be used for landfill. Instead, these sediments will be disposed at the Bishan Hazardous Waste Disposal Center (for the project sites in Dianjiang County and Lianping District) or the Changshou Hazardous Wastes Disposal Plant (for Changshou District); (c) for sediments that are not classified as hazardous: the volumes of remaining sediment for disposal in landscaping (Table V-9) will be revised; then, the specific final locations for disposal will be assessed based on the guidelines for *Assessment levels for Soil, Sediment and Water* (2010) of Western Australia.[30]	CPMO, PMOs	EA, ADB

[30] Department of Environment and Conservation. 2010. Contaminated Sites Management Series. Assessment levels for Soil, Sediment and Water

Item	Potential impacts / issues	Mitigation measures	Who implements	Who supervises
	Updating EMP	• Update mitigation measures defined in this EMP based on final detailed design; • Submit the updated EMP to ADB for review; • In case of major changes of project location and/or additional physical components, form a DEIA team to conduct additional DEIA and public consultation. The revised DEIA should be submitted to Chongqing and district/county EPBs and ADB for approval and disclosure. To determine whether the change is minor or major under assistance of LIEC, CPMO and PMOs should consult with ADB.	CPMO, LIEC	EPD, EPBs, ADB
Construction Preparation	Environmental monitoring plan	• Prior to construction, the CPMO and/or PMOs will hire an EMA, to conduct environment monitoring in accordance with the EMP monitoring plan; • Prepare detailed monitoring plan in accordance with the monitoring plan in this EMP.	PMOs, EMAs	PMOs, CPMO, ADB
	Detailed Design	• The ecological dredging and embankment will be designed and identified in detail, to avoid impacts to local and downstream ecosystems.		
	Bidding and contract documents	• Mitigation measures in the EMP are incorporated in all bidding documents; • Bidding documents are sent to ADB for review; • Prepare environmental contract clauses for contractors.	DIs, CPMO, PMOs	LIEC, EPD, EPBs, ADB
	EMP training	• LIEC, or invited environment specialists and/or officials from EPBs provide training on construction environmental management, implementation, supervision, to contractors and CSCs, in accordance with the training plan in this EMP	LIEC, CPMO	EPB, ADB
	Establish GRM	• Responsibility for GRM implementation is assigned to the CPMO and PMO Environmental Officers and CPMO Social Officers and is included in their terms of reference; • The CPMO and PMOs personnel will be aware of, and trained in, the GRM, and will help support the environmental and social officers when necessary; • Key contact details for the GRM (phone number, fax, address, email) will be provided on the CPMO, PMO and/or EPB public websites and information boards at construction sites.	PMOs	CPMO, LIEC, ADB
	Land acquisition and resettlement	• Update LARP after detail design • Establish resettlement office of government officials to manage LARP; • Conduct information dissemination and community consultation programs in accordance with the PRC Land Administration Law (1999) and ADB SPS; • Ensure that all resettlement is reasonably completed before construction starts.	PMOs, LARO	Local Bureaus of Civil Affairs, Land Mgmt, Labor
B. CONSTRUCTION PHASE				

Item	Potential impacts / issues	Mitigation measures	Who implements	Who supervises
Topography and Soils	Earthwork, soil erosion, soil contamination.	• Define spoil disposal sites and borrow pit locations, in the construction tender documents; • Construct intercepting channels to prevent construction runoff entering waterways; • Divert runoff from sites to sedimentation ponds or existing drainage; • Limit construction and material handling during periods of rains and high winds; • Stabilize embankments, and other erosion-prone areas during works; • Minimize open excavation areas and use compaction techniques for pipe trenches; • Properly store petroleum products, hazardous materials and wastes on impermeable surfaces in secured and covered areas; • Rehabilitate all spoil disposal sites and construction sites; • All landscaping will only use native plant species; • Situate construction camps and storage areas to minimize land area required; • Remove construction wastes from the site to the approved disposal sites; • Establish emergency preparedness and response plan for spills including cleanup equipment at each construction site and training in emergency spill response procedures; • Stabilize earthwork areas within 30 days after earthworks have ceased at the sites.	Contractor CSCs	PMOs, EPBs, WRBs, LIEC
Ambient Air	Dust generated by construction activities, gaseous air pollution (SO_2, CO, NO_x) from construction machinery and asphalt pavement after pipeline laying	• Equip material stockpiles and concrete mixing equipment with dust shrouds; • Spray water on construction sites and earth/material handling routes; • For odor impacts during sediment dredging, immediately transport spoil to disposal site after de-watering, in sealed containers. No storage at construction sites; • Cover materials during truck transport; • Purchase pre-mixed asphalt for road surface paving after pipeline laying; if asphalt is heated and mixed onsite, asphalt mixers must be located $\geq$200 m from villages and other sensitive receptors; • Store petroleum or other harmful materials in appropriate places; • Ensure emissions from vehicle and machinery comply with PRC standards of GB18352-2005, GB17691-2005, GB11340-2005, GB2847-2005, and GB18285-2005; • Provide high-horsepower equipment with tail gas purifiers; and • Conduct ambient air monitoring including H_2S caused by sediment dredging.	Contractor CSCs	PMOs, LIEC
Noise	Noise generated from construction activities	• Ensure construction machinery conform to PRC standard of GB12523-2011. • Properly maintain vehicles and machineries to minimize noise. • Apply noise reduction devices or methods where piling equipment is operating, such as construction of bridges and other hydraulic structures, within 300 m of sensitive sites. • Locate sites for rock crushing and concrete-mixing $\geq$500 m from sensitive areas. • Prohibit operation of machinery generating high levels of noise, such as piling, and movement of heavy vehicles along urban and village roads between 20:00 and 06:00. • Place temporary hoardings or noise barriers around noise sources during construction. • Monitor noise at sensitive areas and consult residents at regular intervals (see monitoring	Contractor CSCs	PMOs, LIEC

Item	Potential impacts / issues	Mitigation measures	Who implements	Who supervises
		plan in this EMP). If noise standards are exceeded, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation. • Conduct interviews with residents adjacent to construction sites to identify and resolve issues, including adjustment of work hours of noise-generating machinery. • For **281 households that will be within 40 m of construction works (Section VI.C(5) of EIA)**, particular attention will be provided including: • (a) follow-up consultations with <u>all</u> households prior to the start of any works, to specify the exact planned dates and schedule of works, nature of works, equipment to be used, safety measures, and public access around the works during construction; • (b) installation of noise barriers to reduce as much of the emissions as possible, and/or installation of additional layers on the windows of the affected homes, pending assessment of the most technically effective method and feedback from the community consultations; • (c) agreement on the duration of daily works; and, • (d) provision of temporary housing if requested or needed. **CONTRACTOR PERFORMANCE TARGET: For the 281 households most at risk, the installed noise barriers reduce noise levels by at least 80% (as measured with a handheld meter on each side of the barrier).**		
Surface water pollution and dredging	Impact of embankment and dredging construction on river hydrology	• A dredging plan will be prepared, to be approved by local EPBs and WRBs. • Technical requirements and mitigation measures for dredging will be included in the bidding documents and construction contracts. • The contractor' site EMP will included dredge machinery maintenance, de-watering, emergency preparedness and response mechanism. • Dredging will only be conducted in the dry season (late October to late March). • Dredging sections will be <u>≤</u>300 m to minimize extent of the disturbance at any one time. • The "ecological dredge method" will be applied in all channels except the Yuantai tributary. • For the Yuantai tributary, dry excavation methods will be used but <u>only in the dry season when there is no water flow.</u> • Temporary silt traps and fences will be placed at the downstream end of each channel section being dredged and also along the nearby channel banks, to further reduce the risk of high silt loads being dispersed downstream. • Earth berms or drainage channels will be constructed around the perimeter of the dredge sediment storage and disposal sites to prevent washing away from rainfall. • On-site storage will be limited to de-watering. Supernatant water from the spoil will be treated to meet PRC Integrated Wastewater Discharge Standard (GB 8978-2002). • Odor impacts will be minimized by: (i) timely community consultations to ensure awareness of the issue prior to dredging; (ii) rapid on-site treatment of dredge spoil to minimize time near communities; (iii) transport in sealed containers to avoid odor; (iv) minimizing the	Contractor CSCs, EMA	PMOs, LIEC, EPBs, WRB, reservoir authorities

Item	Potential impacts / issues	Mitigation measures	Who implements	Who supervises
		release of odors by dredging in short sections (<300 m) at any one time. • Once de-watered, sediment will be transported in sealed containers to reuse or disposal sites to minimize odor and leakage onto roads. • Final disposal of the dredged sediments will be pending the results of the second round of water and sediment sampling (see "Detailed Design Stage" of Table EMP-2).		
	Impact of wastewater pollution	• For embankment and dredging, pump slurry to shore and dispose spoil; • Construction wastewater collected in retention ponds and filter tanks to remove silts, oil; • Machine wash-down sites are equipped with water collection basins and sediment traps; • Locate storage / cleaning areas for fuel, machinery and vehicles ≥500 m from waterways; • Storage facilities for fuels, oil, and other hazardous materials will be within secured areas on impermeable surfaces, and provided with bunds and cleanup installations; • Contractors' fuel suppliers must be properly licensed. They shall follow proper protocol for transferring fuel and the PRC standard of JT3145-1991 (Transportation, Loading and Unloading of Dangerous or Harmful Goods); • All earthworks along waterways will be accompanied by measures to minimize sediment runoff, including sediment traps. • Labor camps will be located ≥500 m from waterways; • Portable toilets and on-site wastewater pre-treatment systems will be installed at construction camps along with proper maintenance protocols; • Tailings and wastewater from the works areas will only be discharged: (i) into the tributaries upon which the work is being conducted; and (ii) when the concentration of suspended solids (SS) is less than 20 mg/L; • Water quality (for pollutants such as SS, COD_{cr}, NH_3-N and petroleum) in the project waterways will be monitored by EMAs during construction (Table EMP-8).		
Solid Waste	Solid waste generated by construction activities and from workers' camps	• Provide appropriate waste collection and storage containers at locations away from surface water or sensitive spots; • Arrange with municipal waste collection services for regular collection of waste; • Properly remove and dispose residual materials, wastes and contaminated soils. Paving or vegetating shall be done as soon as the materials are removed to stabilize the soil; • Burning of waste is strictly prohibited; • Provide sufficient garbage bins at strategic locations and ensure that they are protected from birds and vermin, and emptied regularly by the municipal waste collection systems. **CONTRACTOR PERFORMANCE TARGET:** No uncollected waste at close of construction activities each day.	Contractor CSCs	PMOs, LIEC

Item	Potential impacts / issues	Mitigation measures	Who implements	Who supervises
Biological resources	Protection of flora and fauna around construction sites	• Prior to construction, demarcate vegetations e.g. vegetated roadsides, trees, riverbanks; • At main stream of Longxi River and Shuanggui Lake, prior to construction, clearly demarcate the natural areas to avoid damage to the natural vegetation; • As far as possible avoid clearance of any vegetation; • After construction, immediately replant vegetation in any sites subject to clearance; • In compliance with Chongqing Regulation for Landscaping Management: (a) the area of compensatory plantings will be double that of the area of vegetation that is cleared; and (b) a minimum survival rate of 80% of the planted vegetation is required; • Use only native plant species of local provenance for all re-vegetation.	Contractor, CSCs	PMOs, LIEC
Socio-economic resources	Impact on physical cultural resources	• Establish chance-find procedures for physical cultural resources; • If a new site is unearthed, work shall be stopped immediately and local BCR and the PMO promptly notified.	Contractor, CSCs	PMOs LIEC, cultural relic bureaus
	Temporary interruption to water supply from pipeline or embankment construction	• Use coffer dams and temporary diversion channels to maintain continued water flow while works are conducted; • Prior to works, re-confirm the planned construction schedule and site EMP actions; • Inform residents at least two days before any planned water interruptions; • Assist residents if requested with community water storage during the interruption period; • Interruptions to water supply should not be longer than one (1) day; • In case of accidental interruption, immediately inform affected communities and assist with water supply until the issue is resolved.	Contractor, CSCs,	PMO, county EPB
	Community health and safety	• Prepare and implement a traffic control plan, for approval by local traffic management administration before construction. This will include scheduling or diverting construction traffic to avoid peak hours, regulating traffic at road crossings, selecting routes to reduce disturbance, reinstating roads, and opening them to traffic when construction is completed; • Underground facilities survey and protection. Pipeline construction activities will be planned to minimize disturbances to utility services. • Residents and businesses will be informed in advance through media and information boards of the construction activities, dates and duration of expected disruption; • Signs will be placed at construction sites informing people of the project GRM, potential dangers (e.g. moving vehicles, hazardous materials, excavations) and safety issues. • Heavy machinery will not be used at night; and • All sites will be secured from unauthorized public access.	Contractor, CSCs	PMOs LIEC, labor bureaus
	Occupational health and safety	• Prepare environmental, health and safety plan, to include: i) Clean and sufficient supply of fresh water for construction sites, camps, offices; ii) Sufficient latrines and other sanitary arrangements at construction sites and work camps; iii) Garbage receptacles and regular emptying; and iv) Provide safety clothing to workers as needey (e.g. boots, helmets, gloves, goggles, ear protection) in accordance with health and safety regulations for workers;	Contractors	CSCs, PMOs, LBs, EPBs, LIEC

Item	Potential impacts / issues	Mitigation measures	Who implements	Who supervises
		• Emergency response plan prepared and approved by PMOs and EPBs. Establish emergency phone links with township hospitals. Maintain a first-aid base in each construction camp; • Establish a records management system for occupational accidents, diseases, incidents. The records will be reviewed during compliance monitoring and audits; • Safety communication. Ensure that occupational health and safety matters are given a high degree of publicity to all persons on-site. Display posters prominently; and • Training, awareness and competence. Train all workers in basic sanitation, health and safety matters, and work hazards. Implement awareness and prevention program for HIV/AIDS and other diseases – target the local community and construction workers. **CONTRACTOR PERFORMANCE TARGET: Camps clean, emergency response plans in place, and 100% of workers aware of emergency response procedures.**		
	Community consultation	• Meetings are held with residents at construction sites prior to the start of any works. Especially, for the 281 households affected by noise. • Community feedback is documented and solutions to any concerns are discussed. • Contractor site plans are updated as needed to incorporate the solutions, including revisions in work schedules, daily working hours, construction methods, and/or mitigation methods. • CCSs revise their monitoring schedules and monitoring criteria as needed to reflect the updated contractor site management plans. • See also Section G of the EMP.	Contractors, CSCs	PMOs, EPBs, LIEC

CPMO = Chongqing project management office (municipal-level PMO), CSC = construction supervision company, EA = executing agency, EPB = environment protection bureau, EMA = Environmental Monitoring Agency; EPB = the municipal and district/county environment protection bureau, IA = implementing agency, LARP = Land acquisition and resettlement plan, LARO = Land Acquisition and Resettlement Office (in each of the three project county/districts), LB = labor bureau, LIEC = loan implementation environment consultant, PMO = project management office (under project implementing agency), POP = persistent organic pollutants, WRB = water resource bureau.

Table EMP-3: Potential Impacts and Mitigation Measures during Operation

Potential Issues	Mitigation Measures and/or Safeguards	Implement	Supervise
Embankments – Stability	• Implement annual (as a minimum) inspections of all project embankments for physical integrity. If signs of failure are discovered, implement a repair program immediately.	WRBs	PMOs, CPMO
Embankments – Routine maintenance of embankment and landscaping	• Integrate routine maintenance activities into existing work program of the county WRB teams; • Monthly maintenance (at least in summer) of re-vegetated embankments – pruning, weeding and replacement of dead or dying plants; • Inspect for signs of plant disease and/or pests and implement control measures as necessary; • At least once a year in May-June (i.e. before the rainy season) remove solid waste and debris – dispose in municipal landfill; • Prohibit or remove any illegal structures which are found, to maintain free water flow.	WRBs	PMOs, CPMO
Shuanggui Lake – water allocations and ecological flows	• Comply with existing ecological flow requirements for the lake • Control flush spills; • Maintain safe and sustainable lake levels during dry and wet seasons	Reservoir authority	PMOs, CPMO
Noise – from operation of pumping stations	• Maintain acoustic barriers and sound absorbing materials; • Consult nearby residents in first 3 months of operation and assess any noise impacts	EMA	EPB
Management – insufficient capacity for EMP	• Conduct comprehensive training for EMP implementation	CPMO, LIEC, EMA, EPD, EPB	CPMO

CPMO = Chongqing project management office, EPB = environment protection bureau, EMA = Environmental Monitoring Agency, LIEC = loan implementation environment consultant, PMO = project management offices, WRB = water resource bureau.

D. Environmental Monitoring, Inspection and Reporting

10. Three types of project monitoring will be conducted under the EMP: (i) internal monitoring – to be conducted by the three PMOs and the CSCs; (ii) external monitoring – of air, water, noise and soil standards – to be conducted by the certificated EMA in each project county/district; and (iii) compliance monitoring – to be conducted by both the EMA and LIEC, to ensure the EMP is being implemented.

11. The project monitoring program focuses on the environment in the project areas of influence in the three county/districts (Table EMP-5). The program covers the scope of monitoring, monitoring parameters, time and frequency, implementing and supervising agencies, and estimated costs. The monitoring shall comply with the methodology provided in the relevant national environmental monitoring standards. Other associated standards to be followed are the national environmental quality standards of ambient air, surface water, sediment and noise, and the pollutant discharge standards.

12. **Internal monitoring.** During construction, the CSCs and three PMOs will be responsible for conducting internal environmental monitoring in accordance with the monitoring plan (Table EMP-5). Results will be reported through the CSC monthly reports to the PMOs and CPMO.

13. **External monitoring.** The PMOs will contract at least one EMA to conduct environmental monitoring in accordance with the monitoring program (Table EMP-5). A detailed cost breakdown will be provided by the EMA when the environmental

monitoring program is updated at the start of each component implementation. Monitoring will be conducted during construction and operation periods, until a project completion report (PCR) is issued. Semiannual monitoring reports will be prepared by the EMAs and submitted to CPMO and the PMOs.

14. **Compliance monitoring for EMP 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 reports provided by the EMAs. The findings of the LIEC will be reported to ADB through the semiannual 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 LIECs will help the CPMO prepare the reports and submit the English report to ADB for disclosure.

15. **Project completion environmental audits.** Within three months after each subproject completion, or no later than a half year with permission of the local EPBs, environmental acceptance monitoring and audit reports of each subproject completion shall be (i) prepared by a licensed environmental monitoring institute[31] in accordance with the PRC Guideline on Project Completion Environmental Audit (2001), (ii) reviewed for approval of the official commencement of individual subproject operation by environmental authorities, and (iii) finally reported to ADB through the semiannual EMP monitoring and progress reporting process.

16. **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 Reporting Plan

Report	From	To	Frequency of Reporting
A. Construction Phase			
Internal progress reports	CSCs	PMOs	Monthly
External reports	Local EMAs	CPMO, PMOs	Semi-annual
Environmental acceptance monitoring and audit reports	Licensed institute	EPBs, CPMO, PMOs	Within three months after component completion
Compliance monitoring with EMP – progress reports	CPMO / LIEC	ADB	Semi-annual (through semi-annual project progress reports)
B. Operation Phase			
EMP progress reports	CPMO	ADB	Semi-annual

[31] Mostly the institute is the municipal or district/county environmental monitoring station under the municipal or district/county EPB.

Table EMP-5: Environmental Monitoring Program

Subject	Parameter	Location	Frequency	Implement	Supervise
1. **Construction**					
Internal monitoring (contractors, CSCs, CPMO and PMO Environment Officers)					
Ambient air quality	Dust mitigation measures proposed in EMP; equipment maintenance	Visual inspection at all construction sites	1 time / week	Contractor, CSC	PMO, LIEC
Noise	LAeq: measured with hand-held meter **Contractor performance targets: (i) noise level meets standard at site boundary; (ii) for 281 households most at risk from the construction noise, the installed noise barriers reduce noise levels by at least 80%***	Construction site boundary	Weekly or more during peak construction levels at individual sites	CSC, PMO, LIEC	PMO, LIEC
Solid waste	Garbage and construction wastes **Contractor performance target: no uncollected waste at close of construction activities each day**	Visual inspection at all construction sites and work-camps	Daily	Contractor, CSC	PMO, local EPB, Sanitation bureau
Soil erosion and re-vegetation	Soil erosion intensity and survival rate of re-vegetation	Visual inspection at spoil sites and all construction sites, especially embankment sections of Longxi River and its tributaries, Sanhe and Shuanggui reservoirs	1 time / week; and immediately after heavy rainfall	Contractor, CSC	PMO, LIEC
	Re-vegetation of embankments and other areas,	Visual inspection along embankment sections and all revegetation areas	At least 2 times / year	Contractor, CSC	PMO
Occupational health and safety	Camp hygiene, safety, availability of clean water, EMRs **Contractor performance target: camps clean, EMRs in place; 100% of workers aware of EMR procedures**	Inspection at all construction sites and work-camps	1 time / month	Contractor, CSC	PMO
External monitoring (certificated environment monitoring agencies)					
Quality of sewage and discharge channels at work camps	pH, SS, NH_3-N, COD_{Cr}, petroleum	Domestic wastewater discharge at work-camps	2 times/year during construction	EMA	EPB, PMO
Construction wastewater	SS, oil, pH	(i) 100 m upstream and 500 m downstream of	2 times/year during construction	EMA	EPB, PMO

Subject	Parameter	Location	Frequency	Implement	Supervise
		embankment and dredging sections of Longxi River and its tributaries; (ii) at wastewater discharge points of all construction sites			
Water quality downstream of river section	pH, SS, NH_3-N, BOD_5, COD_{Cr}, Total coliform, oil	500 m downstream of the embankment and dredging sections of Longxi River and its tributaries, Sanhe and Shuanggui reservoirs	2 times / year during construction	EMA	EPB, PMO
Ambient air quality	TSP, PM_{10}, $PM_{2.5}$, NO_x	All construction sites (at least 1 point upwind, 1 point downwind) and nearby sensitive receivers (Section IV of EIA)	2 times / year during construction	EMA	EPB, PMO, LIEC
Noise	LAeq	Boundaries of all construction sites and sensitive receivers (Chapter V-sensitive receivers within project area of influence)	2 times / year (twice a day: once in day time and once at night time, for 2 consecutive days)	EMA	EPB, PMO, LIEC
Solid Waste (garbage, construction wastes)	Work camps and construction waste at construction sites	Visual inspection at all construction sites and work-camps	Once a year	LIEC	CPMO, ADB
Soil erosion and re-vegetation	Soil erosion intensity	Visual inspection at spoil sites and construction sites, especially embankment and dredging sections of rivers, and wetland	At least 1 / year, and 1 after completion of construction	LIEC	LEPB, CPMO, ADB
	Re-vegetation of embankments, buffer zones, spoil disposal sites and construction sites	Visual inspection at sites, and temporary occupied lands	Compliance Monitoring: At least 1 time / year, and 1 after completion of construction	LIEC	CPMO, ADB
Occupational health and safety	Work camp hygiene, safety, availability of clean water, emergency response plans	Inspection at all construction sites and work-camps	At least once a year, and once after completion of construction	LIEC	Sanitation, labor bureaus
2. Operation phase					
Water quality of rivers, and lake	pH, SS, DO, NH_3-N, oil, COD_{cr}, Cr_6+, BOD_5, TN, TP, chloride, NO_3-N, total coliforms	(i) 500 m downstream of embankment and dredging sections of Longxi River and its tributaries in each district/county; (ii) Shuanggui wetland;	2 times / year	EMA and facility operator (LWRB)	PMO, LEPB, CPMO
Noise	LAeq	At:(i) boundary of pump stations; (ii) nearby sensitive receivers	2 times / year (twice a day: once in day time and once at night time for 2 consecutive days)	EMA and facility operator (WRB)	LEPB, IA and CPMO
Soil and Vegetation	Plant survival and coverage	All re-vegetated sites	Spot check, twice a year	PMO	EPB, FB

BOD_5 = 5-day biochemical oxygen demand; COD_{cr} = chemical oxygen demand; CSC = construction supervision company; EMA = environmental monitoring agency; EMR = emergency response plan; EPB = environmental protection bureau; FB = county forestry bureau, IA = implementation agency; LAeq = equivalent continuous A-weighted sound pressure level; LSMI = licensed soil erosion institute; NH_3-N = ammonia nitrogen; NO_x = nitrogen oxides; OPF = operators of project facilities; PM_{10} = particles measuring

≤10μm; CPMO = Project Management Office; SO_2 = sulfur dioxide; SS = suspended solids; TSP = total suspended particle.
*Compared by standing on each side of the noise barrier and measuring noise levels with a hand-held meter.

E. Training and Capacity Building

17. The project county and two districts have no previous experience with ADB-funded projects or safeguard requirements. The experience of individual staff within the district and county EPBs for environmental management varies considerably. Domestic EIAs and project approvals generally include limited mitigation measures, but there is not yet a regulatory requirement in the PRC for EMPs of the scope required by ADB. Implementation of the current EMP represents a significant new task for the local agencies. During the project design phase, two trainings on EMP implementation were conducted, including roles and responsibilities of contractors and CSCs for EMP implementation, the project impacts and mitigation measures.

18. During implementation, a capacity building program will be implemented on: (i) the EMP, including the mitigation measures, monitoring, and reporting; (ii) ecological management of Longxi River and its tributaries, and the Shuanggui and Sanhe reservoirs; (iii) surface water quality protection and improvement; and (iv) sustainable integrated watershed management. Training will be provided by the Chongqing Municipal EPB, three county/districts EPBs, and LIEC. Trainees will be the CPMO, IAs, PMOs, contractors, CSCs, and local WRBs and local agriculture and forestry bureaus (AFBs). The CPMO will arrange the training programs, supported by the LIC and LIEC.

Table EMP-6: Project Environment Training Program

Training program	Scope of Training	Trainer	Trainee	Time	Days	Persons
Procurement and contract management (emphasize EMP implementation)	• ADB procurement guidelines • Bidding document and contract preparation, including EMP clauses • Risk of improper procurement and mitigation measures, and handling variation orders and contract management	LIC	CPMO, PMOs, FB	2	2	50
Implementation of EMP	• Roles, responsibilities, monitoring, inspection, reporting in EMP • Environment monitoring program; • Odor impact from dredged sediment and mitigation measures • Public consultation and participation; • GRM implementation, coordination, reporting, working with the public; • Environment, health and safety during project construction and operation for workers and the community; • Prevention and control of transmissible diseases and HIV/AIDS	LIEC, or experts from EPBs	CPMO, PMO, EPB, other local Units	2	2	50
Ecological embankment and sediment dredging	• Principles of ecological embankment and environmentally friendly dredging; • Dredged sediment dewatering and reuse; • Polluted river/lake restoration; • Principle for balanced flood control and river conservation and restoration	LIEC, Experts from EPBs	CPMO, PMO, EPB, AFB	2	2	50
Ecological management	• Management and conservation of rivers and wetlands • Wetland and biodiversity; • Maintenance of planted vegetation and habitats of the project embankments • Point and non-point pollution control	Experts from EPBs, ADB	PMO, OPF WRB, AFB	2	2	50

Training program	Scope of Training	Trainer	Trainee	Time	Days	Persons
Climate change resilience	• Energy saving and GHG emission reduction in water sector; • Carbon sink by revegetation and forestry	LIEC	PMO, OPF WRB	1	1	50
Emergency preparedness and response planning	• Response mechanism e.g. for spills; • Mitigation measures for hydraulic sectors; • Emergency response team, procedure and actions	Experts from EPBs, LIEC	PMO, OPF, other bureaus	1	1	50
Total				**10**	**10**	**300**

ADB = Asian Development Bank, AFB = Agriculture and forestry Bureau; CAB = civil affairs bureau, EMP = environment management plan, EPB = environment protection bureau, FB = finance bureau, GHG = greenhouse gas, GRM = grievance redress mechanism, LIC = loan implementation consultant, OPF = operator of project facilities, PMO = project implementing unit, CPMO = Chongqing project management office, WRB = water resource bureau.

F. Grievance Redress Mechanism

19. The Environmental and Social Officers of the CPMO and three PMOs will be the lead coordinators for GRM implementation. However, all project agencies and staff will be trained in the GRM and will take an active role in supporting these staff as and when necessary.

20. At the CPMO level, the CPMO Environmental Officer and Social Officer will establish a GRM tracking and documentation system, conduct daily coordination with the PMOs' 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 PMO level, the environment and social officers will instruct contractors and CSCs on the GRM procedures, and coordinate with the local EPBs and other government divisions as necessary. CPMO and PMO staff will be trained and supported by the LIEC and Loan Implementation Social Consultant (LISC).

21. The contact persons for different GRM entry points, such as the CPMO and PMO Environmental and Social Officers, contractors, operators of project facilities (OPFs), and local 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 local EPBs.

22. Once a complaint is received and filed, the CPMO and PMO 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**: 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 PMO fully informed at all stages.

- **Stage 2**: If the issue cannot be resolved in Stage 1, after five calendar days, the PMO and/or CPMO 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 (in operation) will implement the solution within seven (7) calendar days. Written records will be made of all stages and outcomes.

- **Stage 3**: If no solution can be identified by the CPMO and/or PMO, and/or the complainant is not satisfied with the proposed solution, the CPMO and/or PMO will organize, within ten (10) calendar days, a stakeholder meeting (including the complainant, contractor and/or operator of the facility, local EPB, PMO, CPMO). 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.

23. 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, CPMO, PMO, CMG, district/county government, and/or ADB.

24. The CPMO and PMOs 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.

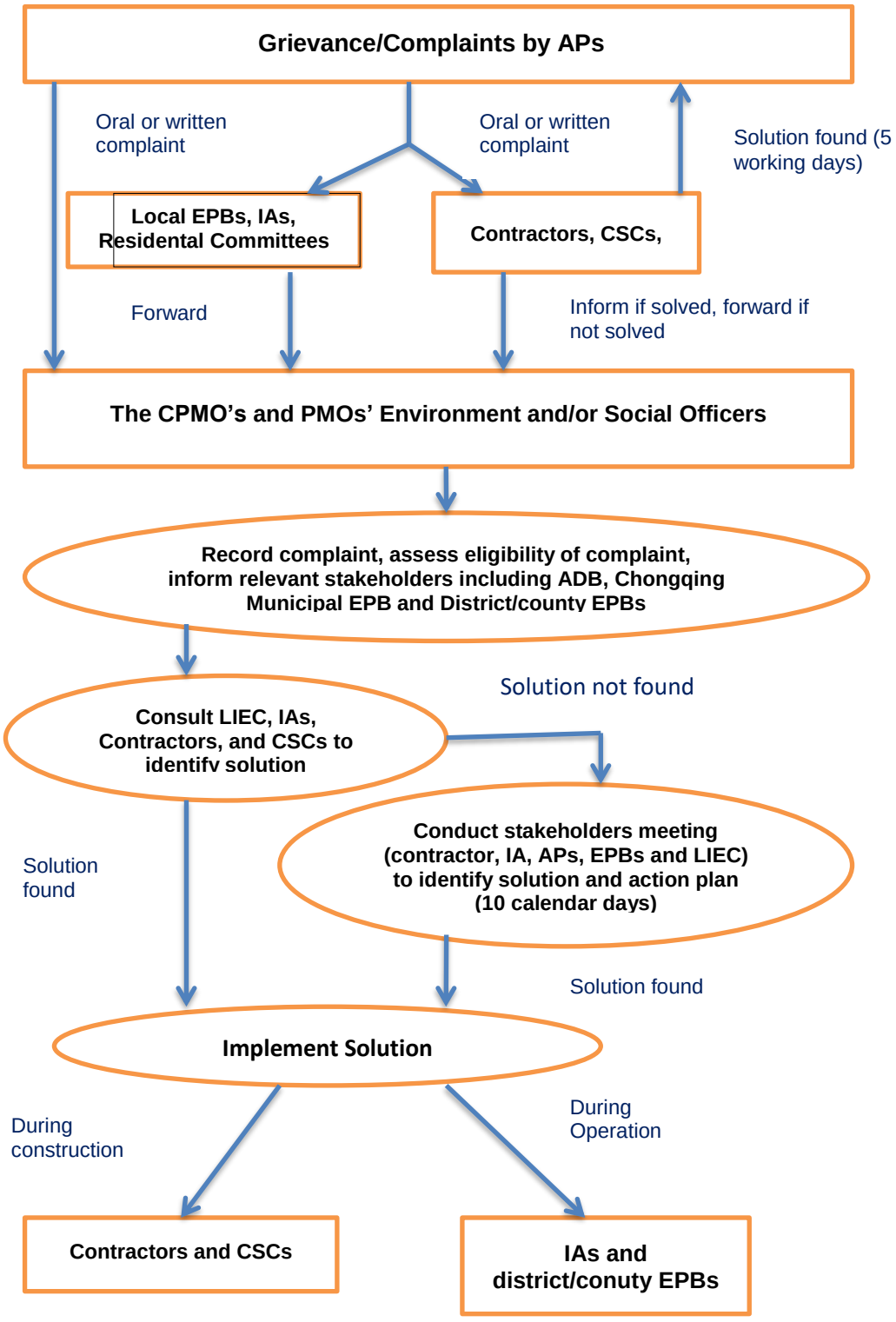


Figure EMP-1: Operation Chart of the GRM

G. Public Consultation and Awareness Raising

25. Three rounds of public consultation were conducted during project preparation (Section VII of the project EIA). During construction, the project will continue to seek

public consultation and raise awareness of project activities, especially those may impact the public such as noise, dust or odor from dredged sediment. The public consultation plan is in Table EMP-7 and includes public participation in evaluating environmental benefits and impacts. The PMOs are responsible for public participation during project implementation. They will be supported by the CPMO Environment and Social Officers and the LIEC.

Table EMP-7: Public Consultation and Participation Plan

Organizer	Approach	Times/Frequency	Subjects	Participants
Construction				
CPMO, PMOs, 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
	Site-specific basis	At least one month before the start of construction at any new site	Anticipated risks – noise, odor, other; Procedures in the event of interruptions to water and wastewater services	
	Public workshops	At least once during peak construction period	EMP implementation progress; construction impacts; adjusting mitigation measures if necessary; feedback	Residents, affected persons, social sectors
Operation				
CPMO, PMO, operators of project facilities	Consultation and site visits	At least once in first year of operation	Effects of mitigation measures, impacts of operation, feedback	Affected persons and/or agencies
	Public workshop	As needed based on consultations	As above	As above
	Public survey	At least once after 1 year of operation	Comments and suggestions	Project beneficiaries

EIA = environmental impact assessment, OPF = operator of project facilities, PMO = IA's project implementing unit, LIEC = loan implementation environmental consultant.

H. Cost Estimates

26. This section provides an estimate of the cost of EMP implementation. The cost comprises three categories: mitigation measures (Tables EMP-2; EMP-3); monitoring (Table EMP-5); and training (Table EMP-6). Costs are presented for the construction phase of five years and the first year of operation i.e. a total of six years. 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; and (iii) salaries of CPMO and PMO staff. Costs for mitigation measures and training are based on estimates in the five DEIAs and/or the experience of the TA consultants from other similar projects. All costs were discussed with the DEIA Institute, CPMO and IAs.

27. The total estimated cost is CNY 66.798 million (USD 10.43 million) for five years construction and the first-year operation (Table EMP-8). The estimated cost for the CPMO is CNY300,000 (0.44%) and for each project district/county is: Liangping (CNY16.038 million; 23.66%); Dianjiang (CNY24.393 million; 35.98%); Changshou (CNY27.067 million; 39.92%).

Table EMP-8. Estimated Cost for EMP Implementation for Five Years Construction and First Year Operation (xCNY10,000). Construction-phase costs will be paid by the contractors (as part of their contracts). **Operational-phase costs** will be paid by each project implementing agency (IA).

Item	Unit	Unit cost	No. units	Total cost	Cost per year	CPMO	Liangping	Dianjiang	Changshou
Design and Pre-construction phase							**IA**	**IA**	**IA**
1.1 Public consultation	Meeting, survey						1.5	1.0	1.5
1.2 LIEC	Consultant PM					18.0			
1.3 Wetland specialist	Consultant PM					12.0			
1.4 GRM	Lump sum						1.0	0.8	1.0
1.5 Second round sediment sampling	Lumpsum						0.8	1.0	1.2
Subtotal						**30**	**1.8**	**1.8**	**2.2**
Construction phase (Table EMP-2)							**Contractor**	**Contractor**	**Contractor**
2.1 Soil erosion and contamination							965	1800	2000
2.2 Dust control							220	300	300
2.3 Noise and vibration							30	30	30
2.4 Surface water pollution							80	50	50
2.5 Solid waste							50	20	20
2.6 Protection of flora and fauna							80	80	100
2.7 Community health & safety							40	40	50
2.8 Occupational health & safety							40	40	50
Subtotal							**1505**	**2360**	**2600**
Operational phase (Table EMP-3)							**IA**	**IA**	**IA**
3.1 Inspection of embankment safety	CNY 1/yr						12	10	15
3.2 Maintenance of embankments	CNY 1/yr						30	20	30
3.3 Maintenance of vegetation	CNY 1/yr						25	20	30
3.5 Noise from pump stations	CNY 1/yr						10	8	10
3.6 Update and implement EMP	CNY 1/yr						1.5	1.0	1.0
Subtotal							**78.5**	**59**	**86**
4. Monitoring during construction (costs paid by each IA)							**IA**	**IA**	**IA**

Item	Unit	Unit cost	No. units	Total cost	Cost per year	CPMO	Liangping	Dianjiang	Changshou
4.1 Surface water quality	2 times/a	0.5	10	5.0	1.0		5.0	5.0	5.0
4.2 Construction wastewater including water quality downstream of reservoir	2 times/a	0.5	10	5.0	1.0		5.0	5.0	5.0
4.3 Ambient air	2 times/a	0.4	10	4.0	0.8		4.0	4.0	4.0
4.4 Noise	2 times/a	0.2	10	2.0	0.4		2.0	2.0	2.0
Subtotal							**16.0**	**16.0**	**16.0**
5. Monitoring during operation (costs to be paid by each IA)							**IA**	**IA**	**IA**
5.1 Water quality (CNY10,000/year)	1 times/a						1.0	1.0	1.0
5.2 Noise	1 times/a						0.5	0.5	0.5
5.3 Vegetation survival	1 times/a						1.0	1.0	1.0
Subtotal							**2.5**	**2.5**	**2.5**
Grand total (xCNY10,000)						**30**	**1,603.8**	**2,439.3**	**2,706.7**
						6,679.8			
Grand total (xUSD10,000)						**4.62**	**246.74**	**375.28**	**416.42**
						1,043.06			
Proportion of total (%)						**0.44**	**23.66**	**35.98**	**39.92**

Source: the DEIAs

I. Mechanisms for Feedback and Adjustment

28. Based on environmental inspection and monitoring reports, the CPMO and PMOs 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 CPMO Environmental Officer and the LIEC will play critical roles in the feedback and adjustment mechanism.

29. If during inspection and monitoring, 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 CPMO and PMOs 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 DEIAs 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 2. ASSESSMENT LEVELS FOR SEDIMENTS

The following guidelines are from: Department of Environment and Conservation. 2010. Contaminated Sites Management Series. Assessment levels for Soil, Sediment and Water. See: https://www.der.wa.gov.au/images/documents/your-environment/contaminated-sites/guidelines/2009641_-_assessment_levels_for_soil_sediment_and_water_-_web.pdf

	Ecological Investigation Levels	Health Investigation Levels			
		A[1]	D	E	F
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Metals/Metalloids					
Antimony, Sb	-	**31**[12]	-	-	**410**[12]
Arsenic, As	20[8]	100[8]	400[8]	200[8]	500[8]
Barium, Ba	**300**[8]	**15,000**[12]	-	-	**190,000**[12]
Beryllium, Be	-	20[8]	80[8]	40[8]	100[8]
Cadmium, Cd	3[8]	20[8]	80[8]	40[8]	100[8]
Chromium[2] (Cr III)	**400**[8]	**120,000**[8]	**480,000**[8]	**240,000**[8]	**600,000**[8]
Chromium[2] (Cr VI)	**1**[8]	100[8]	400[8]	200[8]	500[8]
Cobalt, Co	50[9]	100[8]	400[8]	200[8]	500[8]
Copper, Cu	**100**[8]	1,000[8]	4,000[8]	2,000[8]	5,000[8]
Lead, Pb	**600**[8]	300[8]	1,200[8]	600[8]	1,500[8]
Manganese, Mn	500[8]	1,500[8]	6,000[8]	3,000[8]	7,500[8]
Methyl mercury[3]	-	10[8]	40[8]	20[8]	50[8]
Mercury (inorganic), Hg	1[8]	15[8]	60[8]	30[8]	75[8]
Molybdenum, Mo	40[9]	390[12]	-	-	**5100**[12]
Nickel, Ni	60[8]	600[8]	2,400[8]	600[8]	3,000[8]
Tin, Sn	50[10]	**47,000**[12]	-	-	**610,000**[12]
Vanadium, V	50[8]	**550**[12]	-	-	**7,200**[12]
Zinc, Zn	200[8]	7,000[8]	28,000[8]	14,000[8]	35,000[8]
Other Inorganics					
Boron, B	-	3,000[8]	12,000[8]	6,000[8]	15,000[8]
Cyanides (complexed)[4], CN	50[9]	500[8]	2,000[8]	1,000[8]	2,500[8]
Cyanides (free)[4], CN	10[9]	250[8]	1,000[8]	500[8]	1,250[8]
Phosphorus, P	2,000[8]	-	-	-	-
Sulfur, S	600[8]	-	-	-	-
Sulfate[5], SO_4	2,000[8]	-	-	-	-
ORGANIC COMPOUNDS					
Methyl tertiary butyl ether, MTBE	-	**0.5**[13]	**0.5**[13]	**0.5**[13]	**0.5**[13]
Total Petroleum Hydrocarbons (TPH)					
C_6-C_9	100[7]	-	-	-	-
C_{10}-C_{14}	500[7]	-	-	-	-
C_{15}-C_{18}	1,000[7]	-	-	-	-
>C_{16}-C_{35} (aromatics)	-	90[8]	360[8]	180[8]	450[8]
>C_{16}-C_{35} (aliphatics)	-	5,600[8]	22,400[8]	11,200[8]	28,800[8]

	Ecological Investigation Levels	Health Investigation Levels			
		A[1]	D	E	F
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
>C_{35} (aliphatics)	-	56,000[8]	224,000[8]	112,000[8]	280,000[8]
Monocyclic Aromatic Hydrocarbons					
Benzene	1[10]	**1.1[12]**	-	-	**5.6[12]**
Toluene	3[9]	520[11]	-	-	**5200[11]**
Ethylbenzene	5[9]	230[11]	-	-	230[11]
Xylenes	5[9]	**600[12]**	-	-	**2600[12]**
Polycyclic Aromatic Hydrocarbons (PAHs)					
Total PAHs[14]	-	20[8]	80[8]	40[8]	100[8]
Anthracene	10[9]	**17,000[12]**	-	-	**170,000[12]**
Benzo[a]pyrene	1[9]	1[8]	4[8]	2[8]	5[8]
Fluoranthene	10[9]	**2,300[12]**	-	-	**22,000[12]**
Naphthalene	5[9]	60[11]	-	-	190[11]
Phenanthrene	10[9]	-	-	-	-
Pyrene	10[9]	**1,700[12]**	-	-	**17,000[12]**
Phenols					
Phenol[6]	-	8,500[8]	34,000[8]	17,000[8]	42,500[8]
2-methylphenol	-	**3,100[12]**	-	-	**31000[12]**
3-methylphenol	-	**3,100[12]**	-	-	**31000[12]**
4-methylphenol	-	**310[12]**	-	-	**3,100[12]**
Total phenols	1[9]	-	-	-	-
Polychlorinated Biphenyls (PCBs)					
total PCBs	1[10]	10[8]	40[8]	20[8]	50[8]
OC & OP Pesticides					
Individual organochloride pesticides	0.5[9]	-	-	-	-
Total organochloride pesticides	1[9]	-	-	-	-
Total non-chlorinated pesticides	2[9]	-	-	-	-
Individual non-chlorinated pesticides	1[9]	-	-	-	-
Aldrin plus dieldrin	-	10[8]	40[8]	20[8]	50[8]
Dieldrin	0.2[10]	-	-	-	-
Chlordane	0.5[9]	50[8]	200[8]	100[8]	250[8]
DDT + DDD + DDE	1[9]	200[8]	800[8]	400[8]	1,000[8]
Heptachlor (including its epoxide)	0.5[9]	-	-	-	-
Heptachlor	-	10[8]	40[8]	20[8]	50[8]

BOLD indicates a change from the previous version of this guideline

Key to source of assessment levels:

VIC EPA[7]	NEPM[8]	"Dutch B"[9]	ANZECC B[10]
DoH[11]	USEPA RSLs[12]		DEC/DoH[13]

Notes: Land uses as adopted from the *National Environment Protection (Assessment of Site Contamination) Measure (NEPC 1999)*

A. Standard residential with garden/accessible soil (home-grown produce contributing less than 10 per cent of vegetable and fruit intake; no poultry). This category includes children's daycare centres, pre-schools and primary schools.
D. Residential with minimal opportunities for soil access including dwellings with fully or permanently paved yard space such as high-rise apartments and flats.
E. Parks, recreational open space and playing fields, includes secondary schools.
F. Commercial/industrial includes premises such as shops and offices as well as factories and industrial sites.

– No assessment level available.

1. Site and contaminant-specific assessment required where there is substantial home-grown vegetable and/or poultry consumption. Exposure estimates may then be compared with relevant Acceptable Daily Intakes (ADIs), Provisional Tolerable Weekly Intake (PTWIs) and Guideline Doses (GDs).
2. Valency state should be established initially from assessment of the site history and likely environmental behaviour. If chromium VI could be present, speciation is required to evaluate the risk.
3. Need to determine form of substance from assessment of site history, analysis and knowledge of environmental behaviour.
4. The nature of cyanides on a site must be assessed. To use the HIL for complexed cyanides, no more than five per cent of free cyanides should be present (and vice versa for free cyanides).
5. For protection of built structures (as presented in NEPC (1999)).
6. Odours and skin irritation may occur at lower concentrations. PVC pipes may be affected at high concentrations with possible adverse effects on the water therein.
7. Victorian EPA (1990) Acceptance Criteria in the Clean-up Notice for the Bayside Site, Port Melbourne.
8. National Environment Protection (Assessment of Site Contamination) Measure (NEPC, 1999).
9. Dutch B (Indicative value for further investigation) from Moen, J.E.T., Cornet, J.P and Evers, C.W.A (1986) Soil protection and remedial actions: criteria for decision-making and standardisation of requirements, in Assink, J.W and van den Brink, W.M (1986) Contaminated Soils, First International TNO Conference on Contaminated Soil 11-15 November 1985.
10. ANZECC B (Environmental Investigation Levels) from ANZECC & NHMRC (1992) Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites.
11. DoH (2009b) refer to section 2.2 in the main text
12. US EPA (2009) Regional Screening Levels (RSLs) http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm accessed 13 August 2009.
13. DEC/DoH screening level
14. As a minimum, speciation for benzo[a]pyrene is required.

APPENDIX 3. SUMMARY OF THE PROJECT HYDROLOGICAL ASSESSMENT

1. A Distributed Hydrology Model (DHM) was established by the TRTA Consultant based on local hydrological data, including meteorological data, runoff, and associated spatial map, in order to: (a) simulate the surface runoff under different rainfall intensity conditions, and calibrate the results with reported data to improve the model performance in flood forecasting; and (b) provide the input runoff data for hydrodynamic model.

2. The SWAT model is considered as one of the most suitable DHM for predicting long-term impacts of land management measures on water, sediment, and agricultural chemical yield in large complex watersheds with varying soils, land use, and management conditions. The model has gained international acceptance as a robust interdisciplinary watershed modeling tool. The SWAT model integrates all relevant eco-hydrological processes including water flow, nutrient transport and turn-over, vegetation growth, and land use and water management at the sub-basin scale. In the LX project the ArcSWAT ArcGIS extension is applied in current work, which is a graphical user interface for the SWAT model with the ability of excellent operating spatial datasets.

3. **Spatial Data Collection.** To create a SWAT dataset, the interface needed to access ArcGIS compatible raster (GRIDs) and vector datasets (shapefiles and feature classes) and database files which provide certain types of information about the watershed. The necessary spatial datasets and database files were prepared prior to running the interface. The required spatial datasets included a Digital Elevation Model (DEM), the land cover/land use data, soil data, meteorological data, and runoff data, to calibrate the model simulation result (Table 1).

Table 2: Spatial Datasets compiled for the Hydrological Modeling

Item	Space/time scale	Format	Data sources
DEM	30 m	GRID	GDC
Land cover/Land use	1:100000	GRID	WESTDC
Soil	1:1,000,000	GRID	HWSD
Meteorological data	Daily	Excel	CMADS
Runoff data	Daily	Excel	None

Note. All spatial datasets were defined in the same projected coordinate system (Xi'an 1980 108E) before processing in SWAT model.

4. **DEM Data.** DEM data are the basic input file for SWAT. The TRTA Consultant collected the topographical data provided by Geospatial Data Cloud (GDC). The DEM data are produced based on the ASTER data, currently the only high-resolution image data covering the global land surface. The ASTER GDEM is in GeoTIFF format with geographic coordinates (latitude and longitude) and a 1 arcsecond (approximately 30 m) grid. It is referenced to the WGS84/EGM96 Geographic coordinates and available free of charge. The DHM was applied to the watershed of Longxi river. The watershed is divided into many sub-regions, the water quantities from the rainfall, evaporation and seepages are approximated on the sub-region level, and the runoff processes are computed then, the discharge variation with time at the river mouth) the watershed can be obtained by the hydrology model. The project area is shown in Figure 1.

5. **Land Use Data.** Land use data was collected from the Land and Resources Bureau, and the land cover types are divided into six categories and 25 subclasses, not consistent with the classification approach in SWAT. Thus the land use data needed to be preprocessed to be identified by model.

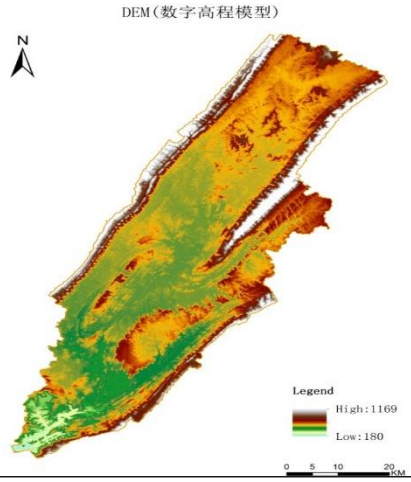


Figure A.1-1 DEM of the Project Area

6. **Soil Data.** Soil data was collected, based on regional soil maps. The soil attributes values have been transferred with US standard, thus can be loaded by SWAT directly. In addition, the soil parameters provided in HWSD are not enough to run model, hence the data also need to be preprocessed as land use data.

7. **Meteorological Data.** The meteorological data are collected from The China Meteorological Assimilation Driving Datasets for the SWAT model (CMADS). The CMADS series of datasets can be used to drive various hydrological models, such as SWAT and the Storm Water Management model (SWMM). The CMADS series of datasets has undergone finishing and correction to match the specific format of input and driving data of SWAT models. This reduces the volume of complex work that model builders have to deal with and allows the models to utilize the datasets directly, thus eliminating the need for any format conversion or calculations using weather generators. The datasets include all 5 kinds of weather data SWAT need covering from 2008 to 2014.

8. **Summary of the DHM performance.** The model results reveal the performance of SWAT model. The model can be calibrated to work out more accurate simulation results for the watershed through adjusting dozens of parameters manually or automatically and provide more. Based on the spatial data collected by the TRTA Consultant, SWAT still reflect the rainfall-runoff relationship in project area. Though there are errors between the results and empirical hydrograph, the changed trend of both may have similarities. It is believed that better calculations can be obtained once the model is corrected in follow-up work.

APPENDIX 4. DRAFT TERMS OF REFERENCE FOR ENVIRONMENTAL POSITIONS

1. CHONGQING PMO ENVIRONMENT OFFICER

A. Background

1. Development projects supported by the Asian Development Bank (ADB) routinely include a project management office (PMO). For this project, the Chongqing PMO (CPMO) 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 CPMO 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 CPMO to implement the project EMP. The officer will report directly to the CPMO. The position is for the entire project duration (5 years).

C. Qualifications

3. The officer will have: (i) a master's degree or higher in environmental management or related field; (ii) at least 10 years of experience in environmental management, monitoring, and/or impact assessment, including specific experience on the management and monitoring of hydropower projects; (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

4. The CPMO Environment 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 project 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 2 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 semiannual environment progress reports.

(xii) Work closely with the CPMO, district and county PMOs, loan implementation consultants, and other agencies as necessary to conduct these tasks.

E. Reporting Requirements

5. Semiannual 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 semiannual monitoring reports, and final responsibility for submission of the monitoring reports to ADB.

2. PROJECT MANAGEMENT OFFICE ENVIRONMENT OFFICERS

A. Background

1. The project will be coordinated by the Chongqing PMO (CPMO). Overall

coordination of the project EMP is the responsibility of the CPMO environment officer. At the field level, implementation of the EMP will be undertaken by the PMOs in the project county and two districts. For this purpose, each PMO requires a PMO Environment Officer.

B. Scope and Duration of Work

2. The three PMO Environment Officer will work on behalf of the PMOs to implement the project EMP in Liangping District, Dianjiang County, and Changshou District, respectively. The officers will report directly to each of their PMO managers and work closely with the county environment protection bureaus (EPBs), environment monitoring agencies (EMAs), and CPMO Environment Officer. The positions are for the entire project duration (5 years).

C. Qualifications

3. The officers will have: (i) a master's degree or higher in environmental management or related field; (ii) at least 10 years of experience in environmental management, monitoring, and/or impact assessment, including specific experience on the management and monitoring of hydropower projects; (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

4. The PMO 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 officers will have the following tasks.

(i) Work closely with the CPMO Environment Officer, EPB, environment monitoring agency, 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 CPMO 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

5. Monthly reports to the CPMO Environment Officer.

3. LOAN IMPLEMENTATION ENVIRONMENTAL CONSULTANT

A. Background

1. The project will be coordinated by the Chongqing PMO (CPMO), whose overall responsibility includes implementation of the project EMP. At the field level, the project will be implemented by a PMO in the project county and two districts. The CPMO and PMOs 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 CPMO and PMOs to implement the project EMP.

B. Scope and Duration of Work

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

C. Qualifications

3. The specialist will have: (i) a master's degree or higher in environmental management or related field; (ii) at least 12 years of experience in environmental management, monitoring, and/or impact assessment, including specific experience on the management and monitoring of hydropower projects; (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

4. Working closely with the CPMO and PMO Environmental Officers, the LIEC will do the following.

5. 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 CPMO and PMOs 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 semiannual 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 CPMO, implementing agencies, and contractors on the specific requirements of the EMP as required.

6. 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) Undertake simple and cost-effective on-site quantitative measurements to regularly check that the construction complies with the environmental monitoring standards and targets, especially for noise, and water turbidity (during the dredging and embankments), using a basic hand-held meter
(vi) Assist the CPMO to prepare semiannual environmental monitoring progress reports for submission to ADB.

APPENDIX 5. SAMPLING LOCATIONS FOR ENVIRONMENTAL BASELINE PARAMETERS

Table 1: Sampling Locations for Baseline Monitoring in Liangping District

Sampling No.	Sampling point (location)	Geographical coordinates
	Surface Water	
W1	500 m upstream of Baihe Bridge on Longxi mainstream	N30º35'39.60″, E107º41'1.72″
W2	1200 m upstream from Dingjia Bridge (Longxi mainstream)	N30° 35.309′, E107°40.584′
W3	1000 m downstream from the confluence point of Sandengpo Tributary and Loangxi mainstream (Longxi mainstream)	N30° 43.507′, E107°37.982′
W4	The wharf of Shuanggui Lake	N30º40'36.38″, E107º45'40.65″
W5	Longdon River, 500 m upstream from Longxi confluence	N30º36'26.59″, E107º40'54.53″
W6	500 m upstream of Shizhu River at Tangjiayuanzi Village	N30º35'46.35″, E107º42'0.10″
W7	100 m upstream at Yu-sui Highway (Longtong River)	N30º36'14.58″, E107º41'29.92″
W8	500 m upstream at the Bridge on No. 303 Provincial highway (Xiaojiagou stream)	N30º36'41.12″, E107º43'25.40″
W9	500 m upstream of Huashigou Stream at confluence with Shizhu River	N30º35'40.47″, E107º43'10.24″
W10	500 m upstream of Baisha River at the confluent point with Da River	N30º40'36.26″, E107º45'40.70″
W11	100 m downstream of Xiaosha River at the confluent point with Zhangxingqiao River	N30º40'33.30″, E107º45'31.79″
W12	1000 m downstream from Pingjin Town (Huilong River)	N30° 34.815′, E107° 32.177′
W13	500 m upstream from the confluence point of Sandengpo Tributary and Loangxi mainstream (Sandengpo Tributary)	N30° 43.854′ E107° 37.854′
	Sediment	
S1	Longxi mainstream; 500 m upstream of Baihe Bridge (Liangping)	30º35'39.60″, 107º41'1.72″
S2	Longdong tributary; 500 m upstream from confluence with Longxi River	30º36'26.59″, 107º40'54.53″
S3	500 m upstream of Shizhu River at Tangjiayuanzi Village	30º35'46.35″, 107º42'0.10″
S4	100 m upstream at Yu-sui Highway (Longtong River)	30º36'14.58″, 107º41'29.92″
S5	500 m upstream at the Bridge on No. 303 Provincial highway (Xiaojiagou stream)	30º36'41.12″, 107º43'25.40″
S6	500 m upstream of Huashigou Stream at the confluent point with Shizhu River	30º35'40.47″, 107º43'10.24″
S7	500 m upstream of Baisha River at the confluent point with Da River	30º40'36.26″, 107º45'40.70″
S8	At Shuanggui-Yayuan Residential Comunity in Zhangxingqiao River	30º36'11.13″, 107º43'6.60″
S9	1200 m upstream from Dingjia Bridge on Longxi River	30°35.309′, 107°40.584′
S10	1000 m downstream of Huilong River from the urban area of Pingjin Town	30°34.815′, 107°32.177′
S11	500 m upstream of Sandengpo tributary from the confluent point with Longxi River	30°43.507′, 107°37.982′
S12	1000 m downstream of Sandengpo tributary from the confluent point with Longxi River	30°43.854′, 107°37.854′
	Ambient Air	
A1	Songzu Village (708 m west of Baisha River)	N30º36'17.96″ E107º41'02.50″
A2	C-block of Shuangguijiayuan Residential Community (200 m north of Shuanggui Lake)	N30º36'36.67″, E107º43'19.97″
A3	Bai'an Village (80 m south of the confluence of Longdong River and Longxi River	N30º36'17.01″, E107º41'4.70″
A4	Wenjiahe Dam (100 m south of the confluence of Longdong River and Xiaojia Stream	N30º36'29.70″, E107º43'28.97″
A5	Dingjiayan Village (20 m east of Longxi River)	N30° 34.950′, E107° 40.389′
A6	Urban area of Pingjin Town (1000 m east of Huilong River downstream)	N30° 34.816′, E107° 32.250′
A7	Daoshiqiao Village (20 m east of Longxi River	N30° 43.524′, E107° 38.021′
A8	East Renmin Road in Liangping District Town	N30º48'25.13″, E107º48'10.26″
	Noise	
N1	30 m from east bank of Longxi River (Liangjiaba Village, at intersection of No.10 Road and No.19 Road	30º36'34.08″, 107º40'49.02″
N2	29 m from south bank, Longdong River-Phase I (Mopan Village)	30º36'17.01″, 107º41'4.70″

Sampling No.	Sampling point (location)	Geographical coordinates
N3	14 m from south bank of Shizhu River (nearby the G20 Highway	30º35'45.21″, 107º42'0.44″
N4	98 m from south bank, Huashi Stream (near Shanshuwan Village)	30º35'36.21″, 07º43'14.45″
N5	39 m from north bank, Longdong River Phase II (near the Second Ring Road	30º36'29.70″, 07º43'28.97″
N6	117 m from north bank, Xiaojia Stream (near G55 Highway)	30º36'37.50″, 07º45'16.58″
N7	98 m from north bank, Shuanggui Lake (Shuanggui Water Supply Co.)	30º38'41.60″, 107º45'16.58″
N8	Northwest bank, Shuanggui Lake (the nursing home)	30º38'33.02″, 107º44'52.23″
N9	62 m from north bank, Zhangxingqiao River (Zhide Primary School)	30º38'54.66″, 107º45'14.86″
N10	72 m from west bank, Shuanggui Lake (West entrance of the park)	30º37'50.45″, 107º44'14.30″
N11	53 m from east entrance of Shuanggui Lake Park	30º38'36.46″, 107º45'49.04″
N12	149 m from north bank, Baisha River (Chenjiaqiao Village)	30º40'38.46″, 107º46'6.04″
N13	40 m from east bank, Longxi River (at police station)	30° 34.917′, 107° 40.737′
N14	50 m from north bank, Huilong River (S102 residential community)	30° 34.798′, 107° 32.053′
N15	20 m from south bank, Huilong River (Pingjin Middle School)	30° 35.512′, 107° 32.576′
N16	10 m from east bank, Longxi River (Daoshiqiao Village)	30° 43.527′, 107° 38.005′

Source: the DEIA Institute

Table 2: Sampling Locations for Baseline Monitoring in Changshou District

Sampling No.	Sampling point (location)	Geographical coordinates
	Surface water	
W1	Shizitan Reservoir section of Longxi mainstream (at outlet of the reservoir to the river)	107°15′26″E, 29°53′39″N
W2	Yanpo Village section of Longxi mainstream (at Yanpo Village of Dandu Town)	107°07′30″E, 29°49′14″N
W3	Zhangjiawan Section of Dayu Stream (Zhangjiawan Village of Haitang Town)	107°15′27″E, 30°11′53″N
W4	Kujian Bridge section of Dayu Stream (Kujian Bridge of Shiyan Town)	107°12′53″E, 30°04′30″N
W5	Wudong Bridge, Dayu Stream (at downstream of Yuntai Town WWTP)	107°13′02″E, 30°07′53″N
W6	Longcheng-Lijing Bridge section of Yuntai River (at the bridge)	107°12′27″E, 29°57′35″N
	Sediment	
S1	Wudong Bridge, Dayu Stream, downstream from Yuntai Town WWTP	107°13′02″E, 30°07′53″N
S2	Longcheng-Lijiang Section of Shuanglong River (Shaunglong Town)	107°12′27″E, 29°57′35″N
S3	Dadu Bridge Section of Longxi River (Dandu Town)	107°08′28″E, 29°49′47″N
	Ambient air	
A1	Haitang Town	107°14′05″E, 30°10′08″N
A2	Shuanglong Town	107°12′26″E, 29°57′20″N
A3	Dadu Town	107°08′33″E, 29°49′39″N
	Noise	
N1	State point of Dayu Stream (Tuqiao Village, Haitang Town)	107°15′39″E, 30°11′57″N
N2	Haitang Town (urban area)	107°14′05″E, 30°10′08″N
N3	Liujiaba New Bridge of Yuntai Town	107°12′44″E, 30°08′33.5″N
N4	Urban area of Yuntai Town	107°12′28″E, 30°08′11″N
N5	The WWTP of Yuntai Town	107°13′02″E, 30°07′50″N
N6	Jizi Bridge on Caijia River of Longhe Town (toll station)	107°11′32″E, 30°00′24″N
N7	Zhujiadong Reservoir of Longhe Town	107°11′18″E, 29°058′36″N
N8	Duanshi Bridge at Longtan Village of Shaunglong Town	107°12′56″E, 29°58′48″N
N9	Urban area of Shuanglong Town	107°12′24″E, 29°57′20″N
N10	Urban area (jiaojia) of Linfeng Town	107°13′02″E, 30°07′53″N
N11	Urban area of Lingfeng Town	107°13′00″E, 29°53′21″N
N12	Urban area of Dandu Town	107°08′32″E, 29°49′39″N

Table 3: Sampling Locations for Baseline Monitoring in Dianjiang County

Sampling No.	Sampling point (location)	Geographical coordinates
	Surface water	
W1	Dianjing No.4 Middle school section on Banqiao River	107.589838°E, 30.475665°N
W2	The starting point of embankment work on Xinmin River in Xinmin Town	107.543206°E, 30.411375°N
W3	Dianjiang No.3 Middle School Section on Longxi mainstream in Gao'an Town	107.362779°E, 30.397024°N
W4	Banjie Bridge section of Longxi River	107.463305°E, 30.284621°N
W5	Bajiantan section of Longxi River	107.258556°E, 30.276986°N
	Sediment	
S1	Under the Bridge of Motan Power Station in Pushun Town (Longxi River)	107.599078°E, 30.455805°N
S2	Under the Huatan Bridge in Gao'an Town (Longxi River)	107.468026°E, 30.278647°N
S3	The end-point of embankment in Wudong Town (Longxi River)	107.34815°E, 30.153746°N
	Ambient air	
A1	The government building in Pushun Town	107.606063°E, 30.463508°N
A2	Dianjiang No. 3 Middle School in Gao'an Town	107.463305°E, 30.284621°N
A3	Fuli Building of Fengshan Park in Dianjiang County Town	107.350352°E, 30.324610°N
	Noise	
N1	Banjie Bridge in Pushun Town	107.589838°E, 30.475665°N
N2	The Government Building in Pushun Town	107.606063°E, 30.463508°N
N3	Dianjiang No.4 Middle School nearer Banqiao River (Zhoujia Town)	107.543206°E, 30.411375°N
N4	The government Building of Zhoujia Town	107.544190°E, 30.414881°N
N5	The stating point of Enbankment work on Xinmin River	107.371595°E, 30.396383°N
N6	Zhenshang Bridge in Xinmin Town	107.395312°E, 30.394498°N
N7	Pingtan Bridge in Gao'an Town	107.461567°E, 30.316312°N
N8	Laoyuan residental community in west urban area	107.463021°E, 30.287759°N
N9	Dianjiang No.3 Middle School	107.463305°E, 30.284621°N
N10	The Government Building in Gaofeng Town	107.412225°E, 30.224068°N
N11	The proposed emergency bridge location	107.423608°E, 30.220842°N
N12	Longtan Village of Wudong Town	107.361703°E, 30.166111°N
N13	Wujia Bridge of Chengxi Town	107.279016°E, 30.224560°N
N14	Dancheng Lake of Chengxi Town	107.262091°E, 30.210676°N
N15	The dam of Sanhe Reservoir	107.376015°E, 30.324897°N

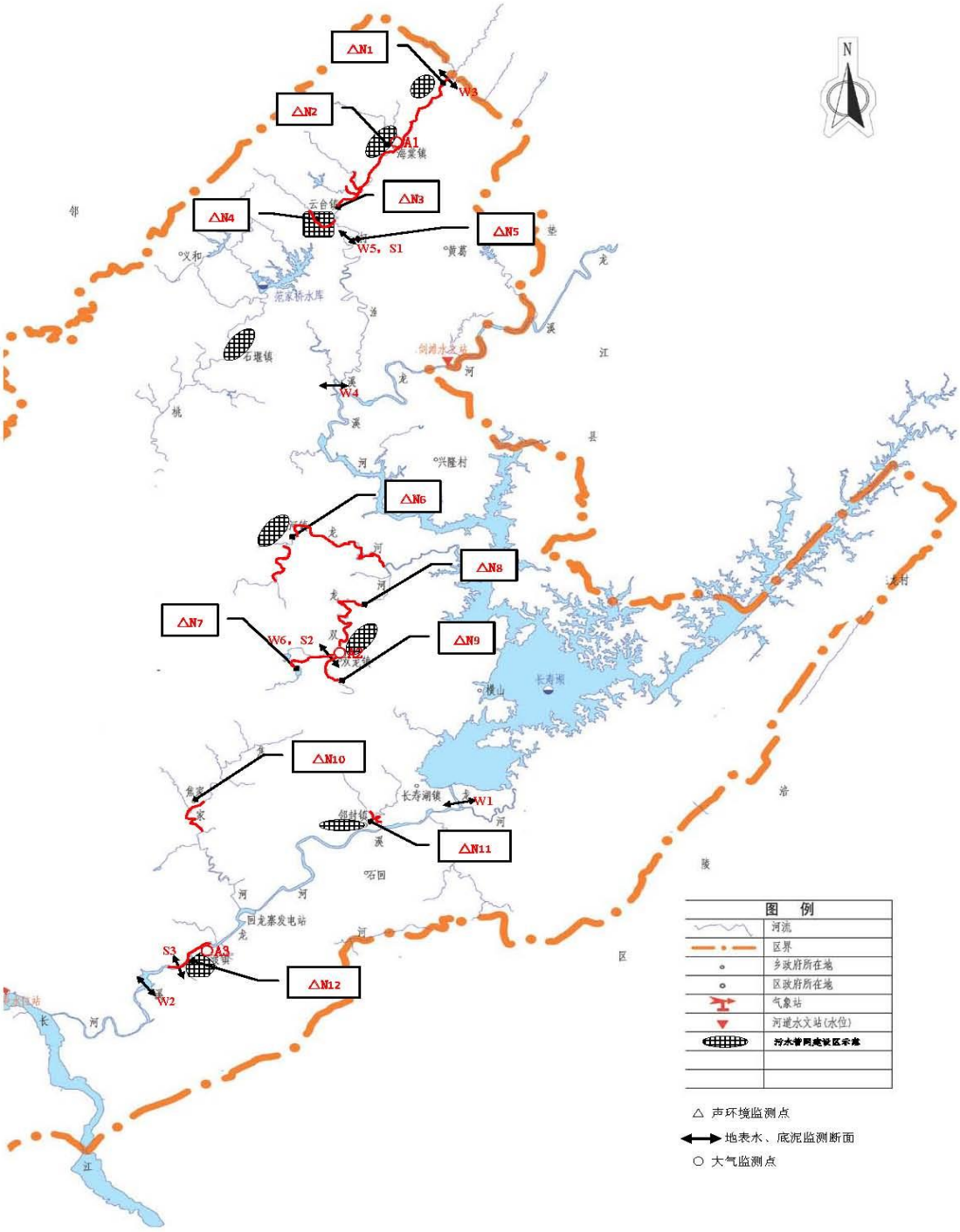


Figure 1: Sampling Locations for Baseline Monitoring in Changshou District (Surface Water, Sediment, Ambient Air and Noise)

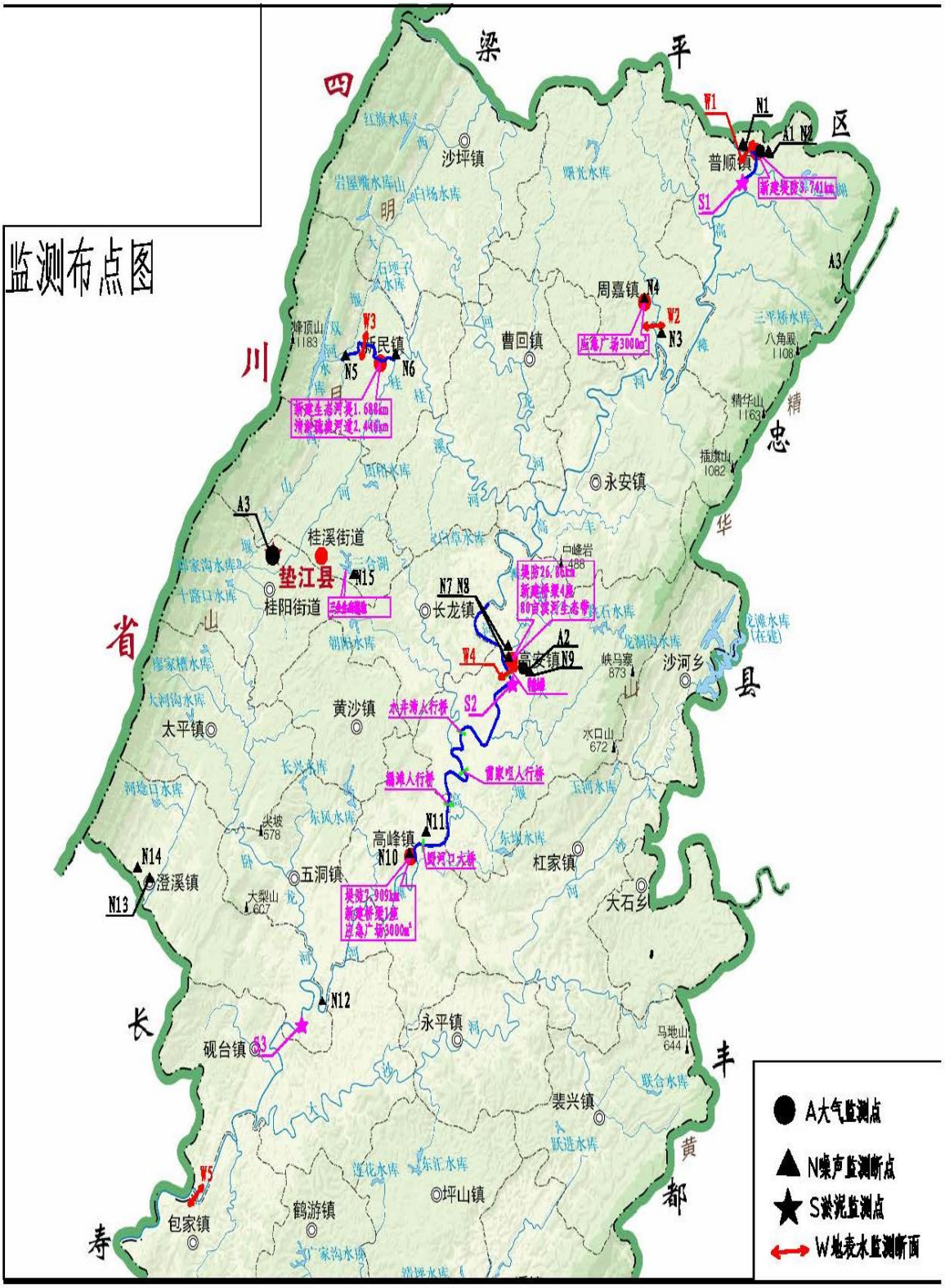


Figure 2: Sampling Locations of Baseline Monitoring for Dianjing District (Surface Water, Sediment, Ambient Air and Noise)

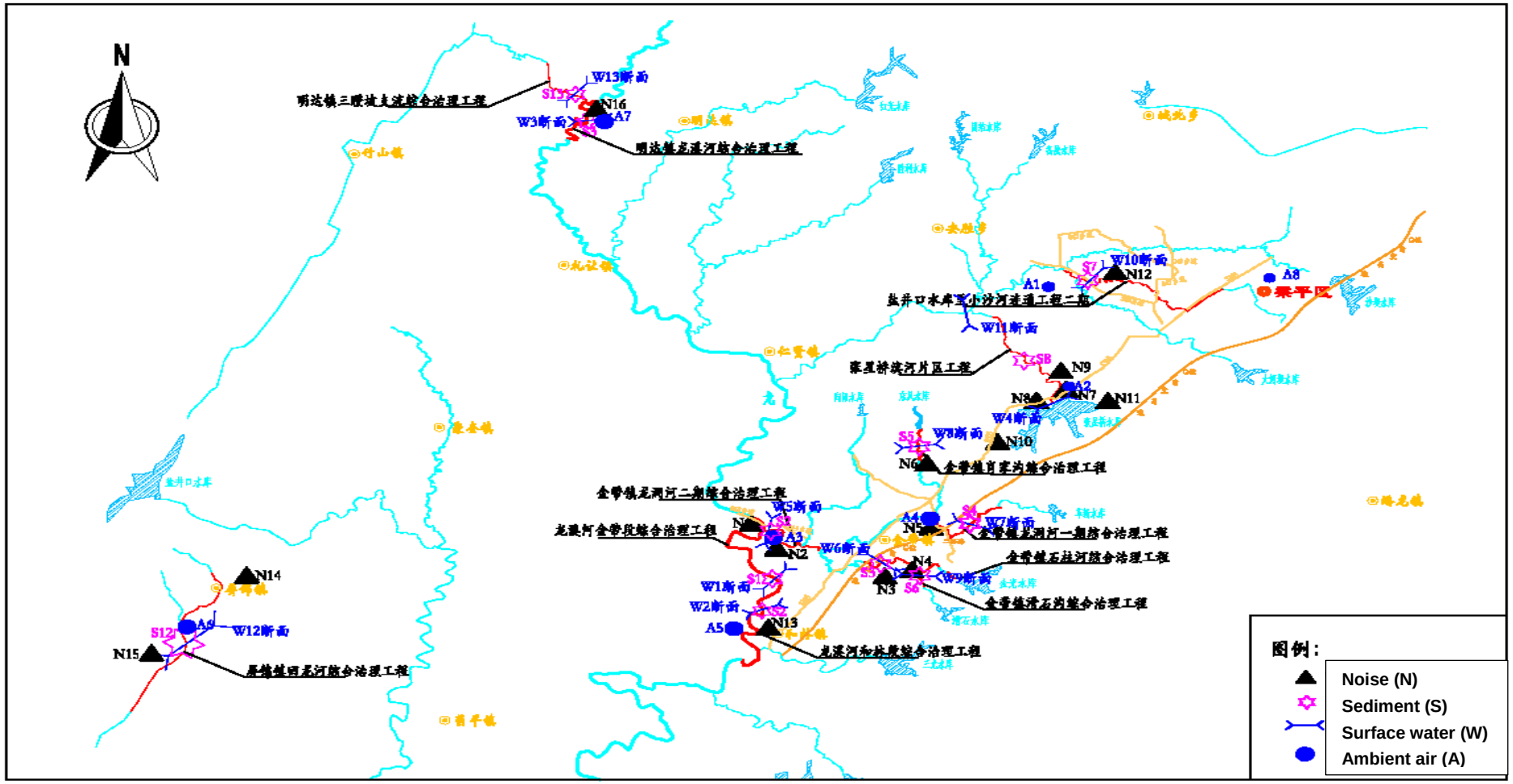


Figure 3: Sampling Locations for Baseline Monitoring in Lianping District (Surface Water, Sediment, Ambient Air and Noise)