AIIB Loan
Post-disaster Reconstruction of Rural Roads in Zhengzhou

Environmental and Social Impact Assessment (ESIA) & Environmental and Social Management Plan (ESMP) Report

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Project Name: AIIB Loan—Environmental and Social Impact Assessment Report on the Project of Post-disaster Reconstruction of Rural Roads in Zhengzhou

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Project Background and Purpose of This Report

Zhengzhou (112°42′-114°14′E, 36°16′~34°58′N) is the capital of Henan Province, located in the north of central Henan, bordered by Kaifeng City to the east, Luoyang City to the west, Xinxiang City and Jiaozuo City to the north across the Yellow River, and Xuchang City and Pingdingshan City to the south. It is 166km long east to west and 75km wide north to south, covering an area of 7,567km^2 by 2020. It has jurisdiction over six municipal districts (Zhongyuan District, Erqi District, Jinshui District, Huiji District, Guancheng Hui District, Shangjie District), five county-level cities (Gongyi City, Xinzheng City, Dengfeng City, Xinmi City, Xingyang City), one county (Zhongmu County), a principal-level Zhengdong New District, a National Zhengzhou Hi-Tech Industrial Development Zone, the National Economic and Technical Development Zone, and Zhengzhou Airport Economy Zone.

On July 20, 2021, Zhengzhou experienced a record-breaking continuous heavy rainfall, causing damage to varying degrees to roads and bridges, resulting in the suspension of transportation construction projects and a serious impact on the urban public and road transportation citywide. The rural highways, which are even more vulnerable, were badly destroyed. The investigation results showed that the county highways, township highways and village roads in the six counties (cities and districts) of Xinmi City, Xingyang City, Dengfeng City, Xinzheng City, Zhongmu County and Gongyi City were hard-hit, and about 682km long roads underwent cave-ins, subsidence, landslide, debris flow, etc.

Rural roads destroyed by the flood

After the rainstorm, resuming the transportation construction and production becomes the top priority of all and also the most urgent concern of the Party committees, governments at all levels and affected residents. According to an overall arrangement, efforts should be made to resume the transportation construction and production as soon as possible to minimize the losses. Therefore, Zhengzhou Highway Development Center put forward the project of post-disaster reconstruction of rural roads in Zhengzhou with loans from the Asian Infrastructure Investment Bank (AIIB). This project includes the following six sub-projects: AIIB Loan—Zhongmu

Sub-project of Post-disaster Reconstruction of Rural Roads ("Zhongmu Sub-project"), AIIB Loan—Dengfeng Sub-project of Post-disaster Reconstruction of Rural Roads ("Dengfeng Sub-project"), AIIB Loan—Gongyi Sub-project of Post-Disaster Reconstruction of Rural Roads ("Gongyizi Project"), AIIB Loan—Xingyang Sub-project of Post-Disaster Reconstruction of Rural Roads ("Xingyang Sub-project"), AIIB Loan—Xinmi Sub-project of Post-Disaster Reconstruction of Rural Roads ("Xinmi Sub-project"), and AIIB Loan—Xinzheng Sub-project of Post-Disaster Reconstruction of Rural Roads ("Xinzheng Sub-project").

The project is about the post-disaster restoration of rural roads, intending to restore the road function and ensure the traffic capacity, by restoring subgrade and pavement damaged by water, repairing subgrade slope collapses, rebuilding bridges on their original site, restoring and improving drainage protection, improving safety facilities, etc. It is to repair the damaged road sections, restore the road function, and detect and eliminate hidden road hazards, to ensure safe traveling.

In principle, this project is primarily aimed at restoring the road function. The locations of water damage are dotted along the road. The permanent land for the project is within the original road land, with no further expansion.

According to the *Opinions on Identification and Screening of Environmental and Social Risks for Post-disaster Reconstruction of Rural Roads in Zhengzhou*, this project has an environmental impact classified into B category, meaning an Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) are required. Following the *Environmental and Social Management Plan Framework for the Reconstruction Project after Rainstorm and Flood Disaster in Henan Province with Emergency Loans from the Asian*

Infrastructure Investment Bank, the *Notice on Strengthening the Administration of Environmental Impact Assessment of Construction Projects Loaned by International Financial Organizations*, the *Law of the People's Republic of China on Environmental Impact Assessment*, the *Regulations on the Administration of Construction Project Environmental Protection* and other provisions, our company, commissioned to Zhengzhou Highway Development Center, has conducted a field investigation on the natural and social environment and ecological status of the project area with extensive public engagement. With these collected data, the feasibility study report and design documents of the project, we've completed the ESIA and ESMP report.

In this report, we analyze the positive environmental impacts and identify, screen and predict the possible negative environmental impacts of this project, and also put forward targeted and effective measures and environmental management plans to minimize unavoidable negative environmental impacts, providing a basis for the independent assessment of the project by the AIIB.

Executive Summary

1. Project brief

This project includes the following six sub-projects: AIIB Loan—Zhongmu Sub-project of Post-disaster Reconstruction of Rural Roads ("Zhongmu Sub-project"), AIIB Loan—Dengfeng Sub-project of Post-disaster Reconstruction of Rural Roads ("Dengfeng Sub-project"), AIIB Loan—Gongyi Sub-project of Post-Disaster Reconstruction of Rural Roads ("Gongyizi Project"), AIIB Loan—Xingyang Sub-project of Post-Disaster Reconstruction of Rural Roads ("Xingyang Sub-project"), AIIB Loan—Xinmi Sub-project of Post-Disaster Reconstruction of Rural Roads ("Xinmi Sub-project"), and AIIB Loan—Xinzheng Sub-project of Post-Disaster Reconstruction of Rural Roads ("Xinzheng Sub-project").

According to a field investigation, the county highways, township highways and village roads in the six counties (cities and districts) of Xinmi City, Xingyang City, Dengfeng City, Xinzheng City, Zhongmu County and Gongyi City were hard-hit, and about 682km long roads underwent cave-ins, subsidence, landslide, debris flow, etc. This project is necessary for the restoration of original road functions, allowing for a smooth trunk road network for people's daily travel, production and life, and for accelerated post-disaster reconstruction and regional economic recovery and development.

This report is based on the AIIB's environmental and social framework, the *Environmental Protection Law of the People's Republic of China*, the *Law of the People's Republic of China on Environmental Impact Assessment* and the *Regulations on the Administration of Construction Project Environmental Protection* (Order No. 253 of the State Council). It analyzes the relation between the project's location and

the red line for ecological protection, determines whether the project is feasible, and identifies the major environmental and social issues involved in the project based on relevant investigation results, and expert and public opinions.

2. Implementation arrangements

Zhengzhou Highway Development Center is the project implementation unit (PIU) responsible for project implementation, project management, and supervision of project construction units and suppliers.

Zhengzhou Highway Development Center was officially established on December 16, 2019. Merged by the former Zhengzhou Road Administration Bureau and Zhengzhou Local Road Administration Office in the institutional reform of provincial and municipal public institutions, it is a Class 1 public institution subordinate to the Municipal Bureau of Transport.

It is mainly responsible for: the organization and implementation of construction and reconstruction, maintenance and management of national, provincial, county and township roads within the city; providing technical support and service guarantee in terms of advisory and demonstration, project review and construction management of highway engineering projects within the city; engaging in the review and approval of highway project budget, funds and relevant changes, the review and approval of final accounts and project completion acceptance; participating in the work related to highway-related safe production, traffic combat readiness and road emergency support; the promotion and application of the city's highway technology policies and innovations, scientific research results, and environmental protection; providing technological support for the road network operation monitoring, etc.

3. Project category

This project is for the restoration of rural roads, mostly built at low standards. The project tasks also include **the reconstruction or repair of 163 bridges**. The damaged sites are dotted along the road in a wide area. Involving no other lands, the project has no further impact on the natural and cultural landscape, except for that during the construction period.

In the construction period, the project may produce wastewater, solid waste, noise, and dust. Also, it may lead to soil erosion to some extent in the rainy season given the broad scope of construction sites. But such adverse effects can be reduced by effective management planning and measures.

According to the AIIB's *Environmental and Social Policy* (ESP), this project is classified as a Category B project. This ESIA report is prepared under the AIIB ESP, Environmental and Social Standards (ESS) and Chinese laws and regulations.

4. Major environmental and social impacts and mitigation measures

This project is a rural road reconstruction project. When the project is completed, the level of traffic noise, ambient air quality and water environment will tend to be stable, restored to the same level as before, and there will be no more negative impact caused by the reconstruction. This project is for the restoration of rural roads, mainly built at low standards. **The project tasks also involve the reconstruction or repair of 163 bridges**. The damaged sites are dotted along the road in a wide area. Involving no other lands, the project has no further impact on the natural and cultural landscape, except for those during the construction period, such as wastewater, solid waste, noise, and dust, which may adversely impact the surrounding environment and local residents.

This project will not result in permanent or temporary forced relocation (relocation or loss of residence) or economic transformation (loss of income source or other livelihoods due to assets or replacement of assets).

During the construction, the environmental and social impacts of the project mainly include noise and dust pollution generated in a short time due to earth excavation, site leveling, construction machinery and transportation, wastewater and solid waste at the construction site, soil erosion to a certain extent especially in the rainy season, and other negative impacts on the place of water source and the Zhengzhou Yellow River Wetland Nature Reserve in Henan, health of workers and travel of residents in surrounding areas. But such impacts are not permanent and can be addressed through mitigation measures outlined in the environmental and social management plan and thorough management during construction.

5. Information disclosure and public consultation

In accordance with the domestic policies and regulations concerning the environmental impact and public engagement as well as the requirements of AIIB's environmental and social management framework, relevant information about the project has been publicized online, questionnaires conducted, and meetings with the public engagement held. Participants of these meetings included residents, vulnerable groups (women, persons with disabilities, the elderly, low-income households) and relevant units.

This project has been strongly supported by the locals and loads of constructive suggestions have been collected. The residents generally wished for the accelerated implementation of the project to restore road traffic for daily use.

6. Grievance mechanism

According to the requirements of AIIB, a grievance redress mechanism (GRM) will be established for the project to collect and deal with public complaints and maximize the environmental and social benefits. This grievance mechanism is included in the ESIA report and will be activated during project implementation.

This grievance mechanism will be open to various groups of residents, including women, the elderly and other vulnerable groups.

At each Project Management Office (Sub-project Office) of each city, full-time personnel are appointed to collect residents' opinions, including complaints. The complaint telephone number of the sub-project office has been publicized through project disclosure.

Those who have been or will possibly be adversely affected by the AIIB's failure to implement its environmental and social framework can make a complaint to the AIIB under the AIIB's policy on the Project-affected People's Mechanism (PPM).

7. Environmental and social management plan

This project has formulated the Environmental and Social Management Plan (ESMP) according to the requirements of the environmental and social assessment framework of the AIIB.

The ESMP will be included in the construction tender documents and managed by the project implementation unit (PIU) - Zhengzhou Highway Development Center to ensure the smooth implementation of the environmental and social impact monitoring plan and mitigation measures.

The Implementation office of the Post-disaster Reconstruction of Rural Roads of the Zhengzhou Highway Development Center will review the implementation of the project through regular environmental and social

management, to ensure compliance with domestic environmental and social laws and the requirements of the AIIB's environmental and social framework.

1 Introduction

1.1 Objective and scope of assessment

1.1.1 Objectives of the assessment

The Project of Post-disaster Reconstruction of Rural Roads in Zhengzhou involves six counties (cities and districts): Xinmi City, Xingyang City, Dengfeng City, Xinzheng City, Zhongmu County and Gongyi City. The project is about the post-disaster restoration of rural roads, intending to restore the road function and ensure the traffic capacity, by restoring subgrade and pavement damaged by water, repairing subgrade slope collapses, rebuilding bridges on their original site, restoring and improving drainage protection, improving safety facilities, etc. It is to repair the damaged road sections, restore the road function, and detect and eliminate hidden road hazards, to ensure safe traveling.

The purpose of the ESIA is to assess and predict potential environmental and social impacts and risks and to develop appropriate mitigation, management and monitoring measures to eliminate, offset or reduce adverse impacts while enhancing and expanding the positive benefits of the proposed project.

1.1.2 Scope of the assessment

1.1.2.1 Scope of environmental assessment

According to the characteristics and practices of the environmental impact assessment for highway construction projects and the environmental characteristics along the roads, the scope of this environmental impact assessment is determined as shown in Table 1-1.

Table 1-1 Scope of environmental impact assessment

Item	Scope
Acoustic environment	Within 200m on both sides from the road centerline; within 200m outside the temporary boundary of the construction site
Ambient air	Within 200m on both sides from the road centerline; within 200m outside the temporary boundary of the construction site
Surface water environment	Within 200m on both sides from the road centerline; an area within 100m at the upper reach and 1000m at the lower reach if the road runs across a river
Ecological environment	Within 200m on both sides from the road centerline; temporary land area, such as the construction site

1.1.2.2 Scope of social assessment

According to the requirements of the *Environmental and Social Management Planning Framework* of this project, surveys are designed based on the industry features and macro objectives of the project, with focus on introducing the social and economic development in the project area and analyzing the major social factors affecting the implementation of the project; identifying the major stakeholders and analyzing their needs and impacts suffered; understanding the situation of the women in the project area, the impact of the project on them and their needs for the project; analyzing the poverty situation in the project area and the impact of the project on the poor population; exploring a way to effectively include the stakeholders into the project, and putting forward the public participation plan; identifying the potential positive and negative impacts and social risks of the project; incorporating the social factors mattering to the realization of project objectives into the project design and proposing measures to avoid or reduce negative impacts.

The social assessment scope of this project is shown in Table 1-2.

Table 1-2 Scope and content of the social assessment

Scope	Content
The project involves 1,689 villages in 97 towns in Xinmi City, Xingyang City, Dengfeng City, Xinzheng City, Zhongmu County, and Gongyi City, benefiting 1,713,811 people directly.	To evaluate the opinions on and attitudes towards the project of various organizations; To evaluate the impact on local organizations and villagers during project implementation; To learn the needs of all stakeholders; To assess the environmental impact during the project implementation; To assess the impact on the production and living of the villagers during the project implementation; To collect all the opinions and suggestions of the villagers.

The main concerns of this assessment include (1) assessment and analysis of the initiatives and reasons of relevant organizations and the public for participating in the project; (2) determination of the benefits (and possible adverse impacts) of the project to different groups and advising on improving efficiency (reducing adverse impacts); (3) the impact of the flood and waterlogging and the impact of road reconstruction on the environment, production and daily life; (4) the mechanism for public engagement with proposals on ways to ensure the active participation of vulnerable groups (including women and children) in the project; (5) provision of community-oriented publicity strategies and guidelines for promoting the involvement of beneficiary groups; (6) establishment of basic social indicators for project monitoring and evaluation; (7) collection of all demands of the villagers.

1.2Assessment methods

1.2.1 Environmental impact assessment and investigation methods

The environmental impact assessment is initiated as per the technical guidelines for environmental impact assessment and the environmental impact assessment specifications of the Ministry of Communications. To allow for a scientific and practical assessment, we assessed the whole project line in combination with the engineering characteristics and surrounding environments of affected roads, with a focus on each damaged site and road section. The assessment methods are listed in Table 1-3 below.

Table 1-3 List of assessment methods

Subject	Current situation assessment	Impact assessment
Environmental impact assessment of surface water	Current situation monitoring and data collection	Data collection and analogy
Ambient air quality assessment	Current situation monitoring and data collection	Analogy
Ecological environmental impact assessment	Data collection, field investigations, remote sensing	Analogy
Public engagement	Disclosure, meetings, individual interviews, field investigations	

(1) Data collection

To refer to relevant materials, including laws and regulations, environmental and social data, and environmental quality monitoring data. As public transportation matters to people's livelihood, it is a hot topic in the media, and that's why we made full use of the Internet to collect relevant data.

Data of the project-affected area included the statistical yearbooks of the local economy and social conditions and were collected through different channels.

(2) Meetings

Face-to-face meetings were held in six districts and counties (Gongyi City, Xingyang City, Dengfeng City, Xinmi City, Zhongmu County and Xinzheng City). Participants were various types of stakeholders (e.g., the disabled, the poor, the elderly,

women, project-affected population). At such meetings, the assessment team collected information on the locals' production, living, demands, worries and suggestions.

(3) Individual interviews

Although the project construction has a generally positive effect on the local socio-economic development, its impact on individuals may vary greatly. So, in addition to the macro analysis, the impact on individuals should also be assessed. Stakeholders' judgment acts as an important basis for determining whether a project has value and social benefits or not. The planning and design of the project should also be optimized from the perspective of stakeholders. For this reason, we interviewed those greatly affected by the project to learn their concerns and suggestions on the project construction.

(4) Field investigation

The field investigation focused on each damage to rural roads in that rainstorm in six districts and counties of Gongyi City, Xingyang City, Dengfeng City, Xinmi City, Zhongmu County and Xinzheng City. Destruction sites involving water sources and the Provincial Zhengzhou Yellow River Wetland Nature Reserve in Henan Province were also inspected, and the distribution of sensitive sites was confirmed with the help of Google Earth. The field investigation personnel were mainly from the highway management departments of districts and counties and local village committees and residents.

1.2.2 Social assessment and investigation methods

1.2.2.1 Social assessment methods

The social assessment of this project covers wide and complex societal issues. Considering the characteristics of factors under investigation, two methods were

adopted: **(1) Quantitative analysis. Indexes such as population structure, education level, and social and economic development level were quantitatively analyzed based on mathematic statistics, so as to offer objective results. (2) Qualitative analysis. Non-quantifiable indexes such as social risk were qualitatively analyzed based on the data obtained from face-to-face meetings and surveys.**

The main assessment methods adopted in this project are as follows:

(1) Social risk assessment

The social risk assessment identifies the social risks arising from changes in social conditions and analyzes the resulting changes in the social environment. The long-standing, far-ranging social risk factors are also a focus of it.

(2) Participatory assessment

Participatory evaluation is an approach where all stakeholders participate in the social evaluation. Participatory evaluation facilitates communication with project stakeholders and effective information exchange, and promotes a greater sense of ownership and commitment to the project by target groups.

(3) Stakeholder analysis

It determines the main stakeholders of the project, their interaction with the project (the effect on stakeholders by the proposed project and the impact on the proposed project by stakeholders), and whether the poor and vulnerable groups can bear the project impacts and costs.

(4) Analysis of relevant institutions

It identifies the capacity of relevant institutions to carry out necessary activities, assesses the adequacy of internal coordination mechanisms and, where necessary, proposes measures to strengthen institutional capacity-building.

(5) Gender analysis

It identifies methods of and barriers to women's participation in the project construction, and describes gender-specific activities and existing channels to gain benefits.

(6) Poverty assessment

According to the poverty line, it identifies the poverty alleviation goals, measures and methods of avoiding changes in risks and seeking development opportunities of the project to the maximum extent, and establishes effective participation mechanisms and channels based on evaluation of various schemes.

(7) Social assessment

It assesses the distribution of the cost-effectiveness varying in stakeholder and time throughout the project implementation, confirms the potential positive and negative impacts on the social environment, including the living environment, economic income, living standards, living quality, employment, local stakeholders, vulnerable groups, men and women, local culture, education, public health, infrastructure and social services, and advises on problems to be addressed.

1.2.2.2 Social assessment survey methods and survey implementation

The Company conducted door-to-door interviews, data collection, field survey, literature research, aerial video recording, interview with key informants, focus group discussions, random interviews and questionnaire survey in the project area from February 19 to 27, 2022, to learn the project information, possible positive and negative impacts, needs and suggestions of local people (including the poor, women, and other groups). See Table 1-4 for specific methods.

1. Literature research

Literature of the project area included the county annals and other documents relating to local conditions and customs, statistical yearbooks and statements of

economic, demographic and social conditions, data on the women's development, and supporting policies, etc.

Data on the economy, transportation, living standards and quality, employment, cultural education, and health of residents were also collected.

2. Field survey and aerial video recording

The field survey and aerial video recording enabled the reviewers to have a better understanding of the overall water damages, social and economic conditions and project construction in the project area, the attitude of different stakeholders and local social organizations in each project area, local social and environmental conditions, the impact of the project on local traffic and environment, and the social and economic life of the affected population.

3. Interviews with key informants

Given the current transportation situation in the project area and the impact of floods and waterlogging on the environment, community safety, transportation, and agriculture for different groups, the advisory consultants interviewed the key informants of relevant institutions of Zhengzhou Highway Development Center, the county and municipal transportation bureaus and rural cadres in the project area. In addition, field surveys and interviews were carried out to learn the willingness of villagers along the water-destroyed roads regarding the reconstruction, the positive and negative impacts of the project, the situation of ethnic minority groups, the poor and women in the project area, and relevant policies.

4. Focus group discussion

To better understand the needs and recommendations of the affected population (including the poor and women) in the project area, we conducted extensive focus group discussions in 19 villages in six counties and cities on the social conditions of local villages, in terms of population, land, agricultural and sideline production, economic income, as well as residents' attitude towards the project, environmental

impact, traffic and travel, and community safety. The discussions were held for rural cadres and villagers (including women and vulnerable groups) respectively.

5. Door-to-door interviews with sample households

The door-to-door interview was conducted with 202 affected households on the impact of the flood disaster on agricultural and sideline production, transportation, environments, and community safety. The interviews were aimed at: (1) understanding their attitude towards and demands for the project and the possible environmental impact and traffic changes due to implementing the project; (2) understanding the production situation and economic income of villagers in the affected area.

6. Random interview

Villagers in the project area, especially in the area where highways were damaged by water, were randomly interviewed on problems they faced in production and daily life, environmental health and transportation, their suggestions and opinions on project implementation, and the positive and negative impacts of the project on them. A total of 45 people were randomly interviewed, including 13 women, accounting for 29%.

7. Questionnaire survey

A questionnaire survey was conducted among villagers and rural cadres in the project area. The survey details include the following items:

1. Family particulars and educational attainment of family members;
2. Production status and economic income in 2021;
3. Influence of flood disaster, including economic loss;
4. Whether they are aware of the project and agree on implementing the project, and by which way they get the news;
5. Demands for the project;

6. Comments of resettled people's comments and suggestions on addressing the environmental impact;
7. Influence of increased traffic flow and people flow on the villagers' work and life in the construction process of this project;
8. Villagers' worries about the project implementation process and suggestions;

Since this project involves different stakeholders, samples of this questionnaire survey covered affected groups varying in age, occupation, household income, gender and household registration. A total of 202 questionnaires were collected. The respondents answered all or part of the questions according to their cognition and willingness, all of which were valid.

Based on sufficient investigation materials, we did our best to make sure that the data collected were accurate and reliable. Also, we adopted mathematical statistics analysis and qualitative analysis to allow for feasible suggestions and accurate assessment results. This report also takes into account constructive comments and suggestions of experts of the AIIB.

Table 1-4 List of Social Assessment Methods

Assessment methods	Time	Work arrangement	Participants	Contents
1. Literature research	February 2022	Review relevant literature of the project and project area under the organization of social assessment specialists	Four members of the research group	Documents related to the project.

Assessment methods	Time	Work arrangement	Participants	Contents
2. Field survey	February 19-27, 2022	Investigate the impact of floods on the local areas.	Four members of the research group and 2 staff members of the project office	Investigate the environmental and traffic conditions of the project area and the impact of floods on local villagers.
3. Interviews on key information	February 19-27, 2022	Interview with persons in charge of relevant institutions and investigate the social impact of the counties and cities involved in highway restoration.	Persons in charge of Zhengzhou Highway Development Center and county- and city-level transportation bureaus	The environmental impact and transportation in the project area, agricultural and sideline production and economic income level of the villagers affected by the project, the situation of poor groups, women, etc., as well as relevant policies.
4. Focus group discussions	February 19-27, 2022	Separate discussions were held for rural cadres, female representatives and vulnerable groups.	Focus group discussions were held in 19 villages in 6 counties and cities. Of the 46 participants, 20 were women.	Investigate the impact of the project on the local environment, transportation, community safety, agricultural and sideline production, as well as attitudes towards the project.
5. Door-to-door interviews	February 19-27, 2022	In-depth interviews were conducted	Four social assessment specialists, two staff members of	Understand their attitudes and needs towards the project as well as the environmental impact and traffic changes that the project

Assessment methods	Time	Work arrangement	Participants	Contents
		with villagers from 19 villages in 6 cities and counties mainly affected by the project, including low-income households and female-headed households.	the project office and 202 households.	might bring to them; the agricultural and sideline production level and economic income of the villagers in the affected area; opinions and suggestions of villagers for project implementation.
6. Questionnaire survey	February 19-27, 2022	Conduct questionnaire surveys in villages within the scope of the project	Four social assessment specialists, and sample households; a total of 202 questionnaires were recalled, all of which were valid.	Investigate villagers' basic information and education level, villagers' demands for the implementation of the project, the impact of environment and traffic, and their needs and suggestions for the project
7. Random interviews	February 19-27, 2022	The social assessment specialists and staff members of the project office conducted random	Social assessment specialists, staff members of the project office	Working and living issues of villagers, and environmental health; Solicit the villagers' suggestions and opinions on the project implementation, and investigate the positive and

Assessment methods	Time	Work arrangement	Participants	Contents
		interviews with the villagers and rural cadres involved in the project		negative impacts of the project implementation on them.

1.3Structure of the report

This report mainly consists of nine parts:

Executive summary: State key facts, material findings and recommended actions.

1 **Project introduction**: including the project brief, the scope of project assessment, the research methods of environmental and social assessment, and the structure of the report.

2 **Policy, legal and administrative framework**: Legal and institutional frameworks for environmental and social assessment in China and the AIIB, applicable environmental guidelines and standards

3 **Project description**: this part discusses the project content, scale, construction period and construction scheme.

4 **Baseline of environmental and social conditions**: this part mainly introduces the relevant geographical, environmental, ecological and socio-economic conditions and environmental quality status of the project area.

5 **Environmental impact and mitigation measures:** this part evaluates the possible environmental impact of the project and identifies mitigation measures to be implemented.

6 **Social impact assessment**: this section assesses the potential impact of the project on society (including vulnerable groups and gender) and identifies mitigation measures to be implemented.

7 **Public consultation and information disclosure**: this section introduces the methods of information disclosure and the way how stakeholders participate; it collects and summarizes the opinions and suggestions of stakeholders.

8 **Grievance redress mechanism**: This section describes the grievance redress framework (both informal and formal) and sets out time frames and mechanisms for addressing complaints about adverse environmental and social impacts.

9 **Environmental and social management program**: This section describes a series of mitigation and management measures that should be taken during project implementation to avoid, reduce, mitigate or compensate for adverse environmental and social impacts. It also introduces the related organization and responsibility arrangement, capability development and training plan established to adapt to the implementation of the environmental and social management program, the time and method of information disclosure and consultation, and the requirements of environmental monitoring.

2 Policy, Legal and Administrative Frameworks

2.1 Applicable national legislative framework

2.1.1 Laws and policies related to environmental assessment

2.1.1.1 Environmental protection laws, regulations and documents

(1) Environmental Protection Law of the People's Republic of China, effective from January 1, 2015;

(2) Environmental Impact Assessment Law of the People's Republic of China, effective from December 29, 2018;

(3) Law of the People's Republic of China on Prevention and Control of Water Pollution, effective from January 1, 2018;

(4) Law of the People's Republic of China on Prevention and Control of Air Pollution, effective from October 26, 2018;

(5) Law of the People's Republic of China on Prevention and Control of Environmental Noise Pollution, effective from December 29, 2018;

(6) Law of the People's Republic of China on Prevention and Control of Environmental Pollution by Solid Waste, effective from September 1, 2020;

(7) Land Administration Law of the People's Republic of China, effective from January 1, 2020;

(8) Highway Law of the People's Republic of China, effective from November 4, 2017;

(9) Water and Soil Conservation Law of the People's Republic of China, effective from March 1, 2011;

(10) Law of the People's Republic of China on the Protection of Wildlife, effective from October 26, 2018;

(11) Regulations of the People's Republic of China on Wild Plants Protection, revised in 2017 and effective from October 7, 2017;

(12) Law of the People's Republic of China on Protection of Cultural Relics, effective from November 4, 2017;

(13) Regulations for the Implementation of the Law of the People's Republic of China on Protection of Cultural Relics (Order No. 687 of State Council), effective from October 7, 2017;

(14) Regulations on the Administration of Construction Project Environmental Protection (Order No. 682 of State Council), effective from October 1, 2017;

(15) Measures for the Administration of Environmental Protection of Transport Construction Projects (Order No. 5 of the Ministry of Communications 2003), effective from June 1, 2003;

(16) Decision of the State Council on Implementing the Scientific Outlook on Development and Strengthening Environmental Protection (GF [2005] No. 39);

(17) Regulations on Soil and Water Conservation of Highway Construction Projects (SB 2001, No. 12);

(18) National Ecological Environment Protection Program (GF 2000 No. 38), effective from November 26, 2000;

(19) Regulations on the Prevention and Control of Pollution in Drinking-Water Source Protection Areas, effective from December 22, 2010;

(20) Reply of the General Office of the Ministry of Environmental Protection to the Opinions on Legal Interpretation of the Provisions on the Protection of Drinking Water Sources in the <Law on Prevention and Control of Water Pollution> (HBH [2008] No. 667);

(21) Notice on Issues related to Environmental Noise in Environmental Impact Assessment of Road and Railway (Including Light Rail) Construction Projects (issued by the former State Environmental Protection Administration [2003] No. 94);

(22) Classified Management Catalogue for Environmental Impact Assessment of Construction Projects (2021 Edition)

(23) Measures for Public Participation in Environmental Impact Assessment (Ministry of Ecology and Environment No. 4)

(24) Regulations of Henan Province on Environmental Protection of Construction Projects (Revised in 2016), effective from May 1, 2007;

(25) Notice of the People's Government of Henan Province on Printing and Distributing the Planning for Functional Zones in Henan Province (YZ [2014] No. 12);

(26) Catalogue of Construction Projects with Environmental Impact Assessment Documents Approved by Department of Ecology and Environment of Henan Province (2019 Version) (Announcement of Department of Ecology and Environment of Henan Province, June 2019);

(27) The 13th Five-Year Plan of Henan for Environment Protection (2016-2020);

(28) Notice of the People's Government of Henan Province on Printing and Distributing the Three-year Action Plan for Pollution Prevention and Control in Henan Province (2018-2020) (YZ [2018] No. 30);

(29) Notice of Leading Group Office of Pollution Prevention and Control of Henan Province on Printing and Distributing Implementation Plan of Air, Water and Soil Pollution Prevention and Control and Agricultural and Rural Pollution Control in 2021 (YHGJB [2021] No. 20);

(30) The 13th Five-Year Plan of Zhengzhou for Environment Protection (2016-2020);

(31) Three-year Action Plan of Zhengzhou for Blue Sky Protection Campaign (2018-2020) (ZB [2018] No. 38);

(32) Three-year Action Plan of Zhengzhou for Water Protection Campaign (2018-2020) (ZB [2018] No. 36);

(33) Three-year Action Plan of Zhengzhou for Soil Protection Campaign (2018-2020) (ZB [2018] No. 37);

(34) Work Program of Zhengzhou for Soil Pollution Prevention and Control (ZZW [2017] No. 224);

(35) Opinions of the Zhengzhou Municipal People's Government on Water Pollution Prevention and Control (ZZW [2017] No. 32);

(36) Emergency Notice of the Department of Natural Resources of Henan Province on Flood Prevention, Emergency Rescue and Land Guarantee Services for Post-disaster Reconstruction (2021);

(37) Notice of the General Office of the People's Government of Henan Province on Accelerating the Preliminary Work of Post-Disaster Reconstruction Projects (YZBMD (2021) No. 37);

(38) Work Program for Post-disaster Reconstruction of Rural Housing in Henan Province by Ministry of Housing and Urban-Rural Development of Henan Province, Henan Finance Department, Henan Emergency Management Department, Department of Natural Resources of Henan Province, Henan Agriculture and Rural Affairs Department (2021);

(39) Notice on the Implementation of the Post-disaster Reconstruction Plan for Transport Infrastructure in Henan Province issued by the Henan Provincial Department of Transportation (2021);

(40) Policies and Measures on Accelerating Post-disaster Reconstruction issued by CPC Henan Provincial Committee and the People's Government of Henan Province (2021);

(41) Notice of Work Plan for Post-disaster Reconstruction of Roads and Waterways in Henan Province in 2021 by Henan Transportation Development Center (2021);

(42) Civil Code of the People's Republic of China (2020)

(43) Constitution of the People's Republic of China (Revised in 2004)

(44) Law of the People's Republic of China on Prevention and Control of Occupational Diseases (December 2018);

(45) Labor Law of the People's Republic of China (December 2018);

(46) Measures for the Administration of the Zhengzhou Yellow River Wetland Nature Reserve

2.1.1.2 Technical Specifications for Assessment

(1) Technical Guidelines for Environmental Impact Assessment - General Program (HJ2.1-2016);

(2) Technical Guidelines for Environmental Impact Assessment - Atmosphere Environment (HJ2.2-2018);

(3) Technical Guidelines for Environmental Impact Assessment - Surface Water Environment (HJ2.3-2018);

(4) Technical Guidelines for Environmental Impact Assessment - Groundwater Environment (HJ610-2016);

(5) Technical Guidelines for Noise Impact Assessment (HJ2.4-2009);

(6) Technical Guidelines for Environmental Impact Assessment - Ecological Impact (HJ19-2011);

(7) Technical Guidelines for Environmental Risk Assessment on Projects (HJ169-2018);

(8) Specifications for Environment Impact Assessment of Highway (JTJ005-96);

(9) Design Specifications of Highway Environmental Protection (JTGB04-2010, Ministry of Communications);

(10) Technical Code on Soil and Water Conservation of Development and Construction Projects (GB50433-2008);

(11) Technical Specifications for Regionalizing Environmental Noise Function (GB/T15190-2014);

(12) Environmental Quality Standards for Noise (GB3096-2008);

(13) Environmental Quality Standards for Surface Water (GB3838-2002);

(14) Ambient Air Quality Standard (GB3095-2012);

(15) Comprehensive Emission Standard of Air Pollutants (GB16297-1996);

(16) Emission Standard of Environment Noise for Boundary of Construction Site (GB12523-2011);

2.1.1.3 Relevant programs

(1) Notice of The General Office of the People's Government of Henan Province on Printing and Distributing the Protection Zoning of Urban Centralized Drinking Water Sources in Henan Province (YZB [2007] No.125);

(2) Notice of the General Office of the People's Government of Henan Province on Printing and Distributing the Protection Zoning of County-level Centralized Drinking Water Sources in Henan Province (YZB [2013] No. 107);

(3) Notice of the General Office of the People's Government of Henan Province on Printing and Distributing the Protection Zoning of Town-level Centralized Drinking Water Sources in Henan Province (YZB [2016] No. 23);

(4) Functional Zoning of the Zhengzhou Yellow River Wetland Nature Reserve;

(5) Protection Zoning of National Aquatic Germplasm Resources Protection of Cyrinus Carpio in Zhengzhou Section of Yellow River.

2.1.1.4 Project Documents

(1) Power of Attorney;

(2) Feasibility Study Report on AIIB Loan—Xinmi Sub-project of Post-disaster Reconstruction of Rural Roads, Zhengzhou Communications Planning Survey & Design Institute;

(3) Feasibility Study Report on AIIB Loan—Xingyang Sub-project of Post-disaster Reconstruction of Rural Roads, Zhengzhou Communications Planning Survey & Design Institute;

(4) Feasibility Study Report on AIIB Loan—Xinzheng Sub-project of Post-disaster Reconstruction of Rural Roads, Zhengzhou Communications Planning Survey & Design Institute;

(5) Feasibility Study Report on AIIB Loan—Gongyi Sub-project of Post-disaster Reconstruction of Rural Roads, Zhengzhou Communications Planning Survey & Design Institute;

(6) Feasibility Study Report on AIIB Loan—Zhongmu Sub-project of Post-disaster Reconstruction of Rural Roads, Zhengzhou Communications Planning Survey & Design Institute;

(7) Feasibility Study Report on AIIB Loan—Dengfeng Sub-project of Post-disaster Reconstruction of Rural Roads, Zhengzhou Communications Planning Survey & Design Institute;

(8) Environmental and Social Management Planning Framework for the Emergency Loan from the AIIB for the Reconstruction Project after Flood Disaster in Henan Province;

(9) Identification and Screening Opinions on Environmental and Social Risks of the AIIB Loan—Post-disaster Reconstruction Project of Rural Roads in Zhengzhou.

2.1.2 Major social policies

(1) Constitution of the People's Republic of China (2004)

(2) Law of the People's Republic of China on the Protection of Rights and Interests of Women (2005)

(3) Special Rules on the Labor Protection of Female Employees (2012)

(4) Law of the People's Republic of China on Prevention and Control of Occupational Diseases (December 2018)

(5) Labor Law of the People's Republic of China (December 2018)

(6) Land Administration Law of the People's Republic of China, August 2004

(7) Regulations for the Implementation of the Land Administration Law of the People's Republic of China (revised on July 29, 2014);

(8) Regulations on the Protection of Basic Farmland (No. 257);

(9) Notice of the Ministry of Human Resources and Social Security on Guiding Opinions on Job Training and Social Security Work for Land-expropriated Farmers Forwarded by the General Office of the State Council (GBF [2006] No. 29).

(10) Notice of the Ministry of Human Resources and Social Security and the Ministry of Land and Resources on Relevant Issues Concerning the Social Security Work for Land-expropriated Farmers (LSBF [2007] No. 14).

(11) Notice of the People's Government of Henan Province on the Promulgation and Implementation of the Comprehensive Land Price Standards for Expropriated Regions in Henan Province (YZ [2016] No. 48);

2.1.3 Relevant requirements of AIIB

(1) Environmental and Social Policy (ESP). The overall policy aims to contribute to these development outcomes by integrating sound environmental and social management into the projects. The overall policy includes Environmental and Social Policy (ESP), Environmental and Social Standard (ESS) and Environmental and Social Exclusion List. The ESP sets out mandatory requirements for the identification, assessment and management of environmental, social risks and impacts associated with projects supported by the Bank and its customers

(2) Environmental and Social Standard (ESS) ESS 1 aims to ensure the environmental and social soundness and sustainability of projects and to support the integration of environmental and social factors into project decision-making processes and implementation. ESS1 applies if a project is likely to have adverse environmental risks and impacts or social risks and impacts (or both). The scope of environmental and social assessment and management measures is proportional to the risks and impacts of a project. ESS 1 provides high quality environmental and social

assessments and management of risks and impacts through effective mitigation and monitoring measures during project implementation. ESS 1 defines the detailed requirements for environmental and social assessments to be carried out on any project invested by the AIIB.

(3) This project shall satisfy local environmental and social laws and regulations, and the ESP and ESS of AIIB. This project is applicable to the Environmental and Social Standard 1: Environmental and Social Assessment and Management, and does not trigger the Environmental and Social Standard 2: Involuntary Resettlement and the Indigenous (Minority) Standards (ESS 3).

2.2 Assessment criteria

2.2.1 Environmental quality standards

(1) Acoustic environment

See Table 2-1 for the implementation standards of acoustic environment quality for each sub-project.

Table 2-1 Quality standard for acoustic environment Unit: dB (A)

Category	Daytime	Nighttime
Category 1	55	45
Category 2	60	50
Standard basis	Environmental Quality Standards for Noise (GB3096-2008)	

(2) Ambient air

Functional zoning of atmospheric environment is not determined. According to the *Ambient Air Quality Standard* (GB3095-2012), the first-level areas include areas requiring special protection such as nature reserves and scenic spots; the second-level areas include residential quarters, mixed-use commercial areas, traffic, living and cultural areas and rural areas designated in urban planning. Therefore, Zhengzhou

Yellow River Wetland Nature Reserve and Zhengzhou Yellow River Scenic Area are subject to Grade I standards of *Ambient Air Quality Standard* (GB3095-2012) and other areas subject to Grade II standards. See Table 2-2 for standard values.

Table 2-2 Ambient air quality standard (Unit: μg/m^3)

Pollutant name	Concentration limit for Grade I standards			Concentration limit for Grade II standards		
	Annual average concentration limit	24-hour average concentration limit	1-hour average concentration limit	Annual average concentration limit	24-hour average concentration limit	1-hour average concentration limit
SO_2	20	50	150	60	150	500
NO_2	40	80	200	40	80	200
TSP	80	120	/	200	300	-/
PM_{10}	40	50	/	70	150	
$PM_{2.5}$	15	35	/	35	75	--/
CO	/	4	10	/	4	10
O_3	/	100 (daily maximum 8-hour average concentration limit)	160	/	160 (daily maximum 8-hour average concentration limit)	200

(3) Surface water

According to the functional requirements of surface water, surface water quality shall be subject to the Class II, Class III and Class IV standards of the *Environmental Quality Standards for Surface Water* (GB3838-2002) (see 2.3 Environmental Protection Objectives for each surface water function in the project area).

Table 2-3 Environmental quality standards for surface water (Unit: mg/L)

Project	pH	COD	Petroleum	Ammonia nitrogen (NH_3-N)
II	6~9	15	0.05	0.5

III	6~9	20	0.05	1.0
IV	6~9	30	0.5	1.5

2.2.2 Pollutant emission standards

(1) Noise during construction

The construction noise shall be subject to the *Emission Standard of Environment Noise for Boundary of Construction Site* (GB12523-2011), and the standard value is shown in Table 2-4.

Table 2-4 Emission limit of environmental noise for boundary of construction site

Unit: dB

Daytime	Nighttime
70	55

(2) Atmospheric pollutants

Atmospheric pollutants shall be subject to the unorganized emission standards in the Comprehensive Emission Standard of Air Pollutants (GB16297-1996). Standard values are shown in Table 2-5.

Table 2-5 Emission limits of atmospheric pollutants

Time	Pollutant name	Concentration limits for unorganized emission monitoring
Construction period	Asphalt fume	The production equipment shall not have any obvious unorganized emission
	Particulate matter (other)	The highest concentration outside the perimeter is 1.0mg/m3

(3) Wastewater

Production wastewater and domestic sewage during construction shall be comprehensively utilized after being treated by oil trap and sedimentation tank, and shall not be discharged.

2.3 Objectives of environmental protection

This project is for the restoration of rural roads, mainly low-grade rural roads. The damaged sites are dotted along the road in a wide area. See Table 2-6 for details of environment-sensitive targets. See Figure 2.3-1 ~ Figure 2.3-9 for details of environment-sensitive targets diagram.

Table 2-6 List of environmental protection objectives

Environmental elements	Name of sensitive spot	Positional relationship with the project	Level of protection
Ambient air	**Villages, hospitals and schools along the project line roads**	**Villages, schools and hospitals within 200m on both sides of the roads, and within 200m beyond the boundary of temporary sites such as construction sites**	**Ambient air level 2**
Acoustic environment	**Villages, hospitals and schools along the project line roads**	**Villages, schools and hospitals within 200m on both sides of the roads, and within 200m beyond the boundary of temporary sites such as construction sites**	**Acoustic environment 1 and 2**
Water environment	Mangshan Mountain Surface Water Source	Some damaged sites of C343, C266 and C808 are located in the secondary protected area of Mangshan Mountain Surface Water Source in Zhengzhou	Case III waters
	Wangcun water source along the Yellow River	Parts of Y140 and Y028 are located in the secondary protected area of Wangcun water source along the Yellow River	Case III waters
	South-to-North Water Diversion Canal	Scope of South-to-North Water Diversion protection zone in Xingyang Section: The first-level protection zone extends 50m from the boundary of the main canal (protective fence or net); the second-level protection zone extends 500m from the boundary of the first-level protection zone. Some of the proposed projects are located in the second-level protection zone, including C465, C363, Y064, C944 (including East	Case II waters

Environmental elements	Name of sensitive spot	Positional relationship with the project	Level of protection
		River Bridge of Longquan Temple) and C011. Scope of South-to-North Water Diversion protection zone in Xinzheng Section: SH115 + 114.2 ~ SH118 + 484.2 and SH174 + 913.1 ~ SH176 + 615.0; the first-level protection zone extends 50m from both sides of the main channel, and the second-level protection zone extends 500m from the first-level protection zone. For other sections in Xinzheng, the first-level protection zone extends 50m from both sides of the main channel, and the second-level protection zone extends 150m from the first-level protection zone. Some of the proposed projects are located in the second-level protection zone: including two damaged sites of Y008 and the pipe culvert in Nianlu Village, Mengzhuang Town (The first-level protection zone extends 50m outside the canal, and the second-level protection zone extends 150m outside the canal), the the pipe culvert in Nianlu Village, Mengzhuang Town and damaged road on its east side (The first-level protection zone extends 50m outside the canal, and the second-level protection zone extends 500m outside the canal)	
	Wangjinglou Reservoir	Some damaged sites such as culverts and Wangshandong are located in the second-level protection zone of water source.	Case III waters
	Liwan Reservoir	The four damaged sites of Y055 are adjacent to the outer edge of the first-level protection zone of Liwan reservoir water source, and they are dotted along the reservoir bank	Case III waters
	Zhifang Reservoir	The damaged sites of CC08, CC33, CC22 and CC38 are located in the second-level protection zone of Zhifang Reservoir, of which CC08 Bridge crosses Shicong River	Case III waters
	Shaolin	Three damaged sites of Lei-jiagou Village	Case III

Environmental elements	Name of sensitive spot	Positional relationship with the project	Level of protection
	Reservoir	Road are located at the outer edge of the second-level protection zone of Shaolin Reservoir	waters
	Quan'men Reservoir	The damaged sites of C603, C608, X062, X048 are located in the second-level protection zone of Quan'men Reservoir, of which one damaged site of C6082 and one damaged site of X062 are near the first-level protection zone	Case III waters
	Baisha Reservoir	One damaged site of X056 and one damaged site of C760 are adjacent to the second-level protection zone of Baisha Reservoir	Case II waters
	Suohe River	Sunzhai Village in Xingyang, east side of Longquan Temple, Liuzhai Town, Dashigu Village	Case IV waters
	Kuhe River	Xingyang X009 Gaoshang Line, Guangwu Town Y082	
	Jalu River	On both sides of the Jalu River, there are some damaged sites, such as G107 auxiliary road, Xingzhuang Village Road, Huizhuang Village Road, etc.	Case IV waters
	Chaohe River	The Chaohe River Bridge in Tanghe Village, Xinzheng, Jiazhuang Bridge east of Dongguozhai Village, and the culvert east of the temple across Chaohe River	Case IV waters
	Shibali River	Xiaolu Village in Longhu Town, circular culvert in Dazhao Village across Shibali River	Case IV waters
	Sishui River	S234 Shangxu Line K106 + 175.500, Anlan Gate, Qucun Village and Donghenan Town across Sishui River	Case IV waters
	Luohe River	Village Road on both sides of Luohe River (C018, C080, Caigou Village Road, C104, etc.) to be rebuilt	Case III waters
	Qingyi River	Wuhuzhao Village Bridge, the circular culvert at Taiqing Village in Guanyinsi Town across the Qingyi River	Case IV waters
	Shuangji River	Many parts of the bridge on Shuangji River have been destroyed and need to be	Case IV waters

Environmental elements	Name of sensitive spot	Positional relationship with the project	Level of protection
		demolished and rebuilt	
Ecology	Henan Zhengzhou Yellow River Wetland Nature Reserve	The damaged sites of Y062 (about 5m) and C772 (about 338m) are located in the pilot zone of the Zhengzhou Yellow River Wetland Nature Reserve in Henan Province	

3 Project Description

3.1 Project composition and distribution

Construction site and scale: including roads in Xinmi City, Xingyang City, Dengfeng City, Xinzheng City, Zhongmu County and Gongyi City, involving about 76 towns, 29 subdistrict offices and 2 scenic spot administration committees. See Figure 3-1 for project distribution. **About 267km of damaged subgrade and 415km of damaged pavement have been repaired this time. The restoration project includes 1,851.106 km^3 subgrade filling and 617.720 km^3 subgrade excavation; 956.271 km^2 cement concrete pavement, and 1,179.372 km^2 asphalt concrete pavement; 625.374 km^3 protective and drainage masonry; reconstruction of 6,138.744 linear meters /127 bridges and repair of 36 bridges at the original site; reconstruction of 253 culverts, and repair of 10 culverts.**

Investment scale: the total investment of the project is planned to be 1,922,408,700 yuan, construction and installation fee is 1,687,747,000 yuan, and the project plans to apply for a loan of 1,623,465,000 yuan from AIIB, and the rest will be funded by county-level finance departments.

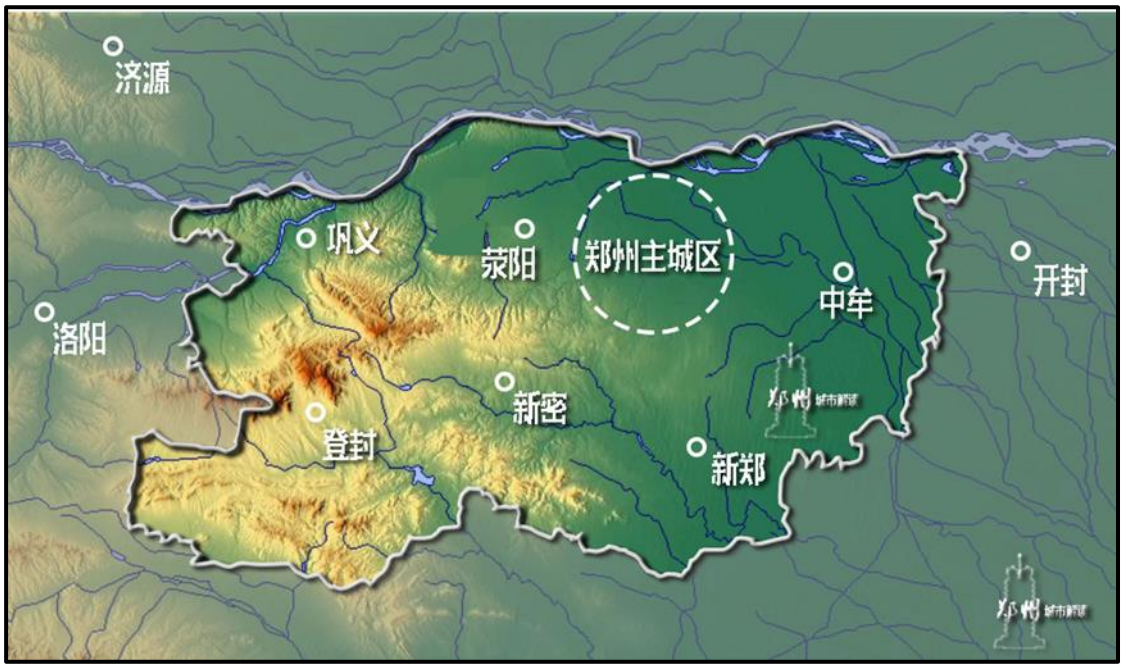


Figure 3-1 Distribution of Post-disaster Reconstruction Project Area of Rural Roads in Zhengzhou

3.2 Sub-project description

3.2.1 AIIB Loan—Xingyang Sub-project of Post-disaster Reconstruction of Rural Roads

3.2.1.1 Project overview and location

The project involves repair of flood damaged subgrade and pavement, bridges & culverts and safety facilities in 12 townships (towns and administration committees) of Sishui Town in Xingyang City, Gaoshan Town, Chengguan Town, Liuhe Town, Cuimiao Town, Gaocun Town, Guangwu Town, Huancuiyu Scenery Spot Administration Committee, Wangcun Town, Jinzhai Town, Yulong Town and Jiayu Town. It includes 329 flood-damaged roads, including 7 county highways, 63 township highways and 259 village roads. See Figure 3-2 Location Map of Xingyang Sub-project for details.

3.2.1.2 Construction scale

The construction mileage is 157.841 km. This project involves 83.61 km^3 subgrade excavation, clearing of 263.65 m^3 slump slope earth, 908.96 km^3 subgrade filling; repair and construction of 261.21 km^2 cement concrete pavement, and repair and construction of 253.35 km^2 asphalt concrete pavement; repair of 191.72 km^3 protective and drainage masonry; construction of 2,238.16 m/36 bridges, repair of 5 bridges, construction of 58 culverts, repair and extension of 4 culverts, restoration and construction of 31,718 m corrugated beam barrier.

The construction period of the project is tentatively scheduled for 8 months. The specific start date is determined according to the project progress.

3.2.1.3 Starting and ending points, intermediate control points, full length, main towns, rivers, roads and railways along the project line, technical standards and project overview

This project is a post-disaster reconstruction project, which maintains the original road route and only reconstructs the flood damaged sections, without adding permanent land. The main towns along the project line are: Sishui Town, Gaoshan Town, Chengguan Town, Liuhe Town, Cuimiao Town, Gaocun Town, Guangwu Town, Huancuiyu Scenery Spot Administration Committee, Wangcun Town, Jinzhai Town, Yulong Town and Jiayu Town.

The main rivers involved in the project: Suohe River, Kuhe River and Sishui River.

3.2.1.4 Project floor area

This project is a post-disaster reconstruction project, which maintains the original road route and only reconstructs the flood damaged sections, without additional floor area. Some nodes have temporary land for construction access roads, all located within the red line of the project. The original land will be restored after the restoration of the flood damaged sites, and farmland, urban land and residential land will not be occupied during the period; clean up sundries in time and level the construction site after the completion of the project.

3.2.1.5 Temporary projects

(1) Construction camps

The project covers a wide range of areas, which are relatively dispersed; Due to

the small scale and short construction period of a single project, no construction camp will be set up and local houses will be rented instead.

(2) Soil collection and spoil

The proposed project is located in central and western Henan Province, which is part of the hilly region of western Henan Province. With relatively rich soil source and basically good soil quality (loess-like silt), it can be used as the filling material for flood-damaged subgrade after mixing with earth, so as to reduce the quantity of spoil and earth transported from other places. After the earth is excavated and leveled off, purchased earth can be used for local road sections lacking earth.

As this project is a restoration project, most of the subgrade spoil is collapsed slope earth, which can be used for earthing up slope in filling sections; As the flood damaged sites are scattered, the local government will coordinate the disposal of excess earth, and no special spoil ground will be set up.

(3) Construction access roads

This project uses the existing security access roads, and no construction access road will be set up.

(4) Mixing station

Due to the short construction period, finished mixtures, such as commercial concrete and finished asphalt concrete, shall be directly purchased, and transported to the paving place by vehicles after being uniformly mixed.

3.2.2 AIIB Loan—Xinmi Sub-project of Post-disaster Reconstruction of Rural Roads

3.2.2.1 Project overview and location

The project involves a total of 204 projects involving 17 townships (towns and offices), 19 county highways, 44 township highways and 141 village roads in Xinmi, with 163km of flood-damaged subgrade and 167km of flood-damaged pavement. See Figure 3-3 Location Map of Xinmi Sub-project for details.

3.2.2.2 Construction scale

It mainly involves the reconstruction of 1,305.92 linear meters/33 bridges, the restoration of 5 bridges, the reconstruction of 57 culverts and the restoration of 6 culverts.

The project involves 431.657 km^3 subgrade filling; 359.319 km^3 subgrade excavation; 577.469 km^2 asphalt concrete pavement; 228.630 km^2 cement concrete pavement.

The construction period of the project is tentatively scheduled for 15 months.

3.2.2.3 Starting and ending points, intermediate control points, full length, main towns, rivers, roads and railways along the project line, technical standards and project overview

This project is a post-disaster reconstruction project, which maintains the original road route and only reconstructs the flood damaged sections, without adding permanent land.

The main towns along the project line include Xinhua Road Sub-district Office, Chengguan Town, Quliang Town and Yuecun Town. Chaohua Town, Fuxi Mountain Scenery Spot Administration Committee, Mining Area Sub-district Office, Micun

Town, Goutang Town, Shengdian Town, Dawei Town, Laiji Town, Baizhai Town, Yuanzhuang Town, Liuzhai Town, Pingmo Town, and Xidajie Sub-district Office.

3.2.2.4 Project floor area

This project is a post-disaster reconstruction project, which maintains the original road route and only reconstructs the flood damaged sections, without additional floor area.

3.2.2.5 Temporary projects

(1) Construction camps

The project covers a wide range of areas, which are relatively dispersed; Due to the small scale and short construction period of a single project, no construction camp will be set up and local houses will be rented instead.

(2) Soil collection and spoil

The project is a post-disaster reconstruction project. After the earth is excavated and leveled off, purchased earth can be used for local road sections lacking earth.

As this project is a restoration project, most of the subgrade spoil is collapsed slope earth, which can be used for earthing up slope in filling sections; As the flood damaged sites are scattered, the local government will coordinate the disposal of excess earth, and no special spoil ground will be set up.

(3) Construction access roads

This project uses the existing security access roads, and no construction access roads will be set up.

(4) Mixing station

Due to the short construction period, finished mixtures, such as commercial concrete and finished asphalt concrete, shall be directly purchased, and transported to the paving place by vehicles after being uniformly mixed.

3.2.3 AIIB Loan—Xinzheng Sub-project of Post-disaster Reconstruction of Rural Roads

3.2.3.1 Project overview and location

This project mainly involves the restoration of flood-damaged subgrade and pavement, bridges & culverts, safety facilities, etc. **It involves a total of 231 flood-damaged sites in 10 townships (towns and administration committees) of Xinzheng City.** See Figure 3-4 Location Map of Xinzheng Sub-project for details.

3.2.3.2 Construction scale

This project involves 33.755 km^3 subgrade excavation, clearing of 30.841 m^3 slump slope earth, and 136.662 km^3 subgrade filling; filling of 86.943 km^3 cement for flood-damaged slope, and pouring of 650.3 m^3 C30 light weight foam concrete; repair and construction of 72.819 km^2 cement concrete pavement, repair and construction of 94.896 km^2 asphalt concrete pavement; repair of 29.354 km^3 protective and drainage masonry; construction of 3 bridges, all are medium bridges (272 m/3 bridges), repair and reinforcement of 1 bridge (75m long); **construction of 40 culverts, including 9 slab culverts and 31 circular culverts, and restoration and construction of 5,304 m corrugated beam barrier;**

The construction period of this project is tentatively scheduled for 15 months, and the specific start and completion date is determined according to the work progress in the early stage of the project.

3.2.3.3 Starting and ending points, intermediate control points, full length, main towns, rivers, roads and railways along the project line, technical standards and project overview

This project is a post-disaster reconstruction project, which maintains the original road route and only reconstructs the flood damaged sections, without adding permanent land. Main towns and townships of the project: Longhu Town, Guodian Town, Xuedian Town, Guanyinsi Town, Mengzhuang Town, Lihe Town, Chengguan Town, Xincun Town and Hezhuang Town, as well as Juci Mountain.

3.2.3.4 Project floor area

This project is a post-disaster reconstruction project, which maintains the original road route and only reconstructs the flood damaged sections, without additional floor area.

3.2.3.5 Temporary projects

(1) Construction camps

The project covers a wide range of areas, which are relatively dispersed; Due to the small scale and short construction period of a single project, no construction camp will be set up and local houses will be rented instead.

(2) Soil collection and spoil

After the earth is excavated and leveled off, purchased earth can be used for local road sections lacking earth.

As this project is a restoration project, and the flood damaged sites are scattered, the local government will coordinate the disposal of excess earth, and no special spoil ground will be set up.

(3) Construction access roads

This project uses the existing security access roads, and no construction access roads will be set up.

(4) Mixing station

Due to the short construction period, finished mixtures, such as commercial concrete and finished asphalt concrete, shall be directly purchased, and transported to the paving place by vehicles after being uniformly mixed.

3.2.4 AIIB Loan—Dengfeng Sub-project of Post-disaster Reconstruction of Rural Roads

3.2.4.1 Project overview and location

It mainly involves the restoration of flood-damaged subgrade and pavement, bridges & culverts, safety facilities and other projects, involving 15 township offices in Dengfeng City. See Figure 3-5 Location Map of Dengfeng Sub-project for project location.

3.2.4.2 Project scale and investment

This project mainly involves the repair of flood-damaged subgrade and pavement, bridges & culverts, safety facilities and other projects, including 321 flood-damaged roads, which include 8 county highways, 21 township highways and 292 village roads. It also involves repair and construction of 64.584 km^2 cement concrete pavement, and 81.402 km^2 asphalt concrete pavement; 83.438 km^3 protective and drainage masonry, and 696.3 m/17 bridges, repair of 15 bridges; construction of 77 culverts.

The construction period of the project is tentatively scheduled for 15 months.

3.2.4.3 Project floor area

This project is a post-disaster reconstruction project, which maintains the original road route and only reconstructs the flood damaged sections, without additional floor area.

3.2.4.4 Temporary projects

1) Construction camp

The project covers a wide range of areas, which are relatively dispersed; Due to the small scale and short construction period of a single project, no construction camp will be set up and local houses will be rented instead.

(2) Soil collection and spoil

As this project is a post-disaster reconstruction project, the flood damaged sites are scattered and not much earth is required, no special spoil ground will be set up and earth can be purchased from outside sources. The local government will coordinate the disposal of excess earth.

(3) Construction access roads

This project uses the existing security access roads, and no construction access roads will be set up.

(4) Mixing station

Due to the short construction period, finished mixtures, such as commercial concrete and finished asphalt concrete, shall be directly purchased, and transported to the paving place by vehicles after being uniformly mixed.

3.2.5 AIIB Loan—Zhongmu Sub-project of Post-disaster Reconstruction of Rural Roads

3.2.5.1 Project overview and location

The project includes 25 county, township and village roads, including 19 flood-damaged roads (3 county highways, 5 township highways and 11 village roads), 4 bridges to be demolished and reconstructed, and 2 bridges to be repaired. See Figure 3-6 Location Map of Zhongmu Sub-project for details. It involves 11 townships and offices, including Dameng Town, Hansi Town, Yaojia Town, Diaojia Town, Langchenggang Town, Wantan Town, Yanminghu Town, Guandu Town, Huangdian Town, Guanghui Sub-district Office and Qingnian Road Sub-district Office, which are all located in Zhongmu.

3.2.5.2 Construction scale

There are 19 roads damaged by flood (3 county highways, 5 township highways and 11 village roads): 6 bridges (3 medium bridges and 3 small bridges) to be demolished and rebuilt. In this project, 114.319 km^2 asphalt pavement and 97.457 km^2 cement concrete pavement are restored; 4 bridges/102.18 m (1 medium bridge/53.06 m, 3 small bridges/49.12 m) are dismantled and rebuilt, and 2 bridges/67 m (1 small bridge/29 m, 1 medium bridge/38 m) are repaired.

The construction period of the project is tentatively scheduled for 8 months.

3.2.5.3 Project floor area

This project is a post-disaster reconstruction project, which maintains the original road route and only reconstructs the flood damaged sections, without additional floor area.

3.2.5.4 Temporary projects

(1) Construction camps

The project covers a wide range of areas, which are relatively dispersed; Due to the small scale and short construction period of a single project, no construction camp will be set up and local houses will be rented instead.

(2) Soil collection and spoil

The project is a post-disaster reconstruction project. After the earth is excavated and leveled off, purchased earth can be used for local road sections lacking earth. As the flood damaged sites are scattered, the local government will coordinate the disposal of excess earth, and no special spoil ground will be set up.

(3) Construction access roads

This project uses the existing security access roads, and no construction access roads will be set up.

(4) Mixing station

Due to the short construction period, finished mixtures, such as commercial concrete and finished asphalt concrete, shall be directly purchased, and transported to the paving place by vehicles after being uniformly mixed.

3.2.6 AIIB Loan—Gongyi Sub-project of Post-disaster Reconstruction of Rural Roads

3.2.6.1 Project overview and location

This project involves 8 county highways, 21 township highways, 73 village roads and 42 bridges in Gongyi. See Figure 3-7 Location Map of Gongyi Sub-project for details.

3.2.6.2 Construction scale

This project involves 8 county highways, 21 township highways, 73 village roads and 42 bridges in Gongyi City. This project involves 255.7 km^3 subgrade filling,

128.3 km^3 subgrade excavation, 119.9 km^3 masonry, 57.9 km^2 asphalt concrete pavement, 231.6 km^2 cement concrete pavement; there are 1,663.18m/42 bridges along the whole project, including 1,524.18m/34 bridges (including 10 slab culverts) newly built, and 139m/8 bridges repaired. The newly-built bridges include 234.12m/2 large bridges, 963.56m/14 medium bridges, 181m/8 small bridges, 89m/9 slab culverts and 56.5m/1 box culvert.

The construction period of the project is tentatively scheduled for 15 months.

3.2.6.3 Project floor area

This project is a post-disaster reconstruction project, which maintains the original road route and only reconstructs the flood damaged sections, without additional floor area.

3.2.6.4 Temporary projects

(1) Construction camps

The project covers a wide range of areas, which are relatively dispersed; Due to the small scale and short construction period of a single project, no construction camp will be set up and local houses will be rented instead.

(2) Soil collection and spoil

The project is a post-disaster reconstruction project. After the earth is excavated and leveled off, purchased earth can be used for local road sections lacking earth. As this project is a restoration project, and the flood damaged sites are scattered, the local government will coordinate the disposal of excess earth, and no special spoil ground will be set up.

(3) Construction access roads

This project uses the existing security access roads, and no construction access roads will be set up.

(4) Mixing station

Due to the short construction period, finished mixtures, such as commercial concrete and finished asphalt concrete, shall be directly purchased, and transported to the paving place by vehicles after being uniformly mixed.

3.3Construction plan

3.3.1 Subgrade earthwork

It is suggested that the subgrade earthwork be mainly constructed by machinery and assisted by manual construction. Under the condition of verifying the length and quantity of the excavation sections, as many working surfaces as possible should be arranged for bulldozer or excavator operations. Loaders and dumper trucks can also be used to transport earth to fill the embankment or dump it at spoil ground. Highly mechanized teams can also use scrapers for continuous excavation and transportation.

Fill operations shall be conducted mainly by loading equipment or a bulldozer, assisted by manual leveling. It is better to level with a leveler and compact by rolling. During the operation, the supporting facilities of mechanical equipment should be adjusted according to the specific situation to avoid labor slowdown. According to the terrain, geology, excavated sections and construction machinery, etc., construction methods that can ensure the stability of slope should be adopted.

3.3.2 Pavement engineering

In order to ensure the smoothness and quality of pavement engineering, it is suggested that all structural layers should be constructed by professional teams. Sub-bases and bases should be paved in layers by pavers, compacted by road rollers,

and each surface layer should be sprayed with penetrating oil by sprinklers. In order to facilitate the control of construction quality and minimize the environmental pollution caused by mixing; this project shall be divided according to the pavement sections. The construction quality of the project shall be strictly controlled in accordance with the *Technical Specifications for Construction of Highwy Base Course of Pavements* and the *Technical Specification for Construction of Highway Asphalt Pavements*.

The pavement construction shall be carried out in strict accordance with the technical specifications for pavement construction, and the construction of the pavement base shall be completed before the rainy season of the year on the premise of ensuring the paving and rolling quality of the pavement sub-base and base materials.

(1) Preparations for construction

For preparation of materials entering the site, emulsified asphalt, aggregate cement and other materials entering the site shall be tested according to the quality standard and batch frequency, and unqualified materials shall not enter the site.

(2) Base construction

① Purchase of commercial water-stabilized mixture

Due to the tight construction period, finished mixtures shall be purchased directly. Mixtures shall be transported to the paving site with dump trucks after being evenly mixed, and if it is too far away, mixtures shall be covered to prevent water loss.

② Base compaction

Before paving the base, the top surface of the base should be cleaned up. Construction shall be carried out in accordance with the paving thickness and type of

compact machinery, number of compaction passes and speed, operation method, process flow, water content control range and dry density determined for the trial pavement section. In the flat curve section, the roller shall roll from the inside to the outside, and the two sides of the pavement shall be rolled 2 ~ 3 times more. The construction delay shall not exceed the initial setting time of the mixture, so as to determine the size of the construction surface. In order to avoid longitudinal joints in the base construction, it is advisable to adopt two pavers 8 ~ 10m apart to pave ahead and roll together. Temporary drainage facilities shall be provided in the whole process of base construction, and no water accumulation on the surface is allowed.

③ Base maintenance

The base shall be maintained for a period (at least one week) after completion, and shall be kept wet during the maintenance period. The minimum temperature during the base construction period shall be above 5℃ and the base construction shall be carried out on non-rainy days.

(3) Construction of surface layer

① Purchase of commercial asphalt concrete

② Storage and transportation

Prior to delivery, the asphalt mixture may be stored in an insulated storage for not more than 6 hours. A clean dump truck is used to transport the mixture, and the inside of the tank can be coated with a thin layer of oil-water mixture. The transport vehicle shall be provided with covering equipment, and all sides of the tank shall be sealed and fastened.

③ Paving

Before paving the mixture, the lower layer of the pavement must be inspected and cleaned. The contact surfaces of curbs and other buildings with asphalt pavement shall be uniformly coated with a thin layer of hot asphalt binder or diluted asphalt. The asphalt concrete surface course shall be continuously constructed and paved over the whole road width. Otherwise, before the next construction, the surface should be cleaned, and the adhesive layer oil shall be poured. Longitudinal and transverse joints in the paving of asphalt mixtures should be minimized, the upper and lower joints shall be staggered by at least 300mm to avoid overlapping. Transverse seams shall be staggered by at least 1m between connected layers and adjacent routes.

④ Compaction

During rolling, the roller shall run from the roadside to the middle of the road. Each overlap of the three-wheel roller shall be 1/2 of the width of the rear wheel, and each overlap of the two-wheel roller shall be 300mm. During initial rolling, the 6-8t smooth-wheel roller or 6-10t vibratory roller (close the vibratory device) is used for initial rolling twice. During the second rolling, the 10-12t three-wheel roller, 10t vibratory roller or corresponding tire roller shall be used. It should be rolled 4-6 times until stable and without significant wheel tracks. At final rolling, the 6-8t vibratory roller is used to roll (close the vibratory device) for 2-4 times.

3.3.3 Bridge engineering

The superstructure of medium and small bridges is made of prestressed hollow slab; the substructure is of a columnar pier and bored pile; the upper structure is prefabricated in a precast yard and transported to the site for unified hoisting so as to save time and control quality.

The construction of bridge pile foundation should avoid the flood season, and the drilling platform should be built near the pile foundation, and the drilling rig should be in place by using the makeshift bridge, and the steel casing should be buried before drilling.

Requirements for safety, environment and emergency pre-change of environment sensitive points in bridge construction:

(1) The construction site, machinery & equipment and safety protection facilities shall be fully inspected and confirmed to meet the safety requirements before bridge construction.

(2) The earth for foundation pit excavation must be piled up in the spoil ground for unified planting and greening to prevent soil erosion; after construction, the temporary prefabrication site, material piling site and construction site must be returned to the people.

(3) The wastewater and waste oil during construction must be purified and shall not be discharged at will to prevent pollution of water sources.

3.3.4 Culvert engineering

Culverts shall be constructed in conjunction with subgrade. The construction arrangement and site layout of culverts shall fully consider the needs of flood control and waterlogging prevention, and shall not affect the normal functions of flood discharge, waterlogging drainage and farmland water conservancy facilities. When necessary, temporary pipelines for drainage and water transmission shall be buried as required and kept unblocked. Before construction of bridges and culverts, make preparations for construction, ensure that necessary mechanical equipment is on site

as scheduled, and supply construction materials. The whole construction period is planned to be two years, and the specific construction scheme is as follows.

(1) The foundation shall be excavated by an excavator in cooperation with manual excavation. Before excavation, the boundary line and excavation depth shall be provided, and the foundation elevation shall be re-measured in time. Over-excavation is strictly prohibited.

(2) After foundation excavation, the foundation shall be treated according to the treatment method specified in the drawings to meet the design requirements.

(3) Cover plates shall be precast (or precast beside culverts, tunnels) at the precast yard and transported to the site by a trailer.

(4) The foundation and concrete platform shall be made of composite steel formwork with channel steel as ribs, and the abutment capping formwork shall be made of steel formwork.

(5) The reinforcing bar shall be uniformly processed in the prefabrication plant, and fabricated and installed on the site.

(6) Culverts and channels should be backfilled in strict accordance with the design drawings, and tamped with small machines to meet the requirements of design and construction specifications.

3.3.5 Seasonal construction

(1) Construction measures in winter

① Keep in touch with the local meteorological department, listen to the weather forecast in time (assign an office staff to be responsible for it), make weather records properly, and prevent cold snap from causing harm to the construction;

② During earth excavation, when digging to unfrozen soil, continuous operation and excavation in layers shall be carried out, and at the end of each day, it shall be covered to avoid repeated freezing;

③ A 30cm thick step should be reserved for the excavated slope, and the step should be cut off after the temperature rises, so as to reach the designed slope;

④ Ensure the drainage work of the construction site;

⑤ The concrete pouring shall be conducted in the noon with higher temperature;

⑥ Adjust the mixing ratio, and add antifreeze agent upon approval of the supervision engineer;

⑦ Make preparations for winter construction.

(2) Measures for construction in rainy season

During construction in rainy season, drainage shall be ensured for subgrade construction; during construction of bridges and culverts, attention shall be paid to rust prevention of steel bars, deformation and subsidence of formwork and supports. Materials such as cement shall be properly kept to prevent caking from moisture.

Preparations before construction in rainy season:

① Compile the feasible construction organization plan for rainy season according to the local climate;

② Build and maintain construction access roads and keep them unblocked;

③ The residence, warehouse and other production facilities shall be protected against rain;

④ Appropriately adjust the material entry and stock arrangement to ensure the supply of construction materials in rainy season;

Precautions for construction in rainy season

① Pay attention to the coordination of subgrade filling and drainage construction, and make full use of the designed drainage facilities for subgrade protection;

② During embankment construction, it shall ensure that excavation, transportation, paving, compaction and leveling are done at all times, and the surface of each layer of fill shall be made into a transverse slope of 2-4% to facilitate drainage.

③ The water content of the compacted subgrade shall be measured frequently. If unqualified, the subgrade shall be dug and dried before being filled and compacted.

④ The concrete pouring site shall be provided with sufficient rain-proof tools, which shall be covered in case of rainy days;

⑤ Strengthen power management to prevent lightning accidents;

⑥ Check all kinds of templates and the foundation of supporting racks, and reinforce them in time;

⑦ Check the water content of concrete sand and other aggregates frequently, and adjust the construction mix proportion in time.

3.3.6 Construction precautions

Be familiar with the drawings and correctly understand the design intention before construction. And restore the center line, carefully retest the elevation of the leveling points along the project line, conduct detailed investigation, statistics, and verify the type and quantity of demolition.

For subgrade filling sections, it is necessary to ensure that the compaction degree of subgrade filling reaches the design requirements. At the same time, the impact of the vibratory roller on the buildings along the project line shall be avoided.

In the construction of pavement engineering, the quality of materials used in each layer shall be strictly controlled, and the mix ratio test shall be conducted and the quantity of various materials shall be well controlled.

The base shall be constructed in strict accordance with the construction specifications. Surface paving shall be solid, smooth and wear-resistant, with good anti-sliding, anti-seepage and anti-fatigue properties and stability against high temperature deformation and low temperature cracking.

For drainage and protection facilities, bridges and culverts along the project line, the bearing capacity of the foundation shall be tested first after foundation excavation, and shall meet the design requirements before construction

All works shall be carried out in strict accordance with relevant technical specifications and operation regulations.

4 Environmental and Social Baseline

4.1 Overview of the natural environment

4.1.1 Geographical location

Zhengzhou (112°42'~114°14'E, 34°16'~34°58'N) is the capital of Henan Province, located in the north of central Henan. It borders the Yellow River in the north, Songshan Mountain in the west, and Huang-Huai Plain in the southeast. It is 166km long and 75km wide, with an area of 7,446.2km^2. Zhengzhou is connected to Kaifeng in the east, Luoyang in the west, Xinxiang and Jiaozuo in the north across the Yellow River, Xuchang and Pingdingshan in the south. The Beijing-Guangzhou Railway meets the Longhai Railway in Zhengzhou, showing its superior geographical position. Located 15km west of Zhengzhou, Xingyang is the closest county-level city in Henan province to the provincial capital, covering an area of 908km^2, including 17km^2 urban built-up area.

Zhongmu County (34°26′-34°56′N, 113°46′-114°12′E) is located in the hinterland of central China and the east part of central Henan Province, under Zhengzhou City. It adjoins Kaifeng to the east, Zhengzhou to the west, Xinzheng and Weishi County to the south, and Yuanyang to the north across the Yellow River. It has a maximum length of 55 kilometers from north to south, a maximum width of 39 kilometers from east to west, and a total area of 917km^2.

Located in the central part of Henan Province, the transition zone from the mountainous area of western Henan to the plain of eastern Henan, Xinzheng borders Zhengzhou to the north, Zhongmu County to the east, Xuchang to the south, and Xinmi to the west, with an area of 884.59 square kilometers. 38km away from Zhengzhou, the provincial capital, it is a key city to open to the outside world and a

pilot city to accelerate the process of urbanization. It is also one of the first ten historical and cultural cities in Henan Province announced in 1989.

Located in central Henan Province, Xinmi City (113°09′-113°40′E, 34°19′-34°40′N) is bordered by Xinzheng City in the east, Dengfeng City in the west, Yuzhou City in the south, Xingyang City in the north, Zhengzhou City in the northeast, and Gongyi City in the northwest. It is 46.2km long from east to west and 32.4km wide from north to south, covering an area of 1,001 km^2.

Xingyang (113°7'-113°30' E, 34°36'-34°59'N), located in the central and northern part of Henan Province, is 15km west of Zhengzhou and adjoins the Yellow River to the north. It is a county-level city affiliated to Zhengzhou and the nearest county-level city to the provincial capital. It adjoins Zhengzhou City in the east, Gongyi City in the west, Xinmi City in the south by the Songshan mountains, Wuzhi County and Wenxian County of Jiaozuo City across the Yellow River in the north, with an area of 943km^2.

Dengfeng City (112°49′-113°19′E and 34°35′-34°15′N), located in the north-central part of Henan Province, at the south foot of Songshan Mountain, borders Xinmi in the east, Yichuan in the west, Yuzhou and Ruzhou in the south, and Yanshi and Gongyi in the north. The city is 56 km long from east to west, and 35.5 km wide from north to south, with a total area of 1220km2.

Gongyi City (112°49′-113°17′E and 34°31′-34°52′N), located at the northern foot of Songshan Mountain, is 76 km away from Luoyang in the west, 82 km away from Zhengzhou in the east. It borders Xingyang in the east, Yanshi and Mengjin in the west, Dengfeng and Xinmi in the south by Songshan Mountain, and Mengzhou and Wenxian in the north across the Yellow River, covering an area of 1,043 km^2.

4.1.2 Landform

The project area is located in Zhengzhou and spans the second and third geomorphic steps in China. The Songshan Mountain in the southwest is in the front edge of the second-level geomorphic step, and the alluvial plain of the Yellow River in the east is in the rear part of the third geomorphic step. The low mountains and hills between mountains and plains constitute the transition zone from the second geomorphic step to the third geomorphic step, comprising low mountains, hills and valley plains. The general feature of the terrain is that it is high in the west and low in the east, changing from low mountains and hills in the west to the Yellow River alluvial plain in the east. The highest point of Zhengzhou is located at Shaoshi Mountain in Dengfeng City, with the altitude of Liantian Peak of 1,512.4 meters; the lowest point is located at Huxinzhuang Village of Hansi Town, Zhongmu County, with an altitude of 73 meters.

Gongyi With an altitude of 100 ~ 200m, Gongyi City is generally high in the south and low in the north, and slopes from southwest to northeast. It is mainly characterized by loess and fluvial landform, mainly loess ridge (loess hill). It is relatively flat overall, with large ground undulations in local areas, and developed loess gullies.

Dengfeng The project area is located in the southwest of the North China Platform in terms of geotectonic element, belonging to the North China stratigraphic region. According to the strata division of central and southern China, Songshan and Jishan community, Archean group, proterozoic group, Paleozoic erathem and cenozoic erathem are all exposed in this area. Sedimentary rock, magmatic rock and metamorphic rock are complete. The geological structural base in the area is

dominated by faults, followed by folds. The faults are not regional deep faults. Due to their small scale and weak activity since the tertiary, the impact on the project may not be considered. The geomorphic unit types from east to west are: low mountains and hills. The surface lithology is mainly loess-like silt.

Xinmi The project spans the second and third geomorphic steps in Xinmi City. The Songshan Mountain in the southwest is in the front edge of the second geomorphic step, and the alluvial plain of the Yellow River in the east is in the rear part of the third geomorphic step. The low mountains and hills between mountains and plains constitute the transition zone from the second geomorphic step to the third geomorphic step, comprising low mountains, hills and valley plains. The project is generally high in the north and low in the south, belonging to the alluvial-proluvial geomorphic unit.

Xingyang Slightly higher in the west, south and north, it slopes gradually from west to east, like a dustpan, which is half plain and half hilly.

Xinzheng In the morphotectonic pattern of Henan Province, Xinzheng is located in the transition zone from the mountainous area of western Henan to the plain of eastern Henan. It is high in the west and low in the east, high in the middle and low in the north and south. The geomorphological types include mountains, hills, downland and plains. Mountains and hills are mainly distributed in the southwest and west, the eastern edge of the Songshan Mountains, mainly composed of Xingshan Mountain, Juci Mountain, Taishan Mountain, Meishan Mountain, Baozhang Mountain, etc. Among them, the main peak of Juci Mountain has an elevation of 793 meters and a relative height of 540 meters, which belongs to low mountains, all other mountain peaks have an elevation of less than 400 meters and a relative height of less than 200

meters, which belong to hills. Mainly distributed in the outer and middle areas of hills, downland is early inclined diluvial plain in front of mountains, which was formed by running water cutting in the later period. Most of it is covered by the Cenozoic Quaternary loess, and some areas are seriously eroded by soil and water. Most of the plains are distributed on the ancient terraces of the Yellow River east of the Beijing-Guangzhou Railway, including most of the areas in Baqian Town, Longwang Town and parts of Hezhuang Town, Xuedian Town and Mengzhuang Town. There are strip-shaped alluvial plains on the banks of Shuangji River, Huangshui River (ancient Qinshui) and Yishui River west of Beijing-Guangzhou Railway, with a small area.

Zhongmu County Due to the alluviation of the Yellow River and the Jalu River in the northern and central parts, and the remaining mountains of the Funiu Mountain in the southern part, Zhongmu County is high in the west and low in the east, high in the north and south, low in the middle, shaped like a trough. The ridges in the south are undulated and two fan-shaped trough-like zones sloping slightly from northwest to southeast are formed along the Yunliang River and the Jalu River in the northern and central part, and a watershed from southwest to northeast is formed from Malinggang to the upper reaches of Mahe River. The red earth well in the north of Zhanzhuang Village, Zhangzhuang Town in the south is the highest point in the county, with an elevation of 154m. The east of Huxinzhuang Village in Hansi Town in the southeast is the lowest point, with an elevation of 73m and a relative elevation difference of 81m. The terrain slopes downward from Laomiaogang, Xiangyun Temple, red earth well and Malinggang, with a slope of 1/100-1/600; while the slope is reduced to 1/1000-1/2000 to the north and east of Taiqian Village of Zheng'an Town, east of Zhangtang Village of Bagang Town and north and east of Yuanjia

Village of Huangdian Town. Walking southward from the Yellow River dike in the northwest to the county boundary in the southeast, we can see a Yellow River old riverway, with slightly trough like terrain. Yangqiao Village of Wantan Town, close to the Yellow River, has an elevation of 84m. The county has an elevation of 78.1m, and 73m in the southeast boundary of the county, with a slope of 1/1000-1/2000.

4.1.3 Geology and earthquakes

(1) Geology

Zhengzhou is located at the eastern end of the complex tectonic belt of the East-west Qinling Mountains on the Sino-Korean paraplatform. Since the Archean time, the superposition and transformation of the different tectonic actions in different directions, such as the three famous orogenic movements of Songyang, Zhongyue and Shaolin, have made the structural form and framework of the area extremely complicated.

The project is located in the north sub-belt of Qinling latitudinal structural belt and the south wing of Xinmi synclinorium. The basic structural form of the base is nearly east-west, and the structure is mainly fracture. The overlying strata are the sediments of Cenozoic subsidence belt, with no large tectonic activity since Cenozoic and stable geological structure.

The upper part of the strata along the project line is the Cenozoic and Quaternary loose sediments. The lithology includes alluvial and slope deposits, including silt, sandy soil and silty clay. The buried strata in the lower part include Cenozoic Tertiary, Carboniferous, Ordovician and Cambrian. The area is covered by the Quaternary Holocene strata, and the underlying strata are the Pre-Tertiary strata. The rock and soil

media related to highway engineering are the Quaternary strata, and only the lithology of the Quaternary strata is described as follows:

① Quaternary Holocene alluvium (Q4al):

It is mainly yellowish-brown, grayish-yellow sandy soil and silt, with 2 ~ 3 layers of cohesive soil under it. The lower part is mainly composed of a thick layer of medium-fine sand, and coarse sand can be found in the Yellow River old riverway. The thickness is 20 ~ 30m.

② Quaternary upper pleistocene series (Q3al):

The buried depth of the roof is between 20 ~ 30m. It is a set of yellow-gray and yellow-brown silt and silty clay interlayer, with 1 ~ 2 layers of medium-fine or silty-fine sand. There are calcareous nodules in the east, with a diameter of 0.5 ~ 1.0cm.

③ Quaternary middle pleistocene series (Q2al):

It is a set of brownish yellow and brown silt and silty clay interlayer, with more silt in the upper part, and more silty clay in the lower part. The clay is sandwiched with 2~4 layers of sand, with the thickness of a single layer of 4~8 meters, up to 16 meters.

④ Quaternary lower pleistocene series (Q1):

This series is a set of alluvial lacustrine strata (Q1dl + 1) and glacial water illuvial horizon (Q1fgl). The former is mainly composed of brown and brownish yellow silty clay, followed by silt and clay, containing silt and medium-fine sand, with the thickness of a single layer of 4 ~ 8m; the latter is a set of greyish-green, brownish-red, brown clay, silty clay and less silt, with 1 ~ 2 layers of silty-fine sand and medium-fine sand. The clay contains Fe ~ Mn nodules and calcium nodules.

(2) Earthquake

The project area is located in the seismic tectonic area of North China, where there are many seismic activities. According to the historical records of earthquakes in Henan Province, there had been more than 50 earthquakes in Dengfeng and Gongyi, and more than 40 earthquakes in Xingyang, 13 of which were clearly recorded. Only four earthquakes occurred in Gongyi. Among them, an earthquake of Sishui occurred on March 10, 119, with an epicentral intensity greater than 8 and the epicenter near Luoyang. The most recent earthquake occurred in Gongyi on December 14, 1973, with a magnitude of 3. On January 4, 1992, a magnitude 4.7 earthquake occurred between Dengfeng and Yuxian.

The geological structure in this area is dominated by faults. Although the basement faults are developed, they have been shaped in Yanshanian with stable geological structure. According to the *Seismic Ground Motion Parameter Zonation Map of China* (GB18306-2001) and the *Code for Seismic Design of Buildings* (GB50011-2010), the seismic fortification intensity of this area is 7 degrees and the peak acceleration of ground motion is 0.10g.

4.1.4 Climatology and Meteorology

(1) Meteorological characteristics

Zhengzhou, where the project is located, is situated in the north temperate zone. With a temperate continental climate, Zhengzhou has four distinctive seasons: the spring is warm and dry, the summer is hot and rainy, the weather is changeable in autumn with drought and flood, and the winter is cold and windy, with less rain and snow.

(2) Temperature

The average annual temperature is 14.4℃. The high temperatures tend to occur from June to July with extremely high temperatures up to 42-45℃; the low temperatures mainly appear in January with an extremely low temperature of -19.7℃. In the whole year, the average daily temperatures above 0℃ last for 293-312 days.

(3) Sunshine, precipitation, and humidity

Here are around 2,400 sunshine hours annually on average, mainly in July and August, accounting for 30% of the total sunshine hours, and less in January and February, accounting for 10% of the total sunshine hours.

The average annual precipitation is 640.9mm, mainly taking place in June and July, and less in December and January. The average annual relative humidity is 60%, with little difference among the four seasons. The relative humidity mainly varies by the monsoon.

(4) Fog, frost, and snow

The foggy days last for about 17 days over the year. The earliest frost generally occurs in late October, and the latest frost appears in late March. The frost-free period in the whole year is 220 days. The average annual snowfall is 11cm with a maximum thickness of 20cm and a maximum frozen soil depth of 11cm.

(5) Wind direction and speed

The wind direction varies across the seasons. The prevailing winds are northeast and northwest winds in winter and southerly winds in summer. In spring and autumn, the wind direction is unstable. As the wind direction of the near-surface layer is affected by terrain, the wind direction varies slightly from place to place. The average annual wind speed is 3m/s and the maximum wind speed is 18m/s.

4.1.5 Hydrology

Zhengzhou is located in the basins of the Yellow River and the Huaihe River, with a total basin area of 7,446.2km^2. The Yellow River Basin in Zhengzhou covers Gongyi and Shangjie District, part of Xingyang, Mangshan Region and a small part of Zhongmu County, Xinmi and Dengfeng, with an area of 1,830km^2, accounting for 24.6% of the city's total basin area. The Huaihe River Basin covers Xinzheng, Zhongyuan District, Erqi District, Guancheng Hui District and Jinshui District, most part of Xinmi, Dengfeng, Xingyang, Zhongmu County and Mangshan Region, with an area of 5,616.2km^2, accounting for 75.4% of the city's total basin area. 124 streams are flowing through the city, among which, 29 rivers have large basin areas: 6 belonging to the Yellow River Basin and 23 belonging to the Huaihe River Basin. The project area is mainly located in the Yellow River Basin with an average annual water volume of 44.41 billion cubic meters (Yellow River Huayuankou Hydrological Station).

(1) Surface water (river)

This engineering route involves the Yellow River and Huaihe River basins, and the surface runoff and incoming water, mainly coming from natural precipitation, are concentrated in flood season, thus most water becomes surplus water. The transit rivers in the engineering region mainly include the Jalu River, Shuangji River and their branches (Huaihe River Basin), and the branches of the Sishui River (Yellow River Basin). The details are as follows:

Jialu River: a secondary tributary of Huaihe River. Originating in the Honggou Canal and Bianshui River in ancient times, it names after Jia Lu, Minister of Works in the Yuan Dynasty, who presided over the dredging of the shui in 1351 AD.

Jialu River, with two main branches, originates in the mountainous area in the

north of Xinmi City. The west branch, known as "Jingshui River" in ancient times, also known as Jiayu River, originates in Changligou Village, Nanwan, Yuanzhuang Town, Xinmi. It runs northeast through Shangwan and Sihe reservoirs in Xingyang, flows into the Changzhuang Reservoir through Zhangzhuang Village, and then converges with the east branch in Zhaopo Village. The east branch has three sources: west source, Shengshui Valley, Baizhai Town, Xinmi, which runs through Shenhe Village and Quandong Village into Jiangang Reservoir; middle source, ice spring and hot spring of Sanli Village, Houzhai Town, Erqi District, which flows through Sanli Village and converges with the west branch at Quandong Village; east source, Empyrean Fairy Temple spring, Liujiagou Village, Houzhai Town, which flows into the Jiangang Reservoir. The two branches of Jalu River converge in Zhaopo Village, and then run northeast through the Xiliu Lake, Shifo Village, Laoyachen Village, flows east through Dongfeng Canal in Gaocun Village, Zhouzhuang Village, Yaoqiao, Dawu Village, Baisha Town, Chengguan Town, Guandu Town, and Huxinzhuang Village in Hansi Town, and flows southeast through Kaifeng County, Weishi County, Fugou County, Xihua County and downtown of Zhoukou into Yinghe River.

The Jalu River has a total length of 246km and a basin area of 5,896km^2. The river section of the Jialu River in Zhengzhou is 137km long, with a basin area of 2,750km^2 and a multi-year average runoff of 299 million m^3, acting as the main drainage channel of Zhengzhou downtown and Zhongmu County.

The Shuangji River, the former Weishui River, originates in Yangcheng Mountain, Dengfeng. The Qin River originates in Jiluo Cove. Both the rivers belong to the Yinghe River system. Wei River and Qin River converge at the southern Jiaoliuzhai Village, the junction of Xinzheng and Xinmi, named Shuangji River. The

river flows southeast through Huangwan, Changge City and Weishi County into the Jialu River. The river section in Zhengzhou is 35.5km long, with a basin area of 239.864km^2, a normal flow rate of 2m^3/s, an average water depth of 0.5m, and a maximum flow rate of 5,320m^3/s, and a minimum flow rate of 0.52m^3/s. The water of the river is mainly used for irrigation.

Sishui River: A tributary of the Yellow River in midstream. Its east branch, originates from the north slope of Wuzhiling Mountain, Tianzhongwan Village, Jianshan Town, Xinmi, flows through Miaozi Town in Xingyang, Mihe Town in Gongyi, Liuhe Town in Xingyang, Gaoyang Town and Xiawo Town in Shangjie District, and Kouzi Village in Sishui Town into the Yellow River. The west branch, originates in Niudan Mountain, which is located the south of Wuzhiling Mountain, north of Gongmiguan Village, Jianshan Town, Xinmi, runs through Zhonggou Village, Xinzhong Town, Xiaoguan Town, and Lianghekou Village in Mihe Town into the east branch. The Sishui River is 42 km long, with a basin area of 560km^2.

(2) Underground water

The type, depth and water storage capacity of the underground water in the region vary greatly, mainly phreatic water.

Take the Beijing-Guangzhou Railway as the boundary, east region is the fluvial plain of the Yellow River, which is a water-rich area, with an underground water depth of 2-10m. The aquifer mainly includes porous phreatic water in the sand layer and silt layer, as well as the feeble confined water in sand water at the bottom. From the west of the Beijing-Guangzhou Railway to Xingyang, the groundwater is poor, with a common underground water depth of 20-30m. The aquifer is mainly a silt layer and ancient sand layer, belonging to phreatic water.

In summary, the eastern region has rich groundwater, while the medium and western region, which is covered by the loess area, belong to the water-poor area.

The groundwater mainly comes from the atmospheric precipitation and infiltration of river, ditch or pool water, thus the water level varies greatly with the season. Evaporation and artificial exploitation are the main drainage ways of the underground water, and in some sections, the underground water may flow into the river.

According to the underwater quality analysis of other projects nearby, the underwater water in the area is neutral water, with non-corrosiveness.

4.1.6 Vegetation

Belonging to a warm-temperate deciduous broad-leaved forest zone, the vegetation here is mainly species growing in North China, including crops, deciduous arbors and shrubs and wild herbs. The artificial vegetation is mainly artificial protection forests, crops, economic fruit forests and trees on "four sides" (sides of roads, ditches, canals and houses), including arbors, shrubs, and herbs. The arbors include Robinia pseudoacacia, Paulownia fortunei, Platycladus orientalis, Albizia kalkora, Salix matsudana, Melia azedarach, Poplar 107 Clone Tree, and Ulmus pumila. Economic forests mainly include peach trees, jujube trees, walnut trees, and grape vines. The shrubs mainly include Amorpha fruticosa, twigs of the chaste tree, Euonymus japonicus, Ligustrum lucidum, Chinese rose, Rosa xanthina, and Lagerstroemia indica. Herbs mainly include Themeda triandra, green bristlegrass, wild chrysanthemum, Bermuda grass, Artemisia, Carex rigescens, blady grass, Bothriochloa ischaemum, and Pulsatilla.

According to the on-site exploration data, there is no animal or plant listed in *List*

of Wild Plants under State Protection and *List of Animals under State Protection* within 500m around the project area.

4.1.7 Soil

The soils in the project mainly include 2 classes (cinnamon soil and brunisolic soil), 5 subclasses, 18 genera, and 26 species. The brunisolic soils are mainly distributed in the mountain zone with a pH value of 6.5-7.5. Generally, the soil in the south of a mountain is weakly alkaline with a pH value of 7-7.5, and the soil is weakly acidic in the north with a pH value of about 6.5-7, suitable for the growth of trees, grass and medicinal herbs. The cinnamon soils are distributed below 800m, including 5 subclasses: typical cinnamon soil, carbonate cinnamon soil, meadow cinnamon soil, leached cinnamon soil, and cinnamon soil. The plow layer is shallow with lots of gravel residues, thus the drought resistance is poor. The soil is generally neutral (pH value of 7.8-8.2) with an average pH value of 7.1. It has an organic matter content of 2.17%, nitrogen content of 0.076%, rapidly available phosphorus of 9.07 ppm, and rapidly available potassium of 95.9ppm, showing poor physical and chemical properties, and low crop yield.

4.2 Introduction to the sensitive area

4.2.1 Zhengzhou Yellow River Wetland Nature Reserve in Henan Province

4.2.1.1 Natural characteristics

1. Landform

The Yellow River runs east through mountains and hills into the vast middle and downstream fluvial plains. Enormous amounts of sediments carried by the River form a large alluvial fan in the flat area, extending to the northeast, east, and southeast. The

riverway in the Zhengzhou Yellow River Wetland Nature Reserve is located on the ridge of the alluvial fan. In the constraint of the artificial embankment, the famous "hanging river on the earth's surface" is formed, with a riverbed 3-5m higher than the ground outside the embankment, and some sections 9-10m higher, forming a unique riverway watershed. Take the Yellow River as the boundary, the north belongs to Haihe River Basin, while the south belongs to Huaihe River Basin. With a distance between the two dikes of 5-10km and a river channel width of 1-3km, the riverbed shows overall flat terrain and complex landform in microscopic view. The terrains mainly include the main river channel, stream (distributary), beach, bottomland and dike. The beaches are divided into three levels according to the overflow conditions at different flow rates: the first level is a "tender beach", which will be submerged at a normal water level; the second level, also known as the second beach, is 1.5m higher than the first level, and will be submerged at a flow rate of 1,000; the third level, known as high beach, is 2.5-4.0m higher than the second beach and is usually not submerged. The water surface altitude inside the embankment is 65-99m.

2. Climate

The Reserve belongs to a warm temperate continental monsoon climate. Under the influence of the monsoon, it is dry and windy in spring, hot and rainy in summer, cool in autumn, and dry and cold in winter. With short spring and autumn, it enjoys four distinct seasons. Showing abundant light, heat and water resources, the moderate climate, as well as rain and heat over the same period are conducive to the growth of various plants. The average annual temperature here is 14.2℃. The coldest month is January, with a monthly average temperature of -3℃ and an extremely low temperature of -17.9℃; the hottest month is July, with a monthly average temperature

of 27.3℃ and an extremely high temperature of 43℃. The average annual sunshine hours are 2,366, with an average annual sunshine rate of 56%. The hours of sunshine in June are 265.6, which is the largest, and that in February is 167.9, which is the smallest. The average annual frost-free period is 227 days. The average annual precipitation days are 82.3 with an average annual natural precipitation of 616mm, mostly from June to September. The average annual evaporation is 1,664.2mm, the evaporation in winter is 7 times higher than the precipitation, and the evaporation in June is 41 times higher than the precipitation. The average annual relative humidity is 68%, with a maximum value of 81% in August, and a minimum value of 61% in January. The average annual wind speed is 2.5m/s with a basic wind pressure of 40kg/m^2, the northeast and northwest winds prevail in winter and spring. As the precipitation varies widely from year to year and season to season, it is prone to disasters such as floods, drought, wind, and hail.

3. Soil

Soil is an important part of the natural landscape. In the long process of development, the soil composition and type vary greatly under the influence of various natural factors and human activities. The soil in the region is developed from the sediment carried by the Yellow River, showing complex types and distributions. The soils here mainly include fluvo-aquic soil and yellow fluvo-aquic soil, also aeolian sandy soil and saline-alkali soil. The soil is regularly distributed, and the fertility is improved gradually due to the decrease of desertification of soils under the action of sorting. In the high beach and second beach, the soils are mainly heavy loam, sandy loam and sandy soil, also sediment. On the tender beach, the soils are mainly sediment and sandy soil, also a small amount of saline-alkali soil in the bottomland.

4. Hydrology

The total length of the river in the region is 158.5km with a gradient of 1/5525. The main tributaries in this section flowing into the Yellow River are Yiluo River (Gongyi) and Sishui River (Xingyang) in the south, as well as Qinhe River and Xinmang River in the north. This section of the Yellow River has a broad and shallow riverbed, multiple alluvions and distributaries, showing severe deposition, and acute swing amplitude in the mainstream, and belonging to typical wandering and flood-prone section. The flood cycle is as follows: the moderate flood (equivalent to 15,000m^3/s of Huayuankou Hydrological Station in 1954) occurs every about 20 years; the major flood (equivalent to 22,300m^3/s at Huayuankou Hydrological Station in 1958) occurs every 50 about years; the catastrophic flood occurs every about 1,000 years. The maximum flood peak flow is 32,000m^3/s (at Huayuankou Hydrological Station in 1796). The floods occur 6-8 times annually and can be up to 10-13 times in a few years. The floods generally occur in July and August, and the extra-large floods occur in mid-August to mid-August. The floods can last for 30-40 days, up to 45 days. Since 1980, the average monthly flow of the Yellow River in the area has been stable at 400-4,500m^3/s. In dry seasons (January to June, November to December), the average monthly flow is 400-1,500m^3/s, usually less than 1,000m^3/s; in flood seasons (July to October), the monthly average flow is 1,200-8,000m^3/s, with a maximum flow of 4,000-8,000m^3/s over the year. The flood peak above 10,000m^3/s occurs every 4-5 years, with a maximum flood peak flow of 15,300m^3/s (Huayuankou Station, August 2, 1982). The annual runoff is 300-600×$10^8$$m^3$/s. The highest water level of the Yellow River is 93-94m above sea level, and the lowest water level is 92-92.4m.

4.2.1.2 Current biological resources

1. Habitat type

A large area of wetlands was formed as the Yellow River runs into the Huang-Huai Plain. Due to the high content of sediment, siltation, erosion, overflow and diversion occur frequently, forming diverse ecological types in this area. The main habitat types are wetlands, forests, shrubs and farmlands.

Wetlands: the wetlands in the Reserve are mainly river wetlands and swamp wetlands. Among them, river wetlands include permanent rivers (riverbeds, low flood plains) and flood plain wetlands (second beaches); swamp wetlands include herbaceous swamps and shrub swamps. Riverbed and low flood plain are mainly distributed in and around the main channel. The vegetation is sparse due to continuous sediment accumulation; the flood plain is distributed between the main channel and high beaches (or flood bank), with crops and natural vegetation alongside the farmland, road and on the uncultivated beach. The swamp wetlands spread in second beaches, high beaches and bottomlands, with abundant plant communities, including Phragmites australis, Typha angustifolia, Nelumbo nucifera, Scripus triqueter, nutgrass flatsedge, Potamogeton distinctus, Lemna minor, Spirodela polyrrhiza, Hydrilla verticillata, Myriophyllum verticillatum, Potamogeton pusillusy, Potamogeton crispus, and Najas marina.

Forests: Due to repeated river erosion and human activities, there have been no natural forests in the Reserve, and most of the natural vegetation has been replaced by farmland, artificial forests and villages. Artificial forests include shelter forests and fruit forests. The shelter forests are spread in the sandy land and roadside along the Yellow River dike, playing the role of flood control, dike and road protection, wind

prevention and sand fixation. The trees are mainly Saliz matsudana, Populus, Ulmus pumila and Robinia pseudoacacia. The fruit forests are commonly distributed in the flat sandy land and region around villages on the high beaches. Such local economic forests mainly include apples, pears, peaches, grapes, jujubes and ginkgo trees. The area of fruit forests is expanding year by year.

Shrub (herb): shrubs (herbs) mainly include sandy shrub (herb) and halophyte shrub (herb), including Agriophyllum squarrosum, Corispermum hyssopifolium, Imperata cylindrica, Tournefortia sibirica, Tamarix chinensis, Polygonum sibiricum, Crypsis aculeata, Puccinellia distans, and Suaeda salsa.

Farmlands: Most of the farmlands are situated at high beaches, but also at the second beaches during non-flood seasons. The main crops are wheat, corns, soybeans, mung beans, peanuts, sorghums, watermelon, and also rice planted outside the dike of the river section in Zhongmu County and Jinshui District.

2. Animal resources

The Reserve belongs to the Palaearctic realm - North China region - Huang-Huai plain subregion. According to previous investigations and historical records, there are 301 species of terrestrial wild vertebrates in the Reserve, including 252 birds, 21 beasts, 11 amphibians and 17 reptiles. Among which, there are 10 species of national first-class protected animals: black stork, white stork, great bustard, white-tailed sea eagle, golden eagle, eastern imperial eagle, Pallas's fish eagle, hooded crane, red-crowned crane and siberian crane; 32species of national second-class protected animals: andrias, great white pelican, spot-billed pelican, eurasian spoonbill, greater white-fronted goose, whooper swan, goose, mandarin duck, glede, northern goshawk, eurasian sparrowhawk, besra, upland buzzard, common buzzard, greater spotted eagle,

vulture, white-tailed eagle, pied harrier, western marsh harrier, osprey, peregrine falcon, red-footed falcon, common kestrel, common crane, demoiselle crane, collared scops owl, eurasian eagle-owl, little owl, long-eared owl, short-eared owl, and otters; 79 species of birds listed in the *Sino-Japan Migratory Birds Protection Agreement*; and 23 species listed in *Sino-Australia Migratory Birds Protection Agreement*.

(1) Beasts

There are 21 species of beasts in the Reserve, belonging to 8 families and 5 orders. Among them, 11 species are rodents, accounting for 52.4%. There are composed of 11 Palaearctic species, accounting for 52.4% of the total number of mammals, 7 oriental species, accounting for 33.3%, and 3 eurytopic species, accounting for 14.3%.

(2) Birds

Up to now, a total of 252 species of birds belonging to 59 families and 17 orders have been recorded. Among them, there are 32 Anatidae species, 10 accipitridae species, 12 ardeidae species, 10 scolopacidae species, 47 pelecanidae species, 2 pelecanidae species, 2 ciconiidae species, 2 threskiorothidae species, 4 falconidae species, 1 pandionidae species, 3 species in 2 families of galliformes, 12 species in 3 families of gruiformes, 42 species in 8 families of charadriiformes, 4 species in columbidae of columbiformes, 4 cuculiformes species, 3 strigidae species, 1 caprimulgiformes species, and 104 species in 28 families of passeriformes.

Among the 252 species, there are 72 eurytopic species, accounting for 28.57% of the total number of birds, 138 Palaearctic species, accounting for 54.76%, and 42 oriental species, accounting for 16.67%. There are 103 species of breeding birds (including resident birds and summer migrants), accounting for 40.87% of the total

number of birds in this area, while there are 148 species of non-breeding birds (including winter migrants and passing migrant birds), accounting for 58.73% of it. Among the 103 species of breeding birds, 28 Palaearctic species account for 27.18%, 34 oriental species account for 33.01%, and 41 eurytopic species account for 39.81%. Whether it is about the fauna composition of the total birds or the breeding birds, it can be seen that Palaearctic species are dominant, followed by eurytopic species, and the proportion of oriental species is the smallest.

The most important feature of bird composition in this area is that migratory birds (including summer migrants, winter migrants and passing migrant birds) account for a large proportion. Among the 252 species of birds, 48 are resident birds, accounting for 19.05% of the total number of bird species in this area, and 129 species of migratory birds, accounting for 75.1% of it. Among the migratory birds, there are 50 species of summer migrants, accounting for 19.84% of the total number of bird species and 38.76% of the total number of migratory bird species; 79 species of winter migrants, accounting for 31.35% of the total number of bird species and 61.24% of the total number of migratory bird species, and 67 species of passing migrant birds, accounting for 26.59% of the total number of bird species and 51.94% of the total number of migratory bird species.

(3) Reptiles

17 species of reptiles belonging to 7 families and 3 orders have been recorded in this area. Among them, there are 2 species in 2 families of chelonia, 4 species in 3 families of lacertiformes, and 11 species in 2 families of ophidia. In terms of fauna composition, 6 eurytopic species account for 35.3%, 4 palaearctic species account for 23.5%, and 7 oriental species account for 41.2%.

(4) Amphibians

There are 11 amphibian species in 5 families and 2 orders, including 6 eurytopic species, 2 oriental species, and 3 palaearctic species. It has the typical characteristics of transitional zone. Among the 11 species, bufo gargarizans, rana limnocharis and rana nigromaculatas are abundant and widely distributed, while other species are few.

(5) Fish

According to the results of the water area survey conducted by Henan Normal University, there are 34 species of fish in the area, belonging to 32 genera, 12 families, and 7 orders. The main commercial fish are grass carp, carp, crucian carp, bighead carp, hemiculter leucisculus, squaliobarbus curriculus, culter erythropterus, and silver carp, snakehead of channidae, and catfish of silphidae. Crucian carp, snakehead, squaliobarbus curriculus, hemiculter leucisculus, and catfish are more common in natural waters such as rivers and ponds. In artificial fish ponds, grass carp, carp, bighead carp, and silver carp are the dominant species.

(6) Insects

According to the investigation and consulting the relevant literature, a total of 426 species of insects belonging to 13 orders and 108 families have been recorded. They are mainly concentrated in lepidoptera, coleoptera, hymenoptera, homoptera, and odonata, accounting for 74.7% of the total number of insect species.

3. Plant resources

(1) Plant species

There are 598 vascular plant species (including 4 varieties) in 284 genera and 80 families in the area, accounting for about 14.6% of the total plant species in the province. Among them, there are 14 pteridophyte species in 9 genera and 8 families,

accounting for 27.6% of the total families, 11.4% of the total genera, and 6.8% of the total species of pteridophytes in Henan. There are 582 angiosperm species and varieties in 273 genera and 70 families, accounting for 35.3% of the total families, 23.5% of the total genera, and 14.7% of the total species of plants in the province. There are only 2 gymnosperm species in 2 genera and 2 families. Among the 598 species of plants, there are 38 species of woody plants and 560 species of herbaceous plants.

(2) Vegetation types

(Aquatic vegetation: Phragmites australis community, typha angustifolia community, lotus community, scripus triqueter community, and sedge community; phytoplankton community (the dominant species is pondweed), duckweed, duckweed community, spirodela polyrrhiza community, hydrilla community, myriophyllum community, potamogeton spinosa community, potamogeton crispus, najas marina community, ceratophyllum community, and bladderwort community. Sandy vegetation: Lespedeza daurica community, robinia pseudoacacia community, agriophyllum squarrosum, corisperinumsp. community, puccinellia tenuiflora community, tournefortia sibirica community, chenopodium viridis community, and artificial sown Astragalus adsurgens community.

Halophytic vegetation: Tamarix community, Siberian polygonum community, crypsis aculenta, puccinellia tenuiflora community, suaeda salsa community, Limonium bicolor community, and chenopodium glaucum community.

Shelterbelt and fruit forest vegetation: Salix matsudana forest, dustpan willow scrub, and apple, pear, peach, grape, jujube and other fruit trees.

(3) Rare plants

Glycine soja is one of the national second-level key protected wild plants. In addition, there are two endemic species in the Yellow River region, corispermum huanghoense and cynanchum riparium.

4.2.1.3 Functional zone

The adjusted Provincial Zhengzhou Yellow River Wetland Nature Reserve, located at 34°48′~35°00′ N and 112°48′～114°14′ E, covers an area of 374.414 square kilometers, with the core area of 98.387 square kilometers, accounting for 26.3% of the total area, the buffer zone of 28.862 square kilometers, accounting for 7.7% of the area, and the experimental area of 247.165 square kilometers, accounting for 66.0% of the area. Here is detailed information:

1. The core area:

The core area consists of 12 parts, covering an area of 98.387 square kilometers, accounting for 26.3% of the total area. The boundary is defined based on the satellite film made in 2012-2016 and the established wetland interpretation mark in combination with the distribution of the protected in the area and the state of the ecological environment. See Figure 3-1 Functional Zoning Map of Provincial Zhengzhou Yellow River Wetland Nature Reserve for details. The project areas include:

(1) the area stretching from Jinggou Village, Kangdian Town, Gongyi City in the west to Peiyu Village Control Project in the east, about 7.902 square kilometers.

(2) the area stretching from the southern part of Peiyu Village Control Project in the west to Shenbei Village, Heluo Town, Gongyi City in the east, about 7.383 square kilometers.

(3) the area stretching from Shenbei Village, Heluo Town, Gongyi City in the west to the western part of Kouzi Village in the east, about 19.272 square kilometers.

(4) the area stretching from Lupo Village, Xuecun Village, Wangcun Town, Xingyang City, to the northern part of Shihenggou in the east, about 6.452 square kilometers.

(5) the area stretching from Guanzhuangyu Village, Gaocun Town, Xingyang City in the west, to the western part of Taohuayu Bridge in the east, about 8.847 square kilometers.

(6) the area stretching from Huangheqiao Village, Guxing Town, Huiji District in the west, to the western part of Nanguotou Square in Zhengzhou Yellow River National Wetland Park in the east, about 3.744 square kilometers.

(7) the area stretching from the eastern part of Nanguotou Square in Zhengzhou Yellow River National Wetland Park in the west to Huayuankou Village, Huayuankou Town in the east, about 3.039 square kilometers.

(8) the area stretching from Nanyuedi Village, Huayuankou Town, Huiji District in the west, to Shenzhuang Village in the east, about 1.322 square kilometers.

(9) the area stretching from Tongzhai Village, Longzihu Sub-district Office, Jinshui District in the west, to Sanliuzhai Village, Wantan Town in the east, about 10.281 square kilometers.

(10) the area stretching from Lizhuang Village, Yanminghu Town, Zhongmu County in the west, to Nanren Village, Langchenggang Town in the east, about 20.668 square kilometers.

(11) the area stretching from the northern part of Nanbeijie Village, Langchenggang Town, Zhongmu County in the west, to the northern part of Nanweitan Village, Zhongmu County in the east, about 3.025 square kilometers.

(12) the area stretching from the northern part of Nanweitan Village, Langchenggang Town, Zhongmu County in the west, to the border of Zhongmu County in the east, about 6.452 square kilometers.

2. The buffer zone:

The buffer zone consists of 12 parts, covering an area of 28.862 square kilometers, about 7.7% of the total area of the Reserve. It is placed between the core zone parts and the experimental zone parts, to separate the core zone section from the experimental zone section. See Figure 3-1 Functional Zoning Map of Provincial Zhengzhou Yellow River Wetland Nature Reserve for details. The project areas include:

(1) the area stretching from the eastern part of Jinggou Village, Kangdian Town, Gongyi City in the west, to Peiyu Village Control Project in the east, about 2.033 square kilometers.

(2) the area stretching from the end of Peiyu Village Control Project in the west, to Shenbei Village, Heluo Town, Gongyi City in the east, about 2.542 square kilometers.

(3) the area stretching from Shenbei Village, Heluo Town, Gongyi City in the west to the western part of Kouzi Village in the east, about 4.042 square kilometers.

(4) the area stretching from Lupo Village, Xuecun Village, Wangcun Town, Xingyang City, to the northern part of Shihenggou in the east, about 2.494 square kilometers.

(5) the area stretching from Guanzhuangyu Village, Gaocun County, Xingyang City in the west, to the western part of Taohuayu Bridge in the east, about 1.732 square kilometers.

(6) the area stretching from Huangheqiao Village, Guxing Town, Huiji District in the west, to the western part of Nanguotou Square in Zhengzhou Yellow River National Wetland Park in the east, about 1.286 square kilometers.

(7) the area stretching from the eastern part of Nanguotou Square in Zhengzhou Yellow River National Wetland Park in the west, to Huayuankou Village, Huayuankou Town in the east, about 1.445 square kilometers.

(8) the area stretching from Nanyuedi Village, Huayuankou Town, Huiji District in the west, to Shenzhuang Village in the east, about 1.221 square kilometers.

(9) the area stretching from Tongzhai Village, Longzihu Sub-district Office, Jinshui District in the west, to Sanliuzhai Village, Wantan Town in the east, about 2.709 square kilometers.

(10) the area stretching from Lizhuang Village, Yanminghu Town, Zhongmu County in the west, to Nanren Village, Langchenggang Town in the east, about square kilometers.

(11) the area stretching from the northern part of Zhongmu Village, Langchenggang Town, Zhongmu County in the west, to the northern part of Nanweitan Village, Zhongmu County in the east, about 1.414 square kilometers.

(12) the area stretching from the northern part of Nanweitan Village, Langchenggang Town, Zhongmu County in the west, to the border of Zhongmu County in the east, about 2.002 square kilometers.

3. The experimental area:

The experimental area, covering an area of 247.165 square kilometers, 66.0% of the total area of the Reserve, is set outside the buffer zone. It extends from Caobaipo Village, Kangdian Town, Gongyi City in the west, to East Langchenggang Village, Langchenggang Town, Zhongmu County in the east, passing many cities such as Gongyi, Xingyang, Huiji District, Jinshui District, Zhengdong New District, and Zhongmu. See Figure 4-1 Functional Zoning Map of Provincial Zhengzhou Yellow River Wetland Nature Reserve for details.

4.2.1.4 The overall layout of the Reserve

The Provincial Zhengzhou Yellow River Wetland Nature Reserve is generally divided into a protected area and an operating area.

1. The protected area

The protected area, composed of core areas and buffer zones, is used to protect the wetland ecosystem, wildlife and natural resources (especially the rare and endangered species). Home to many rare and endangered species, this area deserves key protective efforts.

Measures for the protection of the core area shall be in line with national laws and regulations. No human activity is allowed in the core area except the inspection, observation and regular resource investigation conducted by the protection and management departments. People who need to enter the core area for scientific and educational affairs and some specimens in order to make advances in science and education, shall submit an application and plans and enter the core area after receiving approval.

2. The operating area

The operating area, limited within the experimental area, is set up for the exploration of a mode that sustains the utilization of natural resources. Activities that are allowed in the experimental area include:

(1) conducting scientific investigation and teaching practice, collecting the specimen, and setting up fixed observation points and experimental sites.

(2) fostering rare and endangered wildlife, and exploring an approach that sustains the utilization of wildlife resources.

(3) conducting research on the structure and evolving of wetland ecosystems, and exploring ways to improve the productivity of wetlands.

(4) carrying out activities like popular science tours, ecotourism and summer camps to urge people to protect nature, the environment and inspire their love for the motherland.

4.2.1.5 Ecological function

According to the *Ecological Function Zoning of Henan Province*, the Reserve is classified as the Mountainous and Hilly Ecological Region, the Yellow River Wetland Ecological Sub-region, and the Yellow River Wetland Ecological Function Region in western Henan. As a mountainous and hilly region, the area is a transitional section for the Yellow River flowing from mountain area to plains, with the riverway gradually widened by 3~5km. On the left bank is discontinuous hills, 10~40m above the river, and on the right bank is Mangshan Mountain, 100~150m above the river. The section of the Yellow River belongs to the river valley wetland ecosystem, mainly playing a role in conserving water and wetland ecology. In the face of severe soil erosion caused by high topography and low vegetation coverage, and heavier water pollution in a wider area, drinking water and wetland ecological environment are now

threatened seriously. In such cases, measures must be taken to improve the capability of the industries and enterprises along the river to deal with their possible pollution. Efforts must be put into returning farmland to forests and grasslands and protecting the natural vegetation on both banks, to prevent soil erosion.

4.2.1.6 Location relationship between projects and the Reserve

Project Y062 is located in the experimental area of the Reserve, about 5 meters long. Project C772 is located in the experimental area of the Reserve, about 338 meters long. For more details, please refer to Figure 2.3-9. The projects are rebuilt on their former sites, without new land occupied, which will not cause effects on the wetland.

4.2.2 Zhengzhou Yellow River Common Carp National Aquatic Resources Reserve

4.2.2.1 Overview of the Reserve

The Zhengzhou Yellow River Common Carp National Aquatic Resources Reserve (No. 4101), was set up based on the approval by the Ministry of Agriculture of the PRC on December 12, 2007 (see announcement No. 947 of the Ministry of Agriculture of the People's Republic of China).

The total area of Zhengzhou Yellow River Common Carp National Aquatic Resources Reserve is 246.51 square kilometers, with a core area of 72.49 square kilometers, and an experimental area of 174.02 square kilometers. The Reserve refers to the area of the Yellow River section in Gongyi, Xingyang, Huiji, Jinshui and Zhongmu (cities and districts) of Zhengzhou and the Yiluo River, a branch of the Yellow River, which is within the bank or the River Control Projects, including the water area and seasonal bottomland.

It is located at 112°56′49"~114°04'37"E, 34°46′00"~34°59'54"N. The area covers the Yiluo River from Kangdian Town Bridge (112°56'49"E, 34°46′00"N) to the mouth of the Yellow River (113°03′40"E, 34°50′22"N), 16 km in length; the section from Nanhedu Yellow River Highway Bridge in Heluo Town, Gongyi City (113°03′40"E, 34°50'22"N), to Dam 118 of Yellow River Control and Diversion Project in Jiubao Village, Wantan Town, Zhongmu County (114°02′47"E, 34°56'42"N), 112.82 km in length. The protected area includes two core areas and two experimental areas. The core areas include: the core area of Yiluo River, from Kangdian Bridge in Gongyi City to the mouth of the Yellow River, 16 km in length, an area of 5.34 square kilometers; the core area of Huayuankou, from the boundary pillar in the middle and lower reaches of the Yellow River (113°28′13"E, 34°57'16"N) to the Yellow River Highway Bridge along the Beijing-Zhuhai Expressway in Madu Village, Yaoqiao Town, Jinshui District (113°48′45"E, 34°52'34"N), 36.26km in length, an area of 67,15 square kilometers. The two experimental areas refer to: the east experimental area, from the Beijing-Zhuhai Expressway-Yellow River Highway Bridge to the Dam No. 18 of the Yellow River Control Project at Jiubao Village, Wantan Town, Zhongmu County, 23.82km in length, an area of 86.79 square kilometers; and the west experimental area, from Nanhedu Highway Yellow River Bridge to the boundary pillar in the middle and lower reaches of the Yellow River, 52.72km in length, an area of 87.23 square kilometers.

The special protection period of the core area: April 1 to June 30.

During this period, what needs to be protected are the Yellow River carp and its spawning grounds, feeding grounds and wintering grounds, as well as the aquatic ecology and terrestrial ecosystem in which they live.

4.2.2.2 Functional zoning of the Reserve

1. The core area

According to the distribution of the concentrated area of the spawning grounds of the yellow river carp relying on the investigation data of the fish resources of the Yellow River in the past years and the actual distribution of the spawning grounds, feeding grounds and wintering grounds of the Yellow River carp in the Zhengzhou section of the Yellow River, two core areas were defined, namely, the Huayuankou core area and the Yiluo River core area.

(1) The Huayuankou core area is located in Huiji District, from the boundary tablet in the middle and lower reaches of the Yellow River (113°28′13"E, 34°57'16"N) to the Yellow River Highway Bridge along the Beijing-Zhuhai Expressway in Madu Village (113°48′45"E, 34°52′34"N), located at Madu Village, Yaoqiao Town, Jinshui District, 36.26km in length, an area of 67.15 square kilometers.

(2) The Yiluo River core area is located in Gongyi City, from the Yiluo River Kangdian Bridge (112°56′49"E, 34°46'00"N) to the mouth of the Yiluo River (113°0340"E, 3450′22"N), with a length of 16km and an area of 5.34 square kilometers. With emergent plants surrounding and submerged plants, the core area is indeed an ideal place for the Yellow River carp's spawning.

2. The experimental area

The experimental area, consisting of the western part and the eastern part, covers an area of 174.02 square kilometers, accounting for 71.9% of the total protected area. The eastern experimental area starts from the Beijing-Zhuhai Expressway-Yellow River Highway Bridge to Dam No. 118 of the Yellow River Control Project at Jiubao Village, Wantan Town, Zhongmu County, with a length of 23.82km and an area of

86.79 square kilometers; the west experimental area is from Nanhedu Highway Yellow River Bridge to the boundary pillar in the middle and lower reaches of the Yellow River, with a length of 52.72km and an area of 87.23 square kilometers. The western experimental area is located in the transition zone of the Yellow River from the valley to the plain, where the riverfront area is a hilly area and the beach area is farmland, embracing excellent transport links. The eastern experimental area is an alluvial fan area in the lower reaches of the Yellow River, characterized by wide river channels, siltation and wetland ecological communities. The area within the Yellow River bank is home to numerous permanent residents, with a large agricultural planting area.

See Figure 4-2 for the functional zoning of the Zhengzhou Yellow River Common Carp National Aquatic Resources Reserve

4.2.2.3 Management requirements

The core area is subjected to prohibitive management. Measures for the protection of the core area shall be in line with national laws and regulations. No human activity is allowed in the core area except the inspection, observation and regular resource investigation conducted by the protection and management departments. People who need to enter the core area for scientific and educational affairs and some specimens in order to make advances in science and education, shall submit an application and plans and enter the core area after receiving approval.

The experimental area is subjected to restrictive measures. Keeping the protection, recovery and development of aquatic wildlife germplasm resources in mind, people are allowed to carry out items like seedling cultivation, scientific experiments, teaching practices, exploration and inspections, proliferating, resource

investigation and ecological environment testing; breed and proliferate aquatic wildlife, and explore reasonable development and utilization of Yellow River carp germplasm resources in the protected areas; carry out activities such as technology promotion and ecotourism, and boost the economy and self-support capacity of the protected areas, so as to promote social and economic development, bringing the improvement of ecological benefits, social benefits and economic benefits for the protected area.

4.2.2.4 Location of the project and the protected area

The Reserve refers to the area of the Yellow River section in Gongyi, Xingyang, Huiji, Jinshui and Zhongmu and the Yiluo River, a branch of the Yellow River. It is within the bank or the River Control Project, including the water area and seasonal bottomland. The project lies in the Mangling Town and the area south to the town, and the roads on both sides of the Gongyi Section of the Yiluo River are also beyond the Yellow River Common Carp National Aquatic Resources Reserve in Zhengzhou Section of the Yellow River, away from water.

The wastewater produced by the project shall not be discharged into the surface water along the project line.

4.2.3 Compliance Analysis with the *Regulations on Scenic Spots* (Revision 2016)

The scenic spot related to the project is the Yellow River Scenic Area.

The Yellow River Scenic Area built along the Yellow River, lying 20 km northwest of Zhengzhou, is a national AAAA scenic area and a national water conservancy scenic area.

Table - 4-1 Analysis of compliance between the project and the *Regulations on Scenic Spots*

Provisions of the *Regulations on Scenic Spots*	**Content of the project**	**Compliance**
Article 26 Activities that shall be prohibited in the scenic area: (1) acts that may cause damage to the landscape, vegetation, topography and physiognomy, such as mountain quarrying, mining, land reclamation, and building graves; (2) Building facilities for storing explosive, inflammable, radioactive, toxic or corrosive materials; (3) carving or painting on attractions or facilities; and (4) littering rubbish everywhere.	This is a project of post-disaster reconstruction of rural roads damaged by the "7.20" heavy rainstorm in Zhengzhou, and no extra land area is involved. It is not an activity prohibited by the regulations.	Comply
Article 27 It is forbidden to set up buildings that are of no use for the protection of scenic spots in a way of violating the planning of the scenic spots, such as the development zones set up in the scenic spots, and the hotels, guest houses, training centers and sanatoriums built in the core scenic spots. These factors shall be removed in accordance with the planning of scenic spots.	The roads involved in the project are existing roads in the scenic area, and their construction is in line with the planning of the scenic area.	Comply
Article 30 Construction projects in scenic areas shall conform to the planning of scenic areas and coordinate with the landscape, and shall not destroy the landscape, pollute the environment or hinder sightseeing. Where construction activities are carried out in a scenic spot, the construction unit or unit shall formulate a plan for pollution prevention and control and water and soil conservation and take effective measures. Protect the surrounding landscape, water, forest and grass vegetation, wildlife resources and topography.	The road section of the project is the original road in the scenic area, with no additional land; the project has formulated corresponding pollution prevention and control and water and soil conservation plans.	Comply

Article 33 The administrative authority of scenic spots shall, in accordance with the planning of scenic spots, rationally utilize the resources of scenic spots and improve transportation, service facilities and sightseeing conditions.	Restoration of waterlogged roads in scenic areas is in line with the content of "improve transportation, service facilities and sightseeing conditions".	Comply

4.3 Monitoring and evaluation of the environmental quality status

4.3.1 Current situation and evaluation of ambient air quality

According to the *Technical Guidelines for Environmental Impact Assessment-Atmospheric Environment* (HJ2.2-2018), the data or conclusions in the environmental quality announcement or environmental quality report of the evaluation benchmark year publicly released by the national or local competent department of the ecological environment were given priority for determining whether the area where the project was located reaches the standard or not. The monitoring data of one consecutive year of the evaluation benchmark year in the national or local ambient air quality monitoring network within the scope of evaluation were used. The current data of ambient air quality publicly released by the competent department of the ecological environment were used. In this evaluation, the data from the *Bulletin on Environmental Quality Status of Zhengzhou in 2020* issued by the Zhengzhou Ecological Environment Bureau was referenced, and the evaluation factors are PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, O_3. See Table 4-2 for the statistical results.

Table 4-2 Statistics of ambient air quality monitoring results

Pollutant	Annual index	Current annual average concentration/(μg/≤m^3)	Criterion/(μg/≤m^3)	Percentage/%	Excessive rate	Standard compliance
PM_{10}	Annual average mass concentration	84	70	120	0.2	Excessive
$PM_{2.5}$	Annual average mass concentration	51	35	145.7	0.457	Excessive
SO_2	Annual average mass concentration	9	60	15	0	Up to standard

Pollutant	Annual index	Current annual average concentration/(μg/≤m³)	Criterion/(μg/≤m³)	Percentage/%	Excessive rate	Standard compliance
NO_2	Annual average mass concentration	39	40	97.5	0	Up to standard
CO	95th percentile of 24-h average concentration	1,400	4,000	35	0	Up to standard
O_3	90th percentile of daily maximum 8-h average concentration	182	160	113.8	0.138	Excessive

It can be seen from the above table that PM_{10}, $PM_{2.5}$ and O_3 in Zhengzhou's ambient air did not meet the standards to different degrees in 2020. According to the *Technical Guidelines for Environmental Impact Assessment-Atmospheric Environment* (HJ2.2-2018), the area where the project is located is determined to be a substandard area because all six pollutants have not met the standards.

The analysis shows that PM_{10} and $PM_{2.5}$ exceeding the standard is mainly caused by the dry and windy climate in northern China; Ozone pollution has obvious seasonal characteristics, and its concentration is generally high from May to September. In a hot summer season, due to the strong solar radiation and high temperature, photochemical smog and secondary ozone are easily produced. The continuous high temperature and strong sunshine weather are conducive to the atmospheric photochemical reaction between nitrogen oxides and volatile organic compounds, thus generating strong oxidants such as ozone at the ground level. As a result, ozone increases with temperature.

In view of the fact that the air quality is not up to standard, Zhengzhou is currently implementing the *Notice on Printing and Distributing Implementation Plan for the Air, Water and Soil Pollution Prevention and Control and Agricultural and Rural Pollution Control in Henan Province in 2021* (YHGJB [2021] No. 20) and the *Notice on Printing and Distributing Implementation Plan for Air, Water, Soil, Agricultural and Rural Pollution Prevention and Control in Zhengzhou in 2021* (ZB

[2021] No. 15). By accelerating the adjustment of energy consumption structure, deepening the prevention and control of industrial atmosphere, comprehensively curbing dust pollution and other management measures, the pollutant discharge is reduced, and the regional atmospheric environmental quality is further improved.

4.3.2 Current situation and evaluation of surface water environmental quality

The rivers involved in this project route mainly include Suohe River, Kuhe River, Jialu River, Chaohe River, Shibali River, Sishui River, Yiluo River, Qingyi River, and Shuangji River.

Yiluo River, Kuhe River and Sishui River are from the Yellow River Basin. Yiluo River and the mainstream of the Yellow River are subject to Grade III Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002), and Jialu River and Shuangji River are subject to Grade IV Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002). The surface water status of Kuhe River, Sishui River, Yiluo River, Jialu River and Shuangji River in this evaluation was based on the data from Huayuankou monitored section of the Yellow River in Zhengzhou, Qilipu monitored section of Yiluo River in Gongyi, Chenqiao monitored section of Jialu River in Zhongmu and Huangfuzhai monitored section of Shuangji River in Xinzheng published by Zhengzhou Ecological Environment Bureau from January to December 2021 in the water quality monitoring bulletin of state-controlled sections. See Table 4-3 for monitoring results.

Suohe River, Chaohe River and Shibali River are subject to Grade IV Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002). The surface water status of Suohe River, Chaohe River and Shibali River in this evaluation was

based on the monitoring data from the monitored section of Suoxu River entering Jialu River, the monitored section of Chaohe River entering Qilihe River and the confluence of Shibali River and Shiqili River (upper reaches of Shibali River) in the report of water quality ranking of 10 rivers in Zhengzhou from January to December 2021 released by Zhengzhou Ecological Environment Bureau. See Table 4-4 for monitoring results.

Qingyi River is a tributary of Yinghe River and is from the Huaihe River Basin. It is subject to Grade IV Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002), and the surface water status of Qingyi River in this evaluation was based on the routine monitoring data of water quality of Linying Gaocun Bridge section of Qingyi River downstream. Based on *the Data of Xuchang Environmental Monitoring Yearbook (2020)*, the monitoring statistics of Gaocun Bridge section in Qingyi River are shown in Table 4-5.

Table 4-3 Water quality data of the state-level monitored section (excerpt)

Unit: mg/L

Monitoring factor / Monitoring time	Chemical oxygen demand (mg/L)	Ammonia-nitrogen (mg/L)	Total Phosphorus (mg/L)	Standard compliance		
				Chemical oxygen demand	Ammonia-nitrogen	Total Phosphorus
Huayuankou monitored section of the Yellow River in Zhengzhou: subject to Grade III Standard in the *Environmental Quality Standard for Surface Water* (GB3838-2002)				**≤20mg/L**	**≤1.0mg/L**	**≤0.2mg/L**
Jan. 2021	12.5	0.08	0.03	Up to standard	Up to standard	Up to standard
Feb. 2021	/	0.13	0.057	/	Up to standard	Up to standard
Mar. 2021	/	0.17	0.075	/	Up to standard	Up to standard
Apr. 2021	11	0.7	0.1	Up to standard	Up to standard	Up to standard
May 2021	/	0.09	0.043	/	Up to standard	Up to standard
Jun. 2021	/	0.15	0.062	/	Up to standard	Up to standard
Jul. 2021	14.7	0.02	0.097	Up to standard	Up to standard	Up to standard
Aug. 2021	/	0.04	0.033	/	Up to standard	Up to standard
Sept. 2021	/	1.37	/	/	Below standard	Up to standard
Oct. 2021	19	0.07	0.088	Up to standard	Up to standard	Up to standard
Nov. 2021	-1	0.04	0.067	Up to standard	Up to standard	Up to standard

Monitoring factor / Monitoring time	Chemical oxygen demand (mg/L)	Ammonia-nitrogen (mg/L)	Total Phosphorus (mg/L)	Standard compliance		
				Chemical oxygen demand	Ammonia-nitrogen	Total Phosphorus
Dec. 2021	-1	0.05	0.03	Up to standard	Up to standard	Up to standard
Qilipu monitored Section of Yiluo River in Gongyi: subject to Grade III Standard in the *Environmental Quality Standard for Surface Water* (GB3838-2002)				**≤20mg/L**	**≤1.0mg/L**	**≤0.2mg/L**
Jan. 2021	30	0.57	0.11	Below standard	Up to standard	Up to standard
Feb. 2021	18.3	0.54	0.107	Up to standard	Up to standard	Up to standard
Mar. 2021	15	0.71	0.087	Up to standard	Up to standard	Up to standard
Apr. 2021	13.3	0.48	0.093	Up to standard	Up to standard	Up to standard
May 2021	8	0.25	0.095	Up to standard	Up to standard	Up to standard
Jun. 2021	12	0.3	0.089	Up to standard	Up to standard	Up to standard
Jul. 2021	10	0.71	0.149	Up to standard	Up to standard	Up to standard
Aug. 2021	13.2	0.79	0.207	Up to standard	Up to standard	Below standard
Sept. 2021	15.7	0.56	0.194	Up to standard	Up to standard	Up to standard
Oct. 2021	8	0.51	0.051	Up to standard	Up to standard	Up to standard
Nov. 2021	7	0.99	0.047	Up to standard	Up to standard	Up to standard
Dec. 2021	7.2	0.5	0.073	Up to standard	Up to standard	Up to standard
Chengqiao monitored section of Jalu River in Zhongmu: subject to Grade IV Standard in the *Environmental Quality Standards for Surface Water* (GB3838-2002)				**≤30mg/L**	**≤1.5mg/L**	**0.3mg/L**
Jan. 2021	20	0.37	0.112	Up to standard	Up to standard	Up to standard
Feb. 2021	24	0.27	0.109	Up to standard	Up to standard	Up to standard
Mar. 2021	20	0.51	0.104	Up to standard	Up to standard	Up to standard
Apr. 2021	18	0.44	0.111	Up to standard	Up to standard	Up to standard
May 2021	17.5	0.38	0.104	Up to standard	Up to standard	Up to standard
Jun. 2021	28	0.52	0.123	Up to standard	Up to standard	Up to standard
Jul. 2021	16.5	0.52	0.121	Up to standard	Up to standard	Up to standard
Aug. 2021	/	1.04	0.292	Up to standard	Up to standard	Up to standard
Sept. 2021	20	0.98	0.22	Up to standard	Up to standard	Up to standard
Oct. 2021	9	0.79	0.14	Up to standard	Up to standard	Up to standard
Nov. 2021	12	0.65	0.158	Up to standard	Up to standard	Up to standard
Dec. 2021	27	0.57	0.135	Up to standard	Up to standard	Up to standard
Huangfuzhai monitored section of Shuangji River in Xinzheng: subject to Grade IV Standard in the *Environmental Quality Standard for Surface Water* (GB3838-2002)				**≤30mg/L**	**≤1.5mg/L**	**0.3mg/L**
Jan. 2021	16.5	0.43	0.046	Up to standard	Up to standard	Up to standard
Feb. 2021	19.8	0.37	0.044	Up to standard	Up to standard	Up to standard
Mar. 2021	19.5	0.4	0.057	Up to standard	Up to standard	Up to standard

Monitoring factor / Monitoring time	Chemical oxygen demand (mg/L)	Ammonia-nitrogen (mg/L)	Total Phosphorus (mg/L)	Standard compliance		
				Chemical oxygen demand	Ammonia-nitrogen	Total Phosphorus
Apr. 2021	14	0.21	0.056	Up to standard	Up to standard	Up to standard
May 2021	14.3	0.2	0.053	Up to standard	Up to standard	Up to standard
Jun. 2021	20.3	0.15	0.045	Up to standard	Up to standard	Up to standard
Jul. 2021	12	0.49	0.071	Up to standard	Up to standard	Up to standard
Aug. 2021	22	0.85	0.123	Up to standard	Up to standard	Up to standard
Sept. 2021	14.7	0.7	0.099	Up to standard	Up to standard	Up to standard
Oct. 2021	12.7	0.54	0.094	Up to standard	Up to standard	Up to standard
Nov. 2021	15	0.35	0.067	Up to standard	Up to standard	Up to standard
Dec. 2021	11.3	0.54	0.075	Up to standard	Up to standard	Up to standard

Chemical oxygen demand, ammonia nitrogen and total phosphorus are the main assessment factors in water monitoring. It can be seen from the above table that during the period from January to December 2021, the monitoring results of chemical oxygen demand, ammonia nitrogen and total phosphorus of Chenqiao monitored section of Jialu River in Zhongmu and Huangfuzhai monitored section of Shuangji River in Xinzheng met the requirements of Grade IV Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002). The ammonia nitrogen of Huayuankou monitored section of the Yellow River in Zhengzhou failed to meet the requirements of Grade III Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002) in September 2021. The chemical oxygen demand of Qilipu monitored section of Yiluo River in Gongyi in January 2021, and the total phosphorus of it in August 2021 failed to meet the requirements of Grade III Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002).

Table 4-4 Statistical table of regional surface water environment quality monitoring results

Unit: mg/L

Monitoring factor / Monitoring time	Chemical oxygen demand (mg/L)	Ammonia-nitrogen (mg/L)	Total Phosphorus (mg/L)	Standard compliance		
				Chemical oxygen demand	Ammonia-nitrogen	Total Phosphorus

Monitoring factor / Monitoring time	Chemical oxygen demand (mg/L)	Ammonia-nitrogen (mg/L)	Total Phosphorus (mg/L)	Standard compliance		
				Chemical oxygen demand	Ammonia-nitrogen	Total Phosphorus
Monitored section at the confluence of Shibali River and Shiqili River: subject to Grade IV Standard in the *Environmental Quality Standards for Surface Water* (GB3838-2002)				**≤30mg/L**	**≤1.5mg/L**	**0.3mg/L**
Jan. 2021	20	0.2	0.048	Up to standard	Up to standard	Up to standard
Feb. 2021	26.2	0.22	0.106	Up to standard	Up to standard	Up to standard
Mar. 2021	29.1	0.52	0.084	Up to standard	Up to standard	Up to standard
Apr. 2021	25.8	0.4	0.054	Up to standard	Up to standard	Up to standard
May 2021	19.3	0.41	0.095	Up to standard	Up to standard	Up to standard
Jun. 2021	17.1	0.32	0.074	Up to standard	Up to standard	Up to standard
Jul. 2021	18.7	0.62	0.094	Up to standard	Up to standard	Up to standard
Aug. 2021	12	0.183	0.13	Up to standard	Up to standard	Up to standard
Sept. 2021	22.6	1.74	0.267	Up to standard	Below standard	Up to standard
Oct. 2021	21.7	1.25	0.239	Up to standard	Up to standard	Up to standard
Nov. 2021	23.8	0.9	0.150	Up to standard	Up to standard	Up to standard
Dec. 2021	23.4	0.17	0.074	Up to standard	Up to standard	Up to standard
Monitored section at the confluence of Suoxu River flowing into Jalu River: subject to Grade IV Standard in the *Environmental Quality Standards for Surface Water* (GB3838-2002)				**≤30mg/L**	**≤1.5mg/L**	**0.3mg/L**
Jan. 2021	25.6	0.34	0.162	Up to standard	Up to standard	Up to standard
Feb. 2021	21.9	0.21	0.11	Up to standard	Up to standard	Up to standard
Mar. 2021	21.2	0.11	0.105	Up to standard	Up to standard	Up to standard
Apr. 2021	23.6	0.15	0.104	Up to standard	Up to standard	Up to standard
May 2021	28.1	0.06	0.144	Up to standard	Up to standard	Up to standard
Jun. 2021	24.9	0.12	0.131	Up to standard	Up to standard	Up to standard
Jul. 2021	21.0	0.34	0.162	Up to standard	Up to standard	Up to standard
Aug. 2021	16	0.242	0.13	Up to standard	Up to standard	Up to standard
Sept. 2021	20.2	0.77	0.183	Up to standard	Up to standard	Up to standard
Oct. 2021	23.2	0.45	0.208	Up to standard	Up to standard	Up to standard
Nov. 2021	25.2	0.25	0.19	Up to standard	Up to standard	Up to standard
Dec. 2021	28.7	0.54	0.158	Up to standard	Up to standard	Up to standard
Monitored section at the confluence of Chaohe River flowing into Qilihe River: subject to Grade IV Standard in the *Environmental*				**≤30mg/L**	**≤1.5mg/L**	**0.3mg/L**

Monitoring factor / Monitoring time	Chemical oxygen demand (mg/L)	Ammonia-nitrogen (mg/L)	Total Phosphorus (mg/L)	Standard compliance		
				Chemical oxygen demand	Ammonia-nitrogen	Total Phosphorus
***Quality Standards for Surface Water* (GB3838-2002)**						
Jan. 2021	22	0.237	0.18	Up to standard	Up to standard	Up to standard
Feb. 2021	30	0.341	0.27	Up to standard	Up to standard	Up to standard
Mar. 2021	20	0.308	0.16	Up to standard	Up to standard	Up to standard
Apr. 2021	28	0.297	0.33	Up to standard	Up to standard	Below standard
May 2021	25	0.241	0.36	Up to standard	Up to standard	Below standard
Jun. 2021	24	0.246	0.13	Up to standard	Up to standard	Up to standard
Jul. 2021	28	0.273	0.17	Up to standard	Up to standard	Up to standard
Aug. 2021	23	0.241	0.98	Up to standard	Up to standard	Below standard
Sept. 2021	19	0.217	0.89	Up to standard	Up to standard	Below standard
Oct. 2021	19	0.197	0.81	Up to standard	Up to standard	Below standard
Nov. 2021	19	0.234	0.56	Up to standard	Up to standard	Below standard
Dec. 2021	20	0.245	0.57	Up to standard	Up to standard	Below standard

It can be seen from the above table that during the period from January to December 2021, the monitoring results of chemical oxygen demand, ammonia nitrogen and total phosphorus of the monitored section of Suoxu River entering Jialu River met the requirements of Grade IV Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002). The ammonia nitrogen at the confluence of Shibali River and Shiqili River (upper reaches of Shibali River) failed to meet the requirements of Grade IV Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002) in September 2021. Total phosphorus of Chaohe River entering Qilihe River in April, May, and August-December, 2021 failed to meet the requirements of Grade IV Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002). The main reason was that Chaohe River was polluted by the domestic sewage along it.

Table 4-5 Statistical results of water quality data monitored at Gaocun Bridge over Qingyi River

Unit: mg/L

Monitoring point	Monitoring factor	Annual mean	Standard index	Excess rate	Grade IV water standard	Standard compliance
Monitored section at Gaocun Bridge over Qingyi River	pH	7.9	0.45	0	6~9	Up to standard
	COD	17	0.57	0	30	Up to standard
	Ammonia-nitrogen	0.35	0.23	0	1.5	Up to standard
	Total Phosphorus	0.10	0.33	0	0.3	Up to standard

It can be seen from the above table that the monitoring factors COD, ammonia nitrogen and total phosphorus of the Gaocun Bridge section of Qingyi River met the requirements of the standard limits of water-related factors of Grade IV Standard of *Environmental Quality Standards for Surface Water* (GB3838-2002).

4.3.3 Current situation and evaluation of ecological environment quality

(1) Overview of the investigation

This survey of the ecological environment is mainly based on data collection and field investigation. The ecosystem situation within the assessment area mainly includes urban and agricultural ecology. The project is located in Zhengzhou. In the *Notice of the People's Government of Henan Province on Printing and Distributing the Planning for Functional Zones in Henan Province* (YZ [2014] No. 12), Zhengzhou is considered a national key development zone.

There is no new land for the project. According to the requirements of ecological environment investigation, this evaluation was conducted by a combination of data collection, site survey and analogy analysis to investigate the situation of ecological environment quality. Data collection was the main method in this evaluation. The ecological and resource data from agricultural, forestry, water conservancy and other management departments were collected.

(2) Investigation of the situation of terrestrial plants

The project area has a mild climate and abundant rainfall. The vegetation along the highway is mainly the flora of North China, which belongs to the warm temperate deciduous broad-leaf forest zone. The vegetation is mainly composed of crops, deciduous trees and shrubs and wild herbs. The main types of artificial vegetation are artificial shelter forest, crops, economic fruit forest and trees on "four sides" (sides of roads, ditches, canals and houses). The main plant resources include macrophanerophytes, shrubs and herbs. The arbors include Robinia pseudoacacia, Paulownia fortunei, Platycladus orientalis, Albizia kalkora, Salix matsudana, Melia azedarach, Poplar 107 Clone Tree, and Ulmus pumila. Economic forests mainly include peach trees, jujube trees, walnut trees, and grape vines. The shrubs mainly include Amorpha fruticosa, twigs of the chaste tree, Euonymus japonicus, Ligustrum lucidum, Chinese rose, Rosa xanthina, and Lagerstroemia indica. Herbs mainly include Themeda triandra, green bristlegrass, wild chrysanthemum, Bermuda grass, Artemisia, Carex rigescens, blady grass, Bothriochloa ischaemum, and Pulsatilla.

(3) Investigation of the situation of terrestrial animals

The fauna of the project evaluation area is from the Huang-Huai plain sub-region of North China, and the animal resources are mainly divided into wild animals and farm animals. The area is located in the Central Plains where agriculture was developed earlier in history and is with a large population density, frequent human activities and fewer wild animals. Common animal species include hare, weasel, vole, bat, etc.; birds in a large number of turtledoves, magpies, sparrows, etc.; reptiles are mainly lizards and snakes; amphibians mainly include frogs; there are four kinds of large livestock: cattle, mules, donkeys and others; small livestock and poultry mainly include pigs, sheep, rabbits, chickens, ducks, geese, dogs, cats, etc. The situation

investigation and data collection show that no key protected wild animals are found within the evaluation area.

The animal components in the evaluation area are characterized by low altitude, low environmental heterogeneity, and poor animal species. Reptiles are widely distributed in many species and mainly prey on rats, lizards and other small animals in the farmland. Birds include tree sparrow, russet sparrow, magpie and others. Mammal animals especially those who are large are limited in amount. The dominant species of mammal animals in the region are rodents, including Rattus norvegicus and Mus musculus. In addition, there are a certain number of lepus capensis and bats. Due to frequent human activities, the distribution of animal species and quantity is extremely unstable. The transient living of many animal species in this area makes it difficult to form a stable population.

The evaluation area has a high population density, frequent human activities and small natural animal and plant species. The existing species are planted or cultured artificially with simple population structures and more monodominant communities, reflecting the low level of biodiversity in the area. Rare wild animals under state protection have not been found within the evaluation area.

4.4 Overview of Zhengzhou

Zhengzhou, the political, economic and cultural center of Henan Province, covers a total area of 7,446.2km^2 and an urban area of 1,010.3km^2. Zhengzhou governs 6 municipal districts, 5 county-level cities and 1 county, including Zhongyuan District, Erqi District, Jinshui District, Huiji District, Guancheng Hui District, Shangjie District, Gongyi City, Xinzheng City, Dengfeng City, Xinmi City, Xingyang City and Zhongmu County. It also has a provincial-level Zhengdong New

District, a National Zhengzhou Hi-Tech Industrial Development Zone, the National Economic and Technical Development Zone, and Zhengzhou Airport Economy Zone.

Zhengzhou is a typical city in which ethnic minorities are scattered. By the end of 2020, there were 54 ethnic minorities (except for the Tatar nationality) including the Hui, Manchu, the Mongol nationality and the Uygur nationality, and 192 thousand ethnic minorities registered residents in the city. And there is one ethnic area and one ethnic township, namely Guancheng Hui District in Zhengzhou and Jinzhai Hui Township in Xingyang. There are 6 districts (counties and cities) with an ethnic minority population of more than 10,000 and 51 townships and towns (streets) with an ethnic minority population of more than 1,000. There are 13 ethnic primary and secondary schools.

In 2021, Zhengzhou's GDP was RMB1,269.1 billion, and its total annual grain output reached 1,353,000 tons, including 706,000 tons of summer grain and 647,000 tons of autumn grain. The sown area of grain crops throughout the year was 4.1981 million hectares, among which the summer grain and autumn grain accounted for 2.0414 million hectares and 2.1567 million hectares respectively. As for the various modes of transportation in the transportation industry throughout the year, the freight turnover was 82.12 billion ton-kilometers, and the passenger turnover was 21.39 billion person-kilometers.

By the end of 2021, the city's permanent resident population was 12.742 million, and the urbanization rate of the permanent resident population was 79.1%. The annual per capita disposable income of residents was RMB39,511, the per capita disposable income of urban residents was RMB45,246, the per

capita disposable income of rural residents was RMB26,790, and the annual per capita living consumption expenditure of residents was RMB25,962.

4.5 Overview of the project area

4.5.1 Xinmi City

Xinmi is located at the east foot of Songshan Mountain in the middle of Henan Province and is 40km away from the southwest of the provincial capital Zhengzhou. It is governed by Zhengzhou, with a total area of 1,001km^2. It governs 13 townships (towns), 4 sub-district offices, 1 scenic spot management committee, 304 administrative villages and 52 neighborhood committees.

By the end of 2020, the city's permanent resident population was 826,031, and the urban permanent resident population was 529,272, including 425,509 male and 400,522 female populations. Among the city's permanent resident population, 166,736 were aged 0-14, 516,620 were aged 15-59 and 142,675 were aged 60 and over, of which 106,664 were aged 65 and over, accounting for 12.91%. The GDP throughout the year was RMB70.629 billion, the annual grain planting area was 846,235 hectares, and the total grain output was 222,000 tons, including 113,000 tons of summer grain and 109,000 tons of autumn grain. The per capita disposable income of all residents in the city was RMB30,306, and was RMB23,623 for rural residents and RMB36,357 for urban residents. In 2021, Xinmi's GDP reached RMB71.325 billion, and the per capita disposable income of all residents was RMB32,145.

4.5.2 Xingyang City

Xingyang, 15km away from the west of Zhengzhou, is the county-level city closest to the provincial capital of Henan Province, with an area of 955km^2, including 17 square kilometers of urban built-up area. It governs 10 towns, 1 township and 2

sub-district offices**. In 2021, the population of Xingyang was 730,100, with 380,761 males and 349,374 females. In age structure, the proportion of 0-14 years old was 18.26%, the proportion of 15-59 years old was 63.56%, the proportion of over 60 years old was 18.18%, and the proportion of over 65 years old was 12.97%. There are more than 8,600 people in Jinzhai Hui Township of Xingyang, including more than 7,000 Hui people, accounting for 85% of the township's population. The township is not in the project area.**

In 2021, the city's GDP was RMB55.423 billion and the per capita disposable income of residents was RMB31,861. Xingyang has "Pomegranate in Heyin", "Green Chinese Onion in Guangwu", "Persimmon in Xingyang", "Carp in the Yellow River" and other national geographical-indication products. There are all kinds of industries, accounting for 31 of 39 industries, covering equipment manufacturing, clothing textile and other major categories. In recent years, Fortune Global 500 or China Fortune 500 enterprises such as Caterpillar, China National Machinery Industry Corporation and CRRC have invested in Xingyang. The cultivation and growth of new leading industries such as new materials and equipment manufacturing have been accelerated, and the standardized production line with an annual output of 50 tons of graphene has been completed and put into use. The innovation drive has been continuously strengthened, 22 national science and technology enterprises have been added, and the new century material genome engineering research institute has been rated as the first batch of "Major New R & D Institutions in Henan Province".

4.5.3 Dengfeng City

Dengfeng is 58 km long from east to west and 36 km wide from north to south, with a total area of 1,219km^2. Dengfeng governs 3 streets, 9 towns and 3 townships. The urban built-up area is 50.87 square kilometers, and the total mileage of highways in the city has reached 2,373 km.

The city's permanent resident population is 729,332, including 398,510 males and 330,822 females. In age structure, the proportion of 0-14 years old is 26.55%, the proportion of 15-59 years old is 58.01%, the proportion of over 60 years old is 15.44%, and the proportion of over 65 years old is 11.03%. In 2021, the regional GDP of the whole city reached RMB54.82 billion and the per capita disposable income of residents reached RMB29,958. In 2020, the regional GDP reached RMB45.28 billion and the per capita disposable income of urban residents reached RMB35,480, and the per capita disposable income of rural residents reached RMB21,329.

4.5.4 Xinzheng City

Xinzheng has a total land area of 884.5915km^2, including 548.3366km^2 of arable land and 64.0572 km^2 of forest land. Xinzheng governs 14 townships (towns) and 337 administrative villages.

In 2021, the city's permanent resident population was 1,172,237, including 606,367 males and 565,870 females. In age structure, the proportion of 0-14 years old was 19.75%, the proportion of 15-59 years old was 69.77%, the proportion of over 60 years old was 10.48%, and the proportion of over 65 years old was 7.55%.

In 2021, the city's regional GDP throughout the year reached RMB79.333 billion and the per capita disposable income of urban and rural residents

reached RMB33,019. In 2020, the per capita disposable income of urban and rural residents reached RMB36,711 and RMB24,819 respectively, and the total grain output reached 255,000 tons. All the poor people in the whole city were lifted out of poverty under the current standard. The basic medical insurance for urban and rural residents was fully covered.

4.5.5 Zhongmu County

Zhongmu County covers a total area of 917km^2 and governs 11 towns and 3 streets.

The city's permanent resident population is 702,657, including 369,434 males and 333,223 females. In age structure, the proportion of 0-14 years old is 25.45%, the proportion of 15-59 years old is 60.68%, the proportion of over 60 years old is 13.87%, and the proportion of over 65 years old is 9.81%.

In 2021, the city's regional GDP throughout the year reached RMB44.816 billion and the per capita disposable income of urban and rural residents reached RMB29,271. Zhongmu County integrates the transportation advantages of "railway, highway and aircraft". Lanzhou-Lianyungang Railway and Zhengzhou-Kaifeng Intercity Track have stations respectively in the territory, 20 km to the east of Zhengzhou high-speed railway station; The density of roads in the county is 300 km per 100 square kilometers. There are more than a dozen high-speed off crossings such as Lianyungang-Khorgos Expressway, Zhengzhou-Minquan Expressway and Anyang-Luoshan Expressway, which can radiate the whole county by a 15-minute drive; It is 25 km away from Zhengzhou International Airport in the south, and Zhengzhou-Minquan Expressway can directly connect to the airport; The construction of Metro Line 8 has started. There are 9 complete vehicle manufacturers and more

than 400 auto parts and service enterprises in the county's automobile industry cluster area, and the capacity of new energy batteries reaches 7.2 billion ampere-hours. The 25 new urban communities and 29 new rural communities were built. 155,000 people moved into new communities, and the urbanization rate reached 58%; The forest land area reached 450,000 mu, and the forest coverage rate reached 27.4%; The ecological water system projects such as Moushan Wetland Park, comprehensive treatment of Jialu River and 10000 mu Wetland of Yanming Lake were built.

4.5.6 Gongyi City

Gongyi covers a total area of 1,043km^2.

Gongyi governs 15 towns, 5 sub-district offices, 2 park management committees, 289 administrative villages and 26 neighborhood committees. **The city's permanent resident population is 785,242, with males accounting for 50.98% and females for 49.02%. In age structure, the proportion of 0-14 years old is 18.12%, the proportion of 15-59 years old is 61.75%, the proportion of over 60 years old is 20.13%, and the proportion of over 65 years old is 14.38%.**

Gongyi governs 15 towns, 5 sub-district offices, 2 park management committees, 289 administrative villages and 26 neighborhood committees. The city's permanent resident population is 785,242, with males accounting for 50.98% and females for 49.02%. In age structure, the proportion of 0-14 years old is 18.12%, the proportion of 15-59 years old is 61.75%, the proportion of over 60 years old is 20.13%, and the proportion of over 65 years old is 14.38%.

In 2021, the city's regional GDP throughout the year reached RMB90.188 billion, and the per capita disposable income of urban and rural residents reached RMB33,656. Gongyi has built a convenient and smooth transportation

network. Zhengzhou-Xi'an High-speed Railway, Lanzhou-Lianyungang Railway, Lianyungang-Khorgos Expressway, G310, S312 Expressway along the Yellow River and the West Extension Expressway of Zhongyuan Road cross the east and west. Gongyi-Dengfeng Expressway and S235 run north and south, only one hour's drive from Zhengzhou Xinzheng International Airport and Zhengzhou International Land Port. And, with deep-rooted cultural fertile soil, guided by new urbanization, Gongyi promotes the integrated development of urban and rural areas, and continuously improves the quality of urban functions. The urban built-up area covers an area of 65.87 square kilometers, the urbanization rate reaches 59.81%, and the green land rate and green coverage rate of urban built-up areas reach 35.03% and 37.99% respectively.

4.6Social survey of sample villages in project-affected areas

The project area refers to the area directly and indirectly affected by the project. The directly affected area refers to the area directly affected by the project construction, and the indirectly affected area refers to the area covered by the project.

Based on the principle of extensiveness, economic diversity and regional representativeness, and combined with the random sampling, systematic sampling, stratified sampling and typical sampling methods, 19 administrative villages with serious flood damage were selected as sample villages in this social assessment for interviews and questionnaire surveys, through which we knew the basic situation (such as social and economic conditions) of the sample villages and their suggestions and opinions on the project, and analyzed the project's impact on them. Photos of the discussion and on-site investigation are shown in Figure 4-3. **The social survey results of sample villages are detailed in attached tables 3-1, 3-2 and 3-3.**

Figure 4-3 Photos of interviews with project officers and sample villages

4.6.1 Population distribution of sample villages

There were 10,290 households with 43,411 persons in 19 sample villages in 6 counties (cities) in the project area, with an average of 4.22 persons per household, including 23,144 males, accounting for 53.31%, and 20,267 females, accounting for 46.69%. Of them, 42,525 persons engaged in farming, accounting for 97.96%, and 886 persons engaged in non-farming, accounting for 2.04%. 35 persons belonged to ethnic minorities, accounting for 0.08%. See Table 4-6 for details.

Table 4-6 Demographic results of sample villages in the project area

County/city	Number of households	Population	Male	Female	Agricultural population	Non-agricultural population	Ethnic minority
Dengfeng City	1,663	6,942	3,701	3,241	6,508	434	2
Gongyi City	2,152	8,659	4,318	4,341	8,642	17	19

Xinmi City	1,763	7,409	3,890	3,519	7,314	95	9
Xinzheng City	1,655	7,803	4,530	3,273	7,573	230	4
Xingyang City	1,639	5,929	3,190	2,739	5,918	11	1
Zhongmu County	1,418	6,669	3,515	3,154	6,570	99	0
Total	10,290	43,411	23,144	20,267	42,525	886	35
Proportion		4.22	53.31%	46.69%	97.96%	2.04%	0.08%

In the sample villages, there were 8,604 children aged 16 and younger, accounting for 19.82% of the total population, 25,815 laborers aged between 17 and 60, accounting for 59.47% of the total population, and 8,989 seniors aged over 60, accounting for 20.71% of the total population. Of them, there were 1,285 elderly and disabled people, accounting for 2.96% of the total population. See Table 4-7 for details.

Table 4-7 Survey results of the age structure of sample villages

County/city	Population	Aged 16 years and younger	Aged 17-60	Aged over 60 years	The number of the elderly and disabled
Dengfeng City	6,942	1,488	3,915	1,539	401
Gongyi City	8,659	1,550	5,371	1,738	478
Xinmi City	7,409	1,448	4,321	1,640	91
Xinzheng City	7,803	1,812	4,800	1,191	50
Xingyang City	5,929	1,151	3,178	1,597	131
Zhongmu County	6,669	1,155	4,230	1,284	134
Total	43,411	8,604	25,815	8,989	1,285
Proportion		19.82%	59.47%	20.71%	2.96%

In the sample villages, there were 2,059 people below primary and secondary school education, accounting for 4.74% of the total population, 6,509 people with primary school education, accounting for 14.99% of the total population, 15,912 people with junior middle school education, accounting for 36.65% of the total population, 12,304 people with senior middle school education, accounting for 28.34%

of the total population, 6,627 people above senior middle school education, accounting for 15.27% of the total population. See Table 4-8 for details.

Table 4-8 Survey results of education attainment in sample villages

Village	Below primary education	Primary education	Junior middle school education	Senior middle school education	Senior middle school education or above
Dengfeng City	520	1,747	1,482	1,852	1,341
Gongyi City	223	589	2,775	3,081	1,991
Xinmi City	206	1,413	3,118	1,989	683
Xinzheng City	416	976	3,914	1,792	705
Xingyang City	135	1,033	1,919	1,684	1,158
Zhongmu County	559	751	2,704	1,906	749
Total	2,059	6,509	15,912	12,304	6,627
Proportion	4.74%	14.99%	36.65%	28.34%	15.27%

4.6.2 Agricultural and sideline production levels of sample villages

In the 19 sample villages, there were 42,675.26 mu of arable land, with a per capita area of 0.983 mu, 45 mu of paddy lands, with a per capita area of 0.001 mu, 19,635 mu of irrigated land, with a per capita area of 0.452 mu, 22,995.26 mu of dryland, with a per capita area of 0.530 mu, 3,485 mu of garden land, with a per capita area of 0.080 mu, 58,491 mu of forest land, with a per capita area of 1.347 mu, and 12 mu of aquaculture area, with a per capita area of 0.0003 mu. See Table 4-9 for details.

Table 4-9 Survey results of land in sample villages

County/city	Arable land (mu)	Paddy land (mu)	Irrigated land (mu)	Dryland (mu)	Garden land (mu)	Forest land (mu)	Aquaculture area (mu)
Dengfeng City	6,140.46	45	1,180	4,915.46	200	38,760	12
Gongyi City	4,333	0	290	4,043	35	7,170	0

Xinmi City	7,752	0	100	7,652	100	6,060	0
Xinzheng City	9,340	0	8,160	1,180	3,010	3,663	0
Xingyang City	7,015	0	1,810	5,205	80	358	0
Zhongmu County	8,095	0	8,095	0	60	2,480	0
Per capita	42,675.26	45	19,635	22,995.26	3,485	58,491	12
Proportion	0.983	0.001	0.452	0.530	0.080	1.347	0.0003

In the 19 sample villages, there were 25,195 mu of grain crops, with a per capita area of 0.58 mu, 17,393 mu of cash crops, with a per capita area of 0.401 mu, 2,580 mu of oil crops, with a per capita area of 0.059 mu, 859 mu of cotton, with a per capita area of 0.020 mu, and 3,232 mu of other crops, with a per capita area of 0.074 mu. See Table 4-10 for details.

Table 4-10 Crop planting in sample villages

County/city	Grain crop (mu)	Cash crop (mu)	Oil plant (mu)	Cotton (mu)	Others (mu)
Dengfeng City	2,580	3,990	350	30	100
Gongyi City	3,622	215	92	0	13
Xinmi City	6,732	380	150	0	50
Xinzheng City	5,360	4,660	1,488	0	673
Xingyang City	4,756	1,328	150	20	2,196
Zhongmu County	2,145	6,820	350	809	200
Total	25,195	17,393	2,580	859	3,232
Per capita	0.580	0.401	0.059	0.020	0.074

4.6.3 Income level of sample villages

In terms of the total output value of agricultural and sideline industries, in the 19 sample villages, the per capita annual output was 976.14 kilograms, the per capita

agricultural production was 3,700 yuan, the per capita farming income was 1,700 yuan, the per capita aquaculture income was 3 yuan, the per capita industrial and sideline income was 20,300 yuan, and the per capita net income was 25,653.52 yuan. See 4-11 for details.

Table 4-11 Survey results of agricultural income of sample villages

County/city	Total output value of agricultural and sideline industries (kg)	Agricultural production (RMB10,000)	Ground farming (RMB10,000)	Aquaculture (RMB10,000)	Industrial and sideline products (RMB10,000)	Per capita net income (yuan)
Dengfeng City	6,401,400	1,213.3	350	12	15,784	25,006.19
Gongyi City	1,832,000	2,080.24	140	0	19,557	25,149.83
Xinmi City	2,939,400	675.568	63.5	0	15,900	22,457.91
Xinzheng City	3,202,909	733.606	6,580.9	0	14,632.4	28,126.24
Xingyang City	1,319,700	2,233	50	0	13,447	26,530.61
Zhongmu County	26,680,000	8,949	59	0	8,904	26,858.60
Total	42,375,409	15,884.714	7,243.4	12	88,224.4	
Per capita	976.14	0.37	0.17	0.0003	2.03	25,653.52

Some villagers in Dengfeng City grew grain crops and cash crops, such as wheat and corn at home, while most of the young laborers went out as migrant workers to increase their family income. Tashuimo Village is located at the southern foot of Wuzhi Mountain at an altitude of 1,200 meters. Villagers mostly live in the mountains

or the canyons; therefore, the per capita forest area is large. However, the transportation is inconvenient. Some villagers go out to work, and some villagers plant honeysuckle and walnuts at home. The average annual income of honeysuckle and walnuts per household reaches 20,000 yuan.

The main sources of income of the villagers in the three sample villages in Gongyi City include working in the vicinity or in Zhengzhou, with a monthly salary of 3,000-5,000 yuan, and growing grain crops.

The main sources of income of the villagers in the three sample villages in Xinmi City include grain crops, transport or business. Xiasigou Village has made full use of natural resources to develop tourism. More than 30 villagers are operating B&Bs and farmhouses, with a turnover of about 70,000 to 100,000 yuan, and 10 villagers are doing business, with an annual turnover of 500,000 yuan.

Villagers in Gucheng Village in Xinzheng City mainly grow cash crops such as large cherries and a small number of grain crops. The main sources of their income include house rental, local labor, cattle and sheep breeding, and working in the village-run enterprise Xinzheng Minzhifu Industrial Co., Ltd. with a monthly salary of 4,500 yuan. The company mainly engages in loading and unloading, general cargo warehousing services (excluding hazardous chemicals and other projects that require approval), earthwork construction, house leasing, non-residential real estate leasing, mechanical equipment leasing, property management, property service assessment, cultural and artistic exchange activities, sales of building materials, retail of hardware products, sales of daily necessities, sales of food (only pre-packaged food), sales of health food (pre-packaged), sales of household appliances, sales of electronic components and electromechanical components and equipment, retail of clothing and

apparel, recycling of renewable resources (except productive scrap metal), non-metallic waste and scrap processing. There is an innovation technology park and many warehouses serving South China City in Nianlu Village. The villagers' income is mainly from warehouse leasing, transport, and local work, as well as the jujube processing. The main source of income for villagers in Tanghe Village includes local work.

In Baishuiyu Village, Xingyang City, there are two major growers growing pears and pomegranates, with a total planting area of more than 500 mu. The income per mu of pears is about 10,000 yuan, and the income per mu of pomegranates is about 8,000 yuan. Villagers of Gaoshan Village and Zhonggang Village mainly work in needle plate enterprises and Gaoshan Valve Factory, with a monthly salary of about 3,000-4,000 yuan.

Most villagers in Zhongmu County grow garlic, watermelon and strawberries. There are 200-300 strawberry greenhouses (each covers about one mu) in the village. Vegetables, mainly beans, are grown after garlic. Each family can grow about 3-4 mu of vegetables. Peanuts and staple grain crops (wheat and corn) are also grown in a small amount.

4.6.4 Infrastructure of sample villages

The survey results of the infrastructure in the 19 sample villages are as follows: the total length of roads in the villages is 249.929 kilometers, 84.1265 kilometers of which were damaged by floods. There was also a bridge being destroyed. Village roads connecting the external truck roads are 62.652 kilometers long in total, see Table 4-12 for details. A majority of villagers expressed their wish to repair the flood-damaged roads as soon as possible, because many of these roads were the main

roads back to their villages, as shown in Figure 4-4.

Table 4-12 Survey results of infrastructure in sample villages

Village	Total length of roads in the village (km)	Length of roads destroyed by water (km)	Length of roads in the village connecting to external trunk roads (km)
Dengfeng City	65.3	31.5	5.9
Gongyi City	56	19	16
Xinmi City	37.6	9.5	10.5
Xinzheng City	70.5	22.5	21.3
Xingyang City	14.488	0.324	4.5
Zhongmu County	6.041	1.3025 and a water-destroyed bridge	4.452
Total	249.929	84.1265 another water-destroyed bridge	62.652

Figure 4-4 Current situation of some flood-damaged roads

5 Environmental Impacts and Mitigation Measures

5.1 Identification of environmental impact factors and screening of assessment factors

5.1.1 Identification of environmental impact factors

The environmental impacts during the construction period include: the excavation and filling of road sections, which may cause soil erosion in the rainy season; the impact of spoil on vegetation; the impact of dust generated during the storage and transport of construction materials and harmful gases generated from road paving on ambient air; the impact of construction machinery noise on the living environment of nearby residents; and the impact of construction wastewater on local surface water bodies.

5.1.2 Screening of assessment factors

The main environmental impact assessment factors for the project were screened according to the project characteristics, the surroundings, and the identified impact of the project on the environment, as shown in Table 5-1.

Table 5-1 Screening results of environmental impact factors related to the project

Environmental elements	Construction period
Ecological environment	Soil erosion
Surface water environment	Construction wastewater and domestic sewage from construction workers COD, SS, petroleum, NH_3-N
Acoustic environment	Equivalent continuous A sound level
Ambient air	TSP, asphalt fume
Solid wastes	Construction wastes

5.2Assessment level and assessment period

5.2.1 Assessment level

The post-disaster reconstruction project does not occupy new land, so it has no major impact on the natural and cultural landscape. The impact of the project on the environment is mainly produced during the construction period, mainly the adverse impact of dust, noise, wastewater, and construction waste on the surrounding environment and local residents during the construction process. Therefore, this report only focuses on the impact generated during the construction period and proposes corresponding environmental mitigation measures and environmental management plans.

5.2.2 Assessment period

The assessment was divided into the current situation assessment and impact assessment. The construction period was determined as the impact assessment period.

5.3Assessment focus

The project involves water sources and wetland nature reserves. It is a post-disaster reconstruction project that does not occupy new land, so it has no major impact on the natural and cultural landscape. The assessment focuses on the adverse impact of dust, noise, wastewater, and construction waste on the surrounding environment and local residents during the construction process and its mitigation measures, as well as the environmental management plan during the construction period.

5.4Analysis of project pollution source intensity during the construction period

5.4.1 The intensity of noise pollution source

During the construction of the project, the noise is mainly from mechanical equipment. The mechanical equipment includes bulldozers, loaders, excavators, graders, and road rollers for earth filling of subgrades; drilling machines, hoists, bulldozers, and road rollers for bridge construction; scrapers, mixers, asphalt concrete pavers, concrete mixer trucks, and road rollers for pavement construction. The noise source of the equipment is between 79 and 98 dB(A).

In accordance with the *Emission Standard of Environment Noise for Boundary of Construction Site* (GB12523-2011), the impact scope of construction machinery noise on the surrounding environment was calculated, as shown in Table 5-2.

Table 5-2 The impact scope of construction machinery noise Unit: dB(A)

No.	Machine type	Noise prediction						
		5m	10m	20m	40m	50m	80m	100m
1	Wheel loader	90	84	78	72	70	67.5	65.5
2	Grader	90	84	78	72	70	67.5	65.5
3	Vibratory road roller	86	80	74	68	66	63.5	61.5
4	Double-drum vibratory roller	81	75	69	63	61	58.5	56.5
55	Three-wheel road roller	81	75	69	63	61	58.5	56.5
6	Tire roller	76	70	64	58	56	53.5	51.5
7	Bulldozer	86	80	74	68	66	63.5	61.5
8	Hydraulic excavator	84	78	72	66	64	61.5	59.5
9	Paver	87	81	75	69	67	64.5	62.5
10	Impact drilling machine	98	92	86	80	78	75.5	73.5
11	Pile driver	87	81	75	69	67	64.5	62.5

5.4.2 The intensity of exhaust pollution source

(1) Construction dust

Including dust generated during excavation, filling, bulldozing, and earthwork for subgrade construction and during the loading, unloading, transport, and mixing of cement and lime; dust generated by vehicles transporting materials during road construction; dust generated by the wind blowing during material stacking. The amount of dust generated during material handling in the construction area is related to the speed and load capacity of the transport vehicle, the contact area between tires and the ground, the dust content on the road surface, and the relative humidity.

(2) Asphalt fume

This project adopts commercial asphalt concrete, without an asphalt concrete mixing plant. Asphalt fume mainly occurs during asphalt paving. The toxic and harmful substances in the asphalt fume are mainly THC, phenol and BaP, which will affect the ambient air quality in this area, but the impact area and degree of impact are small.

5.4.3 The intensity of wastewater pollution source

During road construction, the impact on the water environment mainly comes from the construction wastewater and the domestic sewage of the construction workers.

(1) Domestic sewage

The works are scattered, and the construction camps are mainly rented local houses. During the peak period of construction, assuming that each construction area has 20 workers, and each worker uses 40L of water per day, then the discharge of

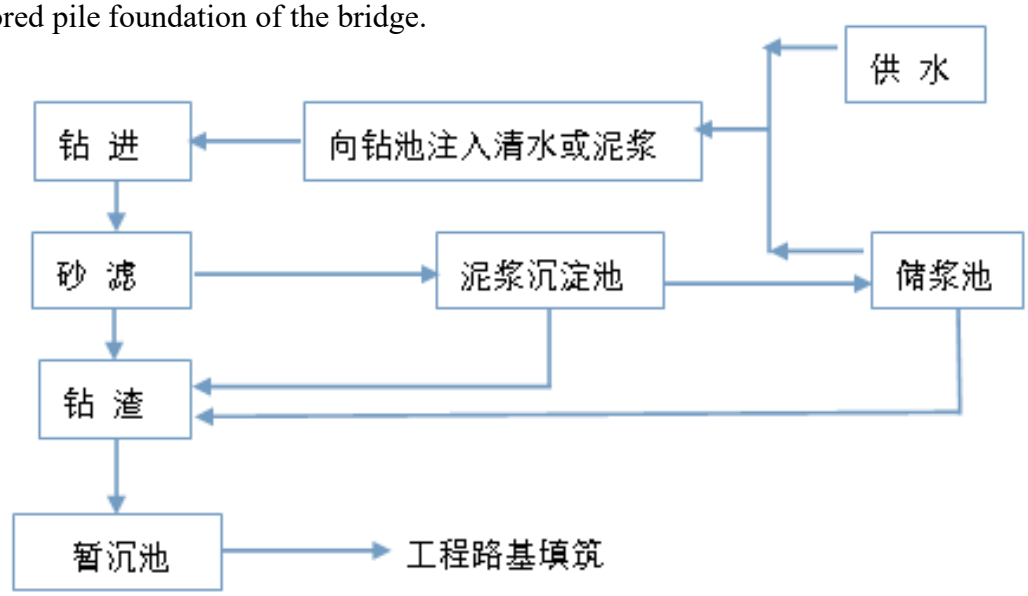
domestic sewage is 0.64t/d in each construction area, and the main pollutants are COD, BOD_5 and SS.

(2) Construction wastewater

Construction wastewater mainly comes from muddy water generated from excavation and drilling during bridge construction, and wastewater generated from maintenance and washing of construction machinery and vehicles.

The wastewater produced by the bridge foundation construction is about $40m^3/h$, and the main pollutant is SS, with a concentration of $2.0\times10^3mg/L$. The pile foundation adopts the bored pile foundation. Now, for the construction of a bored pile foundation, a steel casing is usually buried as a fixed pile position and a drilling guide to protect the orifice and prevent the soil layer at the orifice from collapsing. The drilling mud for the construction of the bored pile foundation is generally composed of water, clay and additives in an appropriate proportion. The additives include CMC, FCI, sodium nitrohumic carbonate, sodium carbonate, PHP, fine barite powder, pulp, dry sawdust, asbestos, and other fibrous matters. The drilling slag is produced as follows: grout is discharged to the grit chamber for sedimentation of earth and rock, and the sedimented earth and rock are drilling slag, which needs to be cleaned regularly, while the supernatant can be recycled. During the drilling, the mixture of drilling slag and mud is sucked out by the sand pump from the hole, flows into the draining tank after the larger particles of drilling slag or medium and fine sand particles are filtered, and then flows into the sedimentation tank, where the mud is naturally precipitated. Afterwards, it flows into the slurry tank through the connection between the sedimentation tank and the slurry tank, then is pumped into the slurry cyclone to filter out the silty fine sand, and finally returns to the hole without

discharging. See Figure 5-1 for the collection and processing of drilling slag from the bored pile foundation of the bridge.



钻进	Drilling
砂滤	Sand filter
钻渣	Drilling slag
暂沉池	Sedimentation tank
向钻池注入清水或泥浆	Filling water or slurry to the drill pool
泥浆沉淀池	Slurry sedimentation tank
工程路基填筑	Subgrade filling
供水	Water supply
储浆池	Slurry tank

Figure 5-1 Flow chart of the collection and processing of drilling slag from the bored pile foundation of the bridge

Each bridge is equipped with one mud pit, one sedimentation tank, and one slurry tank (all are designed as a soil section, 1.5m deep, 5m wide, and 8m long, with the excavation volume of 60m^3 each, and the impermeable membrane is laid).

②Wastewater from maintenance and washing of construction machinery and vehicles, containing oil, suspended solids, and other pollutants. According to relevant information, the measured oil concentration in wastewater from the maintenance and washing of construction machinery and vehicles for Xiaolangdi Project is 1-6mg/L. With reference to the survey of similar projects, 20 construction machinery and equipment (vehicles) need to be cleaned regularly in this project. Assuming that each machinery and equipment consumes 0.5m^3 of water per day, then the amount of wastewater generated per day is 10m^3.

5.4.4 Solid waste emissions

The solid waste during the period of construction includes two parts, one of which is the earthwork of the slope collapse, and the discarded soil after the excavation of the old road; the other part is the domestic waste of builders.

According to the feasibility study report, the recycling of excavated materials for old roads will be strengthened during the period of construction, with more concern on environmental protection design. After the pavement structure of the old road is broken, it can be used as the cushion of the new road section, the shoulder of the earth road, the smooth connection of the flat intersection of the gravel road, or as the traffic protection project of the broken low-grade road;

During the peak period of construction, there are 20 builders in each construction camp, and the amount of domestic waste is 10kg/d at the rate of 0.5kg/person/d.

5.5Environmental impact assessment (EIA)

5.5.1 Assessment of ecological environment impact

The impact of road construction on the ecological environment mainly occurs during the period of construction, which mainly occupies land and changes the nature of land use; changes topography and destroys vegetation; disturbs the surface, resulting in soil erosion, etc.

The project is for the reconstruction of rural roads. This is an in-situ reconstruction without affecting other permanent lands; During the period of construction, it is mainly about the impacts of taking and discarding soil in engineering, and engineering construction on animals and plants.

5.5.1.1 Impact analysis of temporary works on the ecological environment

(1) Impact analysis of taking and discarding soil in engineering

The earthwork excavation of the project is characterized by linear distribution along the road, balancing earthwork by sections in the direction of the road. In accordance with the principle of "making full use of the excavated earthwork and reducing part of excavation that cannot be backfilled and earthwork transported from outside to the construction site when the backfilling part of excavation cannot meet the backfill requirements", the earthwork excavation of the road shall firstly meet the requirements for backfilling and utilization in the area of this pile. The rest shall be transported and utilized by distant piles. The excavated earthwork shall be filled after rolling and crushing. And the impact of the discarded earthwork on the ecological environment is reduced to the maximum extent.

The project is located in plain and hilly areas, with large excavation, mostly loess, which can be directly used as subgrade filler. The balance of excavation and filling of the excavation earthwork is considered, and is utilized and deployed in the area of this pile. As the route of the project is mostly located in hilly areas, the current road

condition is not good, meanwhile, the points damaged by the flood are scattered and the haul distance is far. Considering the inconvenience of earthwork allocation for excavation, the project is constructed in sections. Therefore, the project is no longer set up as a centralized ground for taking and discarding soil. The earthwork can be outsourced and the location of surplus discarded soil is coordinated and solved by the local government. The requirements for the ground selection and protective measures for taking and discarding soil are put forward in this assessment.

Some sections of the project are for the reconstruction of old roads, part of the subgrade of old roads are dug out and some construction waste is produced; According to the feasibility study report, the recycling of excavated materials for old roads will be strengthened during the period of construction, with more concern on environmental protection design. After the pavement structure of the old road is broken, it can be used as the cushion of the new road section, the shoulder of the earth road, the smooth connection of the flat intersection of the gravel road, or as the traffic protection project of the broken low-grade road.

5.5.1.2 Impact analysis of soil erosion

(1) Analysis of main factors affecting soil erosion

① Disturbance of surface area

A large number of buildings and construction roads in the road construction area disturb the original landform, which will cause soil erosion during construction. The large surface area disturbed by engineering construction is one of the main factors causing soil erosion.

② Earthwork construction

During excavation, transshipment and stacking of the earthwork, loose soil will be eroded by water and wind. The earthwork volume of the project is large. If effective preventive measures are not taken, the soil erosion caused by earthwork construction is one of the main sources of soil erosion during construction.

③ Construction technology

The construction sequence of soil and water conservation project has a great influence on its prevention and control effect, and a large number of earthwork projects shall avoid the main flood season; Drainage system shall be built in the construction area first; After the local surface construction is completed, engineering measures shall be taken or vegetation shall be restored in time. If the construction sequence is not proper, soil erosion during construction cannot be effectively prevented. As there are many construction procedures during construction, whether the construction procedures are reasonable or not will greatly affect the amount of soil erosion in the project area.

(2) Protective measures for soil erosion

The impact of construction on the ecological environment mainly includes surface excavation, vegetation destruction, project occupation and so on. During the period of construction, a large amount of earthwork excavation of foundation works may lead to local soil erosion. In order to reduce the ecological impact during the period of construction and reduce soil erosion, the following suggestions are put forward in this assessment:

① Strengthen the management during the period of construction, and the excavated earthwork shall be treated in time. If the earthwork cannot be treated

immediately, it shall be covered and fenced to prevent soil erosion caused by rainwater alluvium;

② Standardize the construction, and try to balance the excavation and filling during construction. Excavation, backfilling, rolling, ridge protection and slope protection measures shall be taken to shorten the construction period and reduce the exposure time of loose ground as far as possible during construction;

③ Reasonably arrange the construction time and try to avoid the rainy season and flood season;

④ Construction machinery, earth and stone, and other building materials shall not be stopped and placed randomly to prevent damage to vegetation and aggravation of soil erosion;

⑤ Construction of rainwater diversion ditch;

⑥ Enclosures shall be set around the construction site to separate the messy construction site from the outside, so as to protect the overall appearance of the built area;

⑦ After the completion of the main works of the project, the site clearing, greening and other supporting works shall be completed as soon as possible to improve the ecological environment on the site. The trees and turf shall be planted to prevent sand and reinforce soil, and improve the local ecological environment.

5.5.1.3 Impact analysis of the engineering construction on wild animals

Human activities are frequent along the project, and the animal resources are mainly artificially raised poultry and livestock, while the species of wild animals are generally common in North China Plain. These animals are mainly kept in captivity and ponds, and there are also a few herbivores that are kept in small areas and short

time in fields, villages and rivers. There is no major gathering area of wild animals within the assessment scope, and the engineering construction activities will not have a significant impact on the wild animals along the project. During the period of construction, the impact of engineering construction on wild animals along the project is also limited and temporary. It is strictly prohibited for builders to kill wild animals. The engineering construction will not cause a significant reduction of animal species in the area along the project. After the completion of the roads, the species and dominant populations of wild animals in the area will remain at the existing level. Through the analysis of the current situation of wild animals along the project and the project situation, the impact of the project as a barrier to the migration and other activities of wild animals is acceptable.

5.5.1.4 Analysis of the impact of engineering construction on wild plants

Through field investigation, the species are mainly common plant species in the area, such as poplar, tung tree, willow, locust tree, and twigs of the chaste tree. It is suggested that the construction unit cut down as few trees as possible, strictly control the construction boundary and reduce the damage to trees. Before construction, it is suggested that the construction unit, under the guidance of the local forestry department, protect the precious protected species within the permanent land requisition of the road in different places if there are protected plants such as wild soybeans. During the period of construction, it is necessary to focus on strengthening the protection of precious plants along the project, provide necessary knowledge training on the protection of wild plants for builders (such as identifying plants and transplanting plants), and it is strictly prohibited to expand the construction scope and destroy vegetation at will. After the implementation of plant protection measures

along the project, the engineering construction will not affect the distribution of plant populations in the area, and only the population composition of forest-derived plants on both sides of the road may change. But the impact on the plants along the project is limited and it will not have a significant impact on the plants in the area.

5.5.1.5 Impact analysis of the engineering construction on Provincial Zhengzhou Yellow River Wetland Nature Reserve

1. Overview of the environment along the project line

A point damaged by the flood of Project Y062 is located in the experimental area of the Wetland Nature Reserve with a length of about 5m. Project C772 is located in the experimental area of the Wetland Nature Reserve with a length of about 338m at the transition section from Mangling to the Yellow River. The project area is in Mangling, where the plants are mainly poplar, tung trees and willows.

There are 12 species of wild mammals in this area, belonging to 5 orders and 7 families. Due to the large population density and intense human activities in this area, there are few large mammals, mostly small mammals, mainly rodents.

The project area is the transition zone from Mangling to river beach. Most of the north side of the project is reclaimed into fish ponds. Human activities are frequent. Only a small number of seasonal migratory birds come here to look for food, but some birds still come here to look for food and live. There are many resident birds such as Pica pica sericea and Passer montanus saturates that nest on the bank. Common birds include Cynaopica cyana interposita, Stumidae cineraceus, Hirunio rustica, etc.

2. Analysis of the impact of the engineering construction on Provincial Zhengzhou Yellow River Wetland Nature Reserve

If the construction wastewater and domestic sewage from the sites of road construction and temporary works are not treated and are washed into the water by the rainwater, they will pollute the water in the Yellow River wetland. This will increase the content of sediment, oil and other pollutants in the Yellow River, with impact on the water quality.

The plant under national key protection distributed in the project area is only the wild soybean, which is widely distributed along the banks of the Yellow River. It has strong ecological adaptability, is resistant to trampling and cutting, and has strong sprouting ability; The project is to reconstruct the original site without additional land occupation. The project area is situated in the collapsed earthwork where loess is exposed and vegetation is less. Therefore, the engineering construction will not affect the population in the construction area; and it will not cause great harm to the whole population of the wild soybean which is widely distributed and is large in number.

Relevant research results show that birds are similar to humans with respect to the perception range of sound. Generally, the audible range at which birds can hear spans from 1~5Hz. They can't hear a low-frequency sound like people. Therefore, some birds have a strong tolerance to noise and can quickly adapt to noise, which also explains why there are birds around the airport. However, scientific research shows that noise will have a certain impact on the reproduction of birds. When the noise reaches a certain value and exceeds the tolerance limit of the birds, they will abandon their nests. Reijnen, a Dutch scholar, spent over ten years observing and studying more than 40 kinds of birds and came to the conclusion that "traffic noise may have a great impact on bird reproduction" (quoted from *Study on the Relationship between Traffic Noise and Bird Reproduction Density*, 1995). He pointed out that when the

equivalent continuous A sound level Leq (24h) throughout the day and night exceeds 50dB (A), the bird reproduction density in the habitat will decline at the rate of 20%~98%. Although the construction period of the project has a great impact on the surrounding acoustic environment, the noise can be reduced to a certain degree by the arbor shrub forest belt in which the birds and other animals mostly live. In addition, birds and other animals in the reserve which mostly live in the core area approximately 2.3km away from the north of the project area will not be influenced by the noise of the project.

The light pollution of the project mainly results from the nighttime lighting at the construction site whose impact on the light ambiance can be ignored due to its low brightness and luminosity. Therefore, the light pollution during the period of construction can be attributed to the headlights of transport vehicles at night. The light pollution during the period of construction will have a certain impact on the normal routine and life of some animals in the reserve. When the nighttime lighting at the construction site has a wide coverage and a high brightness, it is easy to cause the illusion that the animals feel that it's still daytime, thus interfering with the normal foraging of some nocturnal animals (such as owls) and the normal habitation of diurnal animals.

According to the research report of Reijnen in 1995, birds only respond to the vehicle lights without any shelter within 100m. In consequence, the points damaged by the flood in the reserve are located in the Mangling area with some poplar and tung trees. Here night construction is avoided as the scope of flood damage is small and the construction period is short; In addition, since the project passes through the experimental area of the reserve and is more than 2km away from the buffer zone in

the north, the engineering construction will not affect the survival and reproduction of most birds and other animals lived in the reserve.

5.5.2 Analysis and assessment of the impact of construction on surface water

The possible impact on the water environment during the construction of road construction projects mainly comes from two aspects: construction wastewater during construction operations and domestic sewage of construction workers. The construction wastewater of construction operations mainly refers to the mud wastewater with high suspended solids produced by the drilling wastewater and the washing of sand and gravel during the construction of each bridge in the project.

5.5.2.1 Analysis of the impact of construction workers' domestic sewage on the water environment

If we count the number of construction personnel in each construction living area as 20, and their per capita domestic water consumption as 40L/d, the daily discharge of domestic sewage in the construction production living area will be 0.64t/d with the main pollutants as COD, BOD5 and SS. If the domestic sewage is directly discharged without treatment, it will have a certain impact on the nearby surface water.

With the scattered water destruction points, small scale of single water destruction point, and multiple water source protection areas along the route (see Table 2-6 and Fig.2.3-1~Fig.2.3-9 for details), we rent local houses as the construction and living quarters during the construction, and the wash water is collected in the collection pool and then used for watering the site for dust suppression. Dry toilets are cleaned regularly for fertilization of nearby farmland (outside the water source protection area such as the South-to-North Water Diversion Reserve). Under the

premise of strictly implementing the above measures, the domestic sewage of the construction workers will not have adverse effects on surface water.

In addition, a certain amount of domestic waste will be generated in the construction production and living area every day. If the domestic waster is randomly discarded, it may enter the water to cause certain pollution. The assessment requires that the domestic garbage be collected by a special person in a centralized manner, and be cleared and transported on a regular basis.

The impact of the construction workers' domestic sewage on the environment is limited to the construction period, and the time is relatively short. By strengthening the management, it will not have a great impact on the environmental quality of the surface water.

5.5.2.2 Analysis of the impact of construction wastewater on the water environment

The construction wastewater mainly includes the slurry wastewater with high suspended solids with a volume of about $2m^3$ each day. To reduce its impact on the local water environment, effective pollution control measures are taken, including the prohibition on direct discharge into water bodies.

Seepage-proofing sedimentation tanks shall be built in the construction sites to dispose of, treat, and recycle construction mud wastewater. The tank shall be cleaned and buried flatly after construction. In addition, materials containing toxic substances in the construction area, such as asphalt, oil, chemical substances, etc., if they are not kept well and are washed into the water by the rainstorm, will cause great harm to the water body. During the construction period of the project, it is not allowed to stack them within a short distance from the water body along the river. Such materials need

to be properly kept to avoid the aforementioned situations.

In addition, for residual oil, waste oil and washing sewage generated during maintenance of construction machinery, an anti-seepage oil separation tank shall be set at the construction site to timely collect all oily sewage for oil separation treatment.

On the premise of strictly implementing various treatment measures for production and domestic sewage during the construction period and prohibiting the discharge of production and domestic sewage to water bodies along the line, the sewage generated during the construction has little impact on the environment of the surface water.

5.5.2.3 Analysis of the impact of bridge construction on the water environment

(1) Impact of bridge substructure construction on water

The impact of bridge construction on the water environment mainly comes from the construction of the substructure of the bridge, which adopts the form of column piers and bored pile foundations. If the bridge foundation construction is not controlled in the construction links such as dredging at the bottom of the river or flushing of building materials, it will cause turbidity of the cement and affect the water quality of the river. Among them, the drilling and cleaning process of bored pile construction is the main pollution link. At present, the main domestic method to prevent bridge construction from polluting rivers is the cofferdam method. Cofferdam structures with little disturbance to rivers and riverbeds, such as steel sheet pile cofferdams, are adopted. At the same time, the sediment excavated from the foundation pit is removed from the slag extraction cylinder and discharged to the nearby mud sedimentation tank for sedimentation treatment. The supernatant in the

sedimentation tank will evaporate naturally in the evaporation tank, and the sediment and drilling slag deposited in the sedimentation tank will be cleaned and transported regularly to avoid direct discharge into the river waters. Through the above measures combined with strict construction management, the increase of suspended solids in the water body during the construction of the substructure of the bridge can be effectively controlled, and the water quality of the river channel will not be affected.

(2) Impact of bridge superstructure construction on water

In the construction of the upper structure of the bridge, in order to avoid the construction waste falling into the water body and causing water pollution, the construction personnel should be strictly managed, and it is strictly forbidden to litter the waste. Pollution of river water quality.

(3) Impact of other factors on the water during bridge construction

If the materials, oil, and chemicals required for bridge construction are stacked on riversides with loose management and cover, they may be washed into the water body by rainwater during the rainy season or rainstorm period. The powder materials are stacked at a height lower than the water level in the wet season, which may be submerged by the river water in the rainstorm season, thus entering and polluting the river. Moreover, oil leakage of bridge construction machinery and equipment and residual oil during mechanical maintenance, especially oil leakage of machinery and equipment for surface operations, may cause serious oil pollution to water bodies. Therefore, the construction unit must strictly manage the use and stacking of materials, properly handle the oil pollution, and take the following preventive measures: ① The oil used for production must be kept strictly to prevent leakage and water pollution; ② The dirty oil must be collected in a fixed container and be collected

regularly and reasonably ③ Equipment such as drilling rigs must be overhauled and maintained before the start of construction, and special personnel shall be assigned to inspect and supervise the operation of the equipment to prevent oil leakage. ④ The construction unit shall strictly manage and maintain and overhaul the machinery and equipment on a regular basis.

To sum up, by taking the above measures, the construction of the bridge across the river in this project has little impact on the water environment quality that the bridge spans.

5.5.3 Analysis of the impact on air and environment during construction

During the construction period, the pollution to the environment and air near the construction area mainly comes from the following: flying dust from earthwork excavation and filling, material storage yards and construction vehicles and asphalt fumes from asphalt pavement. The specific analysis is as follows:

5.5.3.1 Analysis of impact caused by flying dust during construction

1. Flying dust from earthwork excavation and filling

There is generally a material storage yard in the construction and production area. The amount of flying dust generated in the material storage yard is related to the type and nature of materials and the wind speed. Materials with small specific gravity are easy to raise dust due to disturbance. The flying dust of the storage yard is caused by wind, loading and unloading. Passing vehicles will also raise dust. These will have a certain impact on the surrounding environment. The assessment requires setting up enclosures for the construction and production areas, and the height of the enclosures is not less than 2m. Water should be sprinkled on the bare surface of the site to effectively suppress dust on a regular basis. In addition, stacking positions should be

reasonably arranged in the powder material yard, covered with tarpaulin or other airtight shields. After the above measures are taken, the impact of dust in the construction, production and living areas is small.

2. Flying dust caused by transportation

During the construction process, under the same road conditions, the faster the vehicle speed, the greater the amount of flying dust. At the same speed, the dirtier the road surface, the greater the amount of flying dust. Thus, limiting the speed of vehicles and keeping the road surface clean are effective means to reduce flying dust caused by vehicles. Meanwhile, the assessment requires watering the road on which the vehicle runs to suppress dust during construction.

During the construction period, the transportation of raw materials and earthwork will increase the traffic flow on the road to a certain extent. Thus, flying dust generated by transportation will have a certain impact on the air quality of the sensitive points along the road. In order to reduce the impact of transportation dust on the air quality along the road, according to the assessment criteria: the transportation time of construction materials should be reasonably arranged, vehicles should slow down on roads with sensitive points such as residential areas and schools nearby, and windproof covering measures must be taken during the process of loading and unloading, and use, transportation and storage of cement, sand and gravel to reduce the generation of flying dust.

3. Flying dust of the storage yard

Another major source of flying dust during road construction is flying dust from open storage yards and bare sites caused by wind. Due to construction needs, some building materials need to be stacked in the open air. After excavation, the surface soil

of some construction sites is temporarily piled up in the open air. Under the dry and windy climate, a large amount of flying dust will be generated. The amount of flying dust can be calculated according to the empirical formula of flying dust in the storage yard:

$$Q = 2.1(V_{50} - V_0)^{0.85} e^{-1.023W}$$

where, Q is the amount of flying dust, with the unit of kg/t · year;

V_{50} is the speed of wind at 50m above the ground, with the unit of m/s;

V_0 is the dust-raising wind speed, with the unit of m/s;

W is the water content of dust particles, with the unit of %;

The dust-raising wind speed is related to dust particles and water content. Therefore, reducing open-air stacking, ensuring a certain water content, and reducing bare ground are effective means to reduce flying dust caused by wind. The diffusion and dilution of dust in the air are related to meteorological conditions such as wind speed, as well as the sedimentation speed of dust itself.

The settling velocity of different dust particles is shown in Table 5-3.

Table 5-3 Settling velocity of dust particles with different particle sizes

Dust particle size (μm)	10	20	30	40	50	60	70
Settling velocity (m/s)	0.003	0.012	0.027	0.048	0.075	0.108	0.147
Dust particle size (μm)	80	90	100	150	200	250	350
Settling velocity (m/s)	0.158	0.170	0.182	0.239	0.804	1.005	1.829
Dust particle size (μm)	450	550	650	750	850	950	1050
Settling velocity (m/s)	2.211	2.614	3.016	3.418	3.820	4.222	4.624

It can be seen from the table that the settling velocity of dust increases rapidly with the increase of particle size. The settling velocity is 1.005m/s when the particle size is 250μm. Thus, it can be considered that when the dust particles are larger than 250μm, the main influence range is within the close range of the downwind direction of the dust-raising point. What really affects the environment is some dust with fine particle size. In order to reduce the pollution impact of dust from the yard on sensitive points in residential areas, the assessment requires that the sand and gravel storage yard at the construction site should be set up in the downwind direction of the environmental sensitive point of the nearby village, and be covered with canvas.

In addition, the project is located in Henan and the rainfall is not large. As a result, the moisture content of the sand is not high. Thus, the following measures should be taken to minimize the generation of fugitive dust: ① Take measures to prevent typhoons, rainstorms and floods in the yard, and harden the ground and transportation roads; ② To install sprinkler devices above the yard and sprinkle water regularly to reduce dust, so that the surface moisture content of the yard can be controlled at about 8%. The frequency of watering should be increased in windy weather.

4. Analysis of the impact of flying dust on environmental sensitive points during construction

There are villages, schools, hospitals and other sensitive points within 200m along the project. The assessment recommends the following measures to mitigate the impact of flying dust:

① A construction enclosure with a height of not less than 2.5m should be set up in the construction section near the sensitive point.

② Speed up the construction progress of road sections near sensitive points to reduce the impact time.

③ Appropriately increase the frequency of watering at the construction site near the sensitive points.

④ Material storage yard, construction road, etc. should be set at appropriate positions away from sensitive points.

5.5.3.2 Asphalt fumes

Purchased finished asphalt is used in this project. There is no asphalt mixing plant on the construction site. Thus, the asphalt fumes of this project mainly appear in the process of asphalt pavement laying. The main toxic and harmful substances in asphalt fume are THC, phenol and benzopyrene, which will have a certain impact on the ambient air quality in the area. However, the paving process of this project is short and temporary, and its impact surface and impact degree are small.

In short, the construction period is relatively short compared to the operation period, and its impact is temporary and can be reversed under normal circumstances. Thus, prevention and control measures should be effectively implemented, civilized construction should be emphasized, environmental protection management requirements should be strengthened, a work responsibility system should be formulated, and the supervision and management of the environmental protection department should be obeyed.

5.5.3.3 Analysis of the impact of mechanical exhaust

Fuel-powered construction machinery and transport vehicles emit a certain amount of exhaust gas. The construction unit is required to check the validity and legality of the certificates of transport vehicles and construction vehicles to ensure

that the vehicles used are legal and meet the emission requirements. Transport vehicles are required to choose a reasonable transport route and try to avoid villages and towns, reducing the impact on the surrounding atmosphere.

5.5.4 Assessment of the impact of environmental noise during construction

5.5.4.1 Construction noise

(1) Noise source during construction

During the construction of the project, the noise source mainly comes from mechanical equipment. The main types of machinery and equipment are bulldozers, loaders, excavators, graders, road rollers, etc. for subgrade earthwork filling, drilling rigs, hoists, bulldozers, road rollers, etc. for construction of bridges, scrapers, asphalt pavers, and concrete mixer trucks, road rollers, etc. for pavement engineering construction. The noise source of the equipment is 79~98dB(A), and the source intensity is shown in Table 5-4.

Table 5-4 Test value of noise caused by road engineering construction machinery

S.N.	Type of machinery	Model	Distance from measuring point to construction machinery (m)	Max. sound level (dB)
1	Wheel loader	ZL40	5	90
		ZL50	5	90
2	Grader	PY160A	5	90
3	Vibratory road roller	Y2J10B	5	86
4	Double-drum road roller	CC2	5	81
5	Three-wheel road roller		5	81
6	Tire roller	ZL16	5	79
7	Bulldozer	T140	5	86

S.N.	Type of machinery	Model	Distance from measuring point to construction machinery (m)	Max. sound level (dB)
8	Hydraulic excavator	W4-60C	5	86
9	Paver	Fifond311ABGco	5	84
		VoGELE	5	82
10	Generator set	FKL75	1	87
11	Impact drilling rig machine	22	1	98
12	Pile driver		2	87

(2) Scope of influence of construction noise

The noise value at different distances from the sound source is estimated according to the noise attenuation mode of the point sound source. The prediction mode is as follows:

$$Lp=Lp_0—20lg\ (r/5)$$

where, Lp is the predicted value of construction noise at rm distance from the sound source, with the unit of dB (A);

Lp_0 is the reference sound level at 5m from the sound source, with the unit of dB (A);

Without considering the noise attenuation of trees and buildings, the predicted noise values of various construction machines at different distances are shown in Table 5-5. The impact of mechanical equipment noise on the environment at different stages during the construction period shall be implemented in accordance with *The Emission Standard for Environmental Noise at the Boundary of Construction Sites* (GB12523-2011).

Table 5-5 Influence range of noise caused by main construction machinery

Unit: dB (A)

S.N.	Type of machinery	Predicted noise value						
		5m	10m	20m	40m	50m	80m	100m
1	Wheel loader	90	84	78	72	70	67.5	65.5
2	Grader	90	84	78	72	70	67.5	65.5
3	Vibratory road roller	86	80	74	68	66	63.5	61.5
4	Double-drum road roller	81	75	69	63	61	58.5	56.5
55	Three-wheel road roller	81	75	69	63	61	58.5	56.5
6	Tire roller	76	70	64	58	56	53.5	51.5
7	Bulldozer	86	80	74	68	66	63.5	61.5
8	Hydraulic excavator	84	78	72	66	64	61.5	59.5
9	Paver	87	81	75	69	67	64.5	62.5
10	Percussion drilling machine	98	92	86	80	78	75.5	73.5
11	Pile driver	87	81	75	69	67	64.5	62.5

Many kinds of construction machinery often work together at the construction site. Thus, the noise of the construction site is the sum of the noise of various construction machinery and the noise caused by various vehicles entering and leaving the construction site. See Table 5-6 for the predicted noise values at different distances in different construction stages and the distance to meet the standard.

Table 5-6 Influence range of noise during construction Unit: dB (A)

Engineering	Sound source	50m	100m	150m	200m	250m	300m	400m	500m	Distance to meet standards/m	
										Daytime	Night-time

Subgrade engineering	97.9	63.9	57.9	54.4	51.9	49.9	48.3	45.9	43.9	25	250
Pavement engineering	95.9	61.9	55.9	52.4	59.9	47.9	46.3	43.9	41.9	20	198

According to the *Environmental Noise Emission Standard for Construction Sites* (GB12523-2011), the noise limit of the construction site during the daytime is 70dB (A), and the noise limit during nighttime is 55dB (A). It can be seen from the above table that the noise impact during subgrade construction is relatively large. The noise of construction machinery can reach the standard at a distance of 25m from the construction site during the day, and at a distance of 250m at night.

(3) Noise compliance at the construction site boundary

The assessment requires evaluating the protective enclosures around the construction site. Construction is limited to the protective enclosure. Thus, the daytime noise at the construction site boundary can meet the requirements of the daytime noise limit of 70dB (A) stipulated in the *Environmental Noise Emission Standard for the Construction Site Boundary* (GB12523-2011) during construction. The construction work period should be reasonably arranged during the construction period. No construction will be conducted at night (22:00-06:00) on the road sections near villages and towns to reduce the impact on the surrounding environment.

(4) Impact on sensitive points

Noises generated during the construction period will have a certain impact on the sensitive points along the road. It is suggested, according to the assessment criteria, the following noise protective measures shall be taken to minimize construction noise:

① Protective enclosure is built at the construction site. Construction is limited to the protective enclosure.

② Use low-noise and low-vibration machinery as much as possible. For construction machinery and equipment used in engineering construction, noise measurement under normal working conditions should be carried out in advance. Machinery that exceeds the national standard shall be prohibited from entering the site for construction. During the construction, the equipment should also be regularly maintained to avoid noise enhancement due to poor equipment performance. High-noise equipment should be installed as far away from residential areas as possible to reduce the impact of construction noise on surrounding areas;

③ If construction is carried out in a place close to the sensitive point of the residential area during the day, the construction progress shall be accelerated;

④ Construction time will be reasonably arranged. Construction is strictly prohibited during 22:00-06:00 near villages and towns. If continuous construction is required at night, the approval of the corresponding management department shall be obtained, and an announcement shall be made in a timely manner. Construction operations with strong vibration and high noise are strictly prohibited at night (22:00-06:00);

⑤ Transportation time should be reasonably arranged. Vehicles should slow down on roads near residential areas.

Although construction noise will have a certain adverse impact on the environment, the impact during the construction period is temporary and short-term compared to the operation period. Once construction is over, the construction noise impact will also end.

5.5.4.2 Noise of transportation

During the construction period, the transportation of raw materials and earthwork will increase the traffic flow on the road to a certain extent. Thus, transportation will increase the noise along the road. The impact of construction and vehicles is mainly intermittent, and each impact time is short. In order to reduce the impact of traffic noise along the road, the assessment require that: reasonably arrange the transportation time of construction materials, vehicles should slow down on roads with sensitive points such as residential areas and schools nearby, and random whistling is prohibited.

5.5.5 Analysis and assessment of the impact of solid waste on the environment during construction

The solid waste during the construction period consists of two parts: the old construction waste to be removed from the old road and the domestic waste of the construction workers.

According to the feasibility study report, the recycling of excavated materials from old roads will be strengthened and environmental protection design will be emphasized during the construction period. The broken pavement of the old road can be used as the cushion layer of the new road section, the road shoulder, and the connection of the level crossing of the gravel road, and can also be used as a road protection project for broken low-grade roads.

The construction personnel in a single construction, production and living area of this project are calculated as 20 persons, the domestic garbage is calculated as 0.5kg/person·d, and the domestic garbage generation in the construction, production and living area is 10kg/d. The assessment requires that temporary trash cans be set up in the construction, production and living areas, and the collected garbage should be cleared and transported regularly to the local sanitation department for disposal.

The solid waste generated during the construction period of the project can be properly disposed of through the above treatment measures and strengthening the construction site management.

5.5.6 Analysis of the impact of project construction on protected areas of drinking water sources and protective measures

5.5.6.1 Wastewater

① Construction wastewater

The flood-damaged points in the drinking water source protected area belong to the second-class protected area. Except for the CC08 bridge in Dengfeng, which spans the Shicong River, the rest are on land. Material storage yards and construction sites are set within the are permanently occupied by roads. Important building materials such as cement and steel bars at the construction site are generally stacked in simple warehouses that can prevent rain. Temporary storage sites are covered with tarpaulins to prevent rainwater from polluting water bodies. Sand, stone and other bulk materials need to be covered with dust-proof nets. Thus, construction wastewater is basically not generated in the material storage yard.

Maintenance of the construction machinery and flushing of construction equipment cannot be carried out within the protection zone of the surface water

source. It is forbidden to discharge domestic wastewater, construction construction wastewater and vehicle washing wastewater into the secondary protection zone. The sand and stone washing wastewater is collected in the anti-seepage sedimentation tank ($10m^3$) and recycled.

Maintenance of construction machinery and vehicles shall be strengthened to avoid oil leakage. Meanwhile, maintenance of mechanical vehicles must be performed at professional repair stations. In the event of an oil spill, the contaminated soil must be peeled off and transported away in time.

② Domestic sewage

The assessment requires that the scope of construction camps should be strictly controlled (it is forbidden to set construction camps in the first-level protected areas). Make efforts to rent private houses as construction camps. Temporary mobile toilets should be used if the construction camp is far from villages and towns. The toilet waste should be transported outside of the protected area through special vehicles by the sanitation department on a regular basis. The used water is collected into the anti-seepage collection tank ($5m^3$) and used for dust reduction at the construction site and transportation vehicle tire cleaning. Discharge of sewage into the protected area is prohibited.

5.5.6.2 Exhaust gas

Air pollutants generated during the construction period include flying dust from earthwork in the construction area, site leveling and other construction materials (including steel bars, stones, etc.), and flying dust caused by construction waste handling and bare sites. In addition, construction machinery and vehicles emit a certain amount of exhaust gas during operation. In order to minimize the impact on

the surrounding air during the construction period, the following protective measures shall be taken:

① "Six points in place" must be achieved before the construction site starts, that is, the approval is in place, the report is in place, the governance plan is in place, the supporting measures are in place, the monitoring is in place, and the personnel (management personnel of construction units, and supervisors of responsible departments) are in place;

② "Eight totally" must be achieved during construction, that is, the construction site is totally fenced off, material stacking is totally covered, incoming and outgoing vehicles are totally flushed, the ground of the construction site is totally hardened, the demolition site totally adopts wet work, and the muck vehicle is totally closed for transportation;

③ It is forbidden to mix concrete on-site and to configure mortar on-site;

④ It is forbidden to set up a spoil field within the protected area, and the spoil and slag generated during the construction shall be cleared, transported and utilized in a timely manner;

⑤ Dust is suppressed using water. Arrange special personnel to sprinkle water on the construction site to reduce the amount of dust generated. The amount and frequency of watering should be increased on windy days. In case of strong winds of level 4 or above, stop the construction that is easy to generate dust;

⑥ Construction must be carried out in accordance with the design drawings, and no expansion of the construction scope is allowed.

⑦ After the construction is completed, the vegetation on the site occupied by the construction shall be restored in time.

After the above measures are taken, the dust pollution during the construction period can be greatly reduced. The composition of air pollutants during the construction period is relatively simple, and the impact on drinking water sources is small after measures are taken.

5.5.6.3 Solid waste

The solid waste generated during the construction is mainly construction waste and a small amount of domestic waste from construction workers.

According to the feasibility study report, the recycling of excavated materials from old roads will be strengthened and environmental protection design will be emphasized during the construction period. The broken pavement of the old road can be used as the cushion layer of the new road section, the road shoulder, and the connection of the level crossing of the gravel road, and can also be used as a road protection project for broken low-grade roads.

The domestic garbage of the construction workers should be collected centrally and cleared and transported regularly.

5.5.7 Impact on residents' travel

The proposed project is a post-disaster reconstruction project for rural roads. It is a much-needed channel for local residents to travel, produce and live. The traffic capacity of vehicles will be affected during construction.

5.5.8 Occupational health and safety

Heavy use of heavy construction machinery, tools and materials create physical hazards, including noise, vibration and flying dust. For handling heavy objects and equipment, falling objects, working on smooth surfaces, fire hazards,

and chemical hazards (such as toxic fumes and others), appropriate occupational health and safety production management plans are required.

5.5.9 Traffic and construction safety

Construction can lead to unexpected interruptions to public services and utilities due to damage to water, drainage pipes, and power and communication cables.

5.6 Environmental impact and mitigation measures

5.6.1 Analysis of ecological protection and restoration measures

Given the fact that the project involves the Provincial Zhengzhou Yellow River Wetland Nature Reserve, cultivated land, forest land and nature reserve shall be strictly protected during the construction. Meanwhile, it is essential to do a good job in ecological restoration such as re-cultivation and afforestation. It is strictly prohibited to construct beyond the boundary with no additional occupied land. The collapsed earthwork caused by landslides should be backfilled as much as possible, and the surplus earthwork should be reasonably solved by the government through coordination to solve the problem of spoil. It is strictly forbidden to arbitrarily occupy the land of the Provincial Zhengzhou Yellow River Wetland Nature Reserve by temporary works.

5.6.1.1 Ecological and environmental protection measures for the main project

The ecological and environmental protection measures for the subgrade project of this project are as follows:

In the rainy season, obtaining meteorological information in time and knowing the rainfall situation in advance can help formulate the construction plan. For road sections with high fill and poor geological subgrade, avoiding construction in the

rainy season would be an option. If it is unavoidable, smooth drainage during construction should be ensured with no water soaking the road surface. If the protection works cannot be carried out at the same time, protective measures such as covering the slope and construction surface with waterproof rain cloth shall be taken.

During the subgrade filling process, temporary retaining measures shall be taken at the slope foot to prevent the erosion and loss of the uncompacted filler on the filling slope under rainfall conditions. Considering the terrain, geology, filling materials and engineering materials along the line, the following forms are proposed for embankment protection in the project:

①Seeding Protection

The road sections with a subgrade filling height less than or equal to 6m (H≤6m) are protected by grass planting, and the vegetation is a combination of shrub and grass.

②Masonry protection: In general road sections, when the filling height is more than 6m (H>6m), the side slopes shall be protected by an arched skeleton. Considering the slope protection effect and cost, the arched skeleton slope protection can play a better role in protecting the slope, effectively preventing water and soil loss at a low cost. In this case, C20 concrete arch ring and M7.5 mortar rubble arch frame will be used, and the arched skeleton slope protection with three-dimensional network seeding will be set in the arch ring.

③Retaining wall: When the route in the mountain area passes through the valley, a retaining wall will be set up to shrink the foot of the embankment. The retaining wall set up in this project is a gravity one, being built with mortar rubble. The mortar should be full and all exposed parts of the wall should be pointed. When the joint

strength of the retaining wall reaches 70%, it should be backfilled with water-permeable gravel or rubble to ensure that the compaction degree of the filler is not less than 95%, to ensure that the internal friction angle of the filler is not less than 35°.

For soil stratum, the foundation of the retaining wall is generally buried no less than 1.5m below the natural ground.

5.6.1.2 Protection measures for temporary material yard

Excavated around the material yard, the drainage ditch is easy to adopt a trapezoidal section, with a bottom width of 30cm and height of 30cm. The inner slope ratio is 1:1 and the inner wall is compacted. The drainage ditch is connected with the existing ditches nearby, and the construction materials are covered with canvas, etc.

5.6.1.3 Protection measures for the Zhengzhou Yellow River Wetland Nature Reserve in Henan Province

According to the field survey, no wild soybeans were growing in the project area, and the animals there are common species in Henan Province, most of which are migratory birds. During the construction of the project, strict management and control measures shall be formulated, the construction scope shall be strictly controlled, and unauthorized picking and hunting shall be strictly prohibited. During the construction period, if wild soybeans are found near the construction area, it should be reported to the management agency of the protected area, and corresponding protection measures should be taken at the same time. If they are distributed outside the construction operation area and do not affect the construction operation, in-situ protection measures should be taken as far as possible, otherwise, ex-situ transplanting protection measures should be taken according to the specific situation.

Measures and recommendations to mitigate the impact are as follows:

(1) The construction unit shall establish a construction progress reporting system, strengthen contact and work together with local environmental protection departments and protected area management departments in the early stage of construction and during the entire construction process.

(2) Before the construction personnel enter the protected area for construction, temporary publicity boards around the construction site and the camp should be set up, stating concisely slogans and relevant laws and regulations with the theme of protecting nature, such as the protection of birds and wetland vegetation, penalties of poaching, simple rescue methods and complaint telephone numbers. By conducting ecological protection training and publicizing laws and regulations on nature protection, construction workers will realize the importance of environmental protection and reduce damage outside construction. It is necessary to set up temporary publicity boards and warning signs around the construction site and camp and distribute brochures and pictures.

It is necessary to strengthen the management of construction personnel and take clear measures of reward and punishment. Reward activists who protect the ecological environment and punish those who damage the ecological environment. Also, it is strictly prohibited for construction personnel to hunt wild animals.

(3) It is essential to control the construction scope strictly, minimize the temporary land occupation and strengthen the management. It is strictly prohibited to enter the Provincial Zhengzhou Yellow River Wetland Nature Reserve in Henan Province at will, and it is forbidden to set up construction camps within the protected

area. Construction waste slag and spoil shall be disposed of or transported to designated locations as required. It is not allowed to dump into ditches and rivers.

(4) Management should be strengthened with no activities in non-construction areas. Non-construction activities that disturb animal habitats should be avoided. Also, it is prohibited to hunt wild animals and harvest rare plants. Construction vehicles shall drive along the planned construction road to avoid rolling over the wild vegetation around the construction area.

(5) Construction should be carried out during the day. In other words, it is prohibited at night (20:00 to 6:00 the next day). During construction in the reserve, low-noise equipment shall be used and temporary sound insulation measures shall be taken. Based on the different habits of animals, necessary facilities such as fences and walls shall be arranged around the construction site to prevent animals from entering the construction site and injuring themselves.

(6) If key protected species and their habitats are found during construction, protection measures shall be taken in time, and relevant management departments shall be notified to take further protective measures. When construction activities are carried out near animal activity sites, certain construction protection zones should be reserved to reduce the impact on animals.

(7) During construction, such problems as soil erosion caused by construction should be reduced. All temporarily occupied land shall be revegetated after construction.

(8) It is necessary to optimize the construction plan, promise the construction progress, and shorten the construction time in the protected area as much as possible. During the construction period, especially the high-noise construction operation, it is

essential to avoid the breeding season and peak activity season of birds and fish, so that they can recuperate and reproduce.

(9) Taking appropriate management measures can play a multiplier effect on ecological protection during the construction period, and construction supervision measures can be served as the best management measures during the construction period. During the whole construction period, the position of ecological supervision will either go to the full-time environmental protection personnel of the project supervision department and the construction department temporarily or the management personnel of the reserve. The way of patrol supervision shall be adopted to check the implementation of environmental protection measures and the ecological protection behavior of construction personnel.

(10) The ecological and environmental protection measures proposed in the project design shall be implemented strictly, controlling the environmental pollution caused by construction operations, following the requirements in the soil and water conservation plan to control soil erosion during the construction process, and restoring vegetation in time after the construction.

5.6.2 Water pollution prevention measures during the construction period

(1) Sewage treatment measures for construction, production and living areas during the construction period

During the construction period, the construction personnel work and live together. The daily domestic sewage discharge in the construction and living areas is 0.64t/d, and the main pollutants are COD, BOD and SS. Private houses will be rented in the construction camp. The washing water shall be collected in the collection tank

and used for watering and dusting on the site. The pit toilets will be cleaned regularly, and wastewater will be used for fertilizing nearby farmland (outside the drinking water source protection area).

Simple toilets shall be set up at the construction site to collect excrement and sewage of construction workers. Mobile toilets shall be built in the construction living area before workers enter the site, and shall be set outside the protected area as far as possible. The excrement shall be regularly transported by residents using manure trucks and used as fertilizer. Canteens and accommodation will not be set up in the protected area to reduce pollution to the water environment.

(2) Construction wastewater treatment measures during the construction period

Construction slurry wastewater treatment: The anti-seepage sedimentation tank will be used for treatment and recycling. After the construction is completed, the sedimentation tank will be cleaned and buried.

The treatment of residual oil, waste oil and washing oil sewage: the anti-seepage oil-separation tank shall be set up at the construction site to collect all oily sewage in time that will enter the anti-seepage sedimentation tank for reuse after oil separation treatment.

In addition, materials with toxic substances such as asphalt, oil, chemical substances, etc. shall not be kept within a short distance from the rivers along the line. At the same time, those materials need to be properly stored to avoid being washed into the rivers by rainstorms.

(3) Measures of preventing the impact of bridge construction on surface water

The evaluation suggested that the following pollution prevention measures should be taken in bridge construction:

①During bridge construction, it is necessary to strengthen management, educate workers, and optimize the construction plan by adopting advanced construction techniques, equipment, and scientific management as much as possible, so as to improve the construction progress on the premise of ensuring the quality of the project, and shorten the construction time of bridge construction as much as possible.

②The construction of the substructure of the bridge should be carried out in the dry season as far as possible, and its construction should adopt the cofferdam method with little disturbance to the water flow and river bed. The slurry water generated by the construction shall not be directly discharged into the rivers, and the drilling slag shall not be discarded into the river beach or river channel, so as to prevent the river bed from being raised or the cross-section from being compressed to affect the flood flow function of the rivers. Since sand and stone washing waste cement contains a large amount of sand and is easy to precipitate, it is recommended to set up a sedimentation tank for recycling after treatment.

③During bridge construction, it is strictly forbidden to set up construction production and living areas and building materials storage yard in the river embankment. Meanwhile, it is strictly prohibited to spill oil and chemicals into the rivers.

④It is essential to inspect construction machinery strictly from time to time to prevent oil leakage. An oil-separation sedimentation tank will be set up in the construction area for the construction construction wastewater treatment. After oil separation and precipitation, it will be used for dust reduction in the construction area.

5.6.3 Ambient air pollution prevention measures during the construction period

5.6.3.1 Dust pollution prevention measures during the construction period

According to the *Implementation Plan for the Air Pollution Prevention and Control in Henan Province in 2021* (YHGJB [2021] No. 19), *Standards for Urban Housing Construction, Municipal Infrastructure Engineering and Road Dust Pollution Prevention and Control* (Trial), *Implementation Plan for Air Pollution Prevention and Control in Zhengzhou in 2021* and other documents, the prevention and control measures of dust pollution should be well implemented, and eight "100%" should be abided by at the construction sites: (1) 100% enclosure around the construction site; (2) 100% coverage of material stacking; (3) 100% flushing of access vehicles; (4) 100% hardening of the road surface at the construction site; (5) 100% wet operation on demolition sites and earthworks; (6) 100% closed transportation of muck vehicles; (7) 100% installation of online video surveillance at construction sites with a construction area of more than 10,000 square meters and involving earthwork operations. These documents also state systems such as acceptance after the work starts and restarts, management of dust pollution prevention supervisors, grid administrators and administrators, and dust-prevention budget management. Also, the informatization Supervision Platform with no on-site mixing of concrete and no on-site configuration of mortar should be established, as well as the projects of 100 meters on both sides of the exit of the construction site, which are featured with cleanness, order, and beautification, should be attached importance to.

5.6.3.2 Asphalt fume pollution prevention measures

During asphalt paving, it is essential to select the period with good atmospheric diffusion conditions to reduce the impact of asphalt fume on sensitive points along the line. It is required to implement hygienic protection for asphalt paving operators,

supplying them with masks, goggles, etc., and strengthen labor protection to minimize physical injuries.

5.6.3.3 Measures of preventing exhaust pollution of mechanical equipment

In order to reduce the impact of non-road mobile machinery exhaust on the environment, the following management measures were proposed in the evaluation:

(1) It is necessary to formulate a management system for non-road mobile machinery at the construction site, and establish a management ledger for non-road mobile machinery entering the construction site. The construction unit, the general construction contractor and the supervision unit (referred to as "the three parties involved in the construction") shall perform the inspection and acceptance for non-road mobile machinery entry, fill in their entry inspection and acceptance form, and verify their environmental protection and inspection registration certificate, making each go in with one form and one certificate. The inspection and acceptance form and related materials shall be kept at the construction site for future reference;

(2) The owner of non-road mobile machinery shall be supervised and urged to carry out regular mechanical maintenance to ensure that the exhaust emissions meet the emission standards;

(3) The owner or user (unit or individual, the same below) of non-road mobile machinery shall be required to purchase oil from formal channels, and keep the purchase voucher and establish a ledger;

(4) The pollutant discharge and oil source of the non-road mobile machinery in the project shall be inspected regularly, and those that fail to meet the emission standards and oil consumption standards should be disposed of.

After the above measures are taken, it is ensured that the construction machinery and equipment entering the site can effectively reduce the impact of the construction machinery itself on the environment from the aspects of the equipment itself, oil products, and daily maintenance.

See table 5-7 for the main air pollution prevention measures taken during the construction period.

Table 5-7 List of air pollution prevention measures taken during the construction period of the project

o.	Prevention or protection objects	Prevention or protection measures

o.	Prevention or protection objects	Prevention or protection measures
	Dust from highway construction	1. The construction site should be kept moist and free of obvious floating dust. It is essential to establish a watering and cleaning system in the area where powdery materials are stacked. Especially when construction is close to environmentally sensitive points, the frequency and intensity of watering should be strengthened. 2. The construction bulk materials must be placed in the shed, or when stocked outside, they shall be covered with tarpaulin. The powdered building materials such as cement and lime should be transported in bulk by tank trucks. The powder material stacking point should be kept as far away from the residential area as possible. 3. Earthwork, gravel and other materials shall be covered with tarpaulin during transportation. 4. A wheel cleaning device shall be installed at the exit of the construction site, and people shall be specially assigned for cleaning the wheels and the sanitation of the entrance and exit of the site. It is strictly prohibited for the wheels to take mud on the road. 5. It is necessary to set up an effective and tidy hard enclosure around the construction site without interruption or opening, and close the bottom edge tightly with no leakage of slurry. The enclosure height at the construction site of main road sections in the urban area shall not be less than 2.5m, and that of general road sections shall not be less than 1.8m. The fully enclosed enclosure shall be set for demolition works, and the height of the enclosure shall not be less than 2.5m. The upper part of the enclosure should be equipped with a spray device to ensure full coverage of the enclosure spray, and the interval between each group should not be greater than 4m. 6. The exposed area of the construction site shall be hardened or planted in time to prevent secondary dust pollution. 7. Commercial concrete shall be used as much as possible during construction. 8. It is strictly forbidden to melt asphalt, incinerate plastics, garbage and other toxic and harmful substances and wastes at the construction site, and it is not allowed to use seriously polluting fuels such as coal, carbon and wood. 9. Mechanical dismantling must be supplemented by continuous pressurized watering or spraying to prevent dust from scattering. 10. Dust reduction measures shall be taken during the greening work. When there is a strong wind above level 4 or the municipal government issues an air quality warning, operations such as land leveling, soil replacement, and original soil screening are prohibited. After the land is leveled, the planting work shall be carried out within one week. Given the fact that the land rectification work has been completed, during the period

o.	Prevention or protection objects	Prevention or protection measures
	Material transportation and construction roads	1. Windproof and covering measures must be taken during the process of loading, unloading, using, transporting and storing cement, sand, gravel and other easily lost materials to reduce the generation of dust; 2. It is necessary to be equipped with a sprinkler to sprinkle water on the construction site, the roads entering and leaving the storage yard, and the main material transportation roads; 3. Automatic vehicle washing device shall be set at the entrance and exit of vehicles on the construction site. In special cases, mobile flushing equipment can be used. Specially-assigned people should be responsible for vehicle washing to ensure that no dirt or mud sticks to the exterior, chassis and tires of the vehicle, and that there should be no obvious mud marks on the road within 30 meters of the vehicle exit at the construction site, as well as sand, gravel, lime soil and other materials prone to dust. It is strictly prohibited for vehicles to carry mud on the road. 4. While the main roads on the construction site should be hardened, other roads should be hardened or paved with bricks, coke slag, gravel, etc.
	Construction waste disposal	1. The construction unit shall rationally utilize resources, prevent waste, and reduce the output of construction waste. 2. The construction waste on the construction site shall be stacked in a centralized and classified manner, covered tightly, cleared and transported in time. 3. To clean up the construction waste, the operation method of watering and dust reduction before cleaning shall be adopted, and closed pipes or bags (or containers) should be used to remove and transport by vertical lifting machinery. It is strictly prohibited to scatter at high places. 4. It is strictly forbidden to discard and incinerate various wastes at will on the construction site. 5. The transportation of construction waste should be entrusted to an approved transportation unit, and the responsibility for the prevention and control of transportation dust should be clearly defined in the entrustment contract.

o.	Prevention or protection objects	Prevention or protection measures
	Material Stockyard	Anti-dust, anti-loss and anti-leakage facilities should be established at various storage yards according to specifications, including wind and dust suppression walls, and wind and dust suppression nets. Also, storage yards should be equipped with wind and dust suppression facilities such as spraying, covering and enclosure. The material conveying equipment should be airtight and equipped with dust collection, spraying and other dust-proof facilities at the loading and unloading place. It is necessary to use wet operation for open-air loading and unloading, and it is strictly forbidden to load and unload dry materials.
	On-site construction personnel	Construction personnel should be offered protective equipment, such as protective masks or masks for cement and asphalt construction workers
	Mechanical equipment exhaust	1. It is necessary to formulate a management system for non-road mobile machinery at the construction site, and establish a management ledger for non-road mobile machinery entering the construction site. The construction unit, the general construction contractor and the supervision unit (referred to as "the three parties involved in the construction") shall perform the inspection and acceptance for non-road mobile machinery entry, fill in their entry inspection and acceptance form, and verify their environmental protection and inspection registration certificate, making each go in with one form and one certificate. The inspection and acceptance form and related materials shall be kept at the construction site for future reference; 2. The owner of non-road mobile machinery shall be supervised and urged to carry out regular mechanical maintenance to ensure that the exhaust emissions during the use of non-road mobile machinery meet the emission standards; 3. The owner or user (unit or individual, the same below) of non-road mobile machinery shall be required to purchase oil from formal channels, and keep the purchase voucher and establish a ledger; 4. The pollutant discharge and oil source of the non-road mobile machinery in the project shall be inspected regularly, and those that fail to meet the emission standards and oil consumption standards should be disposed of.

5.6.4 Noise pollution prevention measures during the construction period

①The construction unit must report to the local administrative department of environmental protection where the project is located fifteen (15) days prior to the construction, the project name, construction site, time limit, main equipment used, possible environmental noise value, and environmental noise pollution prevention measures, etc.

②It is essential to select low-noise construction machinery, equipment and technology. Fixed machinery and equipment with large vibration shall be equipped with a vibration-damping base. At the same time, the maintenance of various construction equipment shall be strengthened to maintain their good operation, so as to fundamentally reduce the noise source intensity.

③It is necessary to strengthen construction management, set construction operation time reasonably, and forbid construction at night (22:00~06:00). If continuous construction is really needed, the permission and approval of the corresponding management department shall be obtained and announced in time.

④The existing roads in the project area shall be used to transport construction materials during the construction period, and attention should be paid to reasonably setting the transportation time of construction materials. When driving on the roads near urban settlements and schools, drivers should slow down and not sound their horns.

⑤The sound sources of construction activities such as material transportation and knocking during construction can be solved through civilized construction and effective management.

⑥Temporary sound barriers should be set up on the roads near residential areas to reduce the impact of construction noise. Temporary sound insulation enclosures shall be established during construction at environmentally sensitive points.

Those noise reduction measures can reduce the impact of construction noise. Since the construction period is short, the noise impact will end after the construction period, and the impact of construction noise on residents' lives will also disappear.

5.6.5 Solid waste prevention measures during the construction period

①According to the feasibility report, during the construction period, it is necessary to strengthen the recycling of excavated materials from old roads, and focus on the environmental protection design. After the pavement structure of the old roads are broken, it can be used as the cushion of the new road section, the shoulder of the earth, the smooth connection of the level crossing of the gravel road, and also as the traffic keeping of the low-grade roads that are inaccessible.

②The spoiled soil and slag cleaned up during construction shall be temporarily stored at the designated location and removed and transported in time;

③When transporting bulk materials and wastes, vehicles must be loaded properly and covered with a cloth. Their exterior shall be cleaned before leaving the construction site without spilling along the way;

④The production area and living area shall be equipped with garbage bins so as to centrally collect, clear and transport domestic garbage on a regular basis.

5.6.6 Traffic disruptions and road congestion mitigation measures

The proposed project is for the post-disaster reconstruction of rural roads, which are essential for residents to travel, work and live. Given the fact that the

traffic capacity of vehicles will be affected during the construction period, in order to reduce the impact of construction on residents' travel, the following construction organizations and safety plans are proposed:

1. Construction organizations

Construction organization design should be done well before construction, making the construction plan of each project practical. It is necessary to clarify the technical requirements of construction specifications and construction operation procedures, as well as the post responsibilities and authorities of construction management personnel, so as to use funds according to the quality and progress requirements.

2. Traffic-keeping measures

To ensure the normal travel and construction safety of this section of the road during the construction period, the traffic-keeping measures are as follows:

(1) The construction shall be carried out on only half of the road for major disaster-damaged and reconstructed road sections, including local subgrade and pavement scouring, multiple consecutive subgrade pavement on the same route, damaged bridge and culvert, bridgehead slopes, side slopes, side ditches, protection, drainage, greening and other small water damage or large water damage.

(2) The construction shall be carried out in a closed way to handle the problems such as major flood-damaged restoration and reconstruction sections, large-scale subsidence of subgrade and pavement, overall collapse and road thrust, damaged bridges and other structures, or overall slip or collapse.

(3) During the construction period, the existing surrounding road network shall be used to divert vehicles. Before construction, the construction announcement shall be issued in newspapers, television and other media. Also, obvious signs shall be set up at the starting and ending points in advance, so do early detour signs at reasonable positions and construction signs at 1km from both ends of the project.

(4) During the construction, it is essential to hire traffic-keeping personnel, and formulate a scientific and effective shift system of being on duty 24 hours a day. They should hold responsibility for the key roads, when the situation permits, the traffic police department can be asked to help keep the traffic. The specific work is as follows: ① Guide the vehicles passing through the construction site in an orderly manner according to the set signs, and obey the command of the road administrator and construction security personnel; ② Cooperate with the construction unit to carry out traffic control of highway construction operations, and provide traffic safety services for highway maintenance operations; ③ Strengthen the traffic safety inspection for the construction sections without traffic interruption. In case of a traffic jam, cooperate with the traffic police and the construction unit to divert the traffic. If necessary, be on duty at a designated place.

(5) Emergency plan for security and traffic keeping

① Emergency response to a vehicle breakdown. When directing the vehicle, the traffic diversion team should immediately notify the traffic diversion staff at both ends of the obstruction in case of a breakdown, and divert the traffic to move the failed vehicle to the hard shoulder. Then they should notify the nearby

vehicle maintenance team immediately to rush to the scene to have it repaired. If it cannot be repaired at once, the vehicle should be taken away from the scene by a trailer or a forklift. When the traffic is blocked due to over-width vehicles or other uncertain factors, they shall send personnel to the site to command, eliminate man-made traffic jams, and strive to control the time of traffic jams at each construction point within 30min.

② Emergency response to traffic accidents. In the event of a traffic accident, the traffic diversion team should call the police immediately, cut off the traffic at both ends, direct other vehicles to detour as much as possible, and assist the traffic police department in protecting the accident scene. In case of casualties, the on-site rescue team shall help rescue and wait for the ambulance to send the wounded to the hospital. After the traffic police handled the accident scene, they should send personnel to clear the scene at once, remove all kinds of obstacles and resume traffic as soon as possible.

③ Emergency response to traffic flow during holidays. In view of the sharp increase in traffic during major holidays and golden weeks, it is suggested to stop the pavement construction temporarily, and the road sections that have not started or cannot be completed will be restarted after the holiday. In addition, the staff of the traffic diversion team should stick to their posts to ensure the safety and smoothness of the construction transition section during the golden week.

④ Responses to the vehicles that violate the command. Vehicles that disobey the command, disrupt the order, park indiscriminately and rush through customs shall be handed over to the on-site traffic police to educate the drivers or

detain the vehicles to ensure the traffic safety and smoothness of the construction section.

5.6.7 Occupational Health and Safety Production Management Program

The enterprise safety and health management agency shall be responsible for the occupational health and work safety of the employees, as well as the daily inspection of the employees' working environment. Enterprises shall establish and improve the investigation and rectification system of potential accidents, and take technical and management measures to discover and eliminate potential accidents in time. The investigation and treatment of potential accidents shall be truthfully recorded and notified to the staff. The safety and health management organization shall regularly maintain and inspect the equipment to ensure its normal operation. The maintenance and inspection records shall be kept and signed by relevant personnel. Employees who find potential accidents or other unsafe factors shall immediately report to the person in charge of on-site safety production management, and the person receiving the report shall deal with it in time.

The employees of the enterprise have the right to know the dangerous factors about the workplace or the post, as well as the corresponding preventive measures and emergency measures. They have the right to criticize and report on the existing safety production problems and to refuse illegal orders or carry out risky work. The enterprise shall not reduce its wages and welfare benefits or terminate the labor contract for criticizing, reporting or accusing its production and work safety, illegal command, illegal risk-taking and other acts.

5.6.8 Strict security measures during construction

Before construction, it is necessary to establish temporary roads to ensure the safety of vehicles and pedestrians, and provide clear signs and traffic control measures. The temporary water on the construction site shall be provided with a health and safety guarantee. All staff shall be educated on the safety of water and electricity use. Also, special operators shall be certificated.

Safety signs, warning signs and other signs and slogans stipulated by the state shall be placed in the construction area to prevent residents from entering the building protection area and dangerous areas.

During and before the subgrade construction, a strict construction management plan, construction specifications, and safety and technical operation specifications shall be formulated, on-site dispatchers shall be determined, and safety techniques shall be disclosed to all employees. It is necessary to set up safety protection facilities at the construction site and offer the safety protection products required by the staff. Subgrade construction can only start when it is ready. During subgrade construction, special personnel shall be assigned to the construction area for traffic management, and unified command shall be given to personnel, vehicles and machinery to avoid personal and mechanical accidents. It is necessary to provide enough space for the excavator, and people within the turning radius are not allowed to enter. Special personnel must be assigned to direct earthwork vehicles to enter the construction site for safety. Pedestrians are prohibited from passing through construction sites. When piling up the soil, sidewalks must be reserved in the piling area to avoid piling soil against the wall as far as possible. When piling is necessary, the height should not exceed 1m, and drainage ditches should be set up. During

compaction, the edges should be kept at a sufficient safety distance to prevent accidents. If manual operation is combined with mechanical operation, a certain safety distance should be maintained between man and machine.

Fences should be set up to prevent environmental pollution without affecting the physical and mental health of residents. No one is allowed to be around the machine. It is necessary to ensure that the machine can move back and forth freely, and arrange for specially-assigned people to command on-site to prevent casualties. During pavement construction, the construction personnel shall avoid the construction machinery in time and obey the on-site command. At the end of the construction, the site should be cleaned up in time, and the remaining materials should not be dumped on the roadside, which will affect the safety of pedestrians. Before the construction of the ground court, the traffic in the construction area should be closed with guardrails. Warning signs such as red flags or red lights must be set on the guardrails, and personnel shall be assigned for traffic management. Before the construction, it is necessary to check the integrity of the equipment carefully and work on the maintenance. During the construction of asphalt concrete pavement, attention should be paid to checking the safety of transportation vehicles and electricity use at any time. When vehicles are passing by, traffic management must be carried out to avoid passing vehicles at any time.

COVID-19 pandemic prevention and control measures:

It is essential to grasp the situation of employees timely and accurately, especially those from high and medium-risk areas, and foreign countries. Also, it is necessary to establish and improve employee health records, and strengthen

their health management. Attention should be paid to checking the temperature of employees, pushing them to meet protection requirements, and reducing gatherings and group activities. The sanitation conditions of workplaces and living places should be improved, especially the cleaning and disinfection of workplaces, staff canteens and tableware.

Contractors working in the project area shall cooperate with the communities in epidemic prevention and control, properly carrying out health education for staff, environmental hygiene control around the residence, and management of staff renting local houses to prevent the spread of epidemic diseases that may spread among staff into the community. At the same time, the staff who rent houses in the local area shall abide by the management regulations for the tenants and floating population in the local community and village, cooperate with the epidemic detection and prevention measures in the local community and village, and protect the health of the people in the local community.

6 Survey and Analysis of Social Impact

6.1 Identification of project stakeholders

Project beneficiaries are individuals or groups who can influence or be influenced by the achievement of project objectives. The stakeholder groups of AIIB Loan projects are "those who influence AIIB's actions and policies and are influenced by AIIB projects". Under the premise that poverty alleviation is the goal of AIIB, AIIB divides the various stakeholder groups involved in developing projects into: (1) primary stakeholders, which refer to the target groups of development projects, especially the poor and marginalized groups who are excluded from the development process due to lack of information and power; (2) loan stakeholders, which refer to the government of the borrowing country; and (3) secondary stakeholders, including non-governmental organizations, commercial organizations, and various experts who have the technical expertise and directly face the main stakeholder groups.

As a post-disaster reconstruction project of rural roads, this project is mainly to repair problems such as road collapse, slope collapse, bridge damage, and road thrust caused by floods, so as to restore the smooth traffic in the disaster-hit area and restore the normal production and living order of the masses as soon as possible, promote the reconstruction of the disaster-hit area, and quickly restore the economic development in this place.

Based on field surveys and discussions and interviews with various social strata, it is determined that the primary stakeholders of this project are ordinary residents and villagers in the project area, especially women, the elderly, the poor and other groups. Secondary stakeholders include: (1) relevant institutions such as project management

office, design unit, construction unit, supervision unit and consulting unit; (2) relevant government departments.

Primary stakeholders:

The villagers in the project area are the main stakeholders. They are the target group of the project, especially the poor and marginalized groups who are excluded from the development process due to a lack of information and power. In this survey, it mainly refers to the villagers currently living in the project area. Rural roads are the link connecting local villages and guaranteeing the smooth daily travel of villagers. Due to flood disasters, roads have suffered damage to varying degrees, and there are certain safety risks. The damage to the road also affects the restoration and reconstruction of the disaster-hit area and affects the daily production and life of the villagers. In particular, most of the project area is located in the mountainous and hilly areas, with good tourism resources. Many villagers run homestays and farmhouse restaurants. Damaged roads have damaged their economic benefits. In some project areas, villagers make a living by planting vegetables and fruit trees, and they need smooth roads for the transportation and sales of fresh fruits and vegetables. Therefore, the project is closely related to the villagers, and the villagers are the actual beneficiaries. Labor and mechanics are required during the construction of the project, which can create many employment opportunities. Villagers along the road can participate in the construction and get paid.

There are uncertainties during the implementation of this project. Firstly, construction noise, vehicle exhaust, construction dust pollution, etc. will affect their living environment. Secondly, in some construction nodes, only half of the road is available, and the other half is occupied. A small number of nodes have temporary

land for construction access roads. **Therefore, during the construction of the project, the travel and living environment of the villagers along the road will be affected in the short term.**

In conclusion, the villagers along the rural roads are the most important stakeholders, and their top concern is to protect their interests. In addition, land occupation, demolition and resettlement are not involved in this project, and so it has no impact on vulnerable groups along the road. Local residents are mainly the Han Chinese. Ethnic minorities and the Han people live together here, and there are no ethnic conflicts or religious conflicts.

Secondary stakeholders:

Secondary stakeholders mainly include non-governmental organizations (NGOs), commercial organizations, and various experts who have technical expertise and directly face the main stakeholder groups. Secondary stakeholders of this project are the project management office, the owner, the design unit, the construction unit, the supervision unit, the environmental and social assessment unit and other relevant institutions, as well as relevant government departments. The Zhengzhou AIIB Project Management Office was established for this project according to the survey. The main responsibilities of the project management office are to organize and coordinate the business relationship among the relevant departments, agencies and units, and to guide, liaise and supervise in the preliminary preparation of the project and the implementation of the project. Agencies implementing the project are Zhengzhou Highway Development Center and ministries of transport of various counties and districts. The design unit is Zhengzhou Traffic Planning Survey and Design Research Institute. Only through the coordination and cooperation of these secondary

stakeholders can the AIIB Loan Project of Post-disaster Reconstruction of Rural Roads in Zhengzhou be vigorously promoted and implemented.

In addition to the above key stakeholders, other stakeholders related to this project mainly include: (1) the municipal government and the governments of counties and districts where the project is located; (2) relevant government functional agencies and public functional agencies of counties and districts where the project is located; (3) grassroots administrative and social management organizations of villages and towns; (4) market entities related to the project.

Table 6-1 Analysis of stakeholders of the project

Stakeholders	Main way of being affected	Importance to this project
Ordinary villagers	Beneficial	Strong
Vulnerable groups	Beneficial	Strong
Municipal government and governments of counties and districts where the project is located	Beneficial	Middle
Relevant government functional agencies and public functional agencies of counties and districts where the project is located	Beneficial	Middle
Grassroots administrative and social management organizations of villages and towns	Beneficial	Middle
Design, construction, supervision and assessment units	Beneficial	Middle

6.2 Investigation and analysis of the basic situation of stakeholder sample households

Social assessment specialists and project-related personnel conducted interviews and questionnaires on sample stakeholder households from Feb. 19 to Feb. 27, 2022. The photos are shown in Figure 6-1.

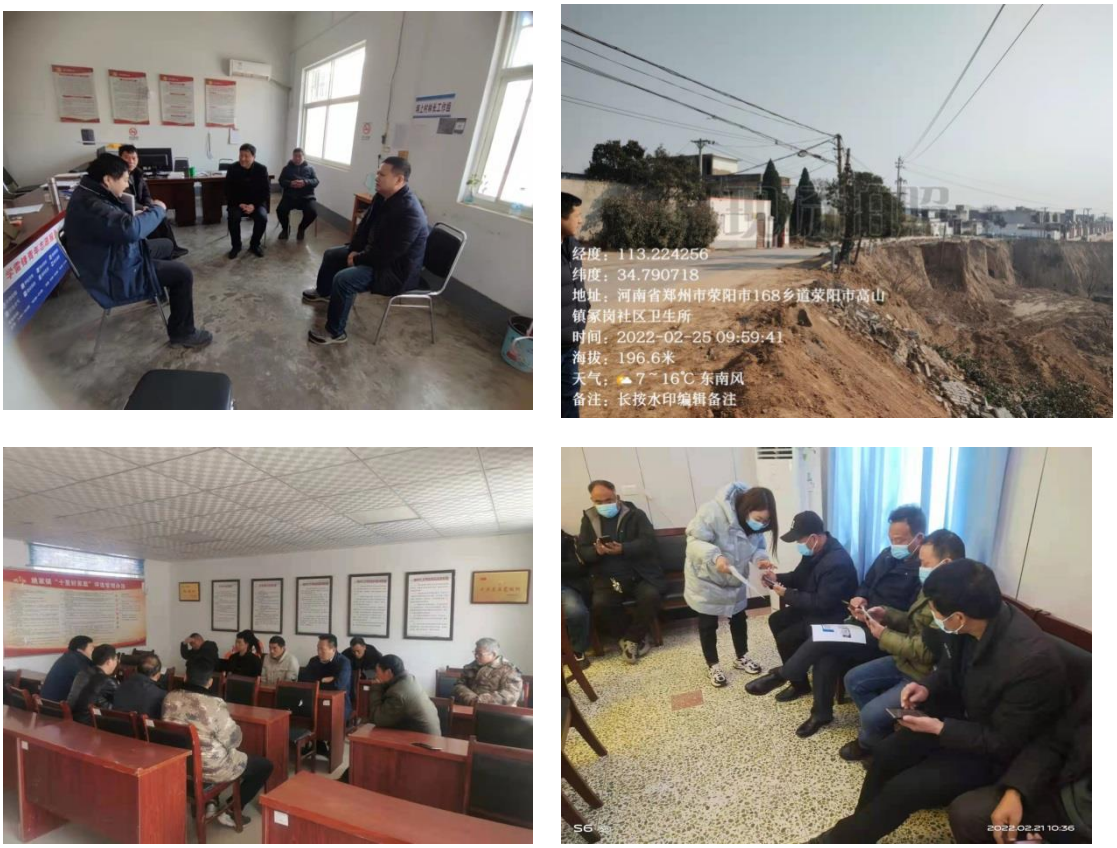


Figure 6-1 On-site aerial photography by social assessment specialists and interviews with sample households

6.2.1 Occupational and age structure of the sample population

A total of 6 counties and cities directly affected by the project, Xinmi City, Xingyang City, Dengfeng City, Xinzheng City, Zhongmu County and Gongyi City, were investigated in the social assessment through door-to-door survey, random survey and questionnaire survey. The survey sample households were distributed in 19 villages, with a total of 202 households, including 492 males, accounting for 50.93%, and 474 females, accounting for 49.07%. A total of 966 people were surveyed, with an average household population of 4.78. Among the 961 persons in the sample households, 99.48% are the Han nationality, 5 persons (0.52% of the total population) are ethnic minorities, 3 persons are the Miao nationality, and 2 persons are of the Hui nationality. The Miao nationality and the Han nationality have lived

together for a long time, and have achieved national integration. The Hui nationality and the Han nationality are related by marriage, but they keep their customs and national beliefs. The survey results are shown in Table 6-2.

Table 6-2 Male-female ratio of sample households

County (city)	Village	Number of households	Male	Female	Number of the Han nationality	Ethnic minority	Subtotal
Dengfeng City	Dongshang Village	12	22	27	49	0	49
	Jiangzhuang Village	10	29	29	58	0	58
	Liyao Village	12	31	28	59	0	59
	Tashuimo Village	10	20	19	39	0	39
Gongyi City	Gaomiao Village	17	43	36	79	0	79
	Huilong Village	11	30	28	58	0	58
	Longmen Village	12	31	32	63	0	63
Xinmi City	Heiyugou Village	12	28	29	57	0	57
	Wenzhuang Village	8	15	21	33	3	36
	Xiasigou Village	10	21	18	39	0	39
Xinzheng City	Gucheng Village	10	23	22	45	0	45
	Nianlu Village	10	30	26	56	0	56
	Tanghe Village	10	25	23	48	0	48
Xingyang City	Baishuiyu Village	12	25	25	50	0	50
	Gaoshan Village	10	31	26	57	0	57
	Zhonggang Village	11	23	24	47	0	47
Zhongmu County	Huizhuang Village	9	24	25	47	2	49
	Liangjiacun Village	6	15	14	29	0	29
	Xiaowangzhuang Village	10	26	22	48	0	48
Total		202	492	474	961	5	966
Average household population		4.78	50.93%	49.07%	99.48%	0.52%	100.00%

In the total sample population of the survey, the age structure statistics are shown in Table 6-3. The number of persons under the age of 17 is 236, persons aged 18-60 are 570 in total, and persons over the age of 60 are 160. It can be seen from the above results: whether it is a door-to-door survey, or a random survey and a questionnaire survey, in the age distribution of the sample population, young adults are the majority,

accounting for 59.01% of the total population, children under the age of 17 accounts for 24.43%, and the population over 60 years old accounts for 16.56%.

Table 6-3 Statistical table of the age structure of sample households

City (county)	Village	Name of householder	Aged 17 years and younger	Aged 18-60	Aged over 60 years	Subtotal
Dengfeng City	Dongshang Village	12	13	25	11	49
	Jiangzhuang Village	10	17	33	8	58
	Liyao Village	12	16	35	8	59
	Tashuimo Village	10	9	29	1	39
Gongyi City	Gaomiao Village	17	16	50	13	79
	Huilong Village	11	7	42	9	58
	Longmen Village	12	14	40	9	63
Xinmi City	Heiyugou Village	12	11	34	12	57
	Wenzhuang Village	8	9	23	4	36
	Xiasigou Village	10	8	27	4	39
Xinzheng City	Gucheng Village	10	15	27	3	45
	Nianlu Village	10	20	25	11	56
	Tanghe Village	10	15	24	9	48
Xingyang City	Baishuiyu Village	12	10	34	6	50
	Gaoshan Village	10	16	26	15	57
	Zhonggang Village	11	6	29	12	47
Zhongmu County	Huizhuang Village	9	11	29	9	49
	Liangjiacun Village	6	7	16	6	29
	Xiaowangzhuang Village	10	16	22	10	48
Total		202	236	570	160	966
Proportion			24.43%	59.01%	16.56%	100.00%

6.2.2 Educational attainment of the sample population

In the sample population of the social assessment survey, the educational attainment is shown in Table 6-4. 391 persons received junior middle school and below education, accounting for 40.48% of the total population; 394 persons received senior middle school (technical secondary school or vocational school) education, accounting for 40.79% of the total population; 181 persons received college education or above, accounting for 18.74% of the total population. The number of highly educated people was generally small because rural education resources were relatively lacking and life was relatively poor in the last century, and many people had to leave school early to go out to work to earn money and support their families. Since the beginning of this century, with the gradual improvement of educational resources and the remarkable improvement of living standards, parents have paid more and more attention to their children's education, and more and more young people have received a better education.

Table 6-4 Educational attainment of the sample population

County (city)	Village	Number of households	Subtotal	Junior high school and below	Senior middle school (technical secondary school, vocational school)	College or above
Dengfeng City	Dongshang Village	12	49	31	15	3
	Jiangzhuang Village	10	58	25	18	15
	Liyao Village	12	59	22	32	5
	Tashuimo Village	10	39	20	9	10
Gongyi City	Gaomiao Village	17	79	26	37	16
	Huilong Village	11	58	20	22	16
	Longmen Village	12	63	21	29	13
Xinmi	Heiyugou	12	57	17	27	13

County (city)	Village	Number of households	Subtotal	Junior high school and below	Senior middle school (technical secondary school, vocational school)	College or above
City	Village					
	Wenzhuang Village	8	36	14	17	5
	Xiasigou Village	10	39	15	19	5
Xinzheng City	Gucheng Village	10	45	19	11	15
	Nianlu Village	10	56	20	26	10
	Tanghe Village	10	48	23	19	6
Xingyang City	Baishuiyu Village	12	50	23	16	11
	Gaoshan Village	10	57	27	19	11
	Zhonggang Village	11	47	18	20	9
Zhongmu County	Huizhuang Village	9	49	19	24	6
	Liangjiacun Village	6	29	14	13	2
	Xiaowangzhuang Village	10	48	17	21	10
Total		202	966	391	394	181
Proportion			100.00%	40.48%	40.79%	18.74%

6.2.3 Average annual disposable income of sample households

The income survey results of sample households are shown in Tables 6-5 and 6-6. Among the sample households, the salary of civil servants is 620,781 yuan, the salary of enterprise employees is 2,770,000, the salary of public institution staff is 4,040,000 yuan, the agricultural income is 1,147,100 yuan, the employment income is 15,583,203 yuan, the business income is 2,280,010 yuan, and the government living allowance and other income is 586,393 yuan. The total income is 23,491,386 yuan. The median per capita net income of the sample households is 21,950.00 yuan, the

average is 24,318.20 yuan, the upper quartile is 15,875.00 yuan and the lower quartile is 31,187.50 yuan.

Table 6-5 Statistical table of income of sample households Unit: yuan

Village	Salary of civil servants	Salary of enterprise employees	Salary of public institution staff	Agricultural income	Employment income	Business income	Government living allowance and other income	Total	Per capita net income
Dongshang Village	0	60,000	0	44,500	1,150,503	20,000	17,120	1,292,123	26,369.86
Jiangzhuang Village	125,000	492,000	0	12,300	382,500	170,000	231,200	1,413,000	24,362.07
Liyao Village	25,000	70,000	0	20,400	1,522,500	220,000	7,000	1,864,900	31,608.47
Tashuimo Village	0	40,000	60,000	61,800	953,700	0	0	1,115,500	28,602.56
Gaomiao Village	38,000	150,000	0	24,100	1,203,000	100,000	4,930	1,520,030	19,240.89
Huilong Village	0	130,000	100,000	38,200	990,000	100,000	200	1,358,400	23,420.69
Longmen Village	100,000	245,000	0	17,500	885,000	190,000	6,000	1,443,500	22,912.70
Heiyugou Village	155,000	65,000	30,000	85,000	765,000	60,000	38,500	1,198,500	21,026.32
Wenzhuang Village	100	28,000	0	13,800	474,000	0	61,500	677,300	18,813.89
Xiasigou Village	0	60,000	0	25,700	685,500	230,010	85,700	1,086,910	27,869.49
Guchen g Village	0	80,000	90,000	175,000	750,000	410,000	1,000	1,506,000	33,466.67
Nianlu Village	20,001	90,000	74,000	27,000	1,099,500	310,000	45,000	1,665,500	29,741.07
Tanghe Village	0	60,000	0	69,000	1,095,000	100,000	0	1,324,000	27,583.33
Baishuiyu Village	0	130,000	50,000	24,000	937,500	100,000	25,500	1,267,000	25,340.00
Gaoshan Village	75,000	532,000	0	20,000	309,000	50,000	7,500	993,500	17,429.82
Zhonggang	0	358,000	0	40,800	693,000	0	33,000	1,124,800	23,931.91

Village	Salary of civil servants	Salary of enterprise employees	Salary of public institution staff	Agricultural income	Employment income	Business income	Government living allowance and other income	Total	Per capita net income
Village									
Huizhuang Village	22,680	50,000	0	165,000	570,000	150,000	11,560	969,240	19,780.41
Liangjiacun Village	0	50,000	0	102,000	360,000	50,000	3	562,003	19,379.41
Xiaowangzhuang Village	60,000	80,000	0	181,000	757,500	20,000	10,680	1,109,180	23,107.92
Total	620,781	2,770,000	404,000	1,147,100	15,583,203	2,280,010	586,393	23,491,386	24,318.20

Table 6-6 Distribution of per capita disposable income of sample households

Income distribution/yuan	Number of households	Proportion
2000-4000	1	0.46%
4000-6000	3	1.39%
6000-8000	5	2.31%
8000-10000	4	1.85%
10001-12000	6	2.78%
12000-14000	16	7.41%
14000-16000	18	8.33%
16,000-18,000	13	6.02%
18,000-20,000	14	6.48%
18,001-20,000	14	6.48%
20,001-22,000	22	10.19%
22,001-24,000	15	6.94%
24,001-26,000	16	7.41%
26,001-28,000	8	3.70%
28,001-30,000	4	1.85%
30,001-33,000	19	8.80%
33,001-36,000	7	3.24%
36,001-40,000	9	4.17%

Income distribution/yuan	Number of households	Proportion
40,001-45,000	6	2.78%
45,001-50,000	4	1.85%
50,001-60,000	5	2.31%
60,001-80,000	5	2.31%
More than 80,001	2	0.93%

6.3 Survey on the influence of flood disaster on main villagers

The survey result of the impact of flood disasters on the sample households of primary stakeholders is shown in Table 6-7. The survey results show that: 14 households think it is very frequent (once every year), 19 households think it is frequent (once every 1-5 years), 16 households think it is infrequent (once every 6-10 years), 153 households think it is very rare (once every more than 10 years). Zhengzhou has a temperate continental monsoon climate, with hot and rainy summers and dry winters. The main flood season in Zhengzhou is from late July to early August. In recent years, there have been economic losses due to floods, but 79 households suffered minor losses, 93 households suffered large losses, and 30 households were not affected. The impact of flood disasters on villagers was significant. The survey data shows that heavy rain easily erodes the soil and causes disasters in mountainous and hilly areas. Many villagers make a living by growing vegetables and fruits, such as garlic and strawberries. Most of these vegetables and fruits are grown in greenhouses, and disaster weather or flood disasters have a huge impact on them.

Table 6-7 Statistical table of flood impact on sample households

County/city	Village	**Have you ever suffered from floods**	**Any economic losses caused by floods in recent years**

		Very frequent (once every year)	**Frequent (once every 1-5 years)**	**Not frequent (once every 6-10 years)**	**Rarely (once every more than 10 years)**	**Yes, a few**	**Yes, heavy losses**	**No**
Dengfeng City	Dongshang Village	1	0	0	11	1	1	10
	Jiangzhuang Village	3	0	0	7	6	1	3
	Liyao Village	4	0	2	6	7	4	1
	Tashuimo Village	1	0	0	9	4	3	3
Gongyi City	Gaomiao Village	0	0	0	17	9	7	1
	Huilong Village	1	0	2	8	4	7	0
	Longmen Village	1	0	1	10	5	6	1
Xinmi City	Heiyugou Village	0	0	1	11	4	8	0
	Wenzhuang Village	0	2	0	6	3	5	0
	Xiasigou Village	0	1	2	7	3	7	0
Xinzheng City	Gucheng Village	0	0	2	8	5	1	4
	Nianlu Village	1	0	0	9	3	7	0
	Tanghe Village	1	3	0	6	2	7	1
Xingyang City	Baishuiyu Village	0	0	2	10	7	4	1
	Gaoshan Village	0	0	0	10	3	4	3
	Zhonggang Village	0	1	0	10	5	4	2
Zhongmu County	Huizhuang Village	1	7	0	1	0	9	0
	Liangjiacun Village	0	1	3	2	4	2	0
	Xiaowangzhuang Village	0	4	1	5	4	6	0
Total		14	19	16	153	79	93	30

The main impacts of flood disasters on sample households in recent years are shown in Table 6-8. The survey result shows that 97 households' houses were damaged, 144 households' crops were flooded, 31 households' livestock were flooded, 173 households suffered from traffic disruption, and 22 households were safe.

Table 6-8 Questionnaire on the main impact of floods on your family in recent years

County (city)	Village	House damage	Crop loss	Livestock loss	Traffic disruption	Life safety
Dengfeng City	Dongshang Village	2	1	0	12	0
	Jiangzhuang Village	4	4	0	10	0
	Liyao Village	4	7	0	12	1
	Tashuimo Village	3	5	0	10	0
Gongyi City	Gaomiao Village	6	14	1	13	3
	Huilong Village	8	10	5	10	3

	Longmen Village	5	9	3	9	1
Xinmi City	Heiyugou Village	8	11	3	11	0
	Wenzhuang Village	4	7	3	8	1
	Xiasigou Village	8	10	0	10	2
Xinzheng City	Gucheng Village	3	8	0	8	2
	Nianlu Village	2	9	0	8	1
	Tanghe Village	6	10	1	10	2
Xingyang City	Baishuiyu Village	7	10	2	10	1
	Gaoshan Village	5	6	4	10	1
	Zhonggang Village	6	7	2	10	1
Zhongmu County	Huizhuang Village	7	9	7	9	3
	Liangjiacun Village	1	5	0	3	0
	Xiaowangzhuang Village	8	2	0	0	0
Total		97	144	31	173	22

Table 6-9 Questionnaire on the main impacts of floods on your family in recent years

County/city	House damage	Crop loss	Livestock loss	Transportation disruption	Life safety
Dengfeng City	17.3%	22.7%	0.0%	58.7%	1.3%
Gongyi City	19.0%	33.0%	9.0%	32.0%	7.0%
Xinmi City	23.3%	32.6%	7.0%	33.7%	3.5%
Xinzheng City	15.7%	38.6%	1.4%	37.1%	7.1%
Xingyang City	22.0%	28.0%	9.8%	36.6%	3.7%
Zhongmu County	29.6%	29.6%	13.0%	22.2%	5.6%
Proportion	20.8%	30.8%	6.6%	37.0%	4.7%

The survey data shows that traffic interruption is the major result of flood disasters, accounting for 37%, and Dengfeng City is the most affected, with this destruction accounting for 58.7%. Dengfeng has many mountains and hills, and has rich tourism resources. Villagers rely on tourism resources and mountains. They grow crops such as pecans and honeysuckle. The interruption of traffic has made it difficult

to transport local specialties, the tourism industry has been hit, and the transportation of production and living materials was difficult.

Therefore, the purpose of this project is to solve the problem of traffic interruption caused by floods, restore the road use function, and ensure the traffic capacity, which is what the villagers around the rural road expect.

6.4 Villagers' attitude towards the project

Villagers' attitude towards the project is shown in Table 6-10. 199 households believed that this project is necessary, 1 household thought it is not necessary, and 2 households were indifferent.

Table 6-10 Questionnaire on villagers' attitudes towards project implementation

County/City	Village	**As far as your concern, is this reconstruction project necessary?**		
		Yes	No	I am OK either way
Dengfeng City	Dongshang Village	12	0	0
	Jiangzhuang Village	10	0	0
	Liyao Village	12	0	0
	Tashuimo Village	10	0	0
Gongyi City	Gaomiao Village	17	0	0
	Huilong Village	11	0	0
	Longmen Village	11	0	1
Xinmi City	Heiyugou Village	12	0	0
	Wenzhuang Village	7	1	0
	Xiasigou Village	10	0	0
Xinzheng City	Gucheng Village	10	0	0
	Nianlu Village	10	0	0
	Tanghe Village	9	0	1
Xingyang City	Baishuiyu Village	12	0	0
	Gaoshan Village	10	0	0
	Zhonggang Village	11	0	0
Zhongmu County	Huizhuang Village	9	0	0
	Liangjiacun Village	6	0	0
	Xiaowangzhuang Village	10	0	0
Total		199	1	2

Table 6-11 Questionnaire on villagers' attitudes towards project implementation

County/city	Yes	No	I am OK either

			way
Dengfeng City	100.0%	0.0%	0.0%
Gongyi City	97.5%	0.0%	2.5%
Xinmi City	96.7%	3.3%	0.0%
Xinzheng City	96.7%	0.0%	3.3%
Xingyang City	100.0%	0.0%	0.0%
Zhongmu County	100.0%	0.0%	0.0%
Proportion	98.5%	0.5%	1.0%

The survey results show that: all the villagers of the sample households in Dengfeng City, Xingyang City and Zhongmu County supported this project, 2 households in Gongyi and Xinmi were indifferent and 1 household in Xinmi thought that this project is not necessary. 98.5% of the sample households supported the project, indicating that the implementation of the project was expected by the local villagers. Villagers expressed at the symposium that they hope the project can be implemented as soon as possible, the sooner the better, preferably before the vegetables and fruits are put on the market.

Table 6-12 Questionnaire on major environmental problems during project implementation

County/City	Village	Noise	Dust	Waste	Construction wastewater	Odor due to silt dredging	Others
Dengfeng City	Dongshang Village	10	4	0	0	0	0
	Jiangzhuang Village	8	8	1	0	0	0
	Liyao Village	8	5	3	0	0	0
	Tashuimo Village	8	8	2	2	1	0
Gongyi City	Gaomiao Village	10	14	11	2	4	0
	Huilong Village	4	3	8	2	3	1
	Longmen Village	4	6	4	1	1	2
Xinmi City	Heiyugou Village	3	7	7	2	2	2
	Wenzhuang Village	1	4	4	0	1	1
	Xiasigou Village	2	3	8	2	1	0
Xinzheng City	Gucheng Village	4	3	8	1	1	0

	Nianlu Village	3	7	7	1	2	1
	Tanghe Village	3	4	7	3	3	0
Xingyang City	Baishuiyu Village	4	9	8	1	2	2
	Gaoshan Village	4	7	6	2	2	1
	Zhonggang Village	5	7	6	1	1	2
Zhongmu County	Huizhuang Village	1	7	0	0	0	2
	Liangjiacun Village	1	3	1	1	0	1
	Xiaowangzhuang Village	6	7	4	2	2	3
Total		89	116	95	23	26	18

The statistical results of the survey on the influence of the increase in traffic and people flow during the construction of the project on the sample households show that 83 sample households believe that the construction process of the project has no impact on their production and life, 104 households believe that there is a certain impact, but it's just a little, and 15 households think it has a great impact. See Table 6-11 for details.

Table 6-13 Statistical table of the impact of increased traffic and people flow during the project construction

County/city	Village	**Will the increased traffic and people flow during the construction of the project affect your work and life?**		
		No	Yes, but just a little	Yes, very much
Dengfeng City	Dongshang Village	12	0	0
	Jiangzhuang Village	10	0	0
	Liyao Village	11	1	0
	Tashuimo Village	8	2	0
Gongyi City	Gaomiao Village	2	14	1
	Huilong Village	0	9	2
	Longmen Village	4	8	0
Xinmi City	Heiyugou Village	4	7	1
	Wenzhuang Village	1	6	1
	Xiasigou Village	3	6	1
Xinzheng City	Gucheng Village	4	6	0
	Nianlu Village	4	5	1
	Tanghe Village	8	1	1
Xingyang City	Baishuiyu Village	3	8	1
	Gaoshan Village	3	7	0

County/city	Village	**Will the increased traffic and people flow during the construction of the project affect your work and life?**		
		No	Yes, but just a little	Yes, very much
	Zhonggang Village	4	4	3
Zhongmu County	Huizhuang Village	0	9	0
	Liangjiacun Village	1	4	1
	Xiaowangzhuang Village	1	7	2
Total		83	104	15

6.5 Analysis of the development of vulnerable groups

Vulnerable groups refer to various groups that are in a disadvantaged position and have difficulties in resource allocation, including women, children, poor people and ethnic minorities. Therefore, it is necessary to investigate and analyze their basic situation at the initial stage of project preparation and investigate their interests and impacts during the project implementation It is necessary to formulate corresponding plans and take corresponding measures according to the factors and degrees of its impact, to minimize or avoid the adverse impact on such groups.

6.5.1 Measures to prevent those who have been lifted out of poverty from returning to poverty again

Measures to prevent those who have been lifted out of poverty from returning to poverty again: all 181 poverty-stricken villages in Zhengzhou City lifted out of poverty in 2020. In 2020, the per capita disposable income of poor farmers reached 15,127 yuan.

In order to prevent those who have been lifted out of poverty from returning to poverty, the *Three-Year Action Plan for Guarantee for Special Poor Groups in Zhengzhou City* was issued in 2021. Two types of safeguards, home support and institutional centralized support, are provided for the extremely poor supporters, the

poor and severely disabled people, the people with severe chronic diseases, the disabled and semi-disabled people, orphans and the elderly:

(1) Home support means that the supporter (guardian) is responsible for all-round care of the home support object such as food, clothing, housing, medical care, travel, and safety. There is a special caregiver in this model. The person being cared for has the same diet and living conditions as the caregiver, ensuring that the sick can be treated, that there is a comfortable place to live, and that there is enough pocket money usually.

(2) Institutional centralized support means that these people are hosted in village-level and town-level elderly care institutions, social welfare institutions and medical and health institutions for support or treatment.

After the implementation of the project, the traffic is smooth, which is conducive to the daily travel of these six special poverty groups, reducing the potential safety hazards in daily activity places, ensuring timely medical treatment, and providing convenient transportation conditions to ensure the timely delivery of guarantee.

6.5.2 Analysis of women's development

The project area involves 6 counties (cities) in Zhengzhou City, including 400,522 women in Xinmi City, 349,374 women in Xingyang City, 330,822 women in Dengfeng City, 565,870 women in Xinzheng City, 333,223 women in Zhongmu City, and 384,926 women in Gongyi City, accounting for 47.81% of the total population. The total population of the 19 sample villages is 43,411, of which 20,267 are women, accounting for 46.69% of the total population.

In order to ensure the rights and interests of women, the Henan Provincial People's Government has issued the *Development Plan for Women of Henan Province*

(2021-2030), mainly to enhance women's sense of gain, safety and happiness. Its main contents are as follows:

1) Ensure women's health, and improve the maternal and child health service system; ensure that all provinces, cities and counties have maternal and child health care institutions, and women's medical care is fair.

2) Fully implement the policy of equality between men and women, improve the cultural quality of rural women, eliminate illiteracy among young and middle-aged women, and ensure that girls receive equal access to compulsory education.

3) Promote equal employment, eliminate gender discrimination in employment, and ensure that women receive fair labor remuneration.

4) Ensure that rural women equally enjoy rights and interests such as the right to land contract management and the right to use homesteads, and to equally enjoy the rights and interests in the distribution of income from rural collective economic organizations and in compensation for land expropriation or requisitioning and resettlement.

5) Advocate to establish a harmonious and civilized marriage and family relationship between men and women, stop all domestic violence against women, guarantee women's property ownership rights and inheritance rights in the family, and guarantee women's right to know and equal treatment of common property in marital relations.

This project is beneficial to the daily travel, production and life of women in the project area. Women will have more time and energy to contribute to the family. Daily life purchasing is mostly completed by women. Smooth roads save women's travel time, ensure women's travel safety, and relieve women's life pressure. In particular, in

rural areas, men go out to work, and many women choose to stay at home to take care of the elderly and children. The cultivation and sale of crops are also the responsibility of women. Therefore, smooth roads in rural areas play an important role in the purchase of living materials and the sale of agricultural products and help improve women's living, working and health levels.

6.5.3 Analysis on minorities

The minority are scattered across Zhengzhou. The number of the minority in 6 counties and cities involved in the project area is 75,000, accounting for 1.5% of the total population. The number of the minority in the sample villages in the project area is 35, accounting for 0.081% of the total population, mainly the Hui nationality. The number of the minority in the sample households is 5, of which 3 are the Miao nationality and 2 are the Hui nationality.

There are no ethnic minorities living in concentrated communities in the project area. The minority is small in number and scattered. They lived together with the Han nationality and they intermarry with the Han nationality. The language they used is the local dialect and mandarin. The Hui people maintain their own habits and beliefs. They do not form fixed residential communities, nor do they form fixed settlements, nor do they have traditional ancestral territories. The ethnic minorities in the project implementation area enjoy the same social and public services as the Han nationality. This project will not have a concentrated impact on the production and life of ethnic minorities, so this section will not go into detail about this.

6.5.4 Involuntary resettlement

This project is to carry out restoration and reconstruction of rural roads damaged by flood on the original site. Thus, **occupation of arable land and houses,**

compensation for demolition and land acquisition and resettlement are not involved in this project. Thus, the reconstruction will be carried out strictly according to the original road width, and the occupation of arable land, urban land and residential land is strictly prohibited during the construction of this project. Therefore, this is no involuntary resettlement in this project.

6.6 Analysis and monitoring of social risk of the project

It is a powerful measure to identify the main social risks related to the design of the project objectives and that may affect the realization of the project development objectives on the basis of field survey and statistical analysis to avoid social risks and ensure the smooth implementation of the project according to the social and economic development law of the project area and the characteristics of the project.

6.6.1 Necessity of project implementation

It is an AIIB Loan project of post-disaster reconstruction of rural roads in Zhengzhou. Rural roads are of great significance for farmers to get rid of poverty and become prosperous, implement the strategy of rural revitalization, and accelerate the modernization of agriculture and rural areas. After the flood, road subsidence and slope collapse occurred in some road sections, resulting in local traffic safety hazards or even road breaks, which seriously hindered people's travel for production and life, and disaster relief, flood control and emergency rescue. The implementation of this project aims to repair the damaged road sections as soon as possible and restore their original function. Thus, the implementation objective of this project is to:

(1) Restore the original road function and keep the arterial road network smooth;

(2) Meet the needs of the masses to travel, and restore production and life;

(3) Accelerate post-disaster reconstruction and promote regional economic recovery and development.

(4) Check hidden road safety hazards and eliminate potential risk factors after the disaster.

Therefore, the goal is right and necessary. The project conforms to the overall and macro interests of the project area, and is supported by government policies at all levels in China and supported by local residents. It aims to restore the original local traffic conditions in the project area.

6.6.2 Identification of social risks in project implementation

There are still certain social risks during the implementation of the project. The social risk analysis of a project is to identify and rank various social factors that may negatively impact the achievement of project objectives or the target beneficiaries. Social factors that have a large impact, a long duration, and easily lead to large contradictions were selected for prediction. The social environment and conditions that may cause such risks were analyzed.

The objective of this project is to restore the original function of the flood-damaged road, and restore the traffic conditions, production conditions and quality of life of the residents along the road. A large number of workers and mechanical tools are required to participate in the project, which can create many employment opportunities. Residents along the road can participate in the construction of the project and get paid. Therefore, this project has an important positive impact.

The road sections to be implemented in this project are all damaged ones caused by floods. The flood-damaged road sections are widely distributed and scattered. There are the following social risks during the implementation of the project:

(1) Many flood-damaged road sections in this project are located in mountainous areas and hills, and the hillsides and roadbeds are washed by rainwater. The project design unit shall optimize the design, the implementation unit shall implement the safety management system, and the project management office and relevant units shall supervise in time to avoid labor safety risks during construction;

(2) During the implementation of the project, the project implementation unit shall strictly implement the safety regulations to guarantee the construction progress and ensure the basic traffic requirements and quality of life of the villagers in the project area, avoiding risks to community safety and villagers' health in the project area;

(3) The rights and interests of vulnerable groups and women are guaranteed during the implementation of the project to avoid the risk of low participation of vulnerable groups and women.

6.6.3 Involuntary resettlement

This project is a restoration project after flood damage, focusing on the restoration of road damage caused by floods. The flood-damaged sections to be repaired are distributed in the current road network in a point-like manner. The project land is within the scope of the original road land, and there is no new land for this project. For details, please refer to the feasibility study report of this project. Thus, involuntary resettlement is not involved in this project.

6.6.4 Analysis of production safety risk

This project is a restoration project after flood damage. The flood-damaged road sections to be repaired cover county roads, township roads and village

roads within the scope of 6 counties (cities and districts), about 76 townships, 29 sub-district offices, and 2 scenic area management committees, and are distributed in a point-like manner. Therefore, the construction of the project involves a wide range and scattered locations. Many are located in mountainous and hilly areas. After the flood, the soil of the mountain is loose and there is a risk of landslide. Thus, production safety risk management is particularly important during the implementation process.

Safety risk management refers to formulating relevant road construction plans, decisions, organization and control for the safety risks arising in the process of highway construction with the rational use of effective resources based on the actual conditions of road construction. In this process, the materials, environment and equipment in road construction are fully adjusted to avoid social risks such as environmental pollution, personal injury, property loss, construction delay and construction quality caused by accidents.

6.6.4.1 Analysis of construction management risk

If there is no sound safety management system during the construction of this project, there is a risk that the safety system cannot guarantee implementation. If the actual situation of the construction is not fully considered during the process of formulating the safety construction plan, resulting in the lack of strong practicability of the safety management system, there will be a risk that the safety system cannot be implemented. Thus, the project management office, the design unit, the construction unit and the supervision unit and so on need to strictly abide by the national laws and regulations, including *The Construction Law of the People's Republic of China*, *The Law of the People's*

***Republic of China on Work Safety*, *Regulations on the Administration of Work Safety in Construction Projects*, to establish and improve the safety risk management system of roads during construction.**

(1) Establish a professional safety management team

Employ professional technicians with corresponding professional qualification certificates. Establishing a safety management department is one of the effective ways to avoid risks. Professional technicians usually have professional technology background and knowledge. They can predict and prevent safety accidents. If safety problems or accidents occur during the construction, professional technicians can find effective methods to solve them in time, avoiding expansion of accidents or unnecessary losses caused by delays.

(2) Develop a construction safety system

A sound construction safety system can form a general constraint on construction management. It builds safety awareness at the institutional level and places responsibility on the individual, which can avoid the risk of insufficient implementation of the safety system caused by the dead zones of management. Urge the construction unit to conduct regular safety training after the production safety system is established. In particular, local migrant workers recruited in the project area shall receive this kind of training, because they may not have rich construction experience. Some villagers shall also receive this training because they have little safety awareness. Safety system training enables them to master the safety system and related safety technology knowledge. Only workers who have passed the safety assessment can be employed.

Clarify corresponding emergency plans when responding to emergencies to avoid safety risks caused by weak safety awareness. The project construction unit formulates an emergency rescue plan for production safety accidents, which is linked with the emergency rescue plan for production safety accidents formulated by the local people's government at or above the county level. Training exercises shall be organized on a regular basis. Once a production safety accident occurs, the relevant personnel at the accident site shall immediately report to the person in charge of the unit. The person in charge of the unit, after receiving the accident report, shall take effective measures quickly and organize rescue to prevent the accident from expanding, and reduce casualties and property losses. At the same time, the person in charge of the unit shall report immediately and truthfully to the local department responsible for the supervision and management of production safety in accordance with the relevant state regulations, and shall not conceal, falsely report or delay the report, and shall not deliberately destroy the accident scene or destroy relevant evidence.

Thus, the responsibilities are clearly defined under a sound safety management system. A sound safety management system and increasing safety awareness of staff can effectively reduce the risk of accidents during construction.

(3) Guarantee input of safety capital and materials

The flood-damaged road sections of this project are scattered, mostly located in mountains and hills, and the mountain roads are rugged. The flood-damaged road sections are often seen with subgrade collapse and bridge damage, which are prone to collapse. Safety materials cannot be insufficient due

to scattered flood-damaged road sections. Attention to safety management and the input of materials and funds cannot be reduced because it is believed that the road grade in some construction areas is not high. Otherwise, potential safety risks will be formed. Thus, attention shall be paid to the configuration of safety protection equipment, the inspection and maintenance of construction machinery and vehicle systems, or the replacement of poorly maintained equipment during construction, to avoid tools, machinery and equipment from working under faulty conditions, and reduce potential safety hazards due to insufficient material or capital investment.

6.6.4.2 Analysis of safety risk of workers

1. Employment benefits during project construction

The construction time estimate is given based on the construction of this project according to the industry standard of the People's Republic of China, *Measures for the Compilation of Investment Estimation of Highway Engineering Construction Projects* JTG 820-2018, *Notification of the Department of Transportation of Henan Province on Issuing Supplementary Provisions for Estimated Budget Preparation Methods for Highway Engineering Construction Projects in Henan Province* (YJW [2019] No. 274) and the *Feasibility Study Report*. According to the estimated fixed budget, the construction period of this project is 15 months for Dengfeng, Xinmi, Xinzheng and Gongyi, and 8 months for Zhongmu and Xingyang, which requires a total of 5,269,723 man-hours (person-days) and 15,078 workers. According to the feasibility study report, the average estimated monthly income of each person is 3,265.5 yuan. The project

management office and the owner unit promise that the project construction unit will give priority to hiring villagers along the rural road.

The construction sites of this project are all in the wild, and most of them are manual labor. The main jobs that are suitable for female employment are technical services and logistics services, which account for about 5% of the total number of workers, that is, about 750 female workers are needed. Therefore, except for some female technicians in technical jobs, the project provides employment opportunities for 180 females.

All in all, 15,078 workers are expected to gain employment benefits from the implementation of this project, of which women are 750, accounting for 4.9% of the total.

2. Analysis of work safety risk

(1) The safety and health conditions of workers shall be improved during the implementation of this project to avoid the risk of safety accidents and personal safety damage.

The construction period is long and the construction work is complicated in this project. The construction site is located in a mountainous and hilly area, with insufficient infrastructure, poor preconditions due to floods and natural factors that will interfere with the normal construction, resulting in many potential safety hazards. These construction conditions often lead to stress and fatigue, posing safety risks.

The project implementation unit shall ensure that electricity, water and road is available at the construction site. It is necessary to ensure the safety of passage and traffic when temporary passages are built. Workers shall receive

safety training in advance to learn about how to use construction equipment, check whether safety measures are in place, and keep in mind the way to safely use electricity and water. Only after passing the examination can they enter the construction site. The floor of the construction site shall be leveled to reduce risks.

It is necessary to formulate a sound and rigorous construction plan during the process of road construction. Arrange safety protection devices before construction, and check whether the working performance of the devices is in good condition. A fence shall be installed on the construction site when the excavator is working to ensure a safe distance and prevent unrelated personnel from breaking in. There must be a special staff command when the vehicle transports soil, and the mound cannot be against the wall and needs to be less than 1m. Measure the safety distance of the edge of the road first when the road roller rolls the road to avoid landslide accidents. Protective measures shall be taken in advance according to the road conditions around the construction site to guide the vehicle to drive safely when concrete is used to pave the road. In order to prevent the collapse of the chisel pile during construction, professional technicians must check whether the protection of the pile satisfies the safety requirement, whether the equipment at the construction site can work normally, and whether the warning line and warning signs are eye-catching on a regular basis.

In short, accidents can be reduced only by improving safety awareness, taking safety protection measures and setting up safety warning signs in dangerous areas. For the analysis of the health risk of workers caused by the

environment during the project implementation, please refer to Section 5.6 environmental impact mitigation measures for details.

(2) Workers receive fair treatment, non-discrimination and equal opportunities.

The project implementation unit shall allow all personnel who meet the employment conditions to participate in the competition for recruitment, and decide whether to hire or not according to their skill level. Pay workers on time. Bonuses and other forms of subsidies are determined according to the working conditions of the worker. The principle of equal pay for equal work is implemented. Workers shall not be treated unfairly because of their nationality, race, gender, religion and background.

The project implementation unit shall not refuse to employ women or raise the employment standards for women on the grounds of gender, except for the types of jobs or positions that are not suitable for women as stipulated by the state.

The implementation unit shall set up suggestion boxes. Workers are allowed to prepare written materials about discrimination, unequal opportunities, etc. and put them in the suggestion box. Human resources executives should address incidents of discrimination or humiliation of employees. If this is the case, the discrimination and stigma should be corrected, the perpetrators should be punished, and workers should be notified of the results.

(3) Worker protection

Project implementation units shall not recruit minors under the age of 16. If the project implementation unit recruits minors older than 16 but less than 18 years old, they shall implement the regulations on the type of work, working

hours, labor intensity and protection measures stipulated by the state in accordance with the relevant regulations of the state, and shall not arrange then to engage in heavy, toxic, harmful and other dangerous operations that endanger the physical and mental health of minors.

The project implementation unit shall prohibit any acts of slavery, forced labor, corporal punishment, imprisonment and threats of violence, and ensure that workers participate in work voluntarily. Recruitment of workers by the project implementation unit must be fair and voluntary. Recruitment of workers by means of coercion or deception is prohibited. During the recruitment period and after workers are employed, valid documents such as the worker's ID card shall not be seized. No deposit or security deposit is charged to workers, and no guarantee or contract is required. No referral fees or other fees may be charged to employees.

(4) Labor organizations

The project implementation unit supports laborers to establish trade unions in accordance with the law. Workers have the right to join and form trade unions regardless of their nationality, race, gender, occupation, religion and educational attainment. The basic responsibility of trade unions is to safeguard the legitimate rights and interests of workers. Trade unions coordinate labor relations and safeguard labor rights and interests through equal consultation and collective contract systems. The daily working body of the trade union is the trade union committee. The members of the trade union committee are democratically elected by the general assembly or the representative assembly. The trade union committee shall have female members.

The trade union assists and guides workers to sign labor contracts with the project implementation unit. On behalf of the employees, the trade union negotiates with the project implementation unit to sign a collective contract. The draft of the collective contract shall be submitted to the employee representative meeting or be discussed and approved by all employees.

If the project implementation units violate the collective contract or infringe upon the labor rights and interests of employees, the trade union may require them to bear the responsibility according to law. If a dispute arises from the performance of the collective contract and cannot be resolved through negotiation, the trade union may apply to the labor dispute arbitration institution for arbitration. If the arbitration institution is dissatisfied with the arbitral award, it may file a lawsuit in people's court.

If the project implementation unit unilaterally terminates the labor contract with the worker, it shall notify the labor union of the reasons in advance. If the trade union believes that the project implementation unit has violated laws, regulations and relevant contracts and needs to re-discuss and deal with it, the project implementation unit shall discuss the opinions of the trade union and notify the trade union of the handling result in writing.

If the project implementation unit violates labor laws and regulations, embezzles employees' wages, fails to provide labor safety and health conditions, arbitrarily extends working hours, infringes on the special rights and interests of female employees, and seriously violates the labor rights and interests of employees, the trade union shall negotiate with the representatives of the project implementation unit and require it to take measures to make corrections. The

project implementation unit shall discuss and deal with these issues and reply to the trade union. If the project implementation unit refuses to make corrections, the trade union may request the local people's government to make a handling decision according to law.

6.6.5 Villagers' health and safety

6.6.5.1 During road operation

This project is a post-flood restoration project, focusing on the restoration of the existing road damage caused by the flood. Thus, after the construction of the project is completed, the normal operation of the road will not harm the health and safety of people in the project area.

(1) After the project is completed and roads are restored, the health and hygiene conditions for the villagers will remain as they were. Sanitation facilities in each village have been built. The villagers have maintained their living habits for many years. Domestic sewage and organic waste are degraded in situ, made into organic fertilizer, and used in farmland. Difficult-to-degrade waste is mainly buried on site. The villagers have formed a sense of garbage sorting and sorting and disposal methods for many years. After the road is repaired, it will not harm the rural sanitary conditions.

(2) After the project is completed and the roads are restored, the safety and order of the villagers will be restored as they were. The village committee is responsible for maintaining community order. Villagers are familiar with each other. Villagers often take the initiative to learn about the situation and pay attention to the entry and exit of strangers when outsiders enter the village. A sense of proactively protecting the safety of the village has been formed in the

local community. This project is to restore the smoothness of the road. Community safety still relies on the independent safety awareness of local villagers. Therefore, there will be no adverse impact on the safety of the community.

6.6.5.2 During the implementation of the project

(1) Epidemic prevention measures

The influx of construction workers and mechanical tools will increase the flow of vehicles and people during the implementation of the project, thus increasing the difficulty of epidemic prevention and control. The contractors in the project area shall cooperate with the communities where they are located in terms of epidemic prevention and control, employee health education, surrounding environmental hygiene control and local rental management of employees to prevent epidemics from spreading to communities and villages. Meanwhile, staff who rent local houses shall abide by various management regulations on community, village residents and floating population, cooperate with the community and villages in epidemic detection and prevention measures, protecting the health of the people in the community.

(2) Traffic guarantee scheme

The construction organization design shall be optimized to avoid interruption of traffic affecting the daily travel and production and life of local villagers during the implementation of the project. Thus, the project implementation unit shall formulate a scheme to ensure normal traffic and increase efforts to keep villagers along the road informed of road traffic changes in a timely manner. The construction unit's specific traffic guarantee scheme is as follows:

For general and major repaired and reconstructed road sections after the disaster, that is, local subgrade and pavement scouring or continuous multiple subgrade pavements on the same road, small or large flood-damaged sections such as bridges and culverts, bridgehead cone slope, side slope, side ditch, protective slope, drainage, greening damage, etc., only half of the road is available, and the other half is occupied.

The construction shall be carried out in a closed and broken way for major flood-damaged road sections, large-scale subsidence of subgrade and pavement, overall collapse and road thrust, damaged bridges and other structures or overall slipped or collapsed sections.

The existing surrounding road network will be used to divert vehicles during construction. Construction announcements will be published in newspapers, television and other media before construction. Clear signs shall be set up at the starting and ending points in advance, and detour signs shall be set up at reasonable positions in advance. Construction signs shall be set up at 1 km from the beginning and end of the project. Signs such as speed limit, load limit and overloaded vehicle detour should be set up within 200 meters of both ends of the bridge and culvert.

Professional safety personnel shall be deployed during the construction period, and a reasonable and effective shift system shall be formulated for 24-hour duty. Personnel shall be dispatched to keep the key road sections smooth. The traffic police department can be asked to help keep the road smooth when appropriate.

(3) Environmental impact

It is easy to cause environmental impact during construction, such as dust, wastewater and noise. The construction unit shall design the construction schedule

reasonably, stop construction at night, maintain and repair large-scale machinery and equipment in time, and install sound-absorbing facilities to avoid noise pollution. It also shall reasonably deal with the discharge and storage of garbage and wastewater, and dispose of them in time to avoid mosquito breeding and pollution of local soil and groundwater environment. Water shall be sprinkled in time during construction to avoid road dust and ensure that there is no floating dust. Please refer to Section 5.6 for the mitigation measures of environmental impact.

(4) Safety guarantee

Set up obvious warning signs and fences in accordance with regulations in places where there may be hidden dangers to prevent hidden safety hazards and loss of life and property caused by entering the construction area by mistake, especially for the elderly and children. The elderly have limited mobility and lack the ability to deal with emergencies. Children are naturally active and curious about new things, and they are prone to curiosity when they see large machinery and equipment. Children are small, their movements are irregular, and there are many blind spots around large equipment, making it difficult to find them. Thus, special attention shall be paid to the safety of the elderly and children. Thus, the construction unit can design warning signs and fences according to the actual situation in the project construction organization design and construction plan. The construction unit shall also form a safety patrol team to maintain social safety during the construction period.

6.6.6 Women's rights

The project area involves 6 counties (cities) in Zhengzhou City, including 400,522 women in Xinmi City, 349,374 women in Xingyang City, 330,822 women in Dengfeng City, 565,870 women in Xinzheng City, 333,223 women in Zhongmu

City, and 384,926 women in Gongyi City, accounting for 47.81% of the total population. The total population of the 19 sample villages is 43,411, of which 20,267 are women, accounting for 46.69% of the total population. There are 474 females in the surveyed sample households, accounting for 49.07% of the total population of the sample households. The proportion is higher than the average level of the sampled villages and also higher than the 6 counties and cities involved in the project area.

Since ancient times, women in the family have been in charge of family finances and children's education; in particular, they own the ownership and control of financial resources and property. At present, such traditions are still preserved in rural families, so women in the family are respected.

Most of the road sections damaged by the flood have roadbed hollowing and collapse, road subsidence and damage, collapse and partial damage of culverts and small and medium bridges, and broken guardrails along the road, which seriously affect the normal travel of residents. This project will help to repair the roadbed, improve the road traffic conditions, and ensure the normal production, life and travel of women along the road. Opening up the end-broken roads and bridges that were washed away by the flood can facilitate the daily travel of women along the road. Repairing the collapsed road surface and strengthening the earthwork on both sides of the mountain can ensure the driving safety on this road section, and ensure the safety of life and property of women and children in the project area. The project construction can improve the quality of life of the women, children and the elderly living nearby, and enable the disadvantaged to have a higher sense of happiness and gain.

Elimination of gender discrimination in employment will be comprehensively implemented during the implementation of the project to create a gender-equal employment mechanism. For employers suspected of gender discrimination in recruitment, the project management office shall conduct interviews and punish them according to law, and urge employers to strengthen self-examination and self-correction of gender discrimination in employment. The labor safety of female workers will be improved. The project management office shall carry out extensive publicity and education on labor safety and health, increase the publicity and implementation of the *Special Regulations on Labor Protection for Female Employees*, and improve the labor protection and production safety awareness of employers and female workers. The labor protection of female workers will be incorporated into the scope of occupational health and safety production supervision and management to strengthen labor safety supervision and labor safety and occupational health supervision of employers. Some non-technical employment opportunities shall be increased, and local women shall be hired to perform greening and logistical services for the construction party, such as planting flowers and plants, greening maintenance and logistical cooking, ensuring equal pay for equal work for men and women.

6.6.7 Ethnic minorities

The ethnic minorities are scattered across this project area. They lived together and intermarry with the Han people. The language they use includes local dialect and mandarin. They do not form permanent settlements, nor do they have traditional ancestral territories. The ethnic minorities in the project implementation area enjoy the same social and public services as the Han

nationality. This project will not have a concentrated impact on the production and life of ethnic minorities, so this section will not go into detail about this.

Conclusion: After comprehensive demonstration and analysis, the positive social impact of this project is greater than the negative social impact, and the latter can be avoided or reduced by some avoidance measures. The social risks that the project may encounter can be resolved or eliminated through preliminary preventive measures to ensure the smooth completion of the project and achieve the expected social and economic goals.

6.6.8 Monitoring the social risk of the project

The project management office shall employ an independent monitoring agency to carry out external monitoring of the social risk mitigation measures of the project during the project implementation stage. The project management office also needs to issue a project monitoring and assessment report every six months to urge relevant government agencies to adjust their work ideas and improve their work methods, so as to eliminate risks as much as possible and ensure the smooth implementation of the project. Specifically, the content and indicators of risk monitoring are shown in Table 6-14.

Table 6-14 Risk monitoring content and indicators of the project

Project risk	Actions	Implementation time	Responsible party	Assisting party	Monitoring indicators
Production safety risk: construction management risk	(1) Professional safety management team (2) Develop a construction safety system (3) Guarantee input of safety capital and materials (4) Increase public participation in this project	Before implementation of the project and during construction	The project management office and the construction unit	County government and village committee	(1) Loans and matching funds are in place in time (2) Complete on time and report expenses in time (3) Project quality
production safety risks and labor safety risks	(1) Ensuring safe and healthy conditions for workers at work (2) Workers receive fair treatment, non-discrimination and equal opportunities. (3) Worker protection measures (4) Workers establish trade unions in accordance with the law	Before implementation of the project and during construction	The construction unit	The owner, the project management office, county governments and village committees	(1) Number and content of worker complaints (2) Number and content of safety training
Villager health and safety risks	(1) Epidemic prevention measures (2) Traffic guarantee program (3) Environmental protection measures (4) Safety guarantee measures	Before implementation of the project and during construction	The construction unit	The owner, the project management office, county governments and village committees	(1) Number and content of complaints from residents about the impact of project construction (2) A series of environmental monitoring reports in the environmental management plan

Women's rights and risks	(1) The construction unit employs the residents of the place where the project is located, especially women, to participate in the construction of this project. (2) Eliminate gender discrimination in employment and create a gender-equal employment mechanism.	Before implementation of the project and during construction	The project management office and the construction unit	The owner, the project management office, county governments and village committees	Number of people involved in project construction, ratio of male to female, salary income, etc.

7 Public Consultation and Information Disclosure

7.1 Village council engagement mechanism

7.1.1 Framework for village council engagement

Project engagement allows stakeholders to influence and jointly control the project's development, decision-making, and resources.

Table 7-1 Framework for village council's engagement in the project

No.	Phase	Step	Role of key stakeholders	Role of government	Role of expert	Effect
Role			Decision maker	Guarantor	Supporter	Unified roles
1	Project preparation	Problem analysis and theme establishment	Analyze their problems concerning family, society, and resources, and identify causes	Provide administrative, policy and financial support	Help key stakeholders analyze the problems and guide them to identify the causes of problems	Identify the actual problems accurately
2		Project content and framework	Present their needs, compare the relationship between the causes of problems and needs, and establish a framework for solving problems	Study whether the government can support programs proposed by major stakeholders	Provide technically feasible advice to governments and key stakeholders based on problem analysis	Integrate project content to actual needs of key stakeholders
3		Project plan	Establish project activity plans based on socio-economic characteristics such as workforce, labor for	Review relationships between major stakeholder plans and government grants	Develop plans with key stakeholders to avoid planning risks	Plan activities can be appropriate to the production season, labor distribut

			different genders and seasons, and define persons in charge, etc.			ion and financial status of major stakeholders
4	Project implementation	Project implementation	Establish the implementation organization system, select the person in charge of each activity, and implement project activities	Provide conditions for implementation	Technical support	Beneficiary groups take responsibility for themselves

The aim is to avoid a situation where key stakeholders are simply seen as passive recipients of aid, interviewees, or laborers in the project development process, and to make it clear that the implemented project should be a process that stimulates key stakeholders to influence and control the development. This process can be achieved by taking into account a broader range of stakeholders throughout the country's economy and other concerned sectors; ensuring that all stakeholders and their relationships are identified and considered at all project phases; making resources, especially financial resources, more accessible to vulnerable groups; and strengthening the management capacity of key stakeholders and their organization's management capabilities. Table 7-1 summarizes the principles and framework for the engagement of key stakeholder village councils in the project.

7.1.2 Principle of village council engagement

During project design, implementation, monitoring and management, to ensure that all beneficiaries can timely receive information related to the project and have equal opportunities to put forward their suggestions and opinions on the

corresponding issues, and also to facilitate the PIU and supervision and management institutions to grasp the project implementation dynamics and make scientific decisions based on the actual situation, it is necessary to pay attention to and clearly define the following principles:

The project information should be kept public. Project publicity needs to be carried out throughout the project cycle. A system of regular public disclosure of project information could be established to regularly publicize project information closely related to major stakeholders and of particular concern to them in public places such as village councils. In addition to this, group meetings, representative meetings, banners, TV and radio can be used to inform key stakeholders of the status of project preparation and implementation.

Major stakeholders should be involved in the implementation of the project. Priority should be given to employing relevant villagers to provide paid labor services for the project.

Attention should be paid to the role of village cadres and village councils in the implementation. The rural cadres need to be engaged in promoting, training, mobilizing, feedbacking the needs of residents, identifying problems, and solving conflicts in the implementation. In the implementation, we can give certain subsidies to the major cadres involved.

7.1.3 Content of village council engagement

In order to make this project practical and reliable, safeguard the legal rights and interests of local residents, reduce dissatisfaction and disputes, and minimize adverse impacts, it is necessary to encourage the villagers to participate in project

consultations during the project preparation phase. The engagement of the village council during this phase is shown in Table 7-2.

Table 7-2 Village council engagement in the project preparation phase

No.	Activity	Description	Method	Participants	Institution responsible	Remarks
1	Project publicity	1. Promote the importance and necessity of project implementation and solicit public opinions and suggestions. 2. It is necessary to timely inform key affected groups of project implementation dates, locations, and other information of concern.	Posters, brochures, internet, radio, TV, public gatherings, banners, flyers	①All members of the village council ②Project owner ③Project management office	Project management office, project owner	Assisted by publicity department, highway center, radio and television bureau, newspaper office, township and neighborhood committee/village offices
2	Analysis of	1. Identify various	Village council/village	①Village council		Assisted by the Social

No.	Activity	Description	Method	Participants	Institution responsible	Remarks
	participatory affected group	groups affected by the project and their basic living status. 2. Determine the positive and negative impacts of project on various groups.	rs' representative meetings	representatives (including representatives of special groups such as poor households and women) ②Village council ③Project owner and project management office		Assessment Team
3	Participatory problem analysis	1. Analyze the environmental problems of the village council/village, and to what extent they affect the development of the village council and the residents.	Village council/villagers' representative meetings			Assisted by the Social Assessment Team
4	Participatory needs	1. Identify the needs of	Village council/village			Assisted by the Social

No.	Activity	Description	Method	Participants	Institution responsible	Remarks
	analysis	various groups affected by the project and analyze the gap between these needs and the project's design.	rs' representative meetings			Assessment Team
5	Question feedback	1. Assessment of project design program and project content. 2. Expectations and suggestions from key stakeholders for the project.	Village council/villagers' representative meetings			Assisted by the Social Assessment Team

7.2Villager involvement

"Villagers engagement" includes direct and indirect engagement. An example of the former can be that residents directly tell the village council and the town government their realistic problems or difficulties, and participate and cooperate in the construction process of the project. And for the latter, an example can be obtaining information from relevant government meetings, documents or work reports, as well as verbal advertising by village council cadres and relevant informants. In order to understand the engagement status of villagers before this assessment, both interviews and questionnaires were used during this assessment to focus on the awareness rate and the recognition of residents about the project.

In the interview process, most of the residents said that roads and bridges in many places were damaged to varying degrees, and the construction of transportation projects was suspended, which seriously affected urban public transportation and passenger and cargo transportation. Rural roads, in particular, had weak infrastructure and were seriously damaged by the flood. The projects mainly consisted of post-disaster reconstruction of rural roads, aimed at repairing roads and ensuring traffic capacity. Therefore, this project was generally accepted by the locals, which was also proven by the questionnaire results.

According to experts' investigation, as of February 27, there had been no consultation between the owner and project design unit and the village council and villagers on the design plan of the project in their respective villages, and no villagers stated that the owner and project design unit had consulted their opinions and suggestions.

Therefore, it is recommended that the owner and the design unit should respectively disclose the design implementation plan of the project, collect opinions

and suggestions of the village council and villagers, and make modifications according to their rationalization.

7.2.1 Investigation of residents' awareness of this project and information channels

The survey on the knowledge of major stakeholder sample households about the implementation of the project can be found in Table 7-3. 168 households knew about the project before this survey, and 34 households did not know about it, which means that most villagers knew about the project. No villagers knew about the project through posters and pamphlets, and only 2 households knew about the project through newspapers and the Internet. 200 villagers heard about the project from village/community meetings or leaders or colleagues, indicating that most villagers learned about the project by word of mouth.

Therefore, it is suggested that the owner disclose this project through TV, newspaper and the internet to publicize the significance, content and progress of the project, with full coverage of villagers along the project line.

Table 7-3 Statistical table of sample households' awareness of this project

County/city	Village	**Did you know about this project before this survey**				
		Yes	No	Posters, pamphlets	Newspapers, the internet	Village/community meetings, leaders or colleagues
Dengfeng City	Dongshang Village	12	0	0	0	12
	Jiangzhuang Village	10	0	0	1	9
	Liyao Village	12	0	0	0	12
	Tashuimo Village	9	1	0	0	10
Gongyi City	Gaomiao Village	17	0	0	0	17
	Huilong Village	6	5	0	0	11
	Longmen Village	8	4	0	0	12
Xinmi City	Heiyugou Village	10	2	0	0	12
	Wenzhuang Village	6	2	0	0	8
	Xiasigou Village	9	1	0	0	10
Xinzheng City	Gucheng Village	9	1	0	0	10

County/city	Village	Did you know about this project before this survey				
		Yes	No	Posters, pamphlets	Newspapers, the internet	Village/community meetings, leaders or colleagues
	Nianlu Village	7	3	0	0	10
	Tanghe Village	9	1	0	0	10
Xingyang City	Baishuiyu Village	11	1	0	0	12
	Gaoshan Village	8	2	0	0	10
	Zhonggang Village	10	1	0	0	11
Zhongmu County	Huizhuang Village	4	5	0	0	9
	Liangjiacun Village	5	1	0	0	6
	Xiaowangzhuang Village	6	4	0	1	9
Total		168	34	0	2	200

7.2.2 Investigation of residents' recognition of the project

According to statistics of the survey on the attitude of sample households towards the construction of this project, 201 households supported the construction of this project after full consideration, 1 household was indifferent, and no sample household was opposed to it. It indicates that the attitude of villagers in this project is positive. For details, see Table 7-4.

Table 7-4 Survey results of attitudes towards project construction

County/City	Village	Do you agree with the implementation of this project		
		Yes	No	I'm OK either way
Dengfeng City	Dongshang Village	12	0	0
	Jiangzhuang Village	10	0	0
	Liyao Village	12	0	0
	Tashuimo Village	10	0	0
Gongyi City	Gaomiao Village	17	0	0
	Huilong Village	11	0	0
	Longmen Village	12	0	0
Xinmi City	Heiyugou Village	12	0	0
	Wenzhuang Village	8	0	0

County/City	Village	Do you agree with the implementation of this project		
		Yes	No	I'm OK either way
	Xiasigou Village	10	0	0
Xinzheng City	Gucheng Village	10	0	0
	Nianlu Village	10	0	0
	Tanghe Village	9	0	1
Xingyang City	Baishuiyu Village	12	0	0
	Gaoshan Village	10	0	0
	Zhonggang Village	11	0	0
Zhongmu County	Huizhuang Village	9	0	0
	Liangjiacun Village	6	0	0
	Xiaowangzhuang Village	10	0	0
Total		201	0	1

Many roads in 6 counties and cities in Zhengzhou City have been damaged by the flood, making it difficult for relevant villagers to travel and affecting their daily production and life. In some areas, the transportation of raw materials is inconvenient, which affects the daily production of factories and increases production costs. The transportation and sales of agricultural and sideline products are also affected. In particular, the rough roads increase the transportation time of fruits and vegetables on the road which have a short shelf life, affecting the quality of fruits and vegetables, and reducing the income of farmers. In some areas, villagers rely on local tourism to develop homestays which are dependent on the smoothness of the road. Therefore, the villagers generally expressed their hope that the road could be repaired quickly, especially before the vegetables and fruits such as garlic and strawberries hit the market.

In summary, the social assessment results show that the current publicity of the project needs to be strengthened. It is recommended that the degree of project information disclosure should be improved, the government should

disclose the progress of the project on the official website, the design and construction unit should consult and disclose information with villagers along the project line, and improve villagers' engagement and consultation.

7.3 Public engagement and information disclosure

In accordance with the requirements of the AIIB ESP and the recommendations of social assessment specialists, Zhengzhou Highway Development Center conducted an extensive information disclosure and public engagement survey.

7.3.1 Purpose of public engagement

In the environmental and social assessment of a project, consultation (or public consultation) with stakeholders is increasingly recognized as an important concept and requirement to improve the authenticity and acceptability of the assessment itself, but also, more importantly, to improve the quality of decision making. Stakeholder consultation/engagement in all phases of developing a project can help improve decision-making and ultimately realize sustainable development.

Stakeholder consultation is a two-way process. For stakeholders, consultation is an opportunity to obtain information about the project, understand its potential impacts, raise questions and concerns, and ask questions. For project proponents, consultation provides an opportunity to learn about the stakeholders and their concerns about the project, their needs and expectations, and their suggestions that may help shape the project and its design. Listening to stakeholders' concerns and feedback can be a valuable source of information, which can improve project design and outcomes, and help project proponents identify and control external risks. It can also underpin future collaboration and partnerships.

7.3.2 Stakeholder identification

Stakeholders are considered to be individuals or organizations that have an interest in or knowledge about this project that contributes insight to solving problems arising from the project or influencing decisions related to this project. By definition, this project has two types of stakeholders, as described below.

Primary stakeholders (also direct stakeholders) refer to grassroots stakeholders, such as those affected by the project and the general public with women living in project areas included. These people are directly exposed to the project's impacts, although in some cases they may not directly benefit from the project.

Secondary stakeholders (also institutional stakeholders) refer to people, departments, agencies, and/or organizations that may not be directly affected by project but may influence the project and its design. They include project proponents, other relevant departments that may play a role in various phases of the project, regulatory agencies, other relevant departments, non-governmental organizations (NGOs), the broader community of interest including academics and journalists, and the general public.

7.3.3 Information disclosure

In accordance with the requirements of *Measures for Public Engagement in Environmental Impact Assessment* (Order No. 4 of the Ministry of Ecological Environment), this project has been disclosed on the website of Dahe Daily (http://www.dahe.com.co/cj/2022/03-02/3355.html) from March 2. As of now, no feedback has been received from the public.


大河网 dahe.cn 首页 >> 新闻中心 >> 财经

行贷款郑州市农村公路灾后恢复重建项目 环境影响评价公众参与第一次公示

2022年03月02日10:09:45 来源：大河网

Screenshot of the disclosure

7.3.4 Meetings and questionnaire survey

Zhengzhou Highway Development Center organized several public engagement meetings between March 5 and March 9, 2022 in Zhongmu County, Xinmi City, Xingyang City, Xinzheng City, Dengfeng City, and Gongyi City. The participants included residents near the major water-damaged roads, employees of nearby factories, and employees of government departments. All information in the meetings was provided in Chinese to ensure their understanding.

Table 7-5 Information about participants in the meetings

Organizational unit	Meeting venue	Date	Participants
Zhengzhou Highway Development Center	Party Service Center of Xijie Village,	March 5, 2022	Residents of Xijie Village near water-damaged

Organizational unit	Meeting venue	Date	Participants
	Chengguan Town, Xinmi City		roads
Zhengzhou Highway Development Center	Party Service Center of Xiasigou Village, Jianshan Township, Xinmi City	March 5, 2022	Residents of Niuxinshi Village and Xiasigou Village near water-damaged road
Zhengzhou Highway Development Center	Party Branch of Gaomiao Village, Mihe Town, Gongyi City	March 6, 2022	Residents of Gaomiao Village near water-damaged roads
Zhengzhou Highway Development Center	Party Branch of Dongzhuyuan Village, Mihe Town, Gongyi City	March 6, 2022	Residents of Dongzhuyuan Village near water-damaged roads
Zhengzhou Highway Development Center	Party Branch of Koutou Village, Xiaoguan Town, Gongyi City	March 6, 2022	Residents of Koutou Village near water-damaged roads
Zhengzhou Highway Development Center	Party Branch of Jiangzhuang Village, Gongcheng Town, Dengfeng City	March 7, 2022	Residents of Jiangzhuang Village near water-damaged roads
Zhengzhou Highway Development Center	Party Service Center of Liyao Village, Shidao Town, Dengfeng City	March 7, 2022	Residents of Liyao Village near water-damaged roads
Zhengzhou Highway Development Center	Convenience Service Center of Dongshang Village, Tangzhuang Town, Dengfeng City	March 7, 2022	Residents of Dongshang Village near water-damaged roads
Zhengzhou Highway Development Center	Party Branch of Baishuiyu Village, Gaoshan Town, Xingyang City	March 7, 2022	Residents of Baishuiyu Village near water-damaged roads
Zhengzhou Highway Development Center	Convenience Service Center of Xucun Village, Gaoshan Town, Xingyang City	March 7, 2022	Residents of Xucun Village near water-damaged roads
Zhengzhou Highway	Zhonggang Village,	March 7,	Residents of Zhonggang

Organizational unit	Meeting venue	Date	Participants
Development Center	Gaoshan Town, Xingyang City	2022	Village near water-damaged roads
Zhengzhou Highway Development Center	Party Branch of Shanchen Village, Management Committee of Juci Mount, Xinzheng City	March 8, 2022	Residents of Shanchen Village near water-damaged roads
Zhengzhou Highway Development Center	Party Branch of Duanzhuang Village, Chengguan Township, Xinzheng City	March 8, 2022	Residents of Duanzhuang Village near water-damaged roads
Zhengzhou Highway Development Center	Party Service Center of Jinglou Village, Chengguan Township, Xinzheng City	March 8, 2022	Residents of Jinglou Village near water-damaged roads
Zhengzhou Highway Development Center	Party Branch of Jiubao Village, Yanminghu Town, Zhongmu County	March 9, 2022	Residents of Jiubao Village near water-damaged roads
Zhengzhou Highway Development Center	Party Service Center of Huizhuang Village, Guandu Town, Zhongmu County	March 9, 2022	Residents of Huizhuang Village near water-damaged roads
Zhengzhou Highway Development Center	Party Branch of Xiaowangzhuang Village, Guandu Town, Zhongmu County	March 9, 2022	Residents of Xiaowangzhuang Village near water-damaged roads

During the meetings, PIU presented information about the project and adverse and beneficial impacts on the surrounding environment and residents during the construction and operation periods. Relevant environmental protection measures, the complaint mechanism that has been established, and the plan to carry out information disclosure and public engagement during the implementation.

The main purposes of the public engagement meetings were to: (1) introduce the main expected environmental impacts and environmental protection measures identified in the EIA; and (2) distribute questionnaires to the participants.

A total of 199 people participated in the meetings (125 men and 74 women). A questionnaire survey was conducted after the meetings, and all 199 participants completed the questionnaire survey.

During the meeting, the participants generally expressed high concern about the construction start time of the project because their daily travels were greatly affected by the water-damaged roads. The residents living in the vicinity of the project were mainly concerned about the dust and noise generated during the construction period. Through the introduction and discussion of dust and noise prevention and control measures during the construction, the participating groups could accept the environmental impacts generated during the construction. At the same time, we introduced the complaint mechanism to the participants to ensure that the rights and interests of the residents could be guaranteed.

	
Meeting venue 1 (Dengfeng City)	Meeting venue 2 (Dengfeng City)
	
Explaining the questionnaire	Participants filling out the questionnaire (Gongyi City)
Interviewing neighboring villagers (Xinmi City)	Interviewing village council staff (Xinmi City)
Participants filling out the questionnaire	Collecting opinions of neighboring villagers

(Xinzheng City)

(Xingyang City)

Meeting venue 3 (Xingyang City)

Meeting venue 4 (Zhongmu County)

Questionnaire:

1. Participant information

Table 7-6 List of participant information

Participant information		**199 questionnaires in total**	**Percentage (%)**
Gender	Male	125	62.8%
	Female	74	37.2%
Age	<20	0	0
	20-40	31	15.6%
	41-60	113	56.8%
	≥60	55	27.6%
Educational	Illiterate	0	0

Participant information		199 questionnaires in total	Percentage (%)
attainment	Primary school	19	9.5%
	Junior middle school	71	35.7%
	Senior middle school	74	37.2%
	Vocational schools	4	2.0%
	College or above	31	15.6%
Ethnicity	Han Chinese	199	100%
	Other	0	0
Career	Farmers	170	85.4%
	Civil servants	10	5.0%
	Employees	6	3.0%
	Other	13	6.6%

2. Questionnaire results

Table 7-7 Questionnaire result list

Question	Option	Selected by (number of people)	Percentage (%)
What do you think of the status quo of environmental quality in your area?	A. Satisficed	166	83.4%
	B. Less satisfied	22	11.1%
	C. Not satisfied	11	5.5%
Do you know about this project?	A. Know a lot	154	77.4%
	B. Know a little	40	20.1%
	C. Don't know	5	2.5%
Are you satisfied with the road traffic condition in the region?	A. Satisficed	145	72.9%
	B. Less satisfied	32	16.1%
	C. Not satisfied	22	11%
Your biggest concerns during project construction	A. Dust	172	86.4%
	B. Noise	32	16.1%
	C. Wastewater	4	2%

	D. Construction solid waste	8	4%
	E. Ecological impact	16	8%
Which one do you think is the most prominent negative impact of the project?	A. Dust	170	85.4%
	B. Noise	39	19.6%
	C. Wastewater	4	2%
	D. Construction solid waste	7	3.5%
	E. Ecological impact	8	4%
After understanding the environmental protection measures during construction, do you accept the environmental impact of this project during construction?	A. Accept	186	93.5%
	B. Basically accept	11	5.5%
	C. Don't accept	0	0
	D. Not sure	2	1%
If the project construction caused pollution to the local environment, you would:	A. Complain to the environmental protection department	18	9%
	B. Choose legal way to solve it	0	0
	C. Negotiate with construction unit or management	154	77.4%
	D. Other	27	13.6%
After thorough consideration, do you support this project?	A. Yes	199	100%
	B. I'm fine either way	0	0
	C. No	0	0

The survey results show that 83.4% of the respondents are satisfied with the current environmental quality in their area. 77.4% of the respondents know this

project very well. The respondents think that the main environmental impacts during the construction of the project are dust (85.4%) and noise (19.6%). After knowing the major expected environmental impacts and environmental protection measures in the EIA, 93.5% accepted the environmental impacts of the project during the construction period. 77.4% said that they would deal with the construction unit or management if an environmental pollution event occurred during the construction. These public concerns can be addressed by integrating the safeguard mitigation measures in the project Environmental Management Plan into the project design.

Public support for the project is very high, with 100% of respondents expressing support for the project and expressing a desire to begin construction as soon as possible.

For the respondents who are more concerned about the construction period dust, noise impact on the surrounding residents, the construction unit in the construction process should take relevant dust and noise prevention measures, speed up the project schedule, and shorten the construction period to reduce the impact of construction on the environment.

7.4Public consultation plan

The public consultation plan for this project is shown in Table 7-8.

Table 7-8 List of the public consultation plan

Phase	Consultation content	Information disclosure method	Consulting method	Implementation unit	Participants	Topics to be addressed
Project preparation	Project basic information disclosure and collection of residents' opinions	Posting of notices, disclosure on the Internet	Meetings, individual interviews, on-on-site visits, questionnaires	Sub-project management office, consulting unit	Residents, sub-project management office, Zhengzhou Highway Development Center, consulting unit	Disclose basic project information; Identify the project's stakeholders; Understand the attitude of stakeholders towards the project; Understand the basic needs of the stakeholders, take the stakeholders' opinions and improve the project planning. Answer residents' questions
Project implementation	Construction information Disclosure	Posting notices on bulletin boards, hanging slogans, broadcasting, etc.	Meetings, individual interviews, on-site visits	Sub-project management Office, construction unit	Residents, sub-project management office, construction unit	Make public the construction schedule and progress plan; Distribution of construction sites; Construction unit contact person and contact information, etc. Safety issues that residents need to pay attention to

Phase	Consultation content	Information disclosure method	Consulting method	Implementation unit	Participants	Topics to be addressed
	Reduce construction impact	Posting notices on bulletin boards, hanging slogans, broadcasting, etc.	Meetings, individual interviews, on-site visits	Sub-project Management Office, construction unit	Residents, sub-project management office, construction unit	Make public the construction schedule and progress plan; Distribution of construction sites; Construction unit contact person and contact information, etc. Safety issues that residents need to pay attention to
	Publication of complaints and grievance channels	Posting of bulletins, Internet channels	Meetings, individual interviews, on-site visits, phone calls, emails	Sub-project Management Office, Zhengzhou Highway Development Center, and related government departments	Residents, sub-project management office, construction unit, Ecological Environment Bureau	Collect and solve residents' problems
Project completion	Survey on project completion	Posting of bulletins, internet channels	Meetings, individual interviews, on-site visits	Sub-project management office, consulting unit	Residents, sub-project management office, Zhengzhou Highway Development Center, consulting unit	Collect residents' opinions and assess the completion of project goals to determine whether the project is successful or not

8 Grievance Redress Mechanism (GRM)

During the engineering design and implementation stage of the project, the engagement of the surrounding residents is always concerned, and the potential risks to the environment and society are minimized. To timely and effectively alleviate and solve the unpredictable environmental and social problems in the implementation of the project, a Grievance Redress Mechanism (GRM) and grievance channels are newly built in the project to timely solve the complaints of the affected residents about the construction influence and the workers involved in the project. According to the requirements of AIIB's environmental and social policies and standards, the grievance mechanism will solve any dissatisfaction and complaints in time through an easy-to-understand and transparent process.

8.1 Grievance channels affected by the project

The statistical results of the sample households' grievances show that 189 households reached out to the rural cadres and 13 households to the leaders of township and district governments when villagers encountered problems. See Table 8-1. The investigation results show that it is necessary to publicize the grievance mechanism to the villagers and keep the grievance channels accessible to the villagers.

Table 8-1 Investigation of grievance channels

County/city	Village	**Who will you reach out to raise a grievance and give suggestions to?**	
		Leaders of township and district governments	Rural cadres
Dengfeng City	Dongshang Village	0	12
	Jiangzhuang Village	0	10
	Liyao Village	0	12
	Tashuimo Village	0	10
Gongyi City	Gaomiao Village	2	15

County/city	Village	**Who will you reach out to raise a grievance and give suggestions to?**	
		Leaders of township and district governments	Rural cadres
	Huilong Village	1	10
	Longmen Village	0	12
Xinmi City	Heiyugou Village	1	11
	Wenzhuang Village	0	8
	Xiasigou Village	1	9
Xinzheng City	Gucheng Village	3	7
	Nianlu Village	1	9
	Tanghe Village	0	10
Xingyang City	Baishuiyu Village	0	12
	Gaoshan Village	1	9
	Zhonggang Village	0	11
Zhongmu County	Huizhuang Village	1	8
	Liangjiacun Village	0	6
	Xiaowangzhuang Village	2	8
Total		13	189

According to the requirements of AIIB's environmental and social policies, we've established a grievance mechanism to solve the environmental, health, safety, and social problems arising from the construction and operation of the project. The grievance mechanism mainly includes the following objectives: (1) To provide communication channels for local villagers to solve environmental and social problems and complaints that may arise during the construction of the project; (2) To promote the trust and mutual understanding between the project and local villagers; (3) To ensure that local villagers agree with the project. The mechanism applies to all villagers in the project area, including women, children, ethnic minorities and poor people. The mechanism can be implemented through interviews, written complaints, telephone calls, e-mails, etc. The mechanism is mainly used to deal with all impacts brought by the project, such as dust and noise generated during the construction of the project, safety measures to protect

the public and construction workers, and waste and noise generated during the operation of the project, etc.

Before the construction, the contact information of the contact points (Zhengzhou Highway Development Center, Sub-project Office, Ecological Environment Bureau, construction unit, supervision company, etc.) for raising grievances will be determined. Part of the contact information is as follows. The contact information (telephone number, address, e-mail address) of the contact points will be disclosed on the information boards at the construction site and the operation site.

Table 8-2 Contact person for grievance (partial)

Unit	Title	Person to contact	Tel.
Zhengzhou Highway Development Center	Deputy Director	He Xin	13503849061
Xinmi Local Highway Administration Office	Deputy Director	Jia Songchao	13838534488
Gongyi Highway Development Center	Deputy Director	Tan Shizhao	18695811998
Dengfeng Local Highway Administration Office	Chief of Engineering Section	Liu Feng	13523546123
Xinzheng Rural Highway Administration Office	Branch Secretary	Wang Tianpeng	13592538777
Zhongmu County Bureau of Transport	Chief of Planning Section	Qin Huanzhao	13598055069

Xingyang Local Highway Administration Office	**Deputy Secretary**	**Wang Limin**	**13783507899**

If the local villagers are affected negatively in the construction process, they can directly complain to the engineering contractor, sub-project office, Zhengzhou Highway Development Center and local ecological environment department through the village committee. The only limitation of the existing Complaints and Proposals Office is the lack of designated staff and a specific timetable for resolving complaints. The mechanism, therefore, is established against this limitation.

The grievance mechanism of the project meets national standards and the environmental and social impacts of the project do not infringe on the basic interests of residents, which is ensured. In 2005, the State Council promulgated *the Regulation on Letters and Visits* (No. 431), which clarified the mechanism for local governments at all levels to accept complaints and proposals from citizens and protected local governments at all levels from retaliation. The grievance mechanism defines the time required for each step, and the specific steps are as follows.

If the project manager receives a grievance, the person in charge of the PIU shall first verify whether the grievance is related to the project. If the grievance is related to the project, whether the grievance is related to the environment and society or not, the person in charge shall initiate coordination and solve the grievance. If the grievance has nothing to do with the project, the person in charge shall submit the grievance to relevant competent departments on behalf of the complainant. All grievances shall be

documented, and the whole process of grievances shall be notified to relevant personnel. The basic steps and time frame of the grievance mechanism are as follows:

Stage 1 (5 days): (1) In case of any problems in the preparation and construction of the project, the affected people may first complain to the environmental and social office or the local contractor during the construction in written or oral form. The environmental and social office and the contractor shall first verify the problem and stop the relevant construction activities (such as excessive noise and dust in the construction, which are unacceptable to residents) (2) Before the problem is solved, the relevant construction activities shall not be resumed. (3) On the day of receiving the complaint, the contractor shall notify the environmental and social office of the PIU of the complaint and its treatment measures, and the project management office shall record them. (4) The contractor shall make a definite reply to the affected people within two days. (5) The problem shall be solved within 5 days of the complaint. The PIU shall notify the local village committee or the local environmental protection agency of the incident and keep in touch with them.

Stage 2: (5 days) If the contractor cannot solve the problem in Stage 1, the PIU shall try its best to solve it. The PIU shall first evaluate the complaints and put forward solutions to the affected people within 2 days. If the affected people agree to the solution, the contractor will solve the problem within 5 days, and all solutions will be documented. At the end of Stage 2, AIIB will be informed of the results.

Stage 3 (15 days): If the PIU is unable to determine the solution and implementation scheme, or the affected people are not satisfied, the PIU will organize a meeting with major stakeholders (including contractors, affected people, local environmental departments and the PIU) A scheme shall be made to all parties,

including the key steps to solve this problem. Or the contractor or operator shall immediately implement the resolution and solve the problem within 15 days. All measures and results shall be documented. After Stage 3 is completed, the PIU will report the results to AIIB.

During the grievance process, the contractor or operator and the PIU shall inform the affected people at any time. The grievance mechanism will not prevent the affected people from claiming compensation from other institutions, such as local village committees, municipal governments, courts, and AIIB.

AIIB has established a grievance mechanism for people affected by the project, so that grievances can be examined fairly and justly. The targets of this mechanism are: the people whose social and environmental policies of the AIIB project have not been correctly implemented, which causes or may cause the negative impacts of the project on the people, and whose interests are not protected by the project management office or the management organization of AIIB. AIIB's grievance mechanism with details is on the website query: https://www.aiib.org/en/policies-strategies/operational-policies/policy-on-project-affected-mechanisms.html.

8.2Grievance channels for employees

According to experience, a separate complaint handling center shall be set up to handle complaints from workers working at construction sites to contractors. These complaints are from wages, overtime pay, timely payment of wages, accommodation problems, or facilities related to drinking water, sanitation and medical services.

The proposed project will set up a grievance committee, which will mainly deal with any complaints from construction workers, including those directly or indirectly

involved. The members of the grievance committee include: the environmental and social office of the PIU, supervision engineers, workers and contractors' representatives. The environmental and social office of the implementation unit will handle complaints, ensuring that the affected workers will not be dismissed because of complaints, nor will they be threatened to withdraw their complaints before the formal hearing.

The formal hearing will be held in a safe environment and open to other workers to ensure its fair and open. The grievance committee records the following information at the hearing: (1) the details of the complaint; (2) reasons for accepting and rejecting complaints and the number of accepted and rejected complaints; (3) solutions agreed with the affected people. The grievance committee will keep records of all complaints and settlement results, and report to AIIB through environmental or social monitoring reports. These records shall be provided to relevant parties and AIIB for review when necessary.

8.3Archiving and periodical supervision

The PIU is responsible for all expenses related to the grievance committee, including the meeting, travel and accommodation of the affected people and project personnel.

All complaints received shall be documented, including the contact information of the affected people, the date of receipt of the complaint, the content of the complaint and the agreed measures to deal with the complaint. The records and their results will be disclosed in the office and included in the monitoring report submitted to AIIB.

The commissioner of the PIU shall regularly check the work of the grievance committee and verify its effectiveness, especially its ability to avoid complaints and solve complaints.

Since the project does not involve land requisition and is to restore road function and solve problems such as mass travel, the potential social risk of the project is very low. Based on the reasonable grievance mechanism and strict environmental control policies, the related risks and potential impacts during the construction period of the project are controlled.

9 Environmental and Social Management Plan (ESMP)

The *Environmental Management Plan* defines mitigation measures to avoid, prevent, mitigate and compensate the negative environmental and social impacts of the project, and also defines the responsibilities of relevant institutions. And, a monitoring mechanism has also been established to monitor whether the project meets the relevant laws, regulations and standards of China and the requirements of AIIB's environmental and social policies. The *Environmental Management Plan* includes the following contents: (1) the institutions that implement the *Environmental Management Plan* and their responsibilities; (2) mitigation measures; (3) requirements for inspection, monitoring and report preparation; (4) capacity building and institution building; (5) feedback and adjustment mechanism; (6) grievance mechanism.

9.1Institutional arrangements and responsibilities of environmental and social management

Zhengzhou Highway Development Center is the project implementation unit, which is responsible for the implementation, management, supervision of contractors (construction units) and suppliers and the daily management of the project. See Table 9-1 for relevant institutions and responsibilities for the implementation of the *Environmental and Social Management Plan*.

Table 9-1 Relevant institutions and responsibilities for the implementation of the *Environmental and Social Management Plan*

Institution	Responsibility
PIU (Zhengzhou	**Overall project management and environmental guarantee** ① Supervise and manage the daily implementation of the project

Highway Development Center)	② Recruit and manage design agencies, purchasing agents, contractors (construction units) and construction supervisors according to regulations of the government ③ Submit bidding documents, bidding assessment reports and other documents to AIIB for approval as required ④ Supervise and monitor the construction quality ⑤ Coordinate with AIIB on all aspects of project implementation ⑥ Assign a department to be responsible for environmental and social affairs ⑦ Engage an environmental testing company to carry out external environmental monitoring ⑧ Be responsible for the operation of the grievance mechanism
External environmental monitoring unit	During the implementation of the project, implement the environmental monitoring plan
External social monitoring unit	Monitor whether the implementation of the project complies with the AIIB policy
Contractor (construction unit)	① Ensure that enough funds and manpower are available to implement the mitigation measures and monitoring schemes in the *Environmental Management Plan* during the whole construction stage ② Be responsible for the operation of the grievance mechanism in the construction stage
Construction supervision company	① Ensure that enough funds and manpower are used to supervise and guide the contractor (construction unit), and require the contractor to implement mitigation measures and carry out environmental monitoring in time according to the requirements of the Environmental Management Plan ② Supervise the construction progress and quality ③ Appoint qualified personnel responsible for occupational health and safety to conduct regular on-site supervision of the contractor (construction unit) ④ Supervise the implementation performance of the contractor's (construction unit's) *Environmental Management Plan* ⑤ Perform simple and cost-effective quantitative field measurements using

	basic hand-held equipment to regularly check that construction meets environmental monitoring standards and objectives of the project, especially concerning noise and air quality ⑥ Submit the monitoring report of the *Environmental Management Plan* to the PIU every month
AIIB	① Supervise project management and timely implement loan-related agreements ② Review the compliance of the project according to the *Environmental Management Plan* ③ Supervise the project progress and regularly review the project ④ Disclose the implementation report of the *Environmental Management Plan* on the website of AIIB

9.2Environmental impact and mitigation measures

The potential environmental impact of the project has been determined in this report, and corresponding mitigation measures have been formulated (see Chapter 5 of this report) See 11-2 for the environmental impact and mitigation measures of the project. The contractor (during the period of construction) will incorporate mitigation measures into the detailed design, tender documents and construction contract manual under the supervision of the environmental and social management department of the PIU and the supervision company. The effectiveness of these measures will be evaluated according to the results of supervision and monitoring to determine whether these measures shall be continued or improved and adjusted.

Table 9-2 Environmental and social management plan of the project

Environmental/social content	Category	Main impacts	Mitigation measures	**Implementation unit**	**Supervisory organization**	**Source of funds**
Pre-construction						
Environment and society	Institutional strengthening	Suitable environmental and social security personnel shall be appointed	At least one full-time and qualified security personnel shall be appointed from the implementation unit of the project. This person will be responsible for coordinating the implementation of the Environmental Management Plan; The implementation unit will hire a third-party environmental monitoring company to provide external support	**Zhengzhou Highway Development Center**	**AIIB**	**Counterpart funds**
	Tendering and bidding	Mitigation measures and monitoring shall be incorporated into tendering and bidding documents	Environmental protection measures in the Environmental Management Plan are included in the tender documents of the project and the contracts for civil engineering and equipment installation. All contractors are required to strictly implement the Environmental Management Plan.	**Zhengzhou Highway Development Center**	**AIIB**	**Design budget with details**
	Capacity building	Training on the Environmental Management Plan shall be carried out	Provide training to contractors and construction supervision companies on the implementation of *the Environmental Management Plan*	**Zhengzhou Highway Development Center**	**AIIB**	**Counterpart funds**
	Grievance mechanism	Impact on the affected people	According to the grievance mechanism proposed in Chapter 8 of this report, the PIU and the construction unit shall establish a grievance mechanism before construction, and designate a person to be responsible for it; And provide relevant training to the person in charge of it. The contact information of the contact person of the grievance mechanism, including telephone number,	**Zhengzhou Highway Development Center**	**AIIB**	**Project budget**

Environmental/social content	Category	Main impacts	Mitigation measures	**Implementation unit**	**Supervisory organization**	**Source of funds**
			address and e-mail, will be disclosed to the public.			
			In-construction			
Environment	Ecological environment	Impact on the surrounding ecological environment	① Soil and water conservation work in excavated and filled areas of highways, bridges and culverts: temporary protective measures such as temporary side ditches, temporary drainage ditches, protective walls and sedimentation tanks are set up in the construction and production areas of the project to prevent soil erosion; Plant fiber blanket and masonry are laid along the slope of the project; ② After the earthwork is balanced, the earth needs to be purchased, and after the pavement structure of the old road is broken, it can be used as the cushion of the new road section, the shoulder of the earth road, the smooth connection of the flat intersection of the gravel road, or as the traffic protection project of the broken low-grade road ③ Ecological education, training and publicity ④ The Yellow River Wetland Nature Reserve needs to set up warning marks such as billboards, warning signs, no singing, and deceleration; Strictly control the construction scope, minimize the temporary land occupation, and strengthen management. It is strictly forbidden to arbitrarily enter the Provincial Zhengzhou Yellow River Wetland Nature Reserve, and it is forbidden to set	**Construction unit**	**Local Ecological Environment Bureau Zhengzhou Highway Development Center**	**Construction budget**

Environmental/social content	Category	Main impacts	Mitigation measures	**Implementation unit**	**Supervisory organization**	**Source of funds**
			up construction camps within the protected areas. Waste slag and soil produced by construction shall be treated as required or transported to the designated place, and dumped into ditches and rivers is not allowed. The management is strengthened, and the activities in non-construction areas are prohibited; Disturbing animal habitats by non-construction activities are avoided. Hunting wild animals and harvesting rare plants are prohibited. The construction scheme shall be optimized, the construction progress shall be paid close attention, and the construction time in the protected area shall be shortened as far as possible.			
	Ambient air	Total suspended particulate, asphalt smoke, construction machinery exhaust	① Enclosure is set at the construction section near the sensitive point, and the height of the enclosure is 2.5m ② The water is sprinkled on the construction site regularly, and the frequency of sprinkling water is increased in windy and dry weather appropriately. ③ Solid wastes on the construction site shall be transported to the designated storage place in time. ④ Transport vehicles are covered with tarpaulins, and it is forbidden to overload them. If the vehicles pass through the sections near sensitive points, please slow down. ⑤ The 100% requirements of 8 construction sites in Zhengzhou shall be met. ⑥ When paving asphalt, a period with good atmospheric diffusion conditions shall be chosen, asphalt paving operators shall be protected in	**Construction unit**	**Local Ecological Environment Bureau Zhengzhou Highway Development Center**	**Construction budget**

Environmental/social content	Category	Main impacts	Mitigation measures	**Implementation unit**	**Supervisory organization**	**Source of funds**
			sanitation, the masks and goggles shall be provided for them, and the labor protection shall be strengthened. ⑦ The owners of non-road mobile machinery shall be urged to carry out mechanical maintenance regularly to ensure that the exhaust emissions of non-road mobile machinery in use meet the emission standards; to purchase oil for non-road mobile machinery from regular channels, and keep the purchase voucher and establish ledger.			
	Noise	Impact of construction noise on sensitive points	① The construction time shall be arranged reasonably, and the operation of noisy equipment shall be prohibited at noon and night. If construction is required due to special circumstances, it can only be carried out with the consent of the Ecological Environment Bureau and other relevant departments; ② When making the construction plan, the simultaneous operation of a large number of high-noise equipment shall be avoided as far as possible. In addition, the operation of a large number of high-noise equipment shall be arranged in the daytime as far as possible to reduce the construction amount at night. A large number of power mechanical equipment shall not be arranged in the same place as far as possible to avoid excessive local sound level; ③ The low-noise equipment shall be used as far as possible, and the maintenance work shall be strengthened.	**Construction unit**	**Local Ecological Environment Bureau**	**Construction budget**

Environmental/social content	Category	Main impacts	Mitigation measures	**Implementation unit**	**Supervisory organization**	**Source of funds**
			④ The throttle of the machines used intermittently during the operating interval shall be turned off or turned off to a minimum; The workers shall be provided with personal protective equipment (PPE) for noise; ⑤ The time and route of the vehicles transporting materials during the period of construction shall be arranged reasonably, and passing residential areas and sections with dense sensitive points shall be avoided as much as possible during transportation and peak periods also shall be avoided; ⑥ Construction vehicles transporting materials or wastes shall be at a low speed when passing through sound-sensitive areas such as residential areas, schools and hospitals, and stop whistling to avoid affecting the normal life of the surrounding residents.			
	Solid wastes	Inappropriate solid waste treatment	① The wastes shall be recycled or reused as much as possible. Waste concrete and other waste construction materials shall be backfilled at the site as far as possible; **The recycling of excavated materials for old roads shall be strengthened, and the environmental protection design shall be paid more attention to. After the pavement structure of the old road is broken, it can be used as the cushion of the new road section, the shoulder of the earth road, the smooth connection of the flat intersection of the gravel road, or as a traffic protection project of the broken low-grade road;**	**Construction unit**	**Local Ecological Environment Bureau**	**Construction budget**

Environmental/social content	Category	Main impacts	Mitigation measures	**Implementation unit**	**Supervisory organization**	**Source of funds**
			② Workers are prohibited from littering; Garbage collection boxes shall be provided in all workplaces. Domestic waste will be collected by the local sanitation department regularly and sent to a landfill for treatment; ③ The excavated soil shall be backfilled on-site as much as possible. After the pavement structure of the old road is broken, it can be used as the cushion of the new road section, the shoulder of the earth road, the smooth connection of the flat intersection of the gravel road, or as a traffic protection project of the broken low-grade road;			
	Wastewater	Surface water pollution caused by construction wastewater and domestic sewage	① Private houses shall be rented in construction production living areas, and the domestic washing wastewater shall be sprayed to reduce dust. Latrine pits shall be cleaned regularly, anti-seepage and oil-separation sedimentation tanks shall be set in the construction areas, and trash cans shall be set reasonably. ② The contractor will formulate measures to control the use of fuel at the construction site as part of its environmental protection measures at the site. ③ The construction site shall be provided with an area specially for cleaning vehicles and wastewater collection devices and sedimentation tanks, and the area shall be restored after the completion of construction. ④ The fuel storage, mechanical maintenance workshop and vehicle cleaning area must be at least	**Construction unit**	**Local Ecological Environment Bureau**	**Construction budget**

Environmental/social content	Category	Main impacts	Mitigation measures	**Implementation unit**	**Supervisory organization**	**Source of funds**
			500m away from the nearest surface water body and outside the water source protection area. ⑤ The lower part of the bridge is constructed in the dry season as far as possible. Sedimentation tanks and evaporation tanks are set at the construction sites at both ends of the bridge, and the slurry water produced by bridge construction can be reused after sedimentation treatment. The cofferdam method is adopted in the lower part of the bridge construction, and the construction and removal of the cofferdam shall protect the water body and avoid large disturbance. Construction machinery and vehicles shall be regularly checked for oil leakage, oil emitting, and oil spilling. ⑥ Strict control measures shall be taken to ensure the comprehensive utilization or reuse of construction wastewater after treatment, and it is strictly forbidden to discharge wastewater into drinking water source protection areas during the period of construction.			
Environment and society	**COVID-19**	**Community health**	**Timely and accurately understand the situation of employees, especially the flow of people from high and medium risk areas such as COVID-19 and abroad, and establish and improve employee health records. The temperature of employees shall be checked regularly, the implementation of personal protection requirements shall be supervised, and staff gathering and collective activities shall be reduced.**	**Construction unit**	**Supervision unit Zhengzhou Highway Development Center**	**Construction budget**

Environmental/social content	Category	Main impacts	Mitigation measures	**Implementation unit**	**Supervisory organization**	**Source of funds**
	Occupational health and safety	**Occupational health and safety of workers**	**Enterprises shall establish and improve the survey and rectification system of hidden dangers of accidents, and take technical and management measures to discover and eliminate them in time. The survey and rectification system of hidden dangers of accidents shall be recorded truthfully and the staff shall be informed. Safety and health management agencies shall maintain, repair and inspect the equipment regularly to ensure proper operation. Maintenance, repair and inspection records shall be kept and signed by relevant personnel. When employees find hidden dangers of accidents or other unsafe factors, they shall immediately report to the person in charge of on-site safety production management, and the receiver shall handle them in time.** **Laborers are treated fairly, without discrimination and with equal opportunities.** **Protection measures for laborers**	**Construction unit**	**Supervision unit Zhengzhou Highway Development Center**	**Construction budget**
	Safety in construction	**Safety**	**A professional safety management team formulates the construction safety system to ensure the investment of safety funds and materials.** **Before construction, the site shall be treated with "electricity, water, roads and ground leveling". The construction of temporary roads must ensure the safety of passing vehicles and pedestrians, and provide clear signs and traffic control measures. Temporary water use at the construction site shall be guaranteed by hygiene**	**Construction unit**	**Supervision unit Zhengzhou Highway Development Center**	**Construction budget**

Environmental/social content	Category	Main impacts	Mitigation measures	**Implementation unit**	**Supervisory organization**	**Source of funds**
			and safety, and all staff shall be educated on water and electricity safety, and the system of holding certificates for special operations personnel shall be strictly implemented. **Safety signs, danger warning marks and other signs and slogans prescribed by the state shall be hung in the construction area to prevent residents from entering the construction protection scope and dangerous areas.**			
	Risk management of rights and interests of women	**Equal employment**	**1) The construction unit introduces the residents, especially women, from the place where the project is constructed to participate in the construction of the project.** **2) Gender discrimination in employment is eliminated and a gender-equal employment mechanism is created.**	**Construction unit**	**The third-party monitoring body Zhengzhou Highway Development Center**	/

9.3Institutional strengthening and capacity building

According to the survey, the institutional capacity, office conditions and equipment configuration of the project are perfect, and the professionals are of high quality and have experience in the preparation, construction and operation of similar domestic projects. However, the project is an AIIB Loan project. Relevant personnel are required to know the operation mode of the AIIB project, and in particular, social and safety requirements can be fully compared with domestic experience, so they are required to further study and train relevant business strategy requirements. See Table 9-3 for the training plan for environmental and social management capacity building.

Table 9-3 Training plan for the capacity building of environmental and social management during the period of construction

Training organization	Training topics	Training objects	Training content	**Number of times**	**Time (day)**	**Number of people**	**Budget (RMB 10,000)**
Zhengzhou Highway Development Center	Environmental policies and regulations	Sub-project office and construction unit	① Environmental protection laws and regulations ② Environmental policies and plans ③ AIIB's environmental management framework	**1**	**1**	**50**	**2**
Zhengzhou Highway Development Center	Social policies and regulations	Sub-project office and construction unit	① Contents of public engagement in China's environmental protection laws and regulations ② Law of the People's Republic of China on the Protection of Rights and Interests of Women ③ Special Provisions on Labor Protection of Female Employees ④ Contents of AIIB's environmental management framework	**1**	**1**	**50**	**2**
Zhengzhou Highway Development Center	Implementation of Environmental and Social Management	Sub-project office and construction unit	① Environmental management responsibilities during the period of construction ② Main tasks and content of environmental management during the period of construction ③ Public engagement during the period of	**1**	**1**	**50**	**2**

Training organization	Training topics	Training objects	Training content	**Number of times**	**Time (day)**	**Number of people**	**Budget (RMB 10,000)**
	Plan		construction ④ Internal monitoring of environmental and social management				
Zhengzhou Highway Development Center	Grievance and dispute resolution	Sub-project office and construction unit	Collection, handling and feedback of residents' opinions	**1**	**1**	**50**	**2**

9.4 Monitoring and reporting

9.4.1 Environmental monitoring

The Environmental Management Plan will include three types of project monitoring: (1) Internal monitoring carried out by the supervision company and Zhengzhou Highway Development Center; (2) External monitoring including air, water and noise monitoring carried out by the environmental monitoring company; (3) Compliance monitoring to ensure the implementation of Environmental Management Plan.

The monitoring plan describes the scope, parameters, time and frequency of monitoring, as well as the implementation and supervision institutions. The monitoring results shall meet the standards mentioned in Chapter 2. These standards are also included in Table 9-4.

Internal monitoring. During the construction stage, the supervision company will carry out internal environmental monitoring according to the requirements of the monitoring plan.

The monitoring results will be submitted to Zhengzhou Highway Development Center by the supervision company in the form of a monthly report.

External monitoring. Zhengzhou Highway Development Center will hire at least one environmental monitoring company to carry out the external environmental monitoring required by Table 9-4. External environmental monitoring will cover the whole construction stage of the project. The environmental monitoring company will prepare the environmental monitoring report, including the monitoring methods and results, and submit the report to Zhengzhou Highway Development Center.

Compliance monitoring of *the Environmental Management Plan*. The environmental and social specialist of Zhengzhou Highway Development Center carries out field investigation to check the project progress and review the implementation of the project progress and *the Environmental Management Plan*, and review the reports prepared by the supervision company and the environmental monitoring company. The field investigation focuses on the implementation of *the Environmental Management Plan*. There is no fixed frequency of field investigations: the environmental and social specialist will conduct field investigations as much as possible within the available budget. The findings will be included in the environmental monitoring report submitted to AIIB.

Environmental monitoring report. Zhengzhou Highway Development Center will prepare the environmental monitoring report (once every quarter in the first year of project implementation. Based on the assessment results of the bank on the implementation of ES-related measures, the report will be prepared once every half a year in the second year), and is submitted to AIIB. The report includes: (1) implementation of the *Environmental Management Plan*; (2) overall effectiveness of the *Environmental Management Plan* implementation; (3) environmental monitoring and results carried out; (4) implementation of capacity building; (5) implementation of public engagement and the operation of grievance mechanism; And (6) problems and actions during the period of construction.

Table 9-4 Environmental monitoring plan

Item	**Monitoring index**	**Location**	**Frequency**	**Budget (RMB 10,000)**	Standard No.	**Executive unit**	**Supervision unit**
1. Internal monitoring - supervision company							
Ambient air	**Implementation of mitigation measures Monitoring of total suspended particulate (TSP)**	**Field investigation in construction site**	**Once a month**	**Included in construction budget**	GB 3095-2012	**Construction unit**	**Supervision company**
Noise	**Monitoring of the boundary of construction site and the noise at sensitive points (L_{Aeq})**	**Boundary of construction site**	**Once a month**	**Included in construction budget**	GB12523-2011; GB12348-2008	**Construction unit**	**Supervision company**
Solid wastes	**Construction waste and domestic waste Performance index: relevant requirements for environmental**	**Field investigation in construction site and construction living area**	**Once a week**	**Included in construction budget**	/	**Construction unit**	**Supervision company**

Item	**Monitoring index**	**Location**	**Frequency**	**Budget (RMB 10,000)**	Standard No.	**Executive unit**	**Supervision unit**
	mitigation measures						
Construction wastewater and domestic sewage	**Comprehensive utilization without discharge**	**Construction production living area**	**Once a week**	**Included in construction budget**	/	**Construction unit**	**Supervision company**
Ecological environment	**Performance index: relevant requirements for environmental mitigation measures**	**Field investigation in construction site and construction living area**	**Once a week**	**Included in construction budget**	/	**Construction unit**	**Supervision company**
2. External monitoring - by the environmental monitoring company							
Ambient air quality	**Total suspended particulate (TSP)**	**For each sub-project, 10 construction sites with serious water damage involving sensitive points are selected for**	**Once a quarter for 2 days each time during the period of construction**	**60**	GB 3095-2012	**External environmental monitoring company**	**Zhengzhou Highway Development Center, AIIB and Ecological Environment Bureau**

Item	**Monitoring index**	**Location**	**Frequency**	**Budget (RMB 10,000)**	Standard No.	**Executive unit**	**Supervision unit**
		monitoring (including at least one upwind and downwind direction) and nearby sensitive points					
Noise	**L_{Aeq}**	**For each sub-project, 10 construction sites with serious water damage involving sensitive points are selected for monitoring, boundary and sensitive points of the construction**	**Once a quarter for 2 days each time during the period of construction, and once a day for the daytime noise and nighttime**		GB12523-2011 GB12348-2008	**External environmental monitoring company**	**Zhengzhou Highway Development Center, AIIB and Ecological Environment Bureau**

Item	**Monitoring index**	**Location**	**Frequency**	**Budget (RMB 10,000)**	Standard No.	**Executive unit**	**Supervision unit**
		site	**noise**				

*In case of exceeding the standard: (1) report to Zhengzhou Highway Development Center immediately; (2) make corresponding actions; (3) conduct follow-up monitoring to determine whether the relevant standards are met after the actions; (4) all problems will be included in the implementation report of *the Environmental Management Plan* submitted to AIIB.

9.4.2 Social monitoring

According to the requirements of the environmental and social framework of AIIB, through the environmental and social impact assessment, once the borrower determines the potential impact and risk of the project, AIIB needs to formulate management measures to reduce or mitigate the negative impact of the project, including the plan on social management. If it is hard for the borrower to implement the social management plan, relevant matters shall be included in the project.

Through the assessment of the social impact of the proposed project, various problems were identified, in such aspects as gender, vulnerable groups, the interests of villagers in the project area, the labor management of participating contractors, grievance mechanism, potential negative impacts in the process of project construction, and other unknown impacts. When the project is completed, the major benefits brought by the project will be realized. The infrastructure in six counties (cities and districts) including Xinmi City, Xingyang City, Dengfeng City, Xinzheng City, Zhongmu County and Gongyi City will be restored or reconstructed, the damaged roads of counties, townships and villages in the disaster area will be repaired, the subgrade, pavement and protective guard will be reconstructed, and the bridges and culverts will also be renovated and rebuilt. The main purpose of social management plan is to maximize the social benefits and minimize potential negative impacts after the implementation of the project.

During the implementation of the project, in order to ensure the environmental and social plan of AIIB is complied with, the project management office will conduct environmental and social monitoring throughout the

construction and operation of the project. The project management office is responsible for internal monitoring, including the implementation of social management plan, grievance and grievance documents, as well as the engagement and consultation of local communities and residents. The vulnerable groups are supported by relevant institutions. The project environmental and social team of the engineering department implements an internal monitoring mechanism, regularly checks relevant activities, and establishes a database to record the consultation with relevant institutions and local residents, as well as complaints received and handled. The major results of internal monitoring will be reported to the project leading group and be included in the project progress report.

In addition, the project management office will hire an independent institution to conduct external monitoring to determine whether the implementation of the project complies with the AIIB policies. Monitoring indexes include the progress of activities described in the project documents; and the satisfaction of relevant individuals or units with the consultation or disclosure of the project; the complaints caused by the project are solved. The external monitoring will be carried out through a combination of a sampling survey, interviews with key stakeholders and group discussion. The external monitoring organization will visit the relevant district, county or street organizations, attend public consultation meetings, assess the effectiveness of public engagement, collect opinions and put forward improvement suggestions. The external monitoring organization will also review the records of the grievance mechanism and determine whether it operates effectively. Finally, the

external monitoring organization submits the monitoring report to AIIB (once every quarter in the first year of project implementation. Based on the assessment results of the bank on the implementation of ES-related measures, the report will be prepared once every half a year in the second year) until the project is completed.

Different from other projects involved in land acquisition and resettlement, the project is to restore and transform the rural roads around six counties (districts) in Zhengzhou, including Zhongmu County, Gongyi City, Xingyang City, Xinmi City, Xinzheng City and Dengfeng City. The related drainage system and safe public facilities are also contained in the project. It is designed to restore road functions and solve problems such as mass travel. It does not involve permanent expropriation of collective land and occupation of state-owned land, and does not involve resettlement impact and compensation for land acquisition (See the feasibility study for details) The budget for social management mainly includes:

(1) The expense of recruiting an independent social monitoring organization during the implementation of the project;

(2) The expense of the project company and the project contractor's organizing relevant personnel to carry out social management training;

(3) The expense of organizing various discussions among key stakeholders during the implementation of the project;

(4) The expense of the establishment and operation of the grievance mechanism during the implementation of the project. Due to the relatively low costs, they will be provided by the corresponding funds of the project company.

At present, the cost of social impact monitoring during the implementation of the project is estimated to be RMB ONE HUNDRED AND FIFTY THOUSAND, including the expense of hiring experts and external monitoring institutions as well as for social impact training. Other estimated management costs are RMB TEN THOUSAND, including the cost for discussion with stakeholders and the project grievance mechanism.

9.4.3 Document management and reporting mechanism

9.4.3.1 Recording mechanism

In order to ensure the effective operation of the environmental management system, a sound recording mechanism shall be established and the following records shall be kept:

(1) Relevant laws and regulations;

(2) Licenses issued by the government;

(3) Relevant environmental and social impacts;

(4) Training records;

(5) Monitoring data;

(6) Problems in environmental management, environmental protection and social management;

(7) Mitigation measures and effectiveness;

(8) Other project-related information;

(9) Audit records of project documents.

In addition, the above records shall be well managed, in terms of their identification, collection, archiving, storage, maintenance, query, retention period and record disposal.

9.4.3.2 Reporting mechanism

The construction unit, monitoring unit and project management office shall record the project progress, implementation of management plan, environmental quality monitoring results and social monitoring results and report them to relevant departments in time during the implementation of the project. It mainly includes the following three parts:

(1) The monitoring unit and the construction unit shall make detailed records of the implementation of ESMP and report them to the PIU in time.

(2) Project progress reports prepared by the PIU, such as a monthly report, quarterly report and annual report, must include the contents of ESMP progress, such as the implementation progress and effect of ESMP.

(3) The report on the implementation of the Environmental and Social Management Plan shall be submitted to Zhengzhou Highway Development Center before the 10th of the last month of each quarter. The report consists of two parts: the summary report on the implementation of the Environmental and Social Management Plan and the professional monitoring report (atmospheric monitoring report and noise monitoring report)

(4) Zhengzhou Highway Development Center submits the ESMP implementation report of the project to AIIB.

The ESMP implementation report can include the following main contents, and the final contents of the report shall be determined after discussion with AIIB:

① Project progress.

② Implementation of ESMP plan.

③ Implementation of the training plan.

④ No public complaints. In case of any complaints, record the main contents, solutions and public satisfaction of the complaints.

See Table 9-5 for the submission time of the monitoring and ESMP implementation report of AIIB.

Table 9-5 Monitoring and report schedule

S.N.	Monitoring and report	Time
1	ESMP implementation report No.1	July 2022
2	ESMP implementation report No.2	October 2022
3	ESMP implementation report No.3	January 2023
4	Summary report	July 2023

9.5Expense estimation

This section has estimated the expense of implementing *the Environmental Management Plan*. The expense includes the following parts: the expense for implementing mitigation measures, the expense for carrying out monitoring plans and the expense of training. The expense covers the whole period of construction.

The expense does not include: (1) the expenses arising from the change and adjustment of detailed design; (2) the expense of internal monitoring. These expenses are included in the construction and supervision contracts. The expense of training is based on the expense experience of other similar projects.

Table 9-6 Expense estimation for the implementation of the environmental and social management plan

No.	Item	Expense (RMB 10,000)
1	Capacity building	8
2	Expense of environmental external monitoring	60
3	Hiring social experts and external monitoring institutions	11.8
4	Other management costs	1
Total		80.8

1 Appendix 1 Village-level social questionnaire for the reconstruction of rural roads in Zhengzhou

County (city): Township/town/community: Village: Tel.:

<table>
<tr><td colspan="3">(1) Infrastructure</td><td>Original condition</td><td>Length damaged by flood</td><td>Bridges (abutments) damaged by flood</td></tr>
<tr><td colspan="3">1. Road or bridge</td><td>Road length (km)</td><td>Road length (km)</td><td></td></tr>
<tr><td colspan="3">Length of roads in the village connecting to external trunk roads (km)</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Road in the village (km)</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">2. Item</td><td colspan="3">2021</td></tr>
<tr><td rowspan="12">(1) Population</td><td rowspan="8">Others</td><td>Households</td><td colspan="3"></td></tr>
<tr><td>Population</td><td colspan="3"></td></tr>
<tr><td>Male population</td><td colspan="3"></td></tr>
<tr><td>Female population</td><td colspan="3"></td></tr>
<tr><td>Including: agricultural population</td><td colspan="3"></td></tr>
<tr><td>Non-agricultural population</td><td colspan="3"></td></tr>
<tr><td>Ethnic minority</td><td colspan="3"></td></tr>
<tr><td rowspan="4">Age structure and special population</td><td>Children aged 16 and younger</td><td colspan="3"></td></tr>
<tr><td>Workers aged 17-60</td><td colspan="3"></td></tr>
<tr><td>Elderly aged over 60</td><td colspan="3"></td></tr>
<tr><td>The elderly and disabled people</td><td colspan="3"></td></tr>
<tr><td>Educational attainment</td><td>Below primary education</td><td colspan="3"></td></tr>
</table>

		Primary education	
		Junior middle school education	
		Senior middle school education	
		Senior middle school education or above	
(2) Land		Total	
		1. Arable land/mu	
		Paddy land/mu	
		Irrigated land/mu	
		Dryland/mu	
		2. Garden land/mu	
		3. Forest land/mu	
		4. Aquaculture area/mu	
(3) Planting area of farm crops		Total	
		1. Grain crop/mu	
		2. Cash crop/mu	
		3. Oil crop/mu	
		4. Cotton/mu	
		5. Others/mu	
(4) Total output value of agricultural and sideline industries		Annual grain output (kg)	
		Agricultural production (field crops and cash crops) (RMB 10,000)	
		Ground farming	

	(RMB 10,000)	
	Aquaculture (RMB 10,000)	
	Total (RMB 10,000)	
(5) Per capita net income (RMB)	Industrial and sideline income (RMB 10,000)	
	Per capita net income in the whole village (RMB)	
	Types of industrial and sideline production participated in by villagers	

2 Appendix 2 Village-level social questionnaire for the reconstruction of rural roads in Zhengzhou for sample households (10 households in each village)

Name of county (city)/township	Name of village/community	**Name: (male) (female)**
Age (check if you agree)	Under 17	
	17-60	
	Over 60	
Gender (check if you agree)	Male	
	Female	
Nationality (check if you agree)	Ethnic Han	
	Ethnic minorities (please specify your nation)	
Educational attainment (check if you agree)	Junior middle school and below	
	Senior middle school (technical secondary school, vocational school)	
	Junior college, university or above	
Annual household income in 2021 (RMB)	Salary of government staff	
	Salary of enterprise employee	
	Salary of teachers or doctors	
	Farmers and agricultural income	
	Employment income	
	Business income	
	Employment income	

	Government living allowance and other income	

3 Appendix 3 Questionnaire on public opinions on the AIIB Loan project of post-disaster reconstruction of rural roads in Zhengzhou

<table>
<tr><td colspan="2">Name</td><td></td><td>Gender</td><td>□ Male
□ Female</td><td>Age</td><td></td></tr>
<tr><td colspan="2">Occupation</td><td></td><td>Nationality</td><td></td><td>Educational attainment</td><td></td></tr>
<tr><td colspan="2">Address</td><td colspan="3">County (district)/Town (township)/Village</td><td>Contact information</td><td></td></tr>
<tr><td>Project brief</td><td colspan="6">The "7.20" rainstorm in Zhengzhou caused serious damage to infrastructure in many places. After the rainstorm, the post-disaster reconstruction of ordinary highway and waterway infrastructure shall be put into practice as soon as possible, and the production and life order of the people in the disaster area shall come back to normal as soon as possible according to the requirements of the overall deployment.
The project is the post-disaster reconstruction project of rural roads in Zhengzhou. The construction scope includes county highway, township highway and village roads within 6 counties (cities and districts) of Xinmi City, Xingyang City, Dengfeng City, Xinzheng City, Zhongmu County and Gongyi City. They are roughly 76 townships, 29 sub-district offices and 2 scenic spot management committees. The project mainly involves the repair of subgrade and pavement damaged by flood, bridges and culverts, safety facilities and other works. It includes 1,259 damage sites, the repair of about 267 kilometers of subgrade, about 415 kilometers of pavement, the reconstruction of 127 bridges, and the repair of 36 bridges; the reconstruction of 253 culverts, and the repair of 10 culverts.</td></tr>
<tr><td rowspan="4">Contents (check the options you</td><td colspan="2">Your attitude towards the current environmental quality in your area</td><td colspan="4">A. Satisfied B. Less satisfied C. Dissatisfied</td></tr>
<tr><td colspan="2">Do you know the project</td><td colspan="4">A. Yes, very well B. Know a little C. Don’t know</td></tr>
<tr><td colspan="2">Are you satisfied with the highway traffic conditions in this area</td><td colspan="4">A. Satisfied B. Less satisfied C. Dissatisfied</td></tr>
<tr><td colspan="2">What are your most concerned problems during the period of construction</td><td colspan="4">A. Dust B. Noise C. Wastewater
D. Construction solid wastes E. Ecological impact</td></tr>
</table>

think appropriate)	In your opinion, which one will have the most adverse effect on the environment during the period of construction:	A. Dust B. Noise C. Wastewater D. Construction solid wastes E. Ecological impact
	Do you accept the environmental impact of the project during the period of construction after knowing the environmental protection measures	A. Yes B. Basically accept C. No D. Not sure
	If the local environment is polluted during the period of construction, you will:	A. Complain to the environmental protection department B. Solve it through legal channels C. Negotiate with the construction unit or management department D. Others (_____)
	Based on your full consideration, do you support the project	A. Yes B. I'm fine with either way C. No (reason: _____)
Your requirements and suggestions for the project		

Annexed Table 3-1 Population distribution of sample villages

County/city	Village	Number of households	Population	Male	Female	Agricultural population	Non-agricultural population	Ethnic minority	Children aged 16 and younger	Workers aged 17-60	Elderly aged over 60	The elderly and disabled people requiring special care	Illiterates	Primary school graduates	Junior high school graduates	Senior middle school graduates	Above Senior middle school education
Dengfeng City	Dongshang Village	347	1,418	740	678	1,208	210	0	238	810	370	234	20	300	305	420	373
Dengfeng City	Jiangzhuang Village	365	1,862	929	933	1,817	45	0	510	1,092	260	6	286	510	496	440	130
Dengfeng City	Liyao Village	367	1,470	711	759	1,380	90	0	318	805	347	29	13	306	350	671	130
Dengfeng City	Tashuimo Village	584	2,192	1,321	871	2,103	89	2	422	1,208	562	132	201	631	331	321	708
Gongyi City	Gaomiao Village	1,111	4,675	2,353	2,322	4,675	0	16	693	2,994	988	115	0	311	1,830	1,560	974
Gongyi City	Huilong Village	465	1,946	1,046	900	1,946	0	0	506	1,046	394	355	35	108	665	501	637
Gongyi City	Longmen Village	576	2,038	919	1,119	2,021	17	3	351	1,331	356	8	60	298	280	1,020	380
Xinmi City	Heiyugou Village	1,112	5,120	2,565	2,555	5,120	0	0	1,075	2,816	1,229	16	8	862	2,213	1,506	531
Xinmi City	Wenzhuang Village	362	1,300	760	540	1,245	55	9	260	820	220	12	32	500	638	70	60
Xinmi City	Xiasigou Village	289	989	565	424	949	40	0	113	685	191	63	85	132	267	413	92
Xinzheng City	Gucheng Village	810	3,985	2,546	1,439	3,785	200	0	1,675	1,625	685	12	158	458	1,758	1,043	568
Xinzheng City	Nianlu Village	495	2,332	1,200	1,132	2,302	30	1	730	1,251	351	15	0	50	1,700	500	82
Xinzheng City	Tanghe Village	350	1,486	784	702	1,486	0	3	350	981	155	23	35	382	765	249	55
Xingyang City	Baishuiyu Village	399	1,305	695	610	1,300	5	1	150	524	628	25	10	224	511	405	155
Xingyang City	Gaoshan Village	765	2,906	1,599	1,307	2,906	0	0	725	1,478	703	68	25	791	872	378	840
Xingyang City	Zhonggang Village	475	1,718	896	822	1,712	6	0	276	1,176	266	38	0	118	536	901	163
Zhongmu County	Huizhuang Village	670	3,098	1,651	1,447	3,098	0	0	425	2,235	438	72	0	195	1,196	1,323	384
Zhongmu County	Liangjiacun Village	278	1,368	730	638	1,280	88	0.00	218	800	350	26	60	210	540	460	98
Zhongmu County	Xiaowangzhuang Village	470	2,203	1,134	1,069	2,192	11	0	512	1,195	496	36	154	346	968	468	267

County/city	Village	Number of households	Population	Male	Female	Agricultural population	Non-agricultural population	Ethnic minority	Children aged 16 and younger	Workers aged 17-60	Elderly aged over 60	The elderly and disabled people requiring special care	Illiterates	Primary school graduates	Junior high school graduates	Senior middle school graduates	Above Senior middle school education
Total		10,290	43,411	23,144	20,267	42,525	886	35	9,547	24,872	8,989	1,285	1,182	6,732	16,221	12,649	6,627
Proportion		4.22		53.31%	46.69%	97.96%	2.04%	0.081%	21.99%	57.29%	20.71%	2.96%	2.72%	15.51%	37.37%	29.14%	15.27%

Annexed Table 3-2 Agricultural and sideline production levels of sample villages

County/city	Village	Arable land (mu)	Paddy land (mu)	Irrigated land (mu)	Dryland (mu)	Garden land (mu)	Forest land (mu)	Aquaculture area (mu)	Grain crop (mu)	Cash crop (mu)	Oil crop (mu)	Cotton (mu)	Others (mu)
Dengfeng City	Dongshang Village	860	45	300	515	0	900	0	860	850	30	0	20
Dengfeng City	Jiangzhuang Village	720.46	0	0	720.46	0	1,660	0	700	0	20	10	0
Dengfeng City	Liyao Village	1,300	0	700	600	200	3,500	12	700	200	300	20	80
Dengfeng City	Tashuimo Village	3,260	0	180	3,080	0	32,700	0	320	2,940	0	0	0
Gongyi City	Gaomiao Village	2,406	0	240	2,166	0	750	0	1,800	110	0	0	0
Gongyi City	Huilong Village	1,086	0	50	1,036	35	820	0	1,002	84	84	0	0
Gongyi City	Longmen Village	841	0	0	841	0	5,600	0	820	21	8	0	13
Xinmi City	Heiyugou Village	5,632	0	0	5,632	0	0	0	5,632	0	0	0	0
Xinmi City	Wenzhuang Village	1,200	0	0	1,200	20	60	0	600	300	50	0	20
Xinmi City	Xiasigou Village	920	0	100	820	80	6,000	0	500	80	100	0	30
Xinzheng City	Gucheng Village	3,890	0	2,860	1,030	2680	1,458	0	1,560	3,280	568	0	658
Xinzheng City	Nianlu Village	4,600	0	4,600	0	0	900	0	3,500	1,100	800	0	0
Xinzheng City	Tanghe Village	850	0	700	150	330	1,660	0	300	280	120	0	15
Xingyang City	Baishuiyu Village	2,228.8	0	0	2,228.8	0	0	0	1,000	200	100	20	600
Xingyang City	Gaoshan Village	3,042	0	1,158	1,884	0	0	0	2,012	1,030	0	0	0

County/city	Village	Arable land (mu)	Paddy land (mu)	Irrigated land (mu)	Dryland (mu)	Garden land (mu)	Forest land (mu)	Aquaculture area (mu)	Grain crop (mu)	Cash crop (mu)	Oil crop (mu)	Cotton (mu)	Others (mu)
Xingyang City	Zhonggang Village	1,744	0	652	1,092	80	358	0	1,744	98	50	0	1,596
Zhongmu County	Huizhuang Village	3,965	0	3,965	0	0	0	0	1,085	2,880	0	689	0
Zhongmu County	Liangjiacun Village	1,900	0	1,900	0	0	2,300	0	260	700	50	0	200
Zhongmu County	Xiaowangzhuang Village	2,230	0	2,230	0	60	180	0	800	3,240	300	120	0
Total		42,675.26	45	19,635	22,995.26	3,485	58,491	12	25,195	17,393	2,580	859	3,232
Per capita		0.983	0.001	0.452	0.530	0.080	1.347	0.0003	0.580	0.401	0.059	0.020	0.074

Annexed Table 3-3 Income and road conditions of sample villages

County/city	Village	Total output value of agricultural and sideline industries (kg)	Agricultural production (RMB10,000)	Ground farming (RMB10,000)	Aquaculture (RMB10,000)	Industrial and sideline industries (RMB10,000)	Per capita net income in the whole village (yuan)	Total length of village roads (km)	Length of road damaged by water (km)	Length of roads in the village connecting to external trunk roads (km)
Dengfeng City	Dongshang Village	602,000	154.5	0	0	3,300	24,361.78	15	8	2
Dengfeng City	Jiangzhuang Village	668,400	203.9	40	0	4,500	25,477.44	20	10	1.3
Dengfeng City	Liyao Village	645,000	251.30	70	12	3,384	25,287.76	16	11	0.6
Dengfeng City	Tashuimo Village	4,486,000	603.6	240	0	4,600	24,833.94	14.3	2.5	2
Gongyi City	Gaomiao Village	1,080,000	1,500	20	0	10,132	24,924.06	10	8	2
Gongyi City	Huilong Village	500,000	380	0	0	4,556	25,364.85	18	8	6
Gongyi City	Longmen Village	252,000	200.24	120	0	4,869	25,462.41	28	3	8
Xinmi City	Heiyugou Village	2,534,400	557.568	0	0	10,675	21,938.61	25	5	4
Xinmi City	Wenzhuang Village	5,000	30	50	0	2,925	23,115.38	7	3	2
Xinmi City	Xiasigou Village	400,000	88	13.5	0	2,300	24,282.10	5.6	1.5	4.5
Xinzheng City	Gucheng Village	1,092,000	258.606	6,580.9	0	3,548	26,066.51	30	16	15
Xinzheng City	Nianlu Village	2,090,909	460	0	0	7,518	34,210.98	30	5	4
Xinzheng City	Tanghe Village	20,000	15	0	0	3,566.4	24,100.94	10.5	1.5	2.3
Xingyang City	Baishuiyu Village	1,000,000	1,000	50	0	2,951	30,659.00	3	0.2	2

County/city	Village	Total output value of agricultural and sideline industries (kg)	Agricultural production (RMB10,000)	Ground farming (RMB10,000)	Aquaculture (RMB10,000)	Industrial and sideline industries (RMB10,000)	Per capita net income in the whole village (yuan)	Total length of village roads (km)	Length of road damaged by water (km)	Length of roads in the village connecting to external trunk roads (km)
Xingyang City	Gaoshan Village	500	1,200	0	0	5,943	24,580.18	5.488	0.073	1.5
Xingyang City	Zhonggang Village	319,200	33	0	0	4,553	26,693.83	6	0.051	1
Zhongmu County	Huizhuang Village	15,680,000	3,449	36	0	3,924	23,915	0.872	Bridge destroyed	1
Zhongmu County	Liangjiacun Village	3,000,000	1,500	0	0	1,642	22,968	4.045	0.4025	1.952
Zhongmu County	Xiaowangzhuang Village	8,000,000	4,000	23	0	3,338	33,414	1	0.9	1.5
Total		42,375,409	15,884.714	7,243.4	12	88,224.4	111,364.51	249.929	84.1265	62.652
Per capita		976.14	0.37	0.17	0.0003	2.03	25,653.52			