Asian Infrastructure Investment Bank

Guangxi Beihai Lianzhou Bay Marine Ecological Restoration and Protection Project

Subproject 2: Blue Carbon Sink Actions

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT
and
ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Entrusted by: Beihai Urban Development and Investment Group Co., Ltd.

Prepared by: Guangxi Huachuan Environmental Protection Consulting Services Co., Ltd.
Guangxi Guoye Project Management Consulting Co. Ltd.

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1. Executive Summary

The Environmental and Social Impact Assessment (ESIA) report focuses on the mangrove restoration component, one of the five major subprojects under the Guangxi Beihai Lianzhou Bay Marine Ecological Restoration and Protection Project (the Project) financed by the Asian Infrastructure Investment Bank (AIIB), which has provided significant support and guidance. The core purpose of this ESIA is to ensure strict compliance with relevant Chinese regulations and to fully meet the requirements of the AIIB Environmental and Social Framework (ESF).

A. Brief project introduction

The Project, proposed by the Beihai Municipal Government of Guangxi Zhuang Autonomous Region to AIIB for financial and technical support, aims to restore the marine ecological environment of Lianzhou Bay. This initiative is based on the implementation of the national green and low-carbon development concept and the Blue Bay Remediation Action, with the goal of enhancing the ecological environment of Lianzhou Bay. In September 2022, the Project was enlisted in the plan of candidate projects in China of utilizing AIIB loans for 2022-2024. This component, Blue Carbon Sink Actions, is the Subproject 2 of the Project.

The total investment of this subproject is CNY 83.63 million financed by domestic counterpart funds. The construction is scheduled to commence in June 2024 and is expected to be completed by October 2024, with a total construction period of approximately 5 months.

The main construction content of this subproject is mangrove restoration, including:

(1) Mangrove restoration, covering an area of 442.49 h ㎡ (including 16.14 h ㎡ of mangrove afforestation). The restoration scheme including: (i) derris removal; (ii) replanting in empty areas; (iii) pest control measures; (iv) establishment of warning signs and patrol monitoring.

(2) Cleaning of spartina alterniflora covers an area of 229.04 h ㎡, utilizing both mechanical and manual methods for clearing.

(3) The implementation area is concentrated in Nanliujiang estuary and Lianzhou Bay area (excluding the Shankou area) . Among them, the mangrove restoration involv

es Shandong Village and Qixing Village in Shagang Town, and Mu'an Village, Yujiang Village, Shachong Village, Matou Village in Dangjiang Town, as well as Ma'an Village and Yanlou Village in Lianzhou Town.； The spartina alterniflora cleaning involves Qixing Village in Shagang Town and Mu'an Village, Shachong Village, and Yujiang Village in Dangjiang Town, all these places are located in Hepu County.

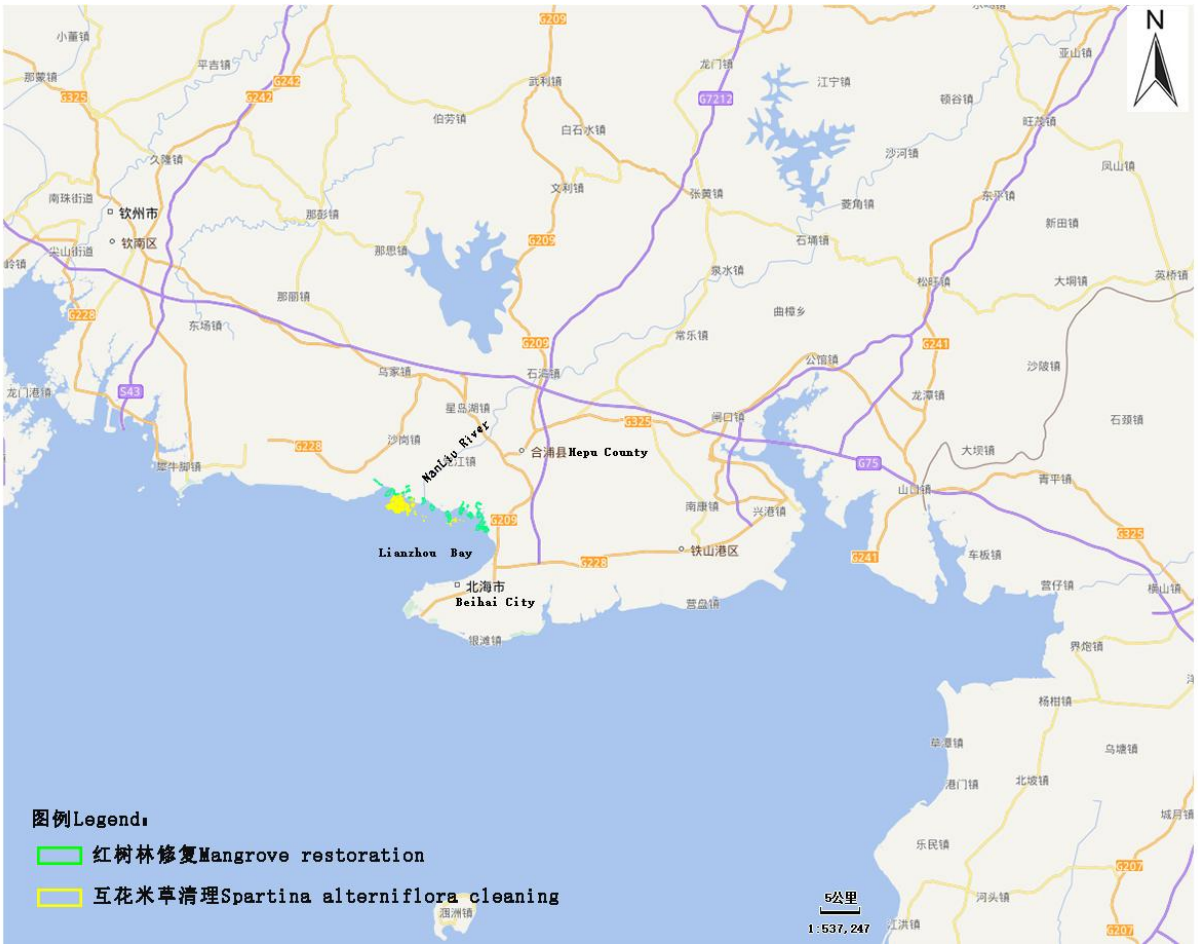


Figure 1 Location of the Subproject

B. Environmental and social risk categorization

According to the environmental and social policy requirements of the AIIB, the Project is classified as an Environment and Social Category “A” project. The policies of the AIIB's Environmental and Social Policy (ESP) applicable to this subproject are as follows:

(1) Environmental and social risks and impacts（ESS1）。 ESS1 is triggered because this subproject may bring about negative environmental and social impacts. This E

SIA is prepared in compliance with ESS1.

(2) Land acquisition and involuntary resettlement (ESS2). ESS2 is not triggered. This subproject involves mangrove afforestation and restoration in Naliujiang estuary a nd Lianzhou Bay area, without land acquisition and house demolition.

(3) Indigenous peoples (ESS3). ESS3 is not triggered. Based on the identification survey on the ethnic minorities, it was found that, in the construction implementation area, the population of the ethnic minorities is extremely low. It mainly consists of scattered minority ethnic populations who have migrated due to marriage or relocation, with no traditional territory of minority ethnic groups. There is no minority ethnic language or traditional culture, and there are no self-identified cohesive minority ethnic groups. So, the Ethnic Minority Development Plan (EMDP) is not required for the subproject.

C. Assessment methodology

The purpose of the ESIA is to evaluate the potential environmental and social impacts and risks of the proposed subproject, assess alternative options, and design appropriate mitigation, management, and monitoring measures to eliminate, offset, or reduce negative environmental and social impacts while enhancing and maximizing its positive benefits. In February 2023, Beihai Urban Development Investment Group Co., Ltd. engaged Guangxi Huachuan Environmental Protection Consulting Services Co., Ltd. and Guangxi Guoye Project Management Consulting Co., Ltd. (hereinafter referred to as the ESIA preparation unit) to undertake the environmental and social impact-related assessment work for the Project.

The ESIA activities are carried out as per the following procedures:

(1) Review relevant technical documents of the Project. Accordingly, carry out the preliminary engineering analysis, identifying key environmental and social impacts, and clearly defining assessment priorities and environmental and social protection objectives. The technical documents reviewed mainly include:

- AII's ESF (adopted in February 2016, revised in February 2019, May 2021, and November 2022).

- Technical Guidelines for Environmental Impact Assessment of Marine Engineering (GB/T 19485-2014)
- Feasibility Study Report of AIIB-financed Guangxi Beihai Lianzhou Bay Marine Ecological Restoration and Protection Project (Prepared by Shenzhen Water Planning and Design Institute, January 2024)
- Operation Plan for Spartina alterniflora Cleaning - Beihai Marine Ecological Protection and Restoration Project in 2024. (Prepared by Beihai Yisen Forestry Design Co., Ltd., April 2024)
- Operation Design for Mangrove Restoration - Beihai Marine Ecological Protection and Restoration Project in 2024. (Prepared by Beihai Yisen Forestry Design Co., Ltd., April 2024)

(2) Conduct site surveys. From March 2023 to December 2023, the EIA consultant conducted site surveys to objectively understand the site selection, site environment, environmental sensitive points, and impact factors of the proposed construction sites and surrounding sensitive areas.

(3) From February 2023 to April 2024, the social consultant conducted surveys on the socioeconomic status of the affected population in the project area, covering the aspects of demographic composition, employment situation, income levels, as well as the availability of infrastructure and public service facilities. In-depth field research, public participation, and negotiation were employed in the project implementation area.

(4) Conduct comprehensive assessment of environmental and social impacts. The ESIA preparation unit conducted an assessment of environmental and social impacts based on engineering analysis, workshops, and field research and in accordance with relevant domestic technical guidelines and assessment methods such as the Technical Guidelines for Environmental Impact Assessment of Marine Engineering (GB/T 19485-2014), as well as the requirements of the AIIB's ESF. Techniques such as analogy analysis and professional judgment were employed to analyze the extent of the project's impacts on the surrounding environment and society, and to propose environmental mitigation measures and recommendations. Based on this assessment, the ESIA and stakeholder engagement plan (SEP) for Subproject 2 of the Project (Blue Carbon Sink Actions) were prepared.

D. Major environmental and social baseline

Conclusion of environmental baseline survey

(1) Sea Water Quality

The water quality at stations W1 and W6 is classified as Inferior Category IV, with exceeded levels of reactive phosphate and inorganic nitrogen. Stations W3, W7, W8, and W9 all meet the requirements of Category III seawater quality standards as per marine functional zoning. Station W2 is classified as Category II, while station W4 is Category IV, and station W5 is Category II.

(2) Marine Sediments

Among the 10 monitoring stations, stations H2, H4, and H5 should maintain the current level of sediment quality. Among them, stations H2 and H5 have sediment quality currently exceeding Category III, while station H4 has sediment quality currently at Category II level. Stations H3 and H8 meet Category III sediment standards, with the exceeding factor of organic carbon. Stations H7 and H10 meet Category II sediment standards. Stations H1, H6, and H9 exceed Category III standards, with the exceeding factors being oil and organic carbon.

Station S2 has sediment quality currently at Category II level. Station S4 has sediment quality currently at Category I level.

Stations S20 and S21 meet the requirements of Category II sediment standards as per marine functional zoning.

(3) Mangrove communities

The mangrove community at the 10 monitoring stations is predominantly composed of early to mid-successional species such as aegiceras corniculatum and kandelia candel. Among them, aegiceras corniculatum, which thrives in low-salinity environment, is the most abundant species. However, the species composition is limited, lacking later successional species such as rhizophora stylosa and bruguiera, showing low species richness. Such indicates a lower stability of the mangrove ecosystem in Lianzhou Bay, making it more susceptible to environmental disturbances. The community type is simple, with four main types of communities: aegiceras corniculatum community, kandelia candel community, kandelia

candel - aegiceras corniculatum mixed community, and kandelia candel + auicennia marina community. There are numerous seedlings of aegiceras corniculatum and kandelia candel in the understory layer, indicating an upward trend in the populations of these species in the mangrove community of Lianzhou Bay, which shows a future tendency of mangrove community development. the aegiceras corniculatum and kandelia candel are expected to remain the dominant species in the mangrove community of Lianzhou Bay in the coming years, with little possibility of significant changes in species composition.

The outer shores of Lianzhou Bay are extensively distributed with Spartina alterniflora which has encroached upon some mangrove gaps. Additionally, the invasive species of sonneratia apetala is widely distributed in the mangrove area of Lianzhou Bay, with some mangroves on the inner shore being entangled with the derris. At station H2, the evidence of unauthorized use of the surrounding intertidal flats for establishing seedling nurseries was found.

(4) Benthic communities in the Lianzhou Bay mangrove forest

In terms of macrobenthic organisms, a total of 14 species across the 10 monitoring stations were found. Among them, the largest group belongs to the phylum arthropoda, with 7 species, dominated by paracleistostoma depressum, paralacydonia paradoxa, and Heteromastus filiforms. The average density of macrobenthic organisms is 19.31 19.31 ind./㎡, with an average biomass of 18.07 g/㎡. Among these, the average density of phylum arthropoda is 18.06 ind./㎡, with an average biomass of 6.81 g/㎡; the average density of mollusks is 4.00 ind./㎡, with an average biomass of 56.15 g/㎡; The abundance (d) ranges from 0.00 to 0.52, and the diversity index (H′) ranges from 0.00 to 1.99. There are relatively more crab burrows observed at station H1 in Gaode Ancient Town and station H4 in Dongwei foreshore. The macrobenthic organisms discovered in this survey are not classified as endangered or protected species.

(5) Atmospheric environment

The project area is classified as meeting air quality standards.

(6) Acoustic environment

In the urban area of Beihai City, the daytime environmental noise level complies with the Class II standard specified in the Technical Specifications for Environmental Noise

Monitoring/Conventional Monitoring of Urban Acoustic Environment (HJ64-2012). Additionally, daytime traffic noise on roads meets the Class I standard outlined in the same technical specifications. The compliance rate of noise monitoring points in urban functional areas of Beihai City during daytime is 97.7%, while the compliance rate during nighttime is 90.9%.

(7) Environmental sensitive targets and key protected objects

The Project covers Qixing Mangrove Conservation Area and Mu'an Mangrove Conservation Area in Hepu County, as well as the Dongwei Mangrove Conservation Area in Haicheng District. The main protected species include Aegiceras corniculatum, Kandelia obovata, Avicennia marina, and Acanthus ilicifolius etc. The mangrove restoration falls under the category of mangrove conservation measures and aligns with the conservation objectives of the mangrove conservation areas. The implementation of the Project complies with the relevant provisions of the Plan for Mangrove Resources Protection in Beihai City (2020-2030). According to the Environmental Impact Assessment Law of the People's Republic of China (revised in 2018) and the Management Directory of EIA Categories of Construction Projects (2021 Edition), the Project is required to submit an Environmental Impact Registration Form before commencement.

This Subproject is located within the important provincial-level wetland area of the Dangjiang Mangrove in Hepu County of Guangxi. The mangrove restoration is a measure to protect mangroves, and the project construction will not cause adverse environmental impacts on the mangrove wetlands.

Conclusion of social baseline survey

(1) Socio-economic profile of project area

The project area is located in the coastal areas of Haicheng District and Hepu County of Beihai City. In 2023, the regional GDP of Beihai City reached CNY 1750.91 billion, with a year-on-year growth of 5.8%, ranking 7th among the 14 cities in Guangxi at the intermediate level. The GDP of Haicheng District in 2023 was CNY 579.43 billion, with a year-on-year growth of 2.9%, ranking 1st among the administrative areas of Beihai City. The GDP of Hepu County in 2023 was CNY 371.93 billion, with a year-on-year growth of 6.2%, ranking 3rd among the administrative areas of Beihai City. The per-capita disposable income of urban and rural residents in Beihai City, Haicheng District, and Hepu County was CNY 43,539 , CNY 44,719, and CNY 42,548 respectively. The per-capita disposable income of rural residents in

Beihai City, Haicheng District, and Hepu County was CNY 20,936, CNY 22,472 , and CNY 20,679 respectively, all of which were higher than the average level in Guangxi. The urban-rural income ratio was 2.08:1, 1.99:1, and 2.06:1 respectively.

(2) Population structure profile in the project area

In terms of population size, by the end of 2022, the permanent population of Beihai City was 1.881 million, ranking 13th among the 14 cities in Guangxi in terms of population size. Meanwhile, the permanent population of Hepu County and Haicheng District in 2022 were 535,600 and 876,800 respectively, ranking first and second in Beihai City. The urbanization rate is moderate, with significant differences among various districts and counties. The urbanization rate of Beihai City is 59.37%, while that of Haicheng District and Hepu County are 98% and 38.09% respectively. In terms of population structure, there is a noticeable urban-rural difference in gender distribution. Gender balance is more evident in Haicheng District, while males constitute a higher proportion in Hepu County. The proportion of ethnic minority population is lower in Beihai City, and even more sparse in Hepu County and the villages directly affected by the project.

(3) Poverty and employment promotion in project area

In terms of social security, from 2019 to 2023, the social security system in Beihai City has been continuously improved, with the number of low-income security beneficiaries increasing annually. By the end of 2023, the number of urban and rural low-income security beneficiaries reached 14,333 and 41,244 respectively, with significant increases in both Haicheng District and Hepu County. At the same time, the number of people receiving subsidies for difficult and severely disabled individuals has also increased.

In terms of employment promotion, in 2023, Beihai City achieved significant results in employment, with urban new employment, reemployment of unemployed individuals, and employment of people facing difficulties in finding jobs all surpassing targets. There is a significant number of rural laborers working outside their hometowns, including those who have shaken off poverty, with a participation rate of 100% in social security schemes. Haicheng District and Hepu County have also made positive progress in employment.

(3) Profile of representative communities / villages in project area

This subproject involves communities and villages in Dangjiang Town, Shagang Town,

and Lianzhou Town of Hepu County, Beihai City. The social consultants selected five directly affected villages as samples to conduct interviews and observations, with the following findings:

The areas affected by the subproject mainly consist of coastal villages and communities, with an average cultivated land area per-capita ranging from 1 to 1.2 mu (about 0.07 to 0.08 ha.), and the relationship between people and land is relatively tense. Residents' livelihoods mainly rely on the sea, with a predominant characteristic of "relying on the sea for sustenance." The main occupations include shallow-sea fishing, shallow-sea aquaculture, and out-of-town labor work and doing business. The economic development level is relatively high locally. From the observations in the villages, the majority of the villagers' residences are brick-and-concrete structure one-storied house or two to four-storied standalone buildings. The general living environment in the villages is relatively good, with convenient transportation and basic public services available.

(4) Economic and social conditions of the representative village households in the project area

The social consultants conducted household surveys with the assistance of village committees, collecting a total of 114 valid questionnaires. The results indicate: (i) the average household size is 4.1 people; (ii) the age group of 36-60 years old is the largest, followed by 17-35 years old, together accounting for 64.32%; (iii) the majority of individuals have attained education up to middle school level, followed by those with primary school education or below, totaling 67.09%; (iv) Outgoing work is the mainstream, surpassing agricultural participation; (v) the average annual per-capita income is CNY 13,459 , with the majority coming from out-going-work (56%), averaging CNY 7,536 per person; (vi) the average annual expenditure per person is CNY 7,355, primarily used for daily living and education; (vii) mobile phones, motorcycles, electric bikes, and air conditioners are relatively common; (viii) the government and village committees actively focus on and assist vulnerable groups in getting jobs.

E. Major environmental impacts and mitigation measures

The environmental impacts and the proposed mitigation measures are as the follows:

(1) Conclusions of the EIA and mitigation measures during construction period.

(i) Hydrodynamic environment.

The component of mangrove restoration belongs to marine use which does not alter the natural attributes of the sea. The construction mainly takes place on intertidal flats after the ebb tide, and the construction process has minimal impact on hydrodynamic conditions. Use of sea area for planting and restoring mangroves will not cause significant changes in wave dynamics. Therefore, the mangrove planting and restoration projects has minimal impact on the hydrodynamic environment and tidal flow field in the area.

(ii) Topography and sedimentation environment.

The mangrove planting and restoration have minimal impact on the topography, geomorphology, and sedimentation environment of the sea area.

(iii) Marine water quality environment.

The construction will be carried out on the inter-tidal flats during low tide, minimizing the production of suspended solids. In the rising tide, a small amount of suspended solids may gradually spread along the edge of the embankment, but with limited negative impacts.

The domestic sewage from workers camp is treated in septic tanks of the rented houses, which will be used for irrigation in the surrounding woodland areas, without direct discharge into the water body, resulting in minimal impact on the nearby marine environment.

(iv) Marine sediment environment.

The mangrove restoration is an ecological rehabilitation process, which can gradually alleviate the degree of sediment siltation, thus benefiting the sediment environment in the region.

(v) Marine ecological environment and marine biology.

Since the construction will be carried out on the inter-tidal flats during low tide, and the open-cutting construction will produced limited suspended solids. During the rising tide, a small amount of suspended solids will slowly disperse at the edge of the deposited soil, showing limited range of being impacted. The increase in suspended solids has minimal effects on the planktonic flora and fauna, fish, and intertidal biotic communities in the surrounding water bodies. In the long term, the removal of spartina alterniflora in this subproject is beneficial to benthic organisms.

(vi) Construction waste gas.

The impact of this subproject on the atmospheric environment mainly manifests in the transportation dust generated during the construction process and the exhaust emissions from construction machinery, transport vehicles, and ships. After implementing measures such as strengthening road watering and cleaning, washing transport vehicles before entering and leaving the site, and enhancing maintenance of construction equipment, vehicles, and ships, the impact of construction waste gas can be effectively controlled.

(vii) Construction noise impact analysis.

The operation of transport vehicles, construction machinery, and ships will generate certain noise pollution. After implementing measures such as scheduling construction activities at appropriate times, enhancing equipment maintenance, and managing transport vehicles and ships, the impact of construction noise on the surrounding environment is minimal.

(viii) Solid waste impact analysis.

The manually harvested stems of spartina alterniflora are transferred to mechanical cleaning areas for deep burial. The collected derris and domestic waste generated by construction workers are centrally collected and transported by the contractor to nearby town waste transfer stations. During the construction period, the solid waste is effectively handled, resulting in minimal impact on the surrounding environment, and the impact ceases at the end of the construction period.

(2) Conclusions of the environmental impact analysis and mitigation measures during operation period.

The subproject is an ecological restoration activity, and its implementation has a positive impact on the regional ecological environment. During the operational period, the environmental impact is minimal. In order to improve the survival rate of the mangroves, relevant measures have been designed, mainly focusing on strengthening the management and maintenance of the mangroves.

G. Major social impacts and mitigation measures

This Subproject has no land occupation. The construction processes such as mangrove restoration and removal of the spartina alterniflora do not entail permanent land acquisition or temporary occupation. The spartina alterniflora stems cleared are manually transferred to the mechanical cleaning area for burial, without adding new land occupation. The construction camp will use existing houses of the villagers nearby the construction area, without requiring additional land occupation.

Based on demand perception of stakeholders and risk identification, an analysis of the positive social impacts and social risks of the subproject were carried out, with the results indicated in the the follows:

The positive social impacts of the subproject include:

(1) Abundant employment opportunities: The construction of this subproject will provide surrounding villagers with temporary and low-skilled employment opportunities during the construction period, including positions such as forestry workers, cleaners, logistics personnel, transportation, catering support, as well as forest rangers during the operational period.

(2) Social benefits: Improving the ecological environment, increasing residents' income; driving the development of related industries such as tourism; enhancing public awareness of environmental protection and scientific literacy.

The social risks of the project implementation mainly include:

(1) Impacts on the existing livelihoods

The construction process and subsequent operation of mangrove restoration have to some extent impacted the livelihoods of residents in nearby villages, especially affecting vulnerable groups such as the elderly, women, and people with disabilities who rely on traditional activities like digging for mud worm and coastal fishing. This impact is particularly evident in the convenience of engaging in these livelihood activities. [①]

(2) Occupational health risks

Risks associated with afforestation and restoration projects include: working environment risks.(i) During construction, the hot and humid environment may lead to

[①] After the mangrove forest is designated as a protected area, according to the relevant provisions of the Guangxi Mangrove Resource Protection Regulations, activities such as mooring of vessels, fishing, placing nets and traps, digging for mud worms and sandworms, harvesting mangrove propagules, encroaching on intertidal flats, dumping garbage, discharging sewage, illegal aquaculture, and releasing harmful substances are prohibited within the mangrove protection zone. The existing nearshore livelihood activities must either pass through the mangrove protection zone or be relocated to other areas.

heatstroke among construction workers, fatigue-induced accidents such as getting stuck in mud or drowning; machinery operation risks; .(ii) During construction, the use of heavy machinery such as excavators and forklifts may result in personal injuries if operated improperly or if equipment malfunctions; insect and animal infestations.(iii) The construction area may be inhabited by mosquitoes, snakes, and other wildlife, posing potential threats to the health of construction workers.

(3) Community security risks.

(i) Tense relationship with the community. The influx of workers may lead to cultural conflicts and integration issues with local residents; there is also a risk of spreading infectious diseases. (ii) Increased interaction between migrant workers and local residents can lead to the transmission of infectious or communicable diseases; there is also a risk of traffic accidents; (iii) During construction operations, the movement of transportation and machinery vehicles may damage existing roads in the community and pose a risk of traffic accidents in villages due to the lack of proper traffic signs.

(4) Labor-management relations and employment risks.

(i) Labor contract disputes. If labor contracts are signed improperly or contain ambiguous terms, it may lead to disputes between employees and employers; Wage arrears. (ii) Due to issues with cash flow or poor management, employers may face difficulties in paying employees' wages on time; Legality of employment risks. (iii) During the construction period, there may be a shortage of local labor, leading to issues such as hiring child labor, gender discrimination, forced labor, and other illegal employment practices.

In response to the identified major social impacts, corresponding mitigation measures have been formulated: (i) providing health and safety protective equipment for labor protection; (ii) strengthening safety education and training for workers; (iii) Enhancing supervision at construction sites; (iv) Improving coordination and communication to reduce the disruptive impact of an influx of workers on local residents and society; (v) regulating traffic management to reduce traffic safety risks; (vi) labor management; (vii) environmental and social management plans, social gender action plans.

H. Implementation arrangement

Beihai Urban Development and Investment Group Co., Ltd. is responsible for coo rdinating and promoting this subproject comprehensively. The overall responsibilities sh all include: (i) designate an environmental and social coordinator for each contract to oversee the implementation and coordination of environmental and social management plans; (ii) ensure that environmental and social management plans, monitoring schemes, and mitigation measures are incorporated into tender documents and construction cont racts; (iii) manage the Grievances Redressing Mechanism (GRM); (iv) handle any unfo reseen adverse impacts promptly and report them to the AIIB in a timely manner; (v) engage qualified external environmental and social monitoring agencies.

Beihai Urban Development Investment Group Co., Ltd. is required to regularly report on the implementation of the project's environmental and social management plan. The environmental and social monitoring report shall be submitted on semi-annual basis.

I. Stakeholder engagement

The social impact assessment of the subproject targets the primary and secondary stakeholders. Primary stakeholders include direct beneficiaries within the scope of the subproject and groups adversely affected by the project construction. To gain deeper insights into the attitudes and willingness to participate in the project among these primary stakeholders, the social consultants organized two town and village cadres consultative meetings. One meeting was organized by the Shagan Town Government of Hepu County, with six main village cadres participating. The other was organized by the Dangjiang Town Government of Hepu County, with nine main village cadres from villages such as Shachong village and Yujiang village. The participants to these meetings also included two relevant personnel from the mangrove conservation area and the mangrove conservation station. In addition, the social consultants conducted household interviews and supplemented with phone interviews in Qixing Village of Shagan Town, Shachong, Yujiang, Muan, Matou villages of Dajiang Town, , Yanlou, as well as Yanlou, Ma'an villages of Lianzhou Town, with a total of 17 villagers interviewed, including 7 women, 3 persons with disabilities, and 2 households under poverty monitoring.

Secondary stakeholders include Beihai Urban Development Investment Group Co., Ltd., Hepu Oceanic Bureau, Bureau of Natural Resources and Planning, Comprehensive Law Enforcement Bureau, Transportation Bureau, Emergency Management Bureau, Health and Health Committee, Human Resources and Social Security Bureau, Disabled Persons' Federation, Women's Federation, town governments, as well as design institute, supervision unit, contractors, media etc. Meanwhile, particular attention was paid to the situation of vulnerable groups and women in livelihood development and public participation.

During the preparatory stage of the subproject, the Guangxi Zhuang Autonomous Region Government published the project identification information on the government website in September 2022. The Beihai Municipal Government released progress information regarding inspections by secondary stakeholders such as AIIB, Guangxi Development and Reform Commission, and the Beihai Municipal Development and Reform Commission on the city government's website in November 2022. In July 2023, the Beihai Municipal Government website issued a public notice about the project's social stability risk survey conducted by an independent agency engaged by the IA. All of these activities aimed to provide the public with information about the subproject. The ESIA preparation unit conducted informed consultations and public participation activities such as institutional interviews, field surveys, focus group discussions, key informant interviews, and questionnaire surveys from February 2023 to April 2024. During these activities, the ESIA preparation unit strictly followed the public participation process to introduce the construction contents, including its environmental and social impacts, the purpose of public participation, and information about the AIIB's requirements regarding public participation and its environmental and social policies.

The identified stakeholders' demands mainly include: (i) the need for villagers to increase employment opportunities and income; (ii) residents' demand for reducing noise pollution; (iii) the need for stakeholders to be informed about project information disclosure; and (iv) the stakeholders' demand to participate in project activities.

Based on questionnaire surveys, focus group discussions, in-depth interviews, and interviews with key informants, an information disclosure and stakeholder engagement plan for this subproject was developed through participatory observation.

J. Grievances redressing mechanism

Throughout the preparation, construction and operation stages of the subproject, in order to promptly understand and address the impacts and issues brought to stakeholders by the subproject, and to ensure residents' demand for information disclosure and broad community participation as much as possible, a project-level grievances redressing mechanism will be established, taking into account the current situation of residents' complaints in the project area. All complaint records and resolutions arising from them will be documented and reported to the AIIB through the semi-annual environmental and social monitoring report.

The GRM mainly includes:

(i) a project-level grievance redressing mechanism, providing a channel for affected residents, social groups, and entities operating in the project area to file complaints during project implementation and operation;

(ii) a worker-level grievance redressing mechanism, including direct workers, contract workers, and project staff, providing a channel for them to lodge complaints.

In addition, the AIIB has established a Project-affected People Mechanism (PPM). When project-affected people believe that AIIB projects have failed to implement their Environmental and Social Policy (ESP) and may or have adversely affected them, and their concerns cannot be satisfactorily resolved through the project's GRM or AIIB management mechanisms, the PPM provides an independent and impartial review opportunity. PPM-related information can be accessed on the following link: https://www.aiib.org/en/policies-strategies/operational-policies/policy-on-the-project-affected-mechanism.html。

2. Introduction

2.1 Background for assessment

The construction content of the AIIB financed Guangxi Beihai Lianzhou Bay Marine Ecological Restoration and Protection Project includes 5 subprojects, respectively coastal water pollution control and environmental improvement, blue carbon sink actions, coastal zone comprehensive improvement, marine safety and environmental monitoring construction, capacity building, and project management support. According to AIIB's policies, the ESP of the Project is categorized as Category A. . To enhance the project's benefits and ensure avoidance, minimization, mitigation, or compensation for adverse impacts on the physical, biological, and human environment associated with the construction and operation stages of the project, and to comply with the requirements of China and the AIIB in environmental and social assessment and management, an environmental and social impact assessment of the Project is required. This report focuses on the environmental and social impact assessment of Subproject 2, Blue Carbon Sink Actions, due to the advanced procurement planning for this subproject.

2.2 Objectives of environmental assessment

The ESIA is to evaluate the potential environmental and social impacts and risks of the proposed subproject, assess alternative options, and design appropriate mitigation, management, and monitoring measures to eliminate, offset, or reduce negative environmental and social impacts while enhancing and maximizing its positive benefits.

2.3 Principles, methodology and process of project assessment

2.3.1 Principles

The EIA must adhere to the principles of sustainable development, ensuring they are scientific, fair, and practical, serving environmental and social decision-making and management. The principles to follow include:

(i) Principle of sustainable development: Commitment to promoting sustainable development, ensuring that investment projects have a positive impact on the environment and society, and complying with relevant environmental and social regulations and

international standards;

(ii) Problem-oriented principle: Comprehensive assessment of potential environmental and social issues associated with the project, proposing appropriate management and mitigation measures to reduce negative impacts and promote positive ones;

(iii) Participatory principle: Extensive cooperation and communication with stakeholders, including primary and secondary stakeholders such as local community residents, relevant government agencies, and other stakeholders, to ensure their voices are heard and included in the assessment process;

(iv) Prevention principle: Taking preventive measures to ensure effective management and control of environmental and social risks during project implementation, detecting and addressing potential issues early.

(v) Transparency principle: Providing sufficient information during the assessment process, disclosing relevant environmental and social information to stakeholders, and engaging in open and transparent communication with them.

(vi) Continuous improvement principle: Continuously improving assessment methods and practices, learning from international best practices, and making continuous improvements based on feedback and lessons learned.

2.3.2 Assessment methodology

The purpose of the ESIA is to evaluate the potential environmental and social impacts and risks of the proposed subproject, assess alternative options, and design appropriate mitigation, management, and monitoring measures to eliminate, offset, or reduce negative environmental and social impacts while enhancing and maximizing its positive benefits.

According to the environmental and social policy requirements of the AIIB, the Project is classified as an Environment and Social Category “A” project, and so an ESIA is required. In February 2023, Beihai Urban Development Investment Group Co., Ltd. engaged Guangxi Huachuan Environmental Protection Consulting Services Co., Ltd. and Guangxi Guoye Project Management Consulting Co., Ltd. (hereinafter referred to as the ESIA preparation unit) to undertake the environmental and social impact-related assessment work for the Project.

The EIA for the Project is based on relevant domestic technical guidelines and evaluation methods such as the "Technical Guidelines for Environmental Impact Assessment of Marine Engineering" (GB/T 19485-2014), as well as the requirements outlined in the AIIB's ESF. Taking into account the engineering characteristics of this subproject and the environmental

features of the coastal area, the assessment is guided by principles of scientific rigor and practicality. Methods such as analogy analysis and professional judgment are employed to analyze the feasibility of pollutant emissions standards and the extent of their impact on the surrounding environment. Based on these analyses, environmental mitigation measures and recommendations are proposed. The social assessment methodology of this subproject primarily follows the guidance provided by the AIIB's ESP, as well as experiences gained from similar projects in China. The main components of the report analysis involve gathering economic and social data through online questionnaire surveys and field surveys, supplemented by data provided by relevant departments.

The ESIA activities are carried out as per the following procedures:

(1) Review relevant technical documents of the Project. Accordingly, carry out the preliminary engineering analysis, identifying key environmental and social impacts, and clearly defining assessment priorities and environmental and social protection objectives. The technical documents reviewed mainly include:

- AII’s ESF (adopted in February 2016, revised in February 2019, May 2021, and November 2022).
- Technical Guidelines for Environmental Impact Assessment of Marine Engineering (GB/T 19485-2014)
- Feasibility Study Report of AIIB-financed Guangxi Beihai Lianzhou Bay Marine Ecological Restoration and Protection Project (Prepared by Shenzhen Water Planning and Design Institute, January 2024)
- Operation Plan for Spartina alterniflora Cleaning - Beihai Marine Ecological Protection and Restoration Project in 2024. (Prepared by Beihai Yisen Forestry Design Co., Ltd., April 2024).
- Operation Design for Mangrove Restoration - Beihai Marine Ecological Protection and Restoration Project in 2024.(Prepared by Beihai Yisen Forestry Design Co., Ltd., April 2024)

(2) Conduct site surveys. From March 2023 to December 2023, the EIA consultant conducted site surveys to objectively understand the site selection, site environment, environmental sensitive points, and impact factors of the proposed construction sites and surrounding sensitive areas.

(3) From February 2023 to April 2024, the social consultant conducted surveys on the socioeconomic status of the affected population in the project area, covering the aspects of demographic composition, employment situation, income levels, as well as the availability of infrastructure and public service facilities. In-depth field research, public participation, and negotiation were employed in the project implementation area. Focus group discussions with stakeholders were organized, inviting local residents, women representatives, and others to engage in in-depth discussions and exchanges regarding the potential impacts of the subproject. This facilitated a better understanding of their needs, concerns, expectations, as well as their attitudes and opinions towards the project construction. Additionally, face-to-face meetings were held with key departments such as the local government, women's federations, and civil affairs bureaus to directly communicate and negotiate on critical issues during project implementation.

(4) Conduct comprehensive assessment of environmental and social impacts. The ESIA preparation unit conducted an assessment of environmental and social impacts based on engineering analysis, workshops, and field research and in accordance with relevant domestic technical guidelines and assessment methods such as the Technical Guidelines for Environmental Impact Assessment of Marine Engineering (GB/T 19485-2014), as well as the requirements of the AIIB's ESF. Techniques such as analogy analysis and professional judgment were employed to analyze the extent of the project's impacts on the surrounding environment and society, and to propose environmental mitigation measures and recommendations. Based on this assessment, the initial draft of ESIA and SEP for Subproject 2 of the Project (Blue Carbon Sink Actions) were prepared.

2.3.3 Structure of the report

The structure of this report includes:

Chapter 1 Executive summary: a general summary of all aspects of the project.

Chapter 2 Introduction: Objectives, principles, process, methodology and report structure.

Chapter 3 Analysis of legal and administrative frameworks and gaps: elaborate the AIIB’s ESS1, and assess how they are applicable in the context of the proposed subproject. Introduce the gaps between the standards of AIIB and Chinese legislation, explore the

disparities between the two sources of requirements, and explain how environmental assessments bridge these gaps.

Chapter Four Engineering analysis: Describe the project background, construction content, and engineering design.

Chapter Five Alternative analysis: Analyze potential alternative solutions from environmental and social perspectives.

Chapter Six Associated facilities analysis.

Chapter Seven Environmental and social baseline analysis: Introduce the relevant geographical, ecological, and socio-economic environments of the project area.

Chapters Eight / Nine Environmental and social impact analysis and mitigation measures: Introduce the assessment of the impact on the physical, biological, socio-economic environment, and climate during the design, construction, and operation stages, and detail the measures to avoid, minimize, mitigate, and/or compensate for environmental impacts.

Chapter Ten Environmental and social management plan: Organizational setup, mitigation plans, internal and external monitoring arrangements, capacity building requirements, implementation costs of environmental management plans, etc.

Chapter Eleven Stakeholder consultation and information disclosure.

Chapter Twelve Grievance Redressing Mechanism.

3. Legal and administrative framework and gap analysis

3.1 Domestic legal, regulatory and policy framework related to environmental and social aspects

3.1.1 Domestic legal, regulatory and policy framework related to environment

3.1. 1.1 National environmental protection laws, regulations, and departmental rules

(1) Environment Protection Law of the People's Republic of China (revised in 2014);

(2) Ocean Environment Protection Law of the People's Republic of China (revised in 2017);

(3) The Environment Impact Assessment Law of the People's Republic of China (revised in 2018);

(4) Law of Management of Sea Areas of the People's Republic of China (2002));

(5) Fisheries Law of the People's Republic of China (revised in 2013);

(6) Law of the People's Republic of China on Protection of Wildlife, (revised in 2018);

(7) Law of the People's Republic of China on Water Pollution Prevention and Control (June 27, 2017);

(8) Air Pollution Prevention Law of the People's Republic of China (revised and promulgated on October 26, 2018);

(9) Law of the People's Republic of China on Prevention of Noise Pollution (promulgated on June 05, 2022);

(10) Law of the People's Republic of China on Prevention of Environmental Pollution Caused by Solid Waste (revised on April 29, 2020) ;

(11) Soil Pollution Prevention Law of the People's Republic of China (promulgated on January 1, 2019) ;

(12) Law of the People's Republic of China for Conservation of Water and Soil (revised in 2011);

(13) Flood Control Law of the People's Republic of China (revised in 2015);

(14) Regulations on Environmental Protection Administration of Construction Projects (promulgated on October 01, 2017, No. 682 Decree of the State Council);

(14) Regulations for the Implementation of the Land Administration Law of the People's Republic of China (No. 743 Decree of the State Council)

(16) Regulations for the Implementation of the Soil Conservation Law of the People's Republic of China (No. 120 Decree of the State Council, revised on January 8, 2011)

(17) Management Directory of EIA Categories of Construction Projects (promulgated on January 1, 2021, Decree No.16, Ministry of Ecology and Environment);

(18) Guideline on Public Participation in EIA (Decree No.16, Ministry of Ecology and Environment, promulgated on January 1, 2021);

(19) "14th Five-Year Plan" for Soil, Groundwater, and Rural Ecological Environment Protection (HTR[2021]120);

(20) Regulations on the Prevention of Pollution Damage to the Marine Environment by Marine Construction Projects (Decree No. 698 of the State Council, 2nd revision on March 19, 2018);

(21) Ocean Environment Management Regulation of the People's Republic of China (revised in 2018); Regulations of the People's Republic of China on Prevention and Control of Pollution Damage to Marine Environment from Coastal Engineering Construction Projects (revised in 2018);

(22) Regulations on the Prevention and Control of Pollution from Ships to the Marine Environment (Decree No. 698 of the State Council, 6th revision on March 19, 2018);

(23) Regulations of the People's Republic of China on the Prevention and Control of Pollution to the Marine Environment by Ships and Relevant Operations (Decree No. 15, 2017, Ministry of Transport)

(24) Regulations on the Management of Sealed Pollution Control Equipment for Ships in Coastal Waters (JHF[2007]9);

(25) Action Plan for the Conservation of Aquatic Biological Resources in China (GHF[2006]9);

（ 26 ） Notice on Further Strengthening Environmental Impact Assessment Management and Preventing Environmental Risks (HF [2012]77);

(27) Notice on Strengthening Risk Prevention and Strict Management of Environmental Impact Assessment (HF [2012]98);

(28) Notice on Further Strengthening the Protection of Aquatic Biological Resources and Strict Management of Environmental Impact Assessment (Jointly issued by the Ministry of Environmental Protection and the Ministry of Agriculture, HF [2013]86);

(29) Notice on Strengthening the Management of Ecological Protection Red Lines (Jointly issued by the Ministry of Natural Resources, Ministry of Ecology and Environment, and State Forestry and Grassland Administration (Trial) (ZRZF[2022]142);

(30) Notice on Further Clarifying Matters Related to the Protection and Compensation of Aquatic Biological Resources in Fishery-related Projects (issued by the General Office of the Ministry of Agriculture and Rural Affairs, NBY[2018]50);

(31) Directory of Wild Animals of National Priority Protection (2019);

(32) Guiding Catalogue for Industrial Restructuring (2024);

(33) Notice on Strengthening the Management of Environmental Impact Assessment for Projects Financed by International Financial Institutions (HJ[1993]324);

(34) Notice on Further Strengthening the Management of Projects Financed by International Financial Organizations (Issued by the National Development and Reform Commission, FGWZ[2008]1269);

3.1.1.2 Local environmental protection laws, regulations, rules, and normative documents

(1) Circular of General Office of the People's Government of Guangxi Zhuang Autonomous Region on Issuing the Management Measures for Environmental Access of Construction Projects in Guangxi (GZBF[2012]103);

(2) Environment Protection Code of Guangxi Zhuang Autonomous Region (revised on July 25, 2019);

(3) Water Pollution Prevention Code of Guangxi Zhuang Autonomous Region (Effective on May 1, 2020);

(4) Drinking Water Source Protection Code of Guangxi Zhuang Autonomous Region (effective on May 1, 2017);

(5) Solid Waste Pollution Prevention and Control Code of Guangxi Zhuang Autonomous Region (effective on July 1, 2022);

(6) Positive List for Ecological Protection in Guangxi Zhuang Autonomous Region (2022);

(7) Prohibited List for Ecological Protection in Guangxi Zhuang Autonomous Region (2022);

(8) Soil Pollution Prevention Code of Guangxi Zhuang Autonomous Region (effective on September 1, 2021);

(9) Opinions of the People's Government of Beihai City on Implementing the Ecological Environment Zoning Control of "Three Lines and One List" (BZF[2021]8);

Management Measures for Shankou Mangrove Ecological Nature Reserves and Beilun River Estuary National Nature Reserves in Guangxi (Decree No.139 of the People's Government of Guangxi Zhuang Autonomous Region)

3.1.1.3 Environment impact assessment technology guidelines

(1) Technical Guidelines for Environmental Impact Assessment of Marine Engineering (GB/T 19485-2014);

(2) Technical Guidelines on EIA: General Principles (HJ 2.1-2016);

(3) Technical Guidelines on EIA: Surface Water Environment (HJ 2.3-2018);

(4) Technical Guidelines on EIA: Atmospheric Environment (HJ 2.2- 2008);

(5) Technical Guidelines on EIA: Acoustic environment (HJ 2.4-2021);

(6) Technical Guidelines on EIA: Ground Water Environment (HJ 610-2016);

(7) Technical Guidelines on EIA: Ecological Impacts (HJ 19- 2022);

(8) Technical Guidelines on Assessment of Environmental Risks of Development Projects (HJ/T 1692018);

(9) Technical Specifications for Environmental Monitoring in Nearshore Waters - Part 1: General Principles"（HJ 442.1-2020）;

(10) Technical Specification for the Impact Assessment of Construction Projects on Marine Biological Resources (SCT 9110-2007)

(11) Technical Specification for the Marine Environmental Monitoring and Tracking of Construction Projects" (State Oceanic Administration, 2002-04)

(12) Specifications for Ocean Monitoring (GB 17378.1~7-2007);

(13) Specifications for Marine Surveys (GB/T 12763.1 ~ 11 - 2007);

(14) Technical Guidelines for Marine Ecological Restoration (Trial) (July 2021);

(15) Technical Guidelines for Mangrove Vegetation Restoration (HY/T 214-2017);

(16) Technical Specification for Mangrove Construction (LY/T 1938-2011).

3.1. 1.4 Environmental quality and pollutants discharge standards

Based on the characteristics and nature of the subproject, the environmental assessment will conduct comparative analysis of applicable domestic environmental quality and pollutant emission standards, as well as relevant requirements in the AIIB's ESF, for which, the stricter standards will be used as the basis for monitoring and evaluation.

1. Environmental quality standards

(1) Sea Water Quality Standards (GB 3097-1997);

(2) Quality of Marine Sediments (GB 18668-2002);

(3) Ambient Air Quality Standards (GB 3095-2012);

(4) Environmental Quality Standards for Noise (GB 3096-2008).

2. Pollutant discharge standards

(1) Integrated Emission Standards of Air Pollutants (GB 16297 - 1996);

(2) Emission Standards for Noise of Construction Site at Boundary （GB 12523-2011）;

(3) Standards for General Industrial Solid Waste Storage and Landfill Pollution Control (GB 18599-2020)

3.1.1.5 Relevant planning and references

(1) Comprehensive Plan for Air Quality Improvement during the 14th Five-Year Plan in Guangxi Zhuang Autonomous Region (GHF [2022] No. 27);

(2) 14th Five-Year Plan for High-quality Development of Marine Ecological Environment Protection in Guangxi Zhuang Autonomous Region;

(3) Functional Zoning of Water Bodies in Guangxi Zhuang Autonomous Region (GZH [2002] No. 239);

(4) Functional Zoning of Marine Areas in Guangxi Zhuang Autonomous Region (2011-2020);

(5) Adjustment Plan for Functional Zoning of Coastal Waters in Guangxi Zhuang Autonomous Region (GHF [2023] No. 9);

(6) Plan for the Delineation of Marine Ecological Red Lines in Guangxi;

(7) The 14th Five-Year Plan for Ecological Environment Protection of Beihai City;

(8) Plan for Aquaculture Waters and Tidal Flats in Beihai City (2018-2030);

9) Plan for Protection of Mangrove Resources in Beihai City (2020-2030);

(10) Master Plan for Land and Space in Beihai City (2021-2035)

(11) Feasibility Study Report of AIIB-financed Guangxi Beihai Lianzhou Bay Marine Ecological Restoration and Protection Project (Prepared by Shenzhen Water Planning and Design Institute, January 2024)；

(12) Operation Plan for Spartina alterniflora Cleaning - Beihai Marine Ecological Protection and Restoration Project in 2024. (Prepared by Beihai Yisen Forestry Design Co., Ltd., April 2024).；

(13) Operation Plan for Mangrove Restoration - Beihai Marine Ecological Protection and Restoration Project in 2024. (Prepared by Beihai Yisen Forestry Design Co., Ltd., April 2024)..

3.1.2 Domestic legal, regulatory and policy framework related to social aspects

The main relevant social laws and regulations applicable to the Project are as follows:

Table 1 Applicable Social Laws and Regulations

Social risks	**Laws and policies**	**Date of effectiveness**
National	Opinions on Strengthening the Development of Mechanisms for Social Stability Risks Assessment for Major Decision-Making Under New Circumstances (ZFB[2021] No. 11)	March, 2021.
	Provisional Methods of the National Development and Reform Commission for Risk Assessment of Social Stability of Fixed Asset Investment Projects (FGTZ[2012]2492);	August 16, 2012.
	Notice of the National Development and Reform Commission on Social Stability Analysis and Compilation of Terms of References of Assessment Report for Key Fixed Assets Investment Projects (Provisional)（FGBTZ[2013]428）	February 17, 2013.
	The Interim Measures for Major Administrative Decision-Making Procedures (Decree No. 713, State Council)	September 01, 2019.
Local	Provisional Methods of Guangxi Development and Reform Commission for Risk Assessment of Social Stability of Fixed Asset Investment Projects" (GFGTZ[2013]833);	July 09, 2013.
Labors management	**Laws and policies**	**Date of effectiveness**
National	Labor Law of the People's Republic of China (revised in 2018);	December 29, 2018.
	Labor Contracts Law of the People's Republic of China (revised in 2012);	September 01, 2021.
	Regulations on Labor Supervision and Inspection (Decree No. 423, State Council) (2004)	December 01, 2004.
	Trade Union Law of People's Republic of China (revised in 2021)	January 01, 2022.
	Law of the People's Republic of China on Prevention and Control of Occupational Diseases (revised in 2018)	December 29, 2018.
	Law of the People's Republic of China on the Protection of Women's Rights and Interests（revised in 2018)	October 26, 2018.
	Special Provisions on Labor Protection for Female Workers (Decree No.619, State Council) (2012)	April 18, 2018.
Local	Notice of the People's Government of Guangxi Zhuang Autonomous Region on Further Implementing the Regulations on Work-related Injury Insurance to Enhance Work-related Injury Insurance Work GZF〔 2018〕 62	January 01, 2019.
	Opinions on Further Strengthening the Prevention and Multi-party Mediation of Labor and Personnel Disputes (Jointly issued by nine departments / divisions including Department of Human Resources and Social Security of Guangxi Zhuang Autonomous Region)	January 29, 2023.
Information disclosur	**Laws and policies**	**Date of effectiveness**

e and public participation		
National	Methods on Public Participation for Environmental Impact Assessment (2018)	January 01, 2019.
	Opinions of the General Office of the State Council on Promoting Government Information Disclosure in the Approval and Implementation of Major Construction Projects (GFB[2017]94)	December 04, 2017.
	Opinions of the General Office of the State Council on Promoting Government Information Disclosure in the Field of Public Resources Allocation (GFB[2017]97)	December 19, 2017.
	Notice of the General Office of the CPC Central Committee and the General Office of the State Council on Issuing the "Opinions on Comprehensive Advancement of Government Information Disclosure"	February 17, 2016.
Local	Notice of the General Office of CCP and the General Office of the People's Government of Guangxi Zhuang Autonomous Region on the Issuance of the Implementation Rules for the Responsibility System for Handling Petitions	July 01, 2017.
Others	**Name of documents**	
	Beihai Municipal Government Work Report (2020-2022)	
	Beihai City Tourism, Culture, Sports, Radio, and Television Development 14th Five-Year Plan	
	Beihai Haicheng District Social and Economic Development Bulletin (2020-2022)	
	Hepu County Social and Economic Development Bulletin (2020-2022)	
	Beihai Women's Development Plan (2021-2030)	
	Beihai Children's Development Plan (2021-2030)	

3.2 Applicability analysis of the AIIB environmental and social standard

The key elements of the AIIB's ESF applicable to this subproject include:

(1) Environmental and Social Policy (ESP)

Environmental and Social Standards (ESSs) and the exclusion list. The ESP sets forth mandatory requirements for the identification, assessment, and management of environmental and social risks and impacts related to the bank and its clients and projects supported by the AIIB.

(2) Environmental and Social Standard No.1 (ESS1)

The ESS 1 aims to ensure the environmental and social soundness and sustainability of Projects and to support the integration of environmental and social considerations into the Project decision-making process and implementation. ESS 1 is applicable if the Project is likely to have adverse environmental and social risks and impacts. Reference should be made to the Environmental and Social Coverage provided under ESS1 in the ESP, while identifying the risks. The scope of the environmental and social assessment and management measures

are proportional to the risks and impacts. The effective mitigation and monitoring measures during the course of Project implementation are formulated. The ESS 1 defines the detailed requirements of the environmental and social assessment to be carried out for any project to be financed by the Bank.

(3) Environmental and Social Standard No.2 (ESS2)

The ESS 2 is applicable if the Project's screening process reveals that the Project would involve Involuntary Resettlement (including Involuntary Resettlement of the recent past or foreseeable future that is directly linked to the Project). Involuntary Resettlement covers physical displacement (relocation, loss of residential land or loss of shelter) and economic displacement (loss of land or access to land and natural resources; loss of assets or access to assets, income sources or means of livelihood) as a result of: (i) involuntary acquisition of land; or (ii) involuntary restrictions on land use or on access to legally designated parks and protected areas. It covers all displacements whether they are full or partial, permanent or temporary. The ESS 2 defined detailed requirements of resettlement planning of the projects involving involuntary resettlement.

(4) Environmental and Social Standard No.3 (ESS3)

If the proposed project area includes Indigenous Peoples (minority ethnic groups) or communities with collective attachment to the land, and they are likely to be affected by the project, ESS3 shall apply.

According to the environmental and social policy requirements of the AIIB, the Project is classified as an Environment and Social Category "A" ， and the AIIB's ESP shall apply, as shown in Table 2.

(1) Environmental and social risks and impacts（ESS1）. ESS1 is triggered because this subproject may bring about negative environmental and social impacts. This ESIA is prepared in compliance with ESS1.

(2) Land acquisition and involuntary resettlement (ESS2). ESS2 is not triggered. This subproject involves mangrove afforestation and restoration in Naliujiang estuary and Lianzhou Bay area, without land acquisition and house demolition. No Resettlement Plan (RP) is required or this subproject.

(3) Indigenous peoples (ESS3). ESS3 is not triggered. Based on the identification survey on the ethnic minorities, it was found that, in the construction implementation area, the population of the ethnic minorities is extremely low. It mainly consists of scattered minority ethnic populations who have migrated due to marriage or relocation, with no traditional

territory of minority ethnic groups. There is no minority ethnic language or traditional culture, and there are no self-identified cohesive minority ethnic groups. The Ethnic Minority Development Plan (EMDP) is not required for this subproject.

Table 2 Applicable Environmental and Social standards

Environmental & Social Standards		Applicability	Remarks
ESS1	E&S assessment and management	If the project may have adverse environmental risks and impacts or social risks and impacts (or both), ESS1 shall apply. .	Triggered. Because this subproject may bring about negative environmental and social impacts. This ESIA is prepared in compliance with ESS1.
ESS2	Involuntary resettlement	If this subproject may cause involuntary resettlement impacts, then ESS2 shall apply.	Not triggered. This subproject involves mangrove afforestation and restoration in Naliujiang estuary and Lianzhou Bay area, without land acquisition and house demolition.
ESS3	Indigenous people (ethic minorities)	If there are indigenous peoples in the project area, and they are likely to be affected by the subproject, then ESS3 shall apply.	Not triggered. There are no indigenous people (ethic minorities) in the project area.

3.3 International conventions

(1) Vienna Convention for the Protection of Ozone Layer (March 22, 1985);

(2) Montreal Protocol on Substances that Deplete the Ozone Layer (Effective from January 1, 1989)

(3) United Nations Framework Convention on Climate Change (June 11, 1992)

(4) Convention on Biological Diversity (June 5, 1992);

(5) The Paris Agreement (2016) .

3.4 Differences between the AIIB policies and relevant domestic policies, and solutions

Analysis of the differences between the AIIB policies and the relevant domestic policies are shown in Table 3. This subproject must simultaneously comply with the requirements of both the AIIB and relevant domestic policies. In case of any conflict, the stricter of the two sets of policies/legislation/standards shall apply.

Table 3 Policies Differences Analysis

Items	AIIB's requirements	China's requirements	Comparative analysis
Policies differences analysis			
Environmental policies and regulations	Including AIIB's ESF, E&S policies and standards.	China's EIA and permitting procedures.	In most cases, national requirements and standards for environmental quality align with AIIB policies and standards (for example, both require the mandatory implementation of an EIA) . However, when there are discrepancies between national and AIIB requirements and standards (for example, national legislation does not mandate the preparation of a separate EMP or any other environmental documents/plans/lists for the project), the more stringent provisions will apply to this subproject.
Screening and categorization.	When sufficient information is available, the AIIB conducts project screening and categorization at the earliest stage of project preparation.	The Management Directory of EIA Categories of Construction Projects provides detailed EIA requirements and categorizes construction projects into three classes based on the "significance" of potential environmental impacts caused by the project and the sensitivity of the project site to the environment. Different reporting requirements are specified accordingly.	If there are discrepancies between the classification requirements of the AIIB and China, the stricter requirements will apply.
Preparation of EIA report.	Categorized into A, B, C and FI categories. The categorization of projects depends on the components that pose the highest environmental or social risks, including relevant direct, indirect, cumulative, and induced impacts. According to the environmental and social policies, the EIA report for Category A projects mainly includes the following sections: (1) Project Description; (2) Policy, Legal, and Administrative Framework, including the international and national legal frameworks applicable to the project; (3) Engineering	For construction projects that have a significant impact on the environment, an EIA report shall be prepared, mainly including the following sections: (1) Overview; (2) General Provisions; (3) Analysis of Construction Project Engineering; (4) Environmental Status Survey and Evaluation; (5) Prediction and Evaluation of Environmental Impact; (6) Feasibility Demonstration of Environmental Protection Measures; (7) Economic Analysis of Environmental Impact; (8) Environmental Management and Monitoring Plan; (9)	Based on the requirements of both the China and AIIB's ESF, an EIA report should be prepared. There are differences in the framework and requirements of the reports between the two entities, and this subproject will follow the requirements of the AIIB.

	Analysis; (4) Analysis of Alternatives; (5) Baseline Environmental and Social Data; (6) Assessment of Environmental and Social Risks and Impacts; (7) Public Consultation and Information Disclosure; (8) Formulation of Mitigation, Monitoring, and Management Measures and Actions in the form of an Environmental Management Plan or Environmental Impact Assessment.	Conclusion of Environmental Impact Assessment.	
Environmental Management Plan.	An Environmental Management Plan (EMP) should be developed, which should include monitoring plans and reporting requirements, as well as institutional arrangements for implementing the plan, along with the proposed mitigation measures.	While identifying potential environmental impacts in accordance with national regulatory requirements for environmental impact assessments, there is no need to prepare a separate EMP or any other environmental documents/plans/lists.	However, in accordance with AIIB requirements, an EMP should be developed and incorporated into the ESF.
Public Consultation.	The borrower is responsible for conducting at least one meaningful consultation for all A, B, C category projects to discuss the issues addressed in the EMP or to discuss the draft of the EMP itself.	During the preparation of the EIA report, the IA shall conduct necessary surveys among the units and the public potentially affected by the project construction, in accordance with the requirements outlined in the Guideline on Public Participation in EIA (Decree No.16, Ministry of Ecology and Environment, promulgated on January 1, 2021).	According to the requirements of the AIIB, public consultations with stakeholders and affected communities are conducted as part of the EIA process. Feedback obtained from these consultations is used to finalize the EIA.
Grievances redressing	AIIB requires its clients to establish appropriate GRM in accordance with the requirements outlined in the ESP and applicable ESS.	In China, complaints are addressed through the environmental complaint hotline established by the Ministry of Ecology and Environment (for example, the 12345 government service hotline, Ecological Environment WeChat Complaint Reporting Official Account, National Ecological Environment Complaint Reporting Platform http://1.202.247.200/netreport/netreport/index). However, there is no need to set up a formal GRM.	AIIB requires to establish appropriate GRM in accordance with the requirements outlined in the ESP and applicable ESS.
Information disclosure	Assist in addressing the concerns or complaints of individuals who believe they have been adversely affected by the project's	China mandates disclosure of domestic environmental impact assessment reports within a limited timeframe, following the	The Project discloses information in accordance with the AIIB's ESP and applicable ESS, making environmental and social

	environmental or social impacts.	Guideline on Public Participation in EIA (Decree No.16, Ministry of Ecology and Environment, promulgated on January 1, 2021). No need for further disclosure.	information available within 60 days prior to the bank's loan approval.
Analysis of the difference in social policies between AIIB and China			
Policies and regulations	Including AIIB's ESF, E&S policies and standards.	Social stability risk assessment and permitting procedures	In most cases, national requirements and standards for social impacts align with AIIB policies and standards.
Screening and categorization.	When sufficient information is available, the AIIB conducts project screening and categorization at the earliest stage of project preparation.	The construction projects involving fixed asset investments in China, which necessitate approval and ratification from the NDRC or reporting to the State Council for approval and ratification, are obligated to conduct social stability risk assessments in compliance with this regulation.	If there are discrepancies between the classification requirements of the AIIB and China, the stricter requirements will apply.
Preparation of ESIA report.	Categorized into A, B, C and FI categories. The categorization of projects depends on the components that pose the highest environmental or social risks, including relevant direct, indirect, cumulative, and induced impacts. According to the environmental and social policies, the EIA report for Category A projects mainly includes the following sections: (1) Project Description; (2) Policy, Legal, and Administrative Framework, including the international and national legal frameworks applicable to the project; (3) Engineering Analysis; (4) Analysis of Alternatives; (5) Baseline Environmental and Social Data; (6) Assessment of Environmental and Social Risks and Impacts; (7) Public Consultation and Information Disclosure; (8) Formulation of Mitigation, Monitoring, and Management Measures and Actions in the form of an Environmental Management Plan or Environmental Impact Assessment.	The social stability risk levels for major projects are divided into three categories: (i) High risk: most of the public holds opinions against the project, with particularly strong reactions, potentially leading to large-scale collective incidents; (ii) Medium risk: Some members of the public express strong opinions against the project, potentially leading to conflicts.	Preparing the ESIA report. There are differences in the framework and requirements of the reports between the two entities, and this subproject will follow the requirements of the AIIB.

Social Development Plan.	Social Development Plan (SDP) and Gender Development Plan should be prepared, along with proposed mitigation measures, to formulate monitoring plans and reporting requirements, as well as to establish institutional arrangements for implementing these plans.	The Social Stability Risk Assessment Report should outline the risk prevention and mitigation measures strategies adopted for the main risk factors based on the characteristics of the proposed project. There is no need to prepare separate EMP or any other environmental documents/plans/lists.	According to AIIB's requirement, a Social Management Plan should be developed and incorporated into the environmental and social management framework (ESMF).
Public consultation.	The borrower of the Project is responsible for conducting at least one meaningful consultation for all A, B, C category projects to discuss the issues addressed in the SDP or the SDP draft itself.	Conduct surveys to gather the opinions and demands of stakeholders regarding the proposed project construction. Focus on visiting those who are most affected by the project and families facing special difficulties, and listen to their opinions in person.	According to the requirements of the AIIB, public consultations with stakeholders and affected communities are conducted as part of the ESIA process. Feedback obtained from these consultations is used to finalize the social impact assessment and management.
Grievances redressing	AIIB requires its clients to establish appropriate GRM in accordance with the requirements outlined in the ESP and applicable ESS.	In China, issues related to social order and public security can be reported to various channels including the "110 Emergency Service Hotline", "12345 Government Service Hotline", "12389 Complaint Reporting Platform", and through petitions to relevant authorities and higher-level units. There is no need for a formal GRM.	AIIB requires to establish an appropriate GRM in accordance with the requirements outlined in the ESP and applicable ESS.
Information disclosure	Assist in addressing the concerns or complaints of individuals who believe they have been adversely affected by the project's environmental or social impacts.	China requires timely disclosure of information in accordance with relevant laws and policies on government information disclosure.	The Project discloses information in accordance with the AIIB's ESP and applicable ESS.

4. Engineering analysis

4.1 Brief introduction

4.1.1 Background

The Beihai City is located on the northeast coast of the Beibu Gulf in southern Guangxi. Beihai City boasts abundant natural resources and a pristine ecological environment. The marine functional area covers an area of 3075.9 k ㎡, featuring numerous harbors and estuaries, with a coastline extending 668.98 k ㎡. The forest coverage rate is 32.64%, with a total forest area of 101,800 ha.. Noteworthy attractions include the nationally-rated 5A Weizhou Island Nanwan Crocodile Mountain Scenic Area, as well as the nationally-rated 4A Beihai Silver Beach Scenic Area, Beihai Jinhai Bay Mangrove Ecotourism Area, and Beihai Old City Scenic Area.

Figure 2 Location Map of Beihai City

With the rapid urban development and population growth in recent years, issues such as lagging infrastructure construction, direct discharge of sewage into the sea,

excessive exploitation of coastal areas, degradation of mangroves, and environmental deterioration have been observed in Beihai City. These issues are exacerbated by external global factors such as the greenhouse effect, resulting in rising water temperatures, drastic changes in ocean currents and climate, and rising sea levels.

In order to restore the marine ecological environment of Lianzhou Bay and respond to the concept of prioritizing ecology and promoting green and low-carbon development, as well as the national Blue Bay Remediation Action, Beihai Municipal Government has requested financial and technical support from AIIB to finance the Guangxi Beihai Lianzhou Bay Marine Ecological Restoration and Protection Project. The Project was enlisted in the plan of candidate projects in China of utilizing AIIB loans for 2022-2024. The objective of the Project is to implement comprehensive ecological and environmental management in Lianzhou Bay, guided by the principles of safety, efficiency, resilience, and green low-carbon development, in accordance with the requirements of the "Blue Bay Remediation Action." The project components include improving the marine water environment, restoring coastal ecosystems, enhancing the disaster prevention and mitigation capabilities of seawall construction, establishing a safety and ecological supervision platform for the bay, and strengthening capacity building. The overall objective is to transform Lianzhou Bay into a beautiful bay suitable for living, working, and leisure, providing robust support and guarantee for Beihai City's sustainable development towards a maritime economy. Additionally, it aims to explore innovative demonstration and highlights that can be replicated and shared globally for the ecological governance of bays.

4.1.2 Project components

The Blue carbon sink actions is one of the subprojects under AIIB financed Guangxi Beihai Lianzhou Bay Marine Ecological Restoration and Protection Project. The project consists of 5 subprojects: coastal water pollution control and environmental improvement, blue carbon sink actions, comprehensive coastal zone improvement, marine safety and environmental monitoring construction, capacity

building, and project management support. Within these subprojects, there are 9 construction components, namely: Nearshore pollution control; Coastal pollution source control and environmental improvement; Mangrove afforestation and restoration; Lianzhou Bay coastal ecosystem restoration; Baiquwei ecological seawall construction in Hepu County; Gulf intelligent sensing network; Gulf big data intelligent analysis platform; Project management support; Capacity building.

In accordance with the project's advance procurement requirements, this ESIA report primarily conducts an environmental impact assessment for the construction components of Subproject 2: Blue Carbon Sink Actions. The construction contents covered by this assessment are shown in Table 4. The total area for mangrove afforestation in this subproject is 723.14 h㎡. This includes 442.49 h㎡ for mangrove restoration (including 16.14 h ㎡ of mangrove afforestation) and 280.65 h ㎡ for mangrove afforestation. However, this assessment primarily focuses on the 442.49 h ㎡ of mangrove restoration. The mangrove afforestation located in Shangkou Town of Hepu County is not within the scope of this assessment.

Table 4 List of Major Construction Contents Covered by the Assessment

Sl.	**Subproject**	**Construction contents under planning**	**Construction contents scheduled to carry out (under this assessment)**	**Construction targets**
1	**Blue carbon sink actions**			
1.1	Mangrove afforestation and restoration	Totally 723.14 h ㎡ of mangrove afforestation, including 442.49 h ㎡ of mangrove restoration (with 16.14 h ㎡ of mangrove planting), 280.65 h ㎡ of mangrove afforestation. Cleaning of spartina alterniflora, 229.04 h ㎡. The	Mangrove restoration 442.49 h ㎡ ; Cleaning of spartina alterniflora 229.04 h ㎡. The implementation area is concentrated in Nanliujiang estuary and Lianzhou Bay area (excluding the Shankou area) .	The mangrove can be restored and added.

Sl.	Subproject	Construction contents under planning	Construction contents scheduled to carry out (under this assessment)	Construction targets
		implementation area includes the Nanliujiang River Estuary, Tieshan Port Area, and the Shangkou Mangrove Ecological National Nature Reserve in Hepu County, Guangxi.		

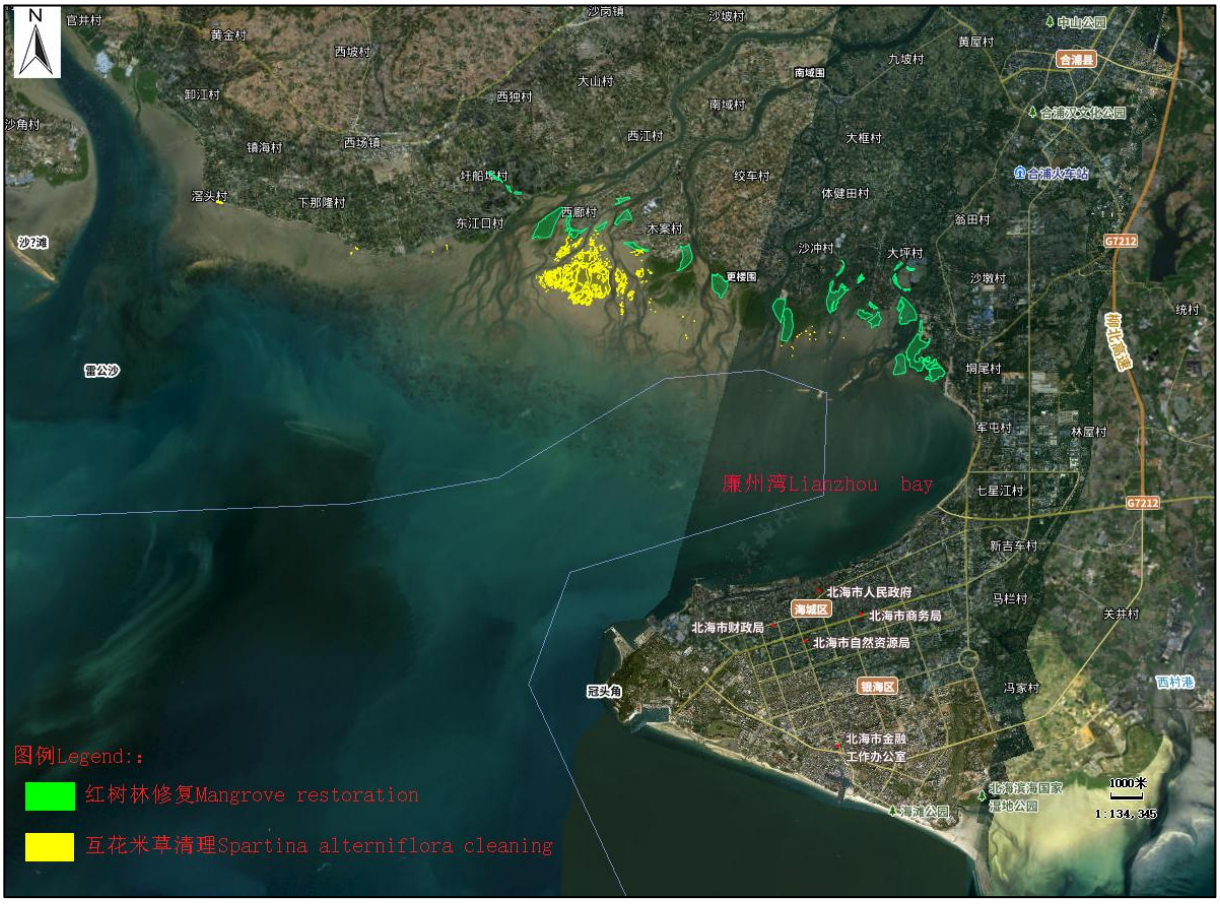


Figure 3 Project layout diagram

4.1.2.1 Mangrove restoration

The total area for mangrove restoration is 442.49 h ㎡, divided into 35 restoration sites. The restoration sites are primarily located at Nanliujiang River estuary and Ximen River estuary in Lianzhou Bay. Detailed information for each site is provided in Table 5.

The derris, a member of the leguminous plant family, exhibits climbing characteristics. It represents another significant harmful species within the mangroves of Beihai. As a climbing shrub, it proliferates rapidly, presenting a new threat to the mangrove ecosystem due to its extensive coverage. Within the mangrove restoration sites, approximately 70.07 h ㎡ are covered by derris, accounting for 13.84% of the restoration area. There are vacant areas totaling 22.32 h ㎡ within the region, constituting 5.04% of the restoration area.

Table 5 Type of Land for Mangrove Restoration (Unit: h ㎡)

Land No. for restoration	Restoration area
HXF1	2.58
HXF2	1.42
HXF3	1.59
HXF4	53.76
HXF5	5.15
HXF6	0.55
HXF7	8.26
HXF8	4.62
HXF9	5.54
HXF10	13.5
HXF11	8.78
HXF12	25.08
HXF13	32.13
HXF14	23.84
HXF15	34.58
HXF16	2.44
HXF17	32.97
HXF18	1.24
HXF19	1
HXF20	2.57
HXF21	9.71

Land No. for restoration	Restoration area
HXF22	12.51
HXF23	2.04
HXF24	4.29
HXF25	1.92
HXF26	1.9
HXF27	1.22
HXF28	1
HXF29	35.51
HXF30	3.27
HXF31	52.56
HXF32	23.99
HXF33	2.01
HXF34	9.08
HXF35	19.88
Total	**442.49**

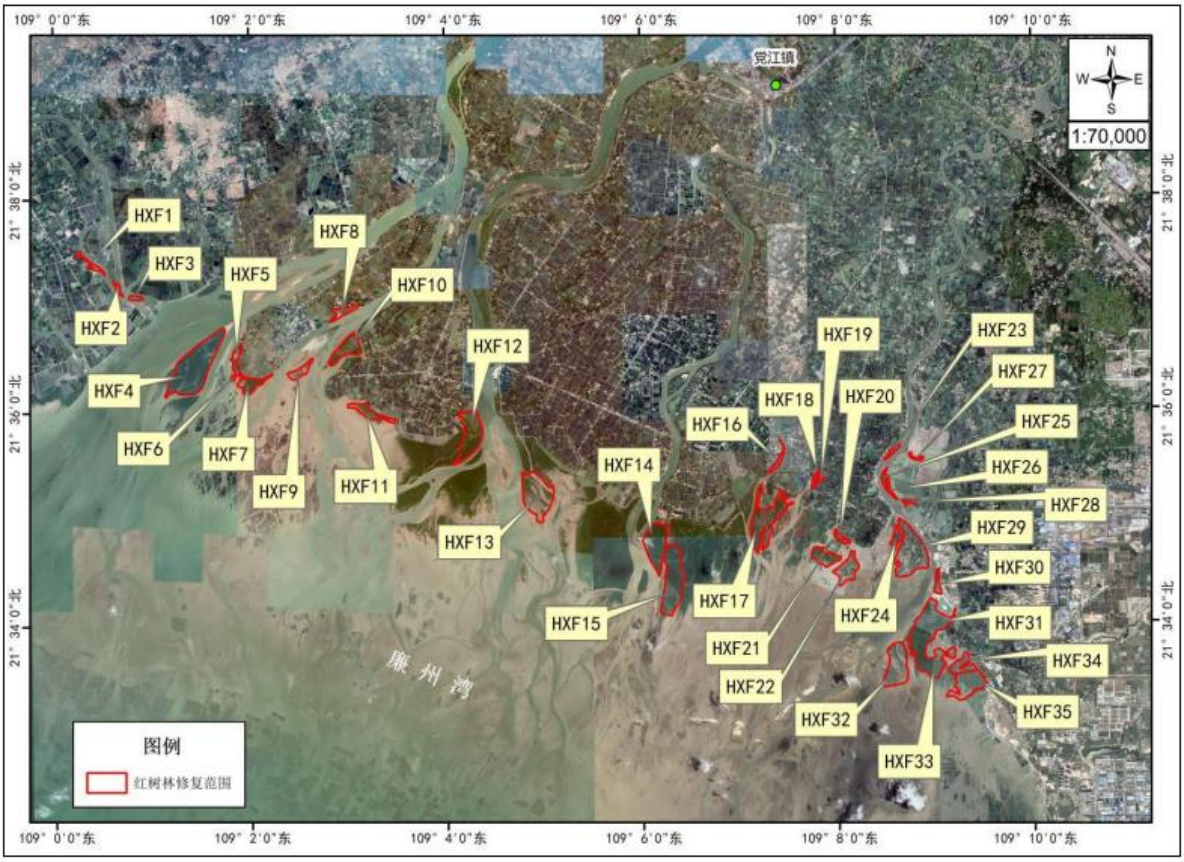


Figure 4 Layout for Mangrove Restoration

To address threats such as derris expansion, inadequate mangrove coverage, pest infestation, and human activities within the mangrove restoration area, targeted

strategies are implemented for mangrove restoration. These strategies include clearing derris, replanting in vacant areas, pest control, and post-restoration maintenance. For areas with relatively good preservation and mild degradation, natural mangrove succession is promoted by enhancing maintenance efforts to eliminate human disturbances and threatening. For mangrove areas experiencing degradation due to derris infestation, restoration primarily relies on artificial interventions such as derris clearance and replanting in vacant areas to facilitate positive community succession or enhance ecological health, thereby promoting mangrove recovery and growth.

The detailed restoration schemes are:

(1) Derris clearing

The area covered by derris within the mangrove restoration zone is 70.07 h ㎡, with 12.03 h ㎡ consisting of concentrated patches of derris and 58.04 h ㎡ of derris entwined around the mangrove trees. Due to the well-developed root system and strong sprouting ability of derris, continuous clearance is required for three years. Different clearance methods are adopted based on the growth status of derris as follows:

(i) Manual combined with mechanical clearance: For the 12.03 h ㎡ of concentrated derris patches, continuous clearance will be conducted over three years, with a cumulative cleared area of 20.46 h ㎡. In the first year, the clearance method involves manual combined with mechanical operations: (i) Manual cutting of the derris vines on the ground; (ii) Collecting the vines and transporting them to nearby town garbage transfer stations; (iii) Using dredging machine to deeply plow and bury the derris roots underground, with a depth of about 60 cm. During excavation, attention should be paid to avoiding mangroves mixed with the derris. For scattered mangrove roots under these parts of the mangroves, manual plowing and excavation will be used for removal. In the second year, with an expected derris germination rate of 50%, which is 6.02 h ㎡, as mangrove seedlings will be planted in this area, manual clearance methods will be used to cut the derris, dredge the roots, and collect them for transportation to nearby town garbage transfer stations. In the

third year, with an expected derris germination rate of 20%, which is 2.41 h ㎡, manual cutting of the derris vines, excavation of the roots, and collection for transportation to nearby town garbage transfer stations will continue.

(ii) Manual clearing: For the 58.04 h ㎡ of derris that are entangled in the mangroves and inaccessible to machinery, manual clearance will be conducted to avoid damaging the mangroves. The method involves cutting the derris vines, excavating the roots, and collecting them for transportation to nearby town garbage transfer stations. Care will be taken to avoid harming the mangrove roots during the excavation of derris roots. This clearance process will be carried out continuously over three years. In the second year, with an expected derris germination rate of 50%, which is 29.02 h ㎡; in the third year, with an expected derris germination rate of 20%, which is 11.61 h ㎡. The total cleared area of derris over three years will be 98.67 h ㎡.

(2) Replanting in empty areas

Replanting will be carried out in the empty areas formed after clearing the derris.

(i) Selection of tree species for replanting

The predominant tree species surrounding the empty areas are Aegiceras corniculatum, with associated species such as Kandelia obovata. Based on the site conditions of the replanting area, the biological and ecological characteristics of the selected tree species, the growth status of surrounding mangroves, and the principle of selecting suitable trees for the site, native mangrove species with good stability and strong resistance are chosen for replanting. The species chosen for planting in the empty areas are Aegiceras corniculatum and Kandelia obovata, with a planting ratio of 3:1 between Aegiceras corniculatum and Kandelia obovata.

Aegiceras corniculatum **Kandelia obovata**

Figure 5 Tree Species for Replanting

(ii) Seedling requirements

Seedling specifications: Select seedlings preferably in biodegradable non-woven fabric containers, aged 2 years or more, with non-woven fabric container and soil ball dimensions of 15 cm (diameter) × 18 cm (height); seedling diameter at ground level ≥ 0.6 cm, seedling height ≥ 50 cm. Seedling sources: Choose local seedling sources. For seedlings sourced from outside the county where the project is located, obtain "Two Certificates and One Label" (Plant Quarantine Certificate, Origin Quarantine Certificate, Seedling Label) before the seedlings leave the nursery. For seedlings sourced within the county where the project is located, obtain "One Certificate and One Label" (Origin Quarantine Certificate, Seedling Label) before the seedlings leave the nursery. Seedling quality: Robust growth, high degree of lignification, sturdy stem, healthy, free from diseases and pests, and well-developed root system.

(iii) Replanting mode

According to the current natural regeneration of mangroves and the growth characteristics of plants in the restoration area, combined with the surrounding mangrove species, and based on the Technical Regulations for Afforestation (GB/T15776-2006) and the Technical Regulations for Mangrove Afforestation (LY/T1938-2011), the replanting mode is planned and designed as follows:

A staggered mixed planting pattern of “3 rows of Aegiceras corniculatum × 1 row of Kandelia obovata” will be adopted, with the spacing of “1 m × 0.8 m”. The

initial planting density is 12,500 plants per hectare.

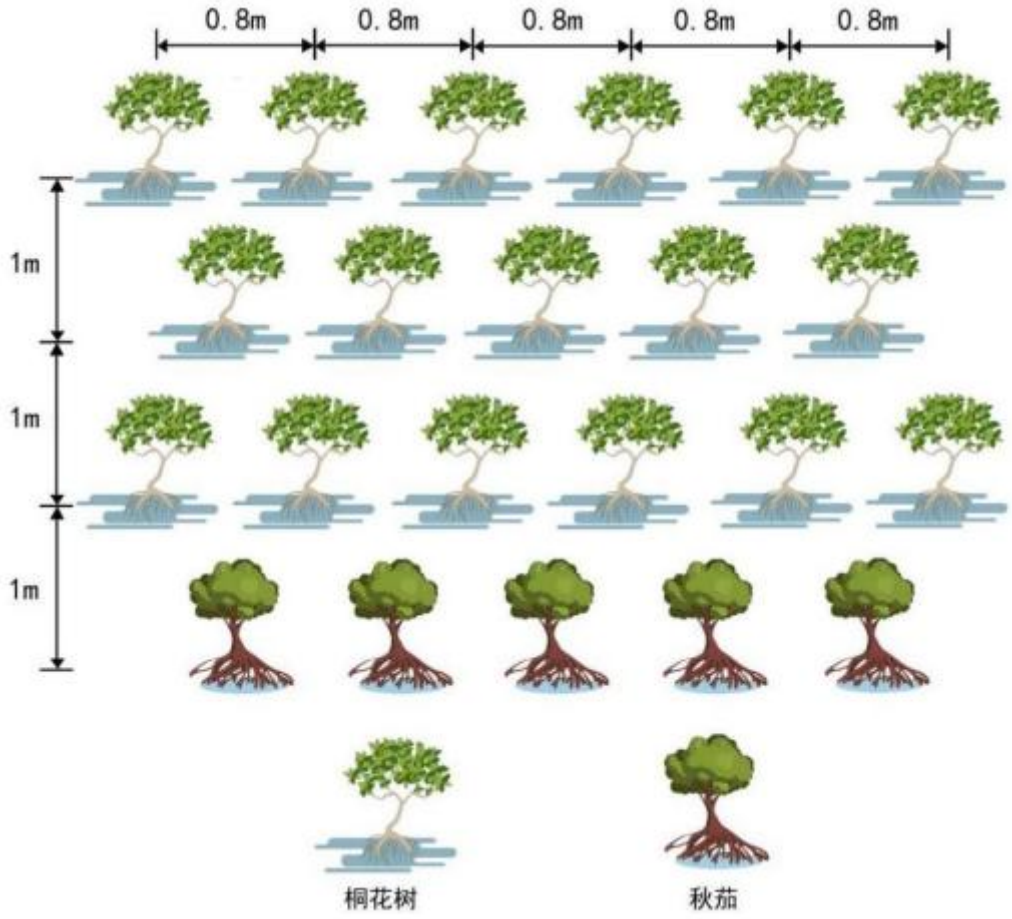


Figure 6 Replanting Mode

(iv) Planting time

Planting is scheduled between May and July.

(v) Land preparation

Before planting, clean up debris such as fishing nets, floating objects, and gravel on the tidal flats, level the land to ensure smooth tidal flow, and prevent water from pooling in depressions. The area for land preparation is 22.32 h ㎡.

(vi) Planting

Biodegradable non-woven container bags are used to prevent the scattering of soil balls from the seedling roots, thus protecting the seedling root system and increasing its survival rate. Before planting, dig planting holes slightly larger and deeper than the soil balls of the seedlings. When planting, cut open the side and

bottom of the non-woven container to prevent root entanglement. Handle the seedlings gently and protect their roots, avoiding the scattering of soil balls. Planting the seedling roots in the pit at a depth equal to the height of the container, gently compact the soil.

To prevent seedling collapse caused by seawater erosion, reinforcement measures are implemented by inserting auxiliary stakes, such as bamboo poles or eucalyptus rods, which are 150cm long and 1~2cm in diameter. These stakes are inserted into the soil beside the seedling trunk at a depth of 75cm, leaving 75cm above the ground. The seedling trunk is then securely tied to the auxiliary stake using binding straps. When binding, ensure some room for growth and avoid tight binding. Once the seedlings develop strong roots and become stabilized, promptly remove the binding straps.

(vii) Wave reduction netting

To prevent human activities and livestock from disturbing and damaging the mangroves, block marine debris and large enteromorpha from entering the mangrove planting area, and protect the mangrove seedlings from being washed away by waves. Install 1m low net and 3m high net side by side along the perimeter of the planting area to withstand wave erosion and potential human and livestock disturbances. The netting length is 3660m. The low nets are primarily for wind and wave reduction, while the high nets are for blocking human and livestock access, marine debris, and large enteromorpha. The specific engineering measures are as follows: use low wooden stakes, 2m high and with a top diameter of at least 10cm, spaced 0.5m apart around the perimeter of the planting area, driven into the soil to a depth of 1 meter with 1 meter exposed above the ground. Hang 27-strand wire mesh with mesh sizes of 3~5cm at a height of 1 meter. Use high wooden stakes, 4.5m high and with a top diameter of at least 8cm, spaced 3m apart, and alternating with the low stakes, driven into the soil to a depth of 1.5m with 3m exposed above the ground. Hang 27-strand wire mesh with mesh sizes of 6~8cm at a height of 3m.

(viii) Nursery management

Nursery management and replanting are crucial steps in improving the effectiveness of mangrove afforestation and promoting tree growth. To enhance the stability and protective function of the mangrove ecosystem, close attention is paid to the growth of mangrove trees. Regular checks are conducted to promptly address issues such as lodging, exposed roots, and damaged seedlings, saplings, and sparse areas. These measures include repositioning, replanting with the intended tree species to avoid the formation of "canopy openings". Clearing Enteromorpha[2]、marine debris, balanus albicostatus[3] in the planting area.

(3) Pest control

Install 443 insect traps to lure and kill common pests in the mangrove forest, such as olive fruit tortrix moth, auicennia marina leaf-eating moth, lasiognatha cellifera, parasa lepida, pseudaulacaspis cockerelli, tussock moth, Buzura suppressaria Guenee, Guangzhou Microlepidoptera, and Erebus macrops etc. The parameters of the insect trap are as follows: Solar panel 50W; Lithium battery: 24AH; Total power: 15W; Operating voltage: 3V; Light source: LED 4W; Insect-killing high voltage: 5000V; Effective range: 1 h ㎡; Stainless steel rod, H=300cm, φ60mm, thickness 2.0mm (304 stainless steel); Stainless steel triangular pile, H= 350cm, φ40mm, thickness 2.0mm (304 stainless steel). During installation, the stainless steel triangular

[2] Enteromorpha is a common green seaweed found along the coast. When it proliferates in large quantities, it blocks sunlight, and dead enteromorpha consumes oxygen in seawater. Chemicals secreted by enteromorpha may also adversely affect other marine organisms, damaging the marine ecosystem and hindering the growth of mangroves. Additionally, enteromorpha can cause mechanical damage to mangrove seedlings. After the seawater recedes, large amounts of enteromorpha become entangled in the branches, twigs, and roots of mangroves, increasing the impact of the tide on the seedlings and potentially washing them away.

[3] Balanus albicostatus belong to the Cirripedia suborder of the Crustacea class. These are fouling organisms. The barnacle cement secreted by juvenile barnacles and adhering to the trunks of mangroves is a major contaminating organism that poses a significant threat to mangrove ecosystems. Due to the adhesive and parasitic nature of barnacle organisms on the surface of mangrove plants, they significantly impede the normal growth of mangrove forests. In natural mangrove forests or newly planted saplings, the barnacles attached to the stems and branches of young trees vary in number from several to hundreds, with some reaching up to four layers. This obstructs the respiratory and photosynthetic processes of mangrove plants, making it difficult for them to grow or causing them to die.

pile is driven into the soil to a depth of 200cm, with a height above the ground of 450cm.

(4) Erecting warning signboards

Set up 30 warning signboards at the shoreline of the restoration site. These signboards aim to remind the public not to damage the mangroves and raise awareness among them about protecting the mangroves. Specifications of the warning signboards. Main frame: 200 cm × 200 cm, made of Φ5 cm thick 3.8 mm hot-dip galvanized steel pipe, with Φ6 cm stainless steel spherical caps. Board: 200 cm × 120 cm, with a thickness of 1 cm, made of PC board, UV printed. Reinforcement: Φ4 cm × 4 cm thick 3.8 mm hot-dip galvanized steel pipe. During the installation of the warning signboards, a pit measuring L30 cm×W30 cm×H50 cm will be dug on the ground. The bottom end of the steel pipe of the signboard will be inserted into the pit to a depth of 50 cm, and after alignment, concrete will be poured into the pit to secure the signboard.

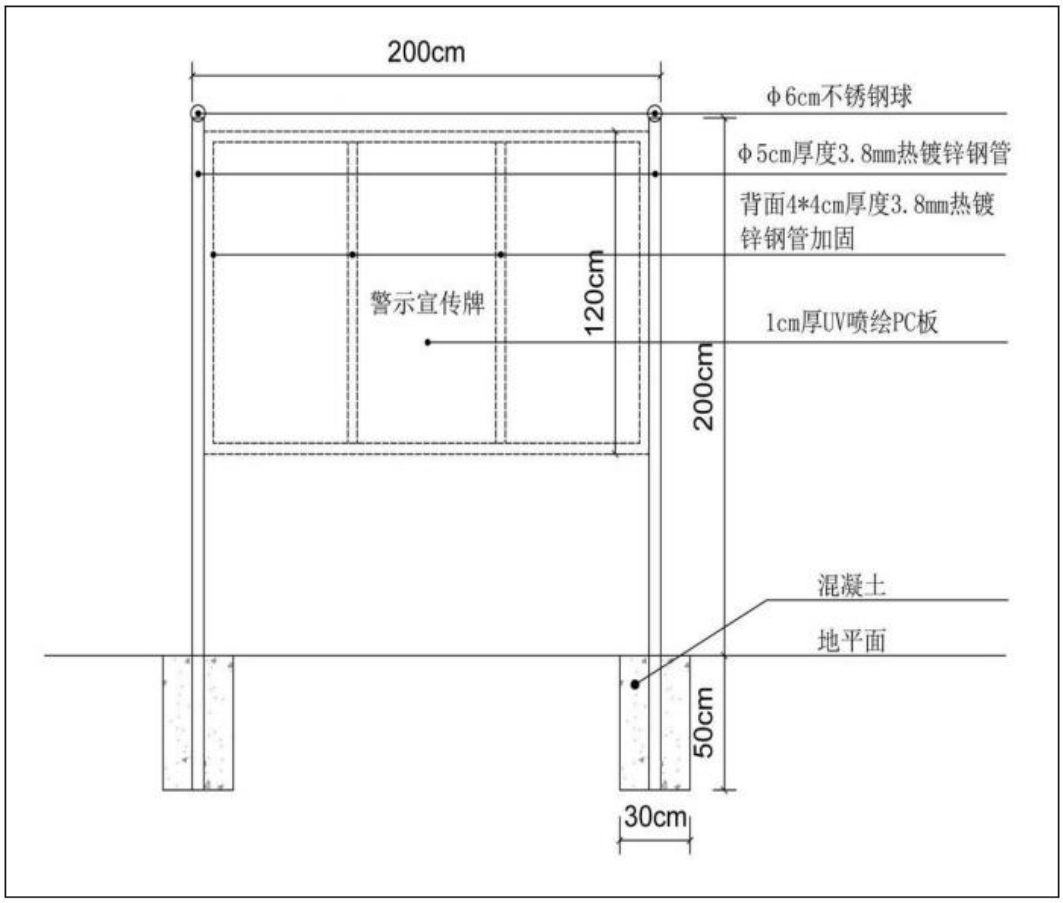


Figure 7 Sample Warning Signboard

(5) Post-restoration maintenance

The 442.49 h ㎡ of mangroves across 35 site plots within the restoration area will undergo regular patrols and maintenance for a duration of 3 years. There will be 7 patrols per month, with each plot requiring 1 workday per patrol. It required to strengthen the manpower arrangement of patrol and management personnel, conduct professional training for them, and ensure that they follow prescribed routes for regular patrols in the restoration area. This enables them to comprehensively and promptly monitor the dynamic situation of the mangrove restoration area, promptly identify and record threats such as diseases, pests, fish vines, spartina alterniflora, drift garbage, forest damage, and human activities, and promptly report and address them. Patrol personnel are required to fill out patrol record forms after each patrol to ensure accurate documentation of patrol times and conditions.

巡护记录表（模板）					
巡护日期：	天气潮汐：				
巡护人员：	巡护地块：				
巡护时间：	巡护路线：				
巡护内容	巡护结果		严重程度		
	有	无	轻微	中度	严重
有无非法采挖、采伐、毁坏红树林等情况					
有无红树林倒伏、死亡情况					
有无互花米草入侵或清理后重新萌生					
有无鱼藤清理入侵或清理后重新萌生					
有无病虫害					
有无藤壶					
有无团水虱					
有无浒苔					
有无排放污水、倾倒废弃物					
有无挖沙虫、泥虫、耙螺等人类活动破坏情况					
有无养殖畜禽破坏					
有无海漂垃圾、枯死木					
支护桩、围网、畦床有无损坏					
宣传牌、诱虫灯有无损坏					
巡护情况及处理结果：（存在上述行为的拍照存档，并在此处详细记录。记录要素包括地点、行为以及处理情况。）					

Figure 8 Patrol Record (template)

4.1. 2.2 Cleaning of spartina alterniflora

The spartina alterniflora has the characteristics of wide salt tolerance, flood

resistance, high adaptability, strong reproductive capacity, and genetic traits. Its population can rapidly expand and proliferate under favorable conditions featured by the point-source diffusion and multi-point outbreaks. Once spartina alterniflora settles in an area, it typically spreads initially through short-distance "flow" dispersal via asexual reproduction. Upon reaching a certain extent, it can further expand through sexual reproduction, occupying new patches by seed insertion and dispersing, germinating, and establishing along specific directions and routes, ultimately forming larger new habitats. Due to its extensive spread, spartina alterniflora encroaches upon valuable mangrove intertidal resources, inhibits the growth of local mangroves, and reduces the growth and aquaculture areas of intertidal zone shellfish. According to the "Investigation Report on the Distribution of Spartina Alterniflora in Coastal Tidal Flats of Beihai City" (September 2018), spartina alterniflora covers an area of approximately 780.34 h ㎡ in the city, posing the greatest area and management difficulties among the three coastal cities in Guangxi. It severely threatens the local mangrove ecosystem, restricting the implementation of mangrove protection and restoration projects. The survey found that spartina alterniflora is widely distributed around the outer tidal flats of Lianzhou Bay, with some mangrove forest gaps invaded by spartina alterniflora.

The total area of spartina alterniflora clearing in this subproject is 229.04 h ㎡, of which 208.27 h ㎡ are cleared mechanically and 20.77 h ㎡ are cleared manually. In Hepu county, the main locations for spartina alterniflora clearing are in Mu'an Village of Dangjiang Town and Qixing Village of Shajiang Town. There are sporadic areas in Shayong Village and Yujiang Village in Dangjiang Town. The distribution of the clearing site plots is shown in the following figure.

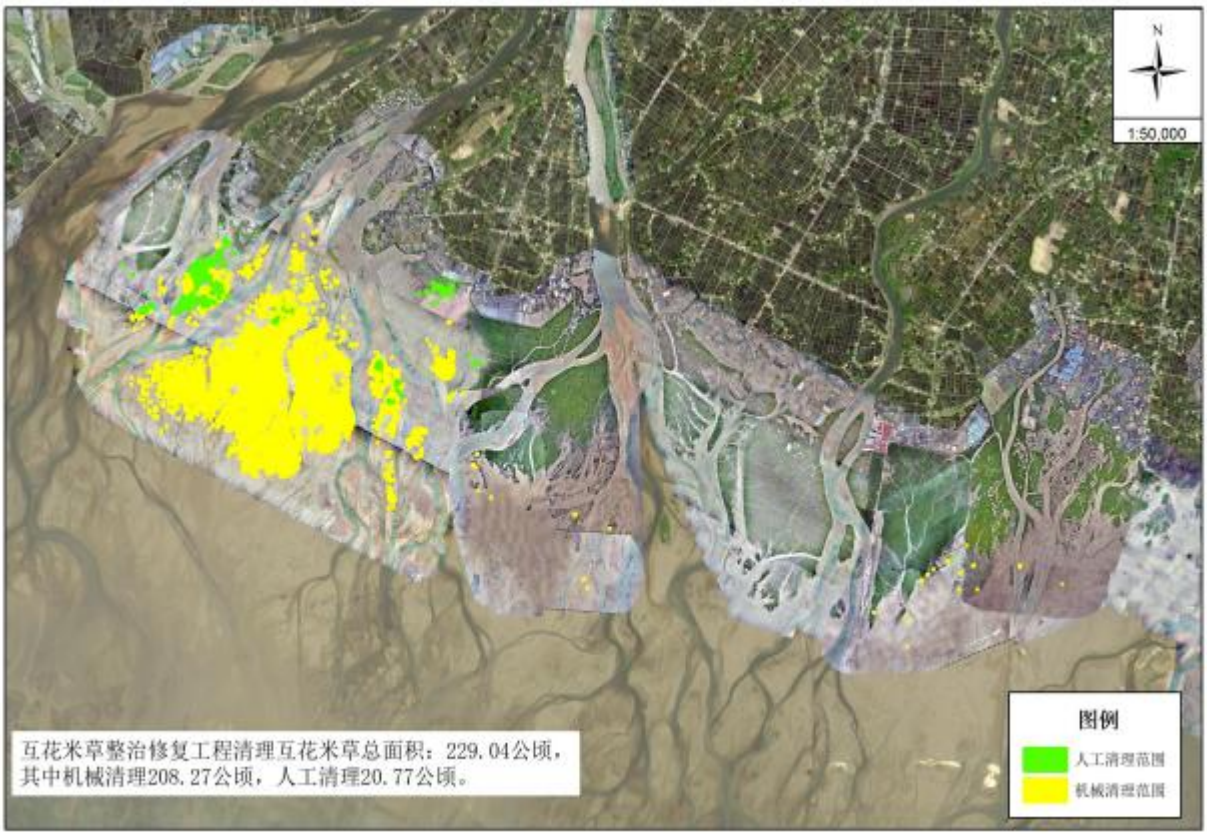


Figure 9 Site Distribution of Spartina Alterniflora Clearing

The implementation schemes for spartina alterniflora clearing of the subproject are:

Due to the developed root system and strong sprouting ability of spartina alterniflora, it requires continuous clearance for 3 years. Based on factors such as the distribution of spartina alterniflora patches in the project area, whether mangroves and mangrove seedlings are present within spartina alterniflora, and the difficulty of access, both mechanical and manual methods are employed for clearance. The total area of spartina alterniflora clearing in the subproject is 229.04 h ㎡ , including 208.27 h ㎡ for mechanical clearing and 20.77 h ㎡ for manual clearing.

(1) Technical scheme for mechanical cleaning

(i) Operation method

For the single species of spartina alterniflora growing on bare mudflats without mangrove intermixing, mechanical cleaning will be carried out using dredger. This method will clear an area of 208.27 h ㎡ area covered spartina alterniflora.

(ii) Operation steps

Floating dredger will be used to dig to a depth of over 80 centimeters, uprooting spartina alterniflora entirely. The stems and rhizomes will then be flipped 180° and buried deep in the mud; afterward, the area will be leveled. Taking advantage of the characteristics of the mudflats, a "film" will form on the surface, inducing anaerobic fermentation, causing spartina alterniflora to decompose beneath the mud, effectively eradicating it.

(iii) Inspection, maintenance and management

After the concentrated cleaning in the first year, at least two professionals will be assigned to conduct inspections of the cleared areas using a combination of drone aerial photography and manual visual observation. The inspection interval will not exceed 10 calendar days during the spring, summer, and autumn seasons (i.e., no less than 3 times per month), and no more than 30 calendar days during the winter season (i.e., no less than 1 time per month). Any invasion of Spartina alterniflora will be promptly detected and recorded. Based on the resilient growth of spartina alterniflora and past project implementation experience, the germination rate of spartina alterniflora is expected to be 50% in the second year and 20% in the third year after one mechanical cleaning session. Therefore, during the germination periods in the second and third years, periodic clearing will continue to target the germinated spartina alterniflora. Over the course of 3 years of patrol and management, there will be 20 working days allocated per hectare each year to achieve the desired clearance effect.

(2) Technical scheme for manually clearing

(i) Operation method

For areas where the mangroves are mixed with the spartina alterniflora, a combined method of "cutting + covering" will be employed for clearing, covering an area of 20.77 h ㎡.

(ii) Operation steps

Using the tidal cycle pattern, boats will be advanced to the area for manual clearing of the spartina alterniflora before high tide. After the tide recedes, manual cutting tools such as handheld mowers and sickles will be used to remove the grass stems from the surface. The cut grass stems will be bundled and collected onto the boat. Once the tide rises again, the boat, now filled with the cut grass stems, will be taken to the mechanical clearing area. After the tide recedes once more, the grass stems will be evenly distributed in the area designated for mechanical clearing. Prior to the next high tide, mechanical clearing operations using floating dredger will be promptly carried out, burying the grass stems along with any manually cut ones.

After cutting the spartina alterniflora, which leaves approximately 10cm of rhizomes, manual raking is required to turn over the rhizomes to a depth of about 30cm.

Promptly covering the cut spartina alterniflora roots is essential using low-transparency coverings such as black plastic sheets (1mm thick impermeable film) to suppress their photosynthesis and induce death. During covering, precautions must be taken to prevent mangrove plants and seedlings from being pressed beneath the film. Careful inspection is necessary, and any plants encountered should be promptly avoided, or small holes should be dug in the film to expose the mangrove plants. To prevent overturning by waves, the overlap rate of the impermeable film should be 40%. When covering, the edges of two sheets should be overlapped and buried in the soil to a depth of 60cm, ensuring no gaps between the sheets. Finally, soil should be evenly spread over the surface of the film and pressed down to prevent it from being lifted by wind and waves. The loss rate of the impermeable film is estimated at 10%. During the maintenance period, any damaged areas found due to waves should be

promptly covered to prevent the emergence of bare spots on the surface, which may lead to the re-infestation of Spartina alterniflora.

(iii) Inspection, maintenance and management

After the concentrated cleaning in the first year, at least two professionals will be assigned to conduct inspections of the cleared areas using a combination of drone aerial photography and manual visual observation. The inspection interval will not exceed 10 calendar days during the spring, summer, and autumn seasons (i.e., no less than 3 times per month), and no more than 30 calendar days during the winter season (i.e., no less than 1 time per month). Any invasion of spartina alterniflora will be promptly detected and recorded. To address recurrence areas, centralized cleaning operations should be organized at least once every two months. Additionally, monitoring and management should be conducted for three years, with 20 working days per hectare annually, to achieve effective eradication.

4.1.2.3 Distribution of temporary construction facilities

The subproject focuses primarily on the area around the mouth of the Nanliujiang estuary and the Lianzhou Bay area, (excluding Shankou area) . The construction activities are relatively concentrated within this scope. It is proposed to lease existing residential buildings near the construction area to serve as workers camps. There is no need for temporary land occupation for workers camps. The camps will have workers dormitories, management offices for construction personnel, houses for storing testing and experimental equipment, and some materials. Auxiliary facilities such as machinery repair shops, vehicle maintenance stations, and automobile repair shops can be set by utilizing the existing facilities in nearby towns and villages.

4.2 Planning compliance analysis

4.2.1 Compliance analysis on marine zoning and marine environmental protection planning

4.2.1.1 Marine functional zoning

(1) Marine functional zoning of the project area

The subproject under assessment is located in the northern coastal waters of Beihai City. According to the "Marine Functional Zoning of Guangxi Zhuang Autonomous Region (2011-2020)," it belongs to the Lianzhou Bay area. The Lianzhou Bay unit is situated in the waters from Guantouling to Dafengjiang estuary, with a coastline length of 110.83 km and a sea area of 770.87 km². The primary functions of this area include port shipping, tourism, leisure, and aquaculture, while also accommodating industrial and urban use. Lianzhou Bay prioritizes the development of the Shibuling Port area, focusing on high-tech industries, business, exhibitions, and tourism. Efforts should be made to minimize the impact on the hydrodynamic environment, tidal volume, and channel siltation in Lianzhou Bay. Additionally, the protection of mangroves at the top of Lianzhou Bay is essential, along with promoting tourism development on the eastern coast. Efficient utilization of fishery resources is emphasized, and the area beyond the 15-meter isobath is mainly designated for agriculture and fisheries. It aims to protect economically important fish species such as Decapterus maruadsi and ParargyropseditaTanaka, including their spawning grounds, wintering areas, foraging grounds, and migration routes. Implement the responsibility system for controlling the total amount of pollutant emissions into Lianzhou Bay.

According to the Marine Functional Zoning of Guangxi Zhuang Autonomous Region (2011-2020), the marine functional zone where the subproject is located is Lianzhou Bay Tourism and Leisure Area (Code A5-11).

The marine functional zoning for the project area and adjacent areas can be found in Table 6 and Figure 10.

Table 6 Summary of Marine Functional Zones around the Subproject

Functional planning	Geographic scope	Zone type	Area/ h ㎡	Coastline length (m)	Management requirement			
					Marine area use management		Marine environment protection	
					Land use control	Sea area use control	Key objectives of ecological conservation	Environmental protection
Lianzhou Bay Tourism and Leisure Entertainment Area （A5-11）	The northern waters of Lianzhou Bay, located between 109°0′E - 109°9′E longitude and 21°29′N - 21°40′N latitude.	Tourism and leisure entertainment area	8611	47090	The basic function of the coastline is for tourism and recreational purposes.	Based on comprehensive scientific survey and justification, suitable offshore artificial island construction, coastal highway development, and tourism infrastructure projects can be undertaken in Lianzhou Bay, provided they do not compromise flood control and discharge safety measures.	Maintain the basic morphology of the coastline and preserve the integrity of significant natural and cultural landscapes.	Urban sewage discharge should be controlled to reduce tourism pollution; seawater quality should meet no less than Category III standards, and marine sediment and marine organisms should meet Category II standards.
Lianzhou Bay Industrial and Urban Sea Area Use Zone (A3-7):	Located in the northeast waters of Lianzhou Bay, between 109°	Industrial and urban use of area area	2312	17310	Ensure the urban construction needs of Beihai Cit	Allow for moderate alteration of the natural attributes of the sea area; optimize the plan for coastal reclamation, prohibiting the formation of	Strengthen dynamic monitoring and tracking management of recl	Before the development of the sea area, the environmental quality of the area should be maint

Functional planning	Geographic scope	Zone type	Area/ h ㎡	Coastline length (m)	Management requirement			
					Marine area use management		Marine environment protection	
					Land use control	Sea area use control	Key objectives of ecological conservation	Environmental protection
	6′E - 109°10′E longitude and 21°30′N - 21°35′N latitude.				y.	artificial shorelines by cutting off bays; restrict the layout of projects with high investment intensity and low output rates close to the shore.	amation activities.	ained at its current state.

Figure 10 Marine Functional Zoning Map

(2) Compliance analysis on the project and marine functional zoning

(i) Marine use management requirements compliance analysis

The usage control requirements for the Lianzhou Bay tourist leisure and entertainment area stipulate that the primary coastal function is for tourism and recreational use. The sea area use control requirements for the Lianzhou Bay tourist leisure and entertainment area: based on comprehensive scientific survey and justification, suitable offshore artificial island construction, coastal highway development, and tourism infrastructure projects can be undertaken in Lianzhou Bay, provided they do not compromise flood control and discharge safety measures. The sea area use control requirements for Lianzhou Bay Industrial and Urban Sea Area Use Zone are to meet the urban development needs of Beihai City. The approved marine use methods allow for moderate alterations to the natural attributes of the sea. Optimize the plan for coastal reclamation while prohibiting the creation of artificial

shorelines by cutting off bays and straightening coastlines. Restrict the placement of projects with high investment intensity and low output rates close to the shoreline.

The subproject utilizes the sea for mangrove restoration and removal of invasive species such as spartina alterniflora. Construction primarily occurs during low tide, minimizing disturbance to the marine environment. The subproject aims to enhance the quantity and health of mangroves in Beihai City, without altering the natural attributes of the sea area. Mangroves, often referred to as "coastal guardians," are one of the most productive marine ecosystems in tropical and subtropical coastal zones. They serve as the first line of defense against coastal erosion, provide habitat for numerous bird species, and contribute to water purification, carbon sequestration, and biodiversity maintenance. They are essential habitats for fish and shrimp, and crucial for bird diversity. The implementation of this subproject contributes to improving the quality of tourism in Lianzhou Bay, showing its compliance with the regulatory requirements and management guidelines for marine in the area.

(ii) Ccompliance analysis with marine environmental protection requirements

For Lianzhou Bay Tourism and Leisure Entertainment Area, the key ecological conservation objectives are to maintain the basic morphology of the coastline and preserve the integrity of significant natural and cultural landscapes. Its environmental protection requirements entail controlling urban sewage discharge, reducing tourism pollution, and ensuring that seawater quality meets no less than Category III standards, with marine sediment and marine organisms meeting Category II standards.

In Lianzhou Bay Industrial and Urban Sear Area Use Zone, the primary ecological conservation objective is to enhance dynamic monitoring and tracking management of reclamation activities. Its environmental protection requirements include maintaining the environmental quality of the area at its current state before sea area development.

The construction contents of this subproject involve mangrove restoration in the Nanliujiang estuary and Lianzhou Bay tidal flat areas, and removal of spartina alterniflora in invaded areas of the Nanliujiang estuary. These activities will not affect

the current shoreline morphology. Upon implementation, the project is expected to increase the quantity and improve the health of mangroves in the region, thereby contributing to maintaining the integrity of the natural landscape. During the construction and operation stages of the project, no pollutants will be discharged into the sea. Any suspended solids resulting from construction disturbance will have a limited impact on water quality and the marine ecological environment. This subproject primarily conducts construction during low tide periods, resulting in minimal impact on the marine environment. By implementing effective pollution prevention and environmental mitigation measures, the environmental impact of the construction can be further reduced. Moreover, the project's main environmental impacts are concentrated during the construction stage, and these impacts will diminish upon the completion of construction. Moreover, the construction is in line with the requirements of sea area usage management and complies with marine environmental protection regulations.

In summary, the construction of this subproject aligns with the Functional Zoning of Marine Areas in Guangxi Zhuang Autonomous Region (2011-2020) .

4.2.1.2 Environmental functional zoning for coastal area

According to the Adjustment Plan for Functional Zoning of Coastal Waters in Guangxi Zhuang Autonomous Region (GHF [2023] No. 9), the project area falls within the ecologically significant tidal flats and shallow marine waters of Lianzhou Bay （GX029BⅡ）. The scope of environmental functional zones, their dominant functions, and water quality objectives are detailed in Table 8.

Table 7 Functional Zoning for the Project Sea Area

Name of environmental functional zone	Code	Category of environmental function zone	Location	Area（km²）	Dominant function	Water-quality protection target
Tidal flats and shallow marine waters of Lianzhou	GX029BⅡ	II	Sea area: east from Yanlou Village of Lianzhou Town (E109°9′30″, N21°33′22″) ; west to Anle Village of Xichang Town (E108°59′33″, N21°36′10″); coast	145	Protecting important tidal flats, shallow marine areas, and	Category II

Name of environmental functional zone	Code	Category of environmental function zone	Location	Area（ km²）	Dominant function	Water-quality protection target
Bay			line delineated by E109°7′15″, N21°30′35″ and E108°59′46″, N21°30′37″.		significant wetland ecosystems.	

Figure 11 Scheme for Adjustment of Environmental Functional Zoning for Coastal Area

The construction contents of the subproject include mangrove restoration and removal of invasive species such as spartina alterniflora. The project implementation will enhance the quantity and health of mangroves in Beihai City. Mangroves, often referred to as "coastal guardians," are one of the most productive marine ecosystems in tropical and subtropical coastal zones. They serve as the first line of defense against coastal erosion, provide habitat for numerous bird species, and contribute to water purification, carbon sequestration, and biodiversity maintenance. They are essential habitats for fish and shrimp, and crucial for bird diversity. The project construction will exert an important role in protecting Lianzhou Bay important tidal flats, shallow

marine areas, and significant wetland ecosystems. Therefore, this subproject construction aligns with Adjustment Plan for Functional Zoning of Coastal Waters in Guangxi Zhuang Autonomous Region (GHF [2023] No. 9.

4.2.1.3 Compliance analysis with 14th Five-Year Plan for High-quality Development of Marine Ecological Environment Protection in Guangxi Zhuang Autonomous Region

The 14th Five-Year Plan for High-quality Development of Marine Ecological Environment Protection in Guangxi Zhuang Autonomous Region stipulates that: By 2025, the ecological environment quality of key bays in Guangxi will continue to improve, the trend of marine ecological degradation will be effectively curbed, typical marine ecosystems will be healthy, the stability of ecological service functions in natural reserves will be enhanced, marine environmental risks will be effectively controlled, comprehensive supervision, early warning monitoring, and emergency response capabilities in coastal areas will be significantly strengthened, and public satisfaction with coastal areas will increase. The main indicators for marine ecological environment protection during the "14th Five-Year Plan" period in Guangxi are as follows:

Table 8 Indicator System for Marine Ecological Environment Protection during the "14th Five-Year Plan" in Guangxi

Sl.	Indicators		Targets for 2025
1	Marine environment quality	The proportion of excellent water quality (Category I and Category II) in the coastal waters of the entire Guangxi	93.0%
2		The proportion of inferior Category V river water flow into the sea at national monitoring sections	0
3	Marine ecological protection and restoration	Rate of preservation of natural coastline on the mainland	≥35%
4		Length of coastline restored and rehabilitated	20 km
5		Area of mangrove coastal wetlands restored for ecological purposes	3500 h ㎡
6		Area of mangroves afforested	1000 h ㎡
7	Seaside environment	Length of coastline rehabilitated	10 km
8		Number of bays developed into beautiful coa	3

Sl.	Indicators		Targets for 2025
	Quality	stal areas.	

In this subproject, an area totaling 442.49 h ㎡ of mangrove restoration and approximately 229.04 h ㎡ of Spartina alterniflora clearing will be conducted in the Nanliujiang Estuary and Lianzhou Bay area. Such implementation represents a significant measure for marine ecological protection and restoration. It can facilitate the continuous improvement of the ecological environment quality of Lianzhou Bay, a key bay in Guangxi, and contribute to curbing the degradation trend of marine ecology in the Lianzhou Bay area while enhancing the stability of ecological service functions. Therefore, the project construction aligns with the 14th Five-Year Plan for High-quality Development of Marine Ecological Environment Protection in Guangxi Zhuang Autonomous Region.

4.2.1.4 Compliance analysis with Plan for Delineation of Marine Ecological Red Lines in Guangxi

According to the Plan for Delineation of Marine Ecological Red Lines in Guangxi, the marine ecological red line in Guangxi is divided into prohibited and restricted areas. There are 2 prohibited areas and 8 restricted areas, totaling 54 zones. Among them, there are 5 prohibited areas and 49 restricted areas. The total area of the marine ecological red line in Guangxi is 4100.65 km² (excluding overlapping areas). The area of the marine ecological red line without excluding overlapping areas is 4239.82 km², accounting for 60.12% of the total area of Guangxi's managed sea area. The mainland coastline of Guangxi's sea area is 1628.59 km long. The designated length of natural coastline (beaches) is 585.53 km, accounting for 35.95% of Guangxi's sea area mainland coastline. The total length of coastline on Guangxi's islands is 550.68 km. The designated length of natural coastline (beaches) on the islands is 469.97 km, accounting for 85.34% of Guangxi's sea area island coastline.

According to the Plan for Delineation of Marine Ecological Red Lines in Guangxi (Figure 14), this subproject is located in the restricted area of Lianzhou Bay's important coastal tourism zone (code 45-Xj10) and the restricted area of the Nanliujiang Estuary (code 45-Xc03). The control measures for restricted red line

areas are as follows: (1) In important estuarine restricted areas, activities such as reclamation, sand mining, setting up direct discharge outlets, and other development activities that may disrupt the ecological functions of estuaries are prohibited. Additionally, efforts will be intensified to rehabilitate and restore important estuarine ecosystems. (2) In important coastal wetland restricted areas, activities such as reclamation, mineral resource exploitation, and other development activities that may alter the natural attributes of the sea area or disrupt wetland ecological functions are prohibited. Efforts will also be enhanced to rehabilitate and restore damaged coastal wetlands.

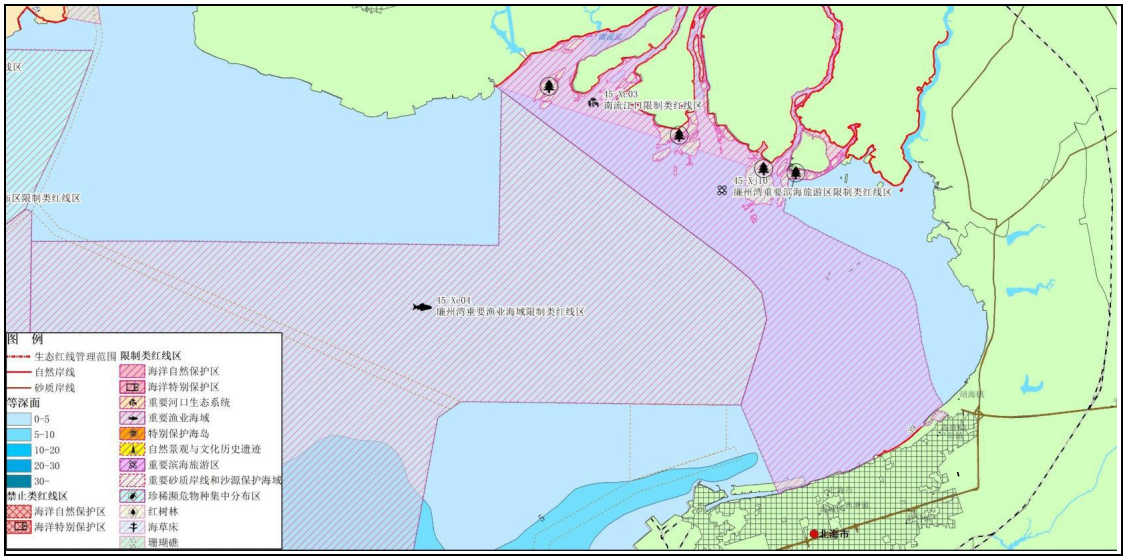


Figure 12 Guangxi Marine Ecological Red Line Control Map — Beihai City (Partial)

This subproject involves mangrove restoration and Spartina alterniflora clearing, activities that do not fall within the prohibited actions specified in the control measures for restricted red line areas, such as reclamation, sand mining, mineral resource exploitation, setting up direct discharge outlets, and other activities that may disrupt estuarine ecological functions or alter the natural attributes of the sea area or disrupt wetland ecological functions. The implementation of the project focuses on the ecological restoration of estuaries and coastal wetlands, aligning with the requirements of the Plan for Delineation of Marine Ecological Red Lines in Guangxi .

4.2.2 Compliance analysis with regional planning

4.2.2.1 Compliance analysis with Opinions of the People's Government of Beihai City on Implementing the Ecological Environment Zoning Control of "Three Lines and One List"

According to the Opinions of the People's Government of Beihai City on Implementing the Ecological Environment Zoning Control of "Three Lines and One List" issued by the Beihai Municipal People's Government in July 2021 (BZF [2021] 8), Beihai City has delineated a total of 71 environmental control units in the nearshore waters. These units are classified into three categories: priority protection units, key control units, and general control units, and are subject to classified management and control. The map of classified coastal waters environmental control units in Beihai City (Partial) is shown in Figure 13.

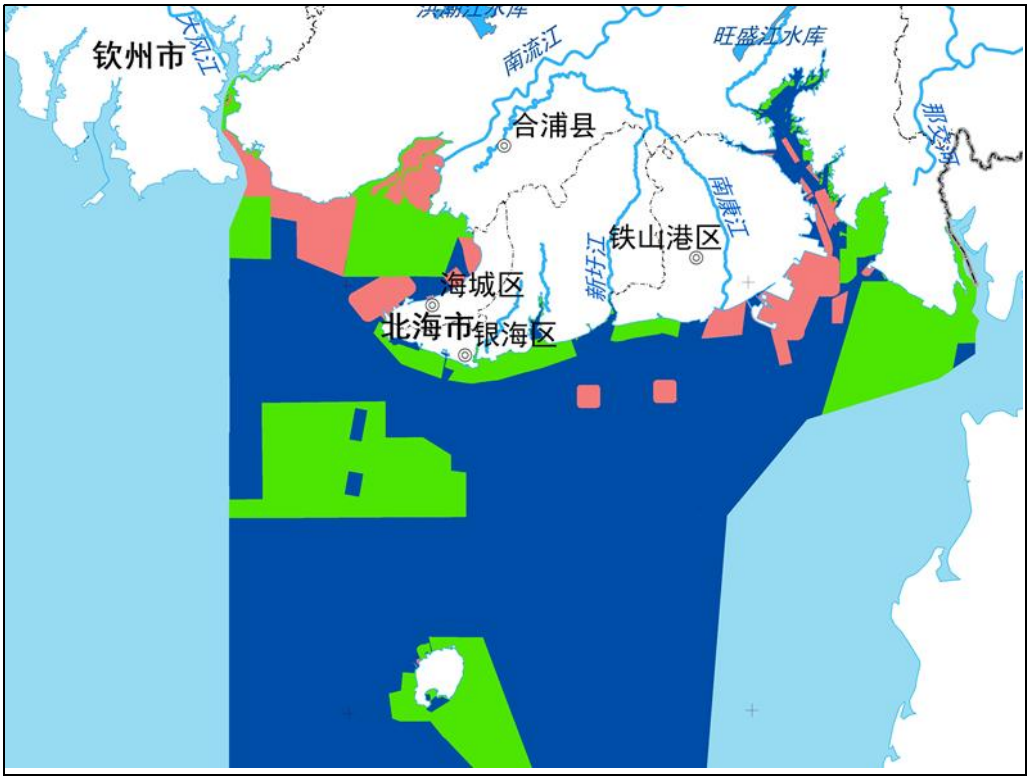


Figure 13 May of Classified Coastal Waters Environmental Control Units in Beihai City (Partial)

This subproject is located within three environmental control units in Beihai city of Guangxi: Shangkou Mangrove National Nature Reserve control unit (Control Code: HY45050010008); Hepu Dangjiang Mangrove Important Wetland Ecological Protection Red Line control unit (Control Code: HY45050010028); Coastal

Ecological Protection Red Line control unit of Lianzhou Bay in Beihai City (Control Code: HY45050010039).

The construction activities of this subproject involve mangrove restoration and Spartina alterniflora clearing. These activities align with the protection objectives of the ecological red line. Therefore, the project construction complies with the requirements of Beihai City's "Three Lines and One List" ecological environment zoning control.

Environmental control unit code	HY45050010008	HY45050010028	HY45050010039
Name of environmental control unit	Guangxi Shankou Mangrove National Nature Reserve Ecological Protection Red Line	Beihai Hepu Dangjiang Mangrove Important Wetland Ecological Protection Red Line	Beihai Lianzhou Bay Coastal Ecological Protection Red Line
Classification of control unit	Priority protection unit	Priority protection unit	Priority protection unit
Spatial layout constraints	1. According to the Guiding Opinions on Coordinating the Delineation and Implementation of the Three Control Lines in National Spatial Planning, the Notice on Strengthening the Management of Ecological Protection Red Lines (Trial) , and the Regulations on the Supervision of Guangxi Ecological Protection Red Lines (Trial)" , in the core conservation areas of natural reserves, human activities are generally prohibited, while in other areas, development or productive construction activities are strictly prohibited. Outside the core conservation areas, development or productive construction activities are also prohibited. Limited human activities are only allowed under the premise of compliance with laws and regulations, and provided they do not damage ecological functions. Once the ecological protection red line is delineated, any unauthorized adjustment is strictly prohibited. In cases where it is deemed necessary to occupy the ecological protection red line for national major project	1. According to the Guiding Opinions on Coordinating the Delineation and Implementation of the Three Control Lines in National Spatial Planning, the Notice on Strengthening the Management of Ecological Protection Red Lines (Trial) , and the Regulations on the Supervision of Guangxi Ecological Protection Red Lines (Trial) , development and production-oriented construction activities are prohibited. Only limited human activities that do not disrupt ecological functions are allowed, provided they comply with laws and regulations. Once the ecological protection red line is delineated, any unauthorized adjustment is strictly prohibited. In cases where it is deemed necessary to occupy the ecological protection red line for national major project construction, the approval process for marine use shall be	1. According to the Guiding Opinions on Coordinating the Delineation and Implementation of the Three Control Lines in National Spatial Planning, the Notice on Strengthening the Management of Ecological Protection Red Lines (Trial) , and the Regulations on the Supervision of Guangxi Ecological Protection Red Lines (Trial) , development and production-oriented construction activities are prohibited. Only limited human activities that do not disrupt ecological functions are allowed, provided they comply with laws and regulations. Once the ecological protection red

	construction, the approval process for marine use shall be conducted in accordance with the procedures stipulated by the state and the autonomous region. 2. The limited human activities permitted are regulated in accordance with the Notice on Strengthening the Management of Ecological Protection Red Lines (Trial) , the Regulations on the Supervision of Guangxi Ecological Protection Red Lines (Trial), as well as the environmental control units at the provincial level of Guangxi and the ecological environment access list. 3. Strict compliance with relevant regulations such as the Regulations on Nature Reserves of the People's Republic of China, the Guangxi Mangrove Resource Protection Regulations and the Management Measures for Shankou Mangrove Ecological Nature Reserves and Beilun River Estuary National Nature Reserves in Guangxi is also required.	conducted in accordance with the procedures stipulated by the state and the autonomous region. 2. The limited human activities permitted are regulated in accordance with the Notice on Strengthening the Management of Ecological Protection Red Lines (Trial) , the Regulations on the Supervision of Guangxi Ecological Protection Red Lines (Trial), as well as the environmental control units at the provincial level of Guangxi and the ecological environment access list. 3. Strict adherence to relevant regulations such as the Law of the People's Republic of China on Wetland Protection, the Regulations on Wetland Protection of Guangxi Zhuang Autonomous Region, and the Regulations on the Protection of Mangrove Resources in Guangxi Zhuang Autonomous Region is also required.	line is delineated, any unauthorized adjustment is strictly prohibited. In cases where it is deemed necessary to occupy the ecological protection red line for national major project construction, the approval process for marine use shall be conducted in accordance with the procedures stipulated by the state and the autonomous region. 2. The limited human activities permitted are regulated in accordance with the Notice on Strengthening the Management of Ecological Protection Red Lines (Trial) , the Regulations on the Supervision of Guangxi Ecological Protection Red Lines (Trial), as well as the environmental control units at the provincial level of Guangxi and the ecological environment access list.

Table 9 Environmental Control Unit of the Project

4.2. 2.2 Compliance analysis with the 14th Five-Year Plan for Ecological Environment Protection of Beihai City

The overall goal of the 14th Five-Year Plan for Ecological Environment Protection in Beihai City is to build a harmonious ecological Beihai for both humans and nature by 2035, essentially achieving the construction goals of Beautiful Beihai. By anchoring the vision for 2035, during the 14th Five-Year Plan period, efforts will be made to essentially construct a harmonious ecological Beihai, striving to become one of the best cities in China in terms of ecology and environmental beauty. The city's image, elegance, and function will be greatly enhanced, transforming into a first-class modern coastal city, and successfully creating a national civilized city and a national ecological garden city.

The 14th Five-Year Plan for Ecological Environment Protection in Beihai City emphasizes the protection and restoration of important estuarine wetlands such as Nanliujiang and and Dafengjiang estuaries, as well as coastal wetlands such as Weizhou Island, Tieshan Port, Yingluo Port, and Xicun Port. It also includes ecological restoration of the bare mudflats from the Marine Industrial Park to Yingpan. Relying on the construction of wetland nature reserves and coastal wetland parks, efforts will be made to expand mangrove wetlands and comprehensively enhance the ecological functions of mangroves.

This subproject will undertake mangrove restoration in the Nanliujiang estuary and Lianzhou Bay area, which aligns with the 14th Five-Year Plan for Ecological Environment Protection in Beihai City.

4.2.2.3 Compliance analysis with Plan for Aquaculture Waters and Tidal Flats in Beihai City (2018-2030)

The Plan for Aquaculture Waters and Tidal Flats in Beihai City (2018-2030) covers both land and marine functional areas under the jurisdiction of Beihai City. By 2030, the plan aims to achieve the following objectives: further optimization of the fishery industry structure, scaling up of aquaculture of characteristic species, revitalization of the pearl industry, significant enhancement of the leading role of

science and technology innovation in aquaculture, notable improvement in the ecological environment of fisheries, and gradual improvement of the policy system benefiting fishermen.

The waters within the jurisdiction of Beihai City are divided into three functional zones: prohibited aquaculture zones, restricted aquaculture zones, and aquaculture zones. The key areas to be protected in the prohibited and restricted aquaculture zones of Beihai City include: 6 drinking water source protection areas; 2 national nature reserves (Shankou Mangrove Ecological Nature Reserve, Hepu Dugong Nature Reserve); 2 important coastal resources (Beihai Coastal Wetland National Park, Beihai Yintan (Silver Beach) - Guantouling Coastal Resource Protection Area); 2 solid mineral areas (Dafengjiang East Bank Solid Mineral Area, Tieshan Port Solid Mineral Area); 1 aquatic germplasm resource protection area (Beibu Gulf National Germplasm Resource Protection Area for Parargyropsedita Tanaka and Penaeus penicillatus); 10 port areas; navigating channel of the entire sea area; key areas for restoration and recovery in Lianzhou Bay; Nanliujiang river (the largest river flowing into the sea in Guangxi); other key harbors, lakes, reservoirs, and important nearshore areas. Accordingly, the plan includes 26 prohibited aquaculture zones and 37 restricted aquaculture zones.

According to the Plan for Aquaculture Waters and Tidal Flats in Beihai City (2018-2030), this subproject is located in the prohibited aquaculture zone. The project implementation can effectively increase the quantity and health of mangroves, thereby protecting marine ecosystems, preserving biodiversity, and improving the ecological environment for fisheries. So, the project construction complies with Plan for Aquaculture Waters and Tidal Flats in Beihai City (2018-2030).

4.2.2.4 Compliance analysis with the Plan for Protection of Mangrove Resources in Beihai City (2020-2030)

According to the Plan for Protection of Mangrove Resources in Beihai City (2020-2030), the total area of mangroves in Beihai City is 4210.99 h ㎡, of which 1162.83 h ㎡ (27.61%) are located within natural reserves and 3048.16 h ㎡ (72.39%)

are outside natural reserves. The plan aims to achieve a mangrove area of 4500 h ㎡ by 2025 and 4600 h ㎡ by 2030. The main types of mangrove communities in Beihai City include rhizophora stylosa, bruguiera, Kandelia obovata, Excoecaria agallocha, Aegiceras corniculatum and auicennia marina. Among them, the auicennia marina, Aegiceras corniculatum, and Aegiceras corniculatum account for 644.97 h ㎡, making them the three main mangrove species in Beihai City. Additionally, there are scattered distribution of rare and endangered species such as Lumnitzera racemosa willd in the vicinity of the Gongguan Town, Hepu County.

The planned goals of the Plan for Protection of Mangrove Resources in Beihai City are: By 2025, all mangroves will have designated management responsibilities; newly planting 624 h ㎡ of mangroves, restoring 1600 h ㎡ of existing mangroves, bringing the total area of mangroves in the city to 4816.78 h ㎡ ; the proportion of mangroves protected in place will reach over 60% through the integration and optimization of natural reserves and the construction of mangrove protection zones; visual monitoring of mangroves will cover the entire city, and the level of protection and management will be significantly improved; and a preliminary mangrove survey, monitoring, and research system will be established. By 2030, the total area of mangroves will remain stable at over 4816.78 h ㎡ , with the proportion of mangroves protected in-place stable at over 60%; a well-equipped, institutionally stable, and advanced mangrove protection management system will be established, with further improvement in supervisory capabilities and standards; comprehensive control of invasive species will be achieved, ensuring the health and stability of the mangrove ecosystem and a noticeable enhancement in ecological functions; the mangrove survey, monitoring, and research system will be further improved; sustainable utilization of mangroves will be essentially realized, and international cooperation and exchanges in mangrove protection and restoration will make a series of achievements.

This subproject plans to restore 442.49 h ㎡ of mangroves in the Nanliujiang Estuary and Lianzhou Bay area. Through proactive mangrove ecological restoration

efforts, the mangrove area will steadily increase, aligning with the objectives outlined in the Plan for Protection of Mangrove Resources in Beihai City (2020-2030).

4.2.2.5 Compliance analysis with the Master Plan for Land and Space in Beihai City (2021-2035)

The Master Plan for Land and Space in Beihai City (2021-2035) encompasses two spatial levels: the city and the central urban area. The planning scope includes the territorial space of both land and sea under the jurisdiction of Beihai City. The planning baseline year is 2020, with the near-term target year set for 2025 and the long-term target year for 2035. The long-range perspective extends to 2050.

The Master Plan for Land and Space in Beihai City (2021-2035) proposes to construct a composite green space system that integrates points, lines, and areas, organically combining artificial and natural environments. This is characterized by an "ecological barrier featuring one belt with two corridors, one spine with multiple spreading veins, and one core with multiple points surrounding." The term "one belt" refers specifically to the coastal ecological resource aggregation belt (including mangroves, beaches, tidal flats, etc.), and the coastal zone of Lianzhou Bay is an important component of this coastal ecological resource aggregation belt.

This subproject will carry out mangroves restoration in Nanliujiang estuary and Lianzhou Bay area to form an ecological barrier. So, the subproject is in alignment with the Master Plan for Land and Space in Beihai City (2021-2035).

4.3 Project institutions and implementation arrangements

4.3.1 Project institutional arrangement

The implementing agency of the Project is Beihai Urban Development and Investment Group Co., Ltd..

The institutional structure for the Project includes: The Project Leading Group for Foreign-funded Project of Beihai City, Project Management Office, Beihai Urban Development and Investment Group Co., Ltd.. Whereas:

1. Project Leading Group

The Project Leading Group (PLG) serves as the highest leadership body for the Project. It is chaired by a leading official appointed by the Beihai Municipal

Government, with the member representatives from relevant government departments such as the Beihai Urban Development Investment Group Co., Ltd., Beihai Oceanic Administration, Water Resources Bureau, Forestry Bureau, Urban Management Bureau, Natural Resources Bureau, Ecological Environment Bureau, Transportation Bureau, and Hepu County. Under the PLG, the Project Management Office (PMO) is responsible for the daily operations of the PLG. The PMO is set at Beihai Development and Reform Commission, with Deputy Director Xie Yousheng concurrently serving as the PMO Director.

The main responsibilities of the PLG include: making decisions related to the Project, approving the overall project plan and implementation schedule, providing policy guidance, coordinating the resolution of project-related issues, and guiding and supervising the implementation of the project.

2. PMO

The PMO operates under the leadership of the PLG, with the responsibilities of:

(1) Overall organization, guidance, coordination, management, and supervision of projects utilizing AIIB loans throughout the city.

(2) Organization of preliminary preparations, work plans, and relevant implementation schemes for projects.

(3) Implementation of decisions made by the PLG and timely reporting of project progress and key developments to the PLG.

(4) Coordination and promotion of management work related to relevant departments and project implementing agency, and resolution of issues arising during project implementation.

(5) Communication and coordination with AIIB.

3. Beihai Urban Development and Investment Group Co., Ltd.

Beihai Urban Development Investment Group Co., Ltd. is the project implementing agency (IA) and is specifically responsible for organizing the implementation and daily management of the project. With the responsibilities of:

(1) Organizing the preparation and submission of project proposals and feasibility study reports.

(2) Organizing the preparation of plans for project-related counterpart funds, finance, procurement, training, etc., and submitting them to the PMO for approval before implementation.

(3) Responsible for project survey, planning and design, tendering and procurement, implementation, management, monitoring, acceptance, and evaluation.

(4) Developing comprehensive annual work plans, semi-annual project progress reports, financial reports, etc.

4.3.2 Implementation progress arrangements

The construction period is about 5 months, scheduled to start in June 2024, and complete in October 2024.

5. Alternatives analysis

5.1 Objectives and principles for alternative analysis

The purpose of alternative analysis is to compare and analyze various options or methods that can be adopted for a project, aiming to optimize the project from an environmental perspective and minimize its environmental impact to the greatest extent possible.

The overall principles of alternative analysis are:

(1) Quantitative comparison principle: Quantify the environmental impact of each alternative solution as much as possible.

(2) Comprehensive comparison principle: Conduct comprehensive comparison and analysis from various aspects including environmental, technical, economic, and social factors.

(3) Compliance principle: The selected solution should comply with relevant development plans and standards, and be adapted to local conditions.

5.2 Zero project analysis

The zero scenario, which means without implementing the Project, will be subjected to comparative analysis from environmental and socio-economic perspectives. The detailed results are presented in Table 10.

Table 10 Zero Project Analysis

Items	With project implementation	Without project (zero project)
Key advantages	Promote the stable development of the mangrove ecosystem in Beihai, achieve the continuous increase of the blue carbon sink represented by mangroves, and enhance the resilience of the marine ecological system in Beihai to climate change.	There are no environmental issues such as ecological destruction, noise, exhaust gas, wastewater, solid waste, etc., during the construction period.
Key disadvantages	(1) During construction, there may be ecological damage and the generation of pollutants such as emissions, noise, wastewater, and solid waste. (2) The project may result in loss of marine biodiversity. (3) The project may pose risks to community safety, fairness in employment opportunities, labor health, labor relations, and labor legality.	It may lead to further degradation of the mangrove ecosystem in the area (rapid spread of invasive species, occupying ecological niches of mangroves, reducing biodiversity, and destabilizing the ecosystem).
Comprehensive analysis	From the sustainable development perspective, implementing the proposed subproject is preferable to the zero alternative.	

5.3 Alternative analysis for cleaning and disposal methods of spartina alterniflora

5.3. 1 Alternative analysis for cleaning method of spartina alterniflora

The total area of cleaning of spartina alterniflora is 229.04 h ㎡. Methods for clearing spartina alterniflora include physical, chemical, and biological control methods. Physical methods include manual removal, cutting, shading, and flooding. Chemical methods mainly involve spraying herbicides, but some herbicides may have adverse effects on surrounding mangroves and the ecosystem's flora and fauna. Biological control methods primarily use biological control agents such as insects and snails, but these methods are still in the experimental stage and have not been widely implemented on a large scale. Detailed information on methods for cleaning spartina alterniflora are shown in Table 11.

Table 11 Comparison of Clearing Methods for spartina alterniflora

	Methods	Advantages	Disadvantages	Environmental and social impacts
Physical method	up-rooting 	1. Environmentally friendly 2. Good results in small-scale removal	1. High cost 2. Great financial and manpower input	**Environmental impact:** It has certain impacts on seawater quality, marine sediments, marine topography and geomorphology, erosion and deposition environment, marine ecological environment, and biological resources, but the impacts are relatively small. **Social Impacts:** Clearing may pose risks to fairness in employment opportunities, labor health, labor relations, and labor legality.
	Cutting 	1. Environmentally friendly 2. Short time, applicable to large area	1. High cost 2. Unable to remove underground rhizomes.	
	Deep tillage 	1. Environmentally friendly 2. Suitable for damaging the underground rhizomes.	1. High cost	
	Shading 	1. Inhibiting the photosynthesis of Spartina alterniflora results, with good removal results.	1. Time consuming 2. Plastic covering films are prone to damage by ocean waves, leading to pollution of the marine ecological environment.	
	Flooding 	1. Good results	1. Time consuming 2. High cost 3. Required to build cofferdam	
	Burning	1. Low cost	1. Burning will easily affect surrounding vegetation 2. So-so clearing effect	
Ch	Glyphosate	1. Quick effect 2. The half-life of	1. Low efficiency	**Environmental impact:**

Methods		Advantages	Disadvantages	Environmental and social impacts
emical methods		pesticide degradation is 33 hours.	2. Residual herbicide.	It has a certain impact on the seawater quality, marine ecological environment, and biological resources, and may affect the flora and fauna in the surrounding mangroves and ecosystems. **Social Impacts:** Clearing may pose risks to fairness in employment opportunities, labor health, labor relations, and labor legality..
	Imazapyr 	1. Good effects 2. Low consumption 3. The half-life of pesticide degradation is 3- 5 days.	1. Residual herbicide.	
	Fluazifop-butyl 	1. Good effects 2. Low consumption	1. Residual herbicide. 2. It is highly stable in water and difficult to degrade. 3. The half-life of pesticide degradation is 15 days.	
	Pyraflufen-ethyl 	1. Good effects 2. Quick effect 3. Low consumption	1. Residual herbicide. 3. The half-life of pesticide degradation is 55- 100 days.	
	Clethodim 	1. Low consumption 3. The half-life of pesticide degradation is 1- 3 days.	1. Low effect	
	Phosphinothricin 	1. Low consumption	1. Residual herbicide. 2. The half-life pesticide degradation is 25 days.	
Biological method	Light cicada	1. Insect eggs can cause damage to the leaves of the Spartina alterniflora.	1. It is in the experimental stage and has not been widely used in practice.	Little environmental impacts.

Based on factors such as the distribution of spartina alterniflora patches in the project

area, whether mangroves and mangrove seedlings are present within spartina alterniflora, and the difficulty of access, both mechanical and manual physical and methods are employed for clearing Spartina alterniflora.

5.3.2 Alternative analysis for disposal of the spartina alterniflora plants

Disposal methods for removed spartina alterniflora plants include deep burial on-site, and resource utilization. The comparative disposal methods are shown in the following table.

Table 12 Comparison of Disposal of Spartina Alterniflora

Items	Deep burial on-site	Resource utilization
Methods	The cleared spartina alterniflora are buried on-site.	Utilized in low-value ways such as for feed, fertilizer, fuel, and raw materials; in high-value ways such as for the production of medicines, health products, high-efficiency bio-batteries, biochar, and extraction of usable genes.
Advantages	The technology is commonly used, will not cause "secondary pollution", without additional land occupation.	Turning the wastes into treasures, with yielding high-value products.
Disadvantages	It is labor-intensive and time-consuming, increasing the cost of mechanized farming.	Some processes are still in the experimental research stage and are far from being scaled up, commercialized, or industrialized.
Environmental impact	Construction disturbance of tidal flats can cause certain impacts on marine sediments, erosion and siltation environments, etc.	The process of resource utilization will generate pollutants such as exhaust gases, wastewater, solid waste, noise, etc.
Social Impacts	Construction may pose risks to fairness in employment opportunities, labor health, labor relations, and labor legality..	Involving more primary stakeholders, which will increase the project's complexity and has a greater impact on its effectiveness.

Based on local characteristics and common treatment methods, this subproject considers mechanically clearing the area and burying the debris on-site. Additionally, the grass stems generated from manual cutting will be transported to the mechanical cleaning area and buried together.

6. Analysis of associated facilities

The term "associated facilities" refers to activities not explicitly outlined in the project description but identified by the bank after consultation with the client as: (i) directly and materially related to the Project; (ii) carried out, or planned to be carried out, contemporaneously with the Project; and (iii) necessary for the Project to be viable and would not be carried out if the Project did not exist.

The construction contents of the AIIB financed project (Subproject 2) under AIIB financing include: mangrove restoration 442.49 h ㎡ ; cleaning of spartina alterniflora 229.04 h ㎡. The implementation area is concentrated in Nanliujiang estuary and Lianzhou Bay area (excluding the Shankou area) . The goal is to restore and increase mangrove coverage.

Based on the definition provided for associated facilities, this subproject does not involve any “Associated Facilities”.

7. Environmental baseline analysis

7.1 Overview of natural environment

7.1.1 Geographical location

Beihai is a prefecture-level city in the Guangxi Zhuang Autonomous Region, located on the eastern coast of the Beibu Gulf in southern Guangxi, between 108°50′45″ E to 109°47′28″ E longitude and 20°26′ N to 21°55′34″ N latitude. Beihai is an important node city in the Beibu Gulf Urban Agglomeration and the Guangxi Beibu Gulf Economic Zone. The city spans approximately 114km north to south and 93km east to west. To the east, it borders Guangdong Province, while to the south, it faces Hainan Province across the sea, and to the west, it borders Vietnam. Distances from Beihai Port: 124 nautical miles to Haikou, 255 nautical miles to Zhanjiang, 480 nautical miles to Guangzhou, 425 nautical miles to Hong Kong, and 157 nautical miles to Hai Phong, Vietnam. By road, it is 204km to Nanning, 106km to Qinzhou, and 171km to Fangchenggang. Administratively, Beihai is divided into 3 districts (Haicheng, Yinhai, Tieshangang) and 1 county (Hepu), covering a total area of 3,337 k㎡.

7.1.2 Geological and landform features

(1) Terrain and landforms

The project area is located on the coast of the Beibu Gulf, belonging to the southwest edge of the coastal mountainous and hilly area in southeastern China. It faces the Beibu Gulf to the south, with the terrain generally higher in the northwest and lower in the southeast. The landforms can be roughly divided into four units: low mountains and hills, alluvial plains, estuarine deltas, and coastal alluvial plains.

Low mountains and hills: Located in the northwest part of Xiniujiao-Ujia-Quanshui, with large undulations in terrain, ranging in elevation from 50m to 500m. Alluvial plains or river terraces: Located on the southeast side of the low mountains and hills, extending from northeast to southwest along both banks of

the Nanliujiang river, distributed between the above line and the line connecting Huancheng-Shikangzhen town - Lingjiao, with relatively flat terrain resembling gentle slopes, and elevations ranging from 5m to 70 m.

Estuarine deltas: Located at the estuary of the Nanliujiang River, mainly concentrated in the southern coastal area of the survey area, particularly around Dangjiang Town, Shagang Town, and Lianzhou Town. The terrain is flat and open, with well-developed water systems resembling branching patterns, and elevations ranging from 1m to 5m.

Coastal alluvial plains: Distributed along the coastline of the Beibu Gulf, with flat and open terrain sloping slightly towards the sea level, and elevations ranging from 0-2m.

(2) Lithology

The exposed strata in the project area mainly consist of Quaternary, Tertiary, Devonian, and Indosinian strata. The lithology of each stratum is described as follows:

(i) Quaternary: Widely distributed in the southern part of the project area, comprising the main strata in the area. The lithology includes clayey sand, gravelly sandstone layers, coarse sand, fine sand, silt, etc.

(ii) Tertiary: Only found in the western part of the project area around Ujia, characterized by clayey sand, gravelly sandstone layers, sandstone, conglomerate, clay layers, and lignite.

(iii) Devonian: Mainly distributed along the northeast-southwest axis of the Gongguan in the central part of the project area, as well as in areas such as Mengyong and Shanzi in the east. The main lithologies are quartz sandstone, conglomerate, sandstone interbedded with shale.

(iv) Silurian: Mainly distributed in the northwest part of the project area around Shantang, Shengping, and Shuiputan; the northern part around Yangshao; the central part around Naliao; the northeastern part around Dashuikeng; and the eastern part around Rongcun and Lingzi. The basic lithologies include quartz sandstone,

sericite-quartz mudstone, fine-grained quartz sandstone, and silty sericite-quartz mudstone.

(v) Igneous rocks: Mainly found in the eastern part of the project area around Qingpingxu, Dadongxu, and in the northern part around Anshixu. There are also small amounts distributed in the northwest part around Nasixu. The main lithologies include granite, biotite granite, and diorite.

(3) Geological structure

The project area belongs to the second-order unit of the Beibu Gulf Sag in the South China Fold System, which has undergone multiple tectonic movements such as the Caledonian, Hercynian-Indosinian, Yanshan, and Himalayan movements, forming a series of folds, faults, and multiple structural basins. According to the nature, scale, and combination arrangement of various structural features, it can be roughly divided into the Huaxia-Xinhuaxia series structures, east-west structures, and northwest structures. The project area is located in the Hepu Basin, belonging to the Huaxia-Xinhuaxia series structure, with the Nalujiang Fault being the main feature. Based on regional geological data and field surveys, the project area is considered a relatively stable area with no evidence of active fault traces.

7.1. 3 Seismic intensity

The project area belongs to the second-order unit of the Beibu Gulf Sag in the South China Fold System, which has undergone multiple tectonic movements such as the Caledonian, Hercynian-Indosinian, Yanshan, and Himalayan movements, forming a series of folds, faults, and multiple structural basins. According to the nature, scale, and combination arrangement of various structural features, it can be roughly divided into the Huaxia-Xinhuaxia series structures, east-west structures, and northwest structures. The project area is located in the Hepu Basin, belonging to the Huaxia——Xinhuaxia series structure, with the Nalujiang Fault being the main feature. Based on regional geological data and field surveys, the project area is considered a relatively stable area with no evidence of active fault traces.

According to the "China Earthquake Parameter Zoning Map" (GB18306-2015），the peak acceleration of ground motion in the project area value is 0.05g, the basic

seismic intensity is VI, showing regional stable structure.

7.1.4 Meteorological climate

The project area is located in the southernmost part of Guangxi, south of the Tropic of Cancer, with relatively low latitude. It has a maritime monsoon climate with typical subtropical characteristics. During the winter months (October to March of the following year), the area is mainly influenced by the northerly monsoon, while during the summer months (April to September), it is primarily affected by the tropical high pressure, strong winds, and southerly monsoon.

The main climatic features include continuous autumn and summer, with a long summer and no severe heat. The climate is generally pleasant. The annual average sunshine duration is 2089.3 hours, and the total solar radiation is 4923 megajoules per square centimeter per year, making it the region with the richest solar radiation in Guangxi. The annual average temperature is 22.6°C, with an average maximum temperature of 26.5°C and an average minimum temperature of 19.8°C. The average number of days with a maximum temperature greater than or equal to 35°C is 0.4, and the average number of days with a minimum temperature less than or equal to 0°C is 0. In recent years, there has been a trend of increasing annual average temperatures in Beihai. According to meteorological data from 2000 to 2020, the annual average temperature in Beihai has risen from 22.6°C to 23.5°C, an increase of about 1°C. The annual accumulated temperature is approximately 7994.8°C. The rainfall is abundant, with distinct wet and dry seasons. The average annual rainfall days are 136, with an average annual rainfall of 1683.0 mm. There is significant inter-annual variability in rainfall, resulting in relative wet and dry seasons. The rainy season occurs from April to September, dominated by the southerly monsoon, while the dry season spans from October to March, dominated by the northerly monsoon.

7.1.5 Hydrological conditions

(1) Overview of the watershed

The main rivers flowing into the Lianzhou Bay include the Nanliujiang River, Haogang River, Ximenjiang River (Nanzhoujiang River), Hougoujiang River, Longtoujiang River, and Qixingjiang River, among which the Nanliujiang River is the

largest river flowing into the sea along the coast of Guangxi. The Nanliujiang River flows into the sea in three places in Dangjiang Town, through Shagang Town, through Yanlou Village in Lianzhou Town, forming a grid-like river system at the estuary, creating the largest delta in Guangxi — the Nanliujiang River Delta. According to data from the Hydrological Station, the average annual runoff volume of the Nanliujiang River is $68.3\times10^8m^3$, and the average annual sediment load is 118.0×10^4t.

The Nanliujiang River is the largest river among the coastal rivers in southern Guangxi, originating from Darongshan Forest Farm in Xinxu Town, Beiliu City. It flows south through Xilangang and Xinxu Towns in Beiliu City, and Maolin Town in Yuzhou District, then turns southwest, passing through Nanjiang, Fumin, Zhangmu, Xinqiao, Wanhe, Shatian Townships, as well as Chengxiang, Lvzhu, Yashan, Dali, Dun Valley, Hejiang, Shahe, and Lingjiao Townships of Bobai County, as well as through Shichong, Quanshui Towns in Pubei County, and Changle, Shikang, Shiwan, Lianzhou, Dangjiang Towns in Hepu County. From Shiwan Town in Hepu County, the Nanliujiang River enters the area with developed river networks. There are four major tributaries flowing into the sea, namely the main stream of the Nanliujiang River, the eastern channel of the Nanliujiang River, the western channel of the Nanliujiang River, and the Zhoujiang River. Due to sediment deposition, the mouth of the Nanliujiang River has formed a delta with an area of up to 550 k ㎡, extending from the top to Changle Town, with a length of about 50 km from northeast to southwest and an average elevation of 40 m. The modern sediment thickness is over 10 m.

The Nanliujiang River basin covers an area of 9168 k ㎡, with an average slope of 0.395‰ and an average width of 32.4 km. The total length of the main and tributaries of the Nanliujiang River is 2032 km, with 61 tributaries and a river network density of 0.222 km/k ㎡. The main and tributaries span eight counties (cities, districts) in three prefecture-level cities of Yulin, Qinzhou, and Beihai. In Hepu County, there are 13 major tributaries such as Zhanghuang River, Wuli River, and Hongchao River, with a total catchment area of 2774.4 k ㎡.

The main stream of the Nanliujiang River in Hepu County is 102.5 km long. The section of the main stream of the Nanliujiang River, between the downstream of the

Zongjiang Bridge lock and the upstream of the Xishan Bridge in Dangjiang Town for about 300 m, is called the main stream of the Zongjiang River. From the Zongjiang Bridge lock downstream to about 4 km downstream is the confluence of the Zongjiang and Nijiang rivers. About 300 m upstream of Xishan Bridge in Dangjiang Town, it naturally divides into two river channels, known as the east and west channels of the Nanliujiang River. The eastern channel of the Nanliujiang River is meandering, flowing from north to south after natural diversion. It passes through Dangjiang Town, Dakuang Village, and Lanxing Village, and enters the sea near Xinkuang Tun in Shaqi Village. About 500m upstream of the Zongjiang Bridge lock, there is an artificial canal connecting the Zongjiang River and Zhoujiang River.

The Zhoujiang River is a downstream natural diversion channel of the Nanliujiang River, with a drainage area of 192 k ㎡ and a total length of 47.7 km. The river meanders from northeast to southwest, passing through the lower reaches of Zhoujiang Kou for 18.6 km, dividing the urban area of Hepu County into two parts. It flows into the Beibu Gulf 15 km downstream from the county seat at Jiufentian. Upstream of the urban area of Hepu County, there are first-level tributaries such as Qilijiang River and Qingshuijiang River. In 1958, the Qingshuijiang Reservoir was built on the Qingshuijiang River, with a total capacity of 70.5 million cubicm and a controlled drainage area of 52 k ㎡. The river has a length of 39.25 km.

Details of the main water systems in Beihai City are shown in the follow map.

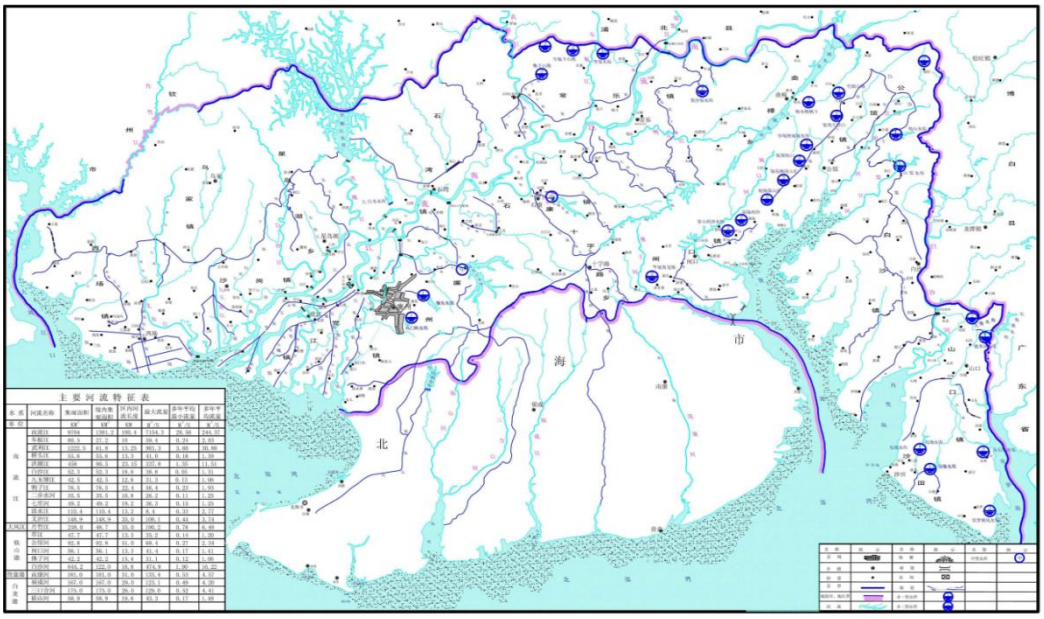


Figure 14 Major Water Systems in Beihai City

(2) Overview of the sea area

The Lianzhou Bay is located on the northern edge of the Beibu Gulf, in the northern part of Beihai City. It is a semicircular water area surrounded by a line connecting Guantouling to the mouth of the Nanliujiang River along the coastline. The bay mouth extends southwestward, with a north-south span of approximately 17.3 km and an east-west span of about 28.4 km. The coastline is approximately 128 km long, covering an area of about 500 k ㎡, making it one of the five major bays in Guangxi. The southern coastline features interconnected mountains and seas, including Guantouling, the Cruise Terminal (under construction), the Ancient Fort, Waisa Island, Zhuhai Old Street, and Golden North Shore (a leisure tourism belt), as well as the historical and cultural ancient town of Gaode (initially built). The northern coastline includes the starting port of the Han Dynasty Maritime Silk Road (initially built), numerous estuaries of the Nanliujiang River, and extensive mangrove forests along the shore.

Lianzhou Bay is a faulted estuary bay composed of Quaternary sedimentary layers. The surrounding land around the bay is mostly alluvial-fluvial plains, characterized by flat terrain with elevations ranging from about 8 to 10m. Rivers such as the Nanliujiang River, Zhoujiang River, and Qixingjiang River flow into Lianzhou

Bay, depositing sediments at the river mouths and forming river delta areas. The coastal landforms of Lianzhou Bay mainly include erosional remnants, alluvial-fluvial plains, marine-fluvial plains, marine erosion landforms, and marine sedimentary landforms. Underwater landforms consist of tidal sand ridges, tidal channels, and underwater deltas. The project area is located on the southern coast of Lianzhou Bay, in the northern part of Beihai City, facing the mouth of the Nanliujiang River to the south. The coastline of the project area consists of sandy beaches, with sandy beaches in the intertidal zone gradually transitioning to muddy flats towards the low tide zone. Due to the relatively weak hydrodynamics of Lianzhou Bay and abundant sediment sources, the sand content increases below the low tide zone, showing a tendency to transition to muddy flats.

The main rivers flowing into the Lianzhou Bay include the Nanliujiang River, Haogang River, Ximenjiang River (Nanzhoujiang River), Hougoujiang River, Longtoujiang River, and Qixingjiang River, among which the Nanliujiang River is the largest river flowing into the sea along the coast of Guangxi. The Nanliujiang River flows into the sea in three places in Dangjiang Town, through Shagang Town, through Yanlou Village in Lianzhou Town, forming a grid-like river system at the estuary, creating the largest delta in Guangxi — the Nanliujiang River Delta.

In recent years, the urbanization and industrialization processes along the coast of Lianzhou Bay have accelerated. Livestock and poultry farming along the coastal areas and aquaculture in the bay have rapidly and disorderly developed. This has led to a sharp increase in various pollutants entering the bay, resulting in a worsening trend of water quality in Lianzhou Bay. With the continuous advancement of marine development and utilization in Lianzhou Bay, the current area of aquaculture is excessive, with high stocking densities. The numerous oyster farming structures have increased resistance to seawater flow. As a result, pollution in the bay has become severe, leading to localized degradation of the marine ecosystem and serious siltation in harbors. The coastline of Lianzhou Bay was originally characterized by excellent sandy beaches. However, due to various factors, there has been significant degradation of these beaches. Additionally, the area behind the high-tide line is

narrow in many places, with the high-tide line encroaching directly on the shoreline. This lack of space during high tide restricts recreational activities such as beach play and relaxation. Furthermore, some areas in the low-tide zone contain construction debris and abandoned stones, affecting the aesthetics and posing safety hazards for activities such as swimming. In the nearshore waters below the low-tide zone, there are also remnants of aquaculture activities and associated structures.

(3) Overview of coastal erosion

Coastal erosion refers to the process where the sediment supply to a certain section of the coastal zone is less than the sediment transport by waves, coastal currents, and tides, leading to a decrease in beach elevation and retreat of the shoreline.

In recent years, the construction momentum of the coastal economic belt in Beihai City has been strong. Significant developments have been made in coastal urban construction, as well as the construction of coastal roads, ports, and terminals. However, these coastal marine engineering projects often lack sufficient emphasis on the protection and utilization of coastal beach resources. Illegal sand mining and construction activities on beaches have also occurred from time to time. These activities have altered the natural landscape of coastal beaches and the hydrodynamic conditions of the coastline, leading to localized coastal erosion in some coastal areas. In the project area, sections such as Shajiao, Lingdi, and Dongwei exhibit significant coastal erosion. Coastal erosion results in the loss and degradation of coastal beaches, as well as damage to coastal engineering and roads.

7.1.6 Marine resources

(1) Port resources

Beihai City has a winding coastline with numerous harbors and estuaries along its more than 500 km coastline. In addition to the mainland, there are also islands such as Weizhou Island and Xieyang Island located more than 20 sea miles away, indicating significant potential for the development and utilization of port resources.

Beihai Port is divided into eight port areas: Tieshan Port Area, Shibuling Port Area, Weizhou Port Area, Dafengjiang Port Area, Dijiao Port Area, Qiaogang Passenger and Tourist Pier Port Area, Langen Port Area, and Shatian Port Area. Among them, the Shibuling Port Area is located at the southern end of Leizhou Bay, in the middle section of the coastline from Dijiao to Guantouling. There is a natural deep trough extending straight out to the sea beyond the coastline, with a depth of 8 to 10m and no sandbars obstructing it. The port has favorable conditions for construction. Currently, there are four berths with a capacity of over 10,000 tons and one berth with a capacity of 5,000 tons, with a total quay length of 886m.

(i) Current situation of the ports

The main port resource in Lianzhou Bay is the Shibuling part area of Beihai Port. Currently, the Shibuling port area has a total of 10 berths, including one berth for 35,000-ton vessels, one for 20,000-ton vessels, two for 10,000-ton vessels, four for 5,000-ton vessels, and two for 3,000-ton vessels, with a total quay length of 1718m. The land area of the port area is 78.76 h ㎡. The annual throughput capacity of the port area is 3.68 million tons, including a container throughput capacity of 40,000 standard containers. The main business includes bulk cargo, general cargo, oil products, and containers.

(ii) Current handling capacity

Beihai Port's Shibuling Port Area currently handles mainly metal ores, non-metallic ores, fertilizers, grains, general cargo, and containers.

(iii) Current status of the navigational channel

The existing navigational channel in the Shibuling Port Area is suitable for vessels of up to 50,000 tons. It aligns with the direction of the deep trough in the Lianzhou Bay, running from the south of the offshore mountains, then turning east to enter the Shibuling Port Area. The channel is straight, without hidden reefs or sandbars, facilitating navigation. The total length for the entrance channel to the Tieshangang Port Area for vessels of up to 50,000 tons is 29.312 km, with the outer channel being 14.816 km long. Except for the inner channel, which widens to more

than 180m like a trumpet shape, the width of the remaining sections is 160m. The bottom depth of the channel is -11.5m, with a tidal range of 3.32m with approximately 2.2 hours of duration, with a reliability rate of 70%. Currently, there is one lighthouse, two beacons, and 20 light buoys in the channel, and the port area is equipped with a set of Differential Global Positioning System (DGPS) navigation monitoring systems.

Figure 15 Diagram of 50,000-tonnage Inbound Channel for Shibuling Port Area in Beihai Port

Figure 16 Diagram of 50,000-tonnage Inbound Channel for Tieshangang Port Area

Due to the ecological degradation in the upstream of the Nanliujiang River, sedimentation has occurred at the downstream estuary, causing the navigation channel to become shallower and narrower. The river continuously bifurcates, ultimately splitting into five outlets to the sea. Presently, as the outbound navigation channel of the Nanliujiang River gradually silted up, the area around the estuary of the Lianzhou Bay has turned into shoals, rendering the estuary inaccessible. Ships are unable to reach the inland river.

(2) Tourism resources

Located in the subtropical region, Beihai City enjoys a warm and humid climate with fresh air. The coastal area, represented by the renowned Silver Beach, boasts picturesque scenery and possesses all the elements necessary for developing coastal tourism, including "sea, sun, and beaches". In the surrounding urban areas, there are mainly four categories of tourism resources: coastal, scenic, cultural, and historical sites.

Coastal tourism resources and development projects in the project area include:

(i) Guantouling ridge

Located at the southwest end of Beihai City, Guantouling Ridge is a small mountain ridge composed of Silurian strata, with its main peak reaching up to 120m. Facing the sea on the east and south sides, it has formed numerous unique sea erosion cliffs, caves, and cavities due to the action of waves and tides. There are well-developed sandy beaches in the small bays at the foot of the ridge, offering beautiful coastal environments and rich marine biodiversity. Visitors can enjoy spectacular sunrise and sunset views. At the foot of the ridge, visitors can appreciate the coastal wonders, while the beachside bathing areas offer delightful experiences. The mountain is covered with dense tropical forests and orchards. About 8km from the city center of Beihai, a scenic road has been constructed through the mountains, developing the mountain-sea scenery into the Guantouling Ridge Forest Park eco-tourism area.

2) Coastal Scenic Road (Haijing Avenue)

The Haijing Avenue is mainly constructed on sandy coastlines or beaches. It runs along the coastline of the Beihai Peninsula, encompassing the coastal areas surrounding Beihai City. The road begins at Qianjiang Yanlou in Hepu and ends at Daguantou, totally 51km in length. Currently, completed sections include Yanlou - Shangri-La, Guantou Ridge - Dadunhai, and Qiaogang - Daguantou.Once all completed, this road and the leisure tourism spots along it will add a significant scenic attraction to Beihai's tourism. Moreover, it will provide great convenience for Beihai's coastal tourism and travel transportation.

(3) Fishery resources

The fishery resources in Beihai City are abundant. The coastline stretches from Yingluo Bay, near the border with Lianjiang County in Guangdong Province, to Dafengjiang River, near the border with Qinzhou City, covering a total length of 500.13km. There are seven fishing ports along the coast, with urban centers as their bases. Among them, Beihai Neigang port, Nanwan Fishing Port (also known as Beihai Fishery Base), and Yingpan Fishing Port are national central fishery ports, while Dianjian and Shatian ports are national primary community fishery ports. Gaode and Weizhou Nanwan are small-scale fishery ports. Additionally, there are some habitual small fishing harbors. Beihai City is located on the shores of the Beibu Gulf, with a total area of approximately 128,000 k ㎡. It is a tropical and subtropical inland sea with natural conditions highly suitable for the rapid growth and reproduction of various marine organisms. It is renowned as one of China's famous fishing grounds and is the main traditional operating area for fishing vessels in Beihai City. The marine biological resources in the Beibu Gulf are rich. According to survey data, there are over 900 species of fish, including more than 50 economically important species. There are over 200 species of shrimp and crab, including more than 10 economically important shrimp species. Crab species include swimming crabs (spotted crab, robber crab), three-spotted crab, red crab, and scylla serrata crab etc. . Economically important shellfish species include Pinctada martensii, venus clam, oyster, amusium shell, atrina pectinata shell, and lotorium snail. According to estimates, the estimated

reserves of fishery resources in the Beibu Gulf are approximately 1.8 million tons, with shrimp resources exceeding 40,000 tons. Furthermore, the area extending from the eastern part of Leizhou Peninsula to eastern Guangdong, eastern Hainan, the outer sea of the Beibu Gulf, and the South China Sea area of the Nansha Islands are also the important fishing grounds for Beihai City's fishing vessels.

(4) Mangroves resources

The mangrove resources in Beihai City currently cover an area of 4192.78 h ㎡. They are distributed along the coastal mudflats in one county, three districts, and 16 townships (subdistricts) within the jurisdiction of the city. Among them, 1142.30 h ㎡ (27.24%) are located within natural protected areas, while 3050.48 h ㎡ (72.76%) are located outside natural protected areas. By administrative region, in Hepu County, mangroves cover 3748.28 h ㎡, involving nine townships including Baisha, Gongguan, Zhakou, Lianzhou, Shagang, Xichang, Dangjiang, Shatian, and Shankou. In Haicheng District, the area is 31.96 h ㎡, involving Gaode Subdistrict. In Yinhai District, it covers 373.72 h ㎡, involving towns such as Fucheng, Pingyang, and Yintan. In Tieshan Port Area, it is 38.82 h ㎡, involving towns like Nankang, Xinggang, and Yingpan. In terms of land type, the area covered by mangroves includes 123.85 h ㎡ of mangrove forests (2.95%), 4020.52 h ㎡ of shrub forests (95.89%), and 48.41 h ㎡ of non-forested land suitable for afforestation (1.15%). The main types of mangrove communities in Beihai City include rhizophora stylosa, bruguiera, Kandelia obovata, Excoecaria agallocha, Aegiceras corniculatum and auicennia marina. Among them, the auicennia marina are 2172.71h ㎡, Aegiceras corniculatum are 1171.66h ㎡, and Aegiceras corniculatum are 644.97 h ㎡, making them the three main mangrove species in Beihai City. Additionally, there are scattered distribution of rare and endangered species such as Lumnitzera racemosa willd in the vicinity of the Gongguan Town, Hepu County.

Beihai City currently has nine natural protected areas, with a total approved area of 35,900 h ㎡. Among them, the sea area is 25,600 h ㎡, and the land area is 10,300 h ㎡. The land area of natural protected areas accounts for 2.58% of Beihai

City's total land area, while the sea area accounts for 8.3% of the city's total sea area. The city has six types of protected areas, including natural reserves, wetland parks, marine parks, and others. Specifically, there are four natural reserves, including two national-level and two provincial level, covering an area of 29,800 h ㎡. There is one provincial level scenic spot without official approval, one provincial level forest park covering 400 h ㎡, one national wetland park covering 2009.8 h ㎡, one national geological park covering 1142.6 h ㎡, and one national marine park covering 2512.92 h ㎡. The mangrove restoration and spartina alterniflora clearing plots will involve the Qixing Mangrove Protection Area in Hepu County, the Muan Mangrove Protection Area in Hepu County, and the Dongwei Mangrove Protection Area in Haicheng District. They do not involve natural reserves or wetland parks.

In Beihai City, the main harmful organisms in the mangroves include species such as Spartina alterniflora, sonneratia apetala, Laguncularia racemosa, and derris. Regarding invasive species, according to the survey report on Spartina alterniflora distribution along the coastal mudflats in Beihai City in 2018, the total area covered by Spartina alterniflora along the coastal mudflats in Beihai City was 780.34 h ㎡, distributed as follows: 567.53 h ㎡ in Hepu County, 181.83 h ㎡ in Tieshan Port District, 30.89 h ㎡ in Yinhai District, and 0.08 h ㎡ in Haicheng District. In terms of potential invasive species, sonneratia apetala, Laguncularia racemosa have spread to varying degrees since their introduction to Beihai City. Currently, sonneratia apetala is mainly concentrated in Lianzhou Bay, while Lumnitzera racemosa is primarily found within the Beihai Fengjiajiang area, part of the Beihai Coastal National Wetland Park. Regarding other harmful organisms, derris, another important harmful species in Beihai's mangroves, poses a new threat to the mangrove ecosystem by spreading extensively through climbing and covering. The preliminary survey area of derris in Beihai City is approximately 176 h ㎡, mainly concentrated in the Dangjiang area of Hepu. In the existing suitable mangrove mudflats, Spartina alterniflora is mostly distributed, with the remaining mudflats generally having low elevations and poor site conditions. The restoration of aquaculture ponds and salt fields for mangrove planting

involves land acquisition and relocation issues. Comparatively, the difficulty of land acquisition for salt field restoration is lower than that for aquaculture pond restoration.

The rich mangrove resources in Lianzhou Bay are mainly distributed along the northern coast of the bay, particularly along the coastline near the mouth of Nanliujiang River. The existing mangrove areas along the coastlines of Dangjiang, Shayong, and Yujiang are 126.11 h ㎡, 187.03 h ㎡, and 47.4 h ㎡ respectively. Specifically, the mangrove area along the coastlines of Muan of Dangjiang town is 23.47 h ㎡, and Sandong of Shagang is 24.72 h ㎡. Additionally, the mangrove area along the coastlines of Qixing is 47.4 h ㎡, and Xichang Dongjiangkou is 20.9 h ㎡. The total mangrove area in the bay's mudflats amounts to 504.63 h ㎡.

The main mangrove species in the mudflats along the northern coast of Lianzhou Bay include Lumnitzera racemosa willd, Kandelia obovata, Aegiceras corniculatum, auicennia marina, Acanthus ilicifolius, bruguiera, hibiscus trionum, Thespesia populnea, bruguiera, acrostichum aureum etc. The well-developed tidal channels within the mangrove area serve as the primary habitat and activity area for marine organisms. The construction of mangrove areas not only significantly contributes to preserving the biodiversity of mangrove ecosystems and studying their ecological functions but also holds practical value in the development of nearshore fisheries, coastal protection, and the conservation of land and water resources.

The total area of mangrove restoration of this subproject is 442.49 h ㎡, including 229.04 h ㎡ of Spartina alterniflora clearing, which is located in the Nanliujiangr estuary and Lianzhou Bay area of Beihai City. The detailed relative spatial relationship thereof is illustrated in Figure 17.

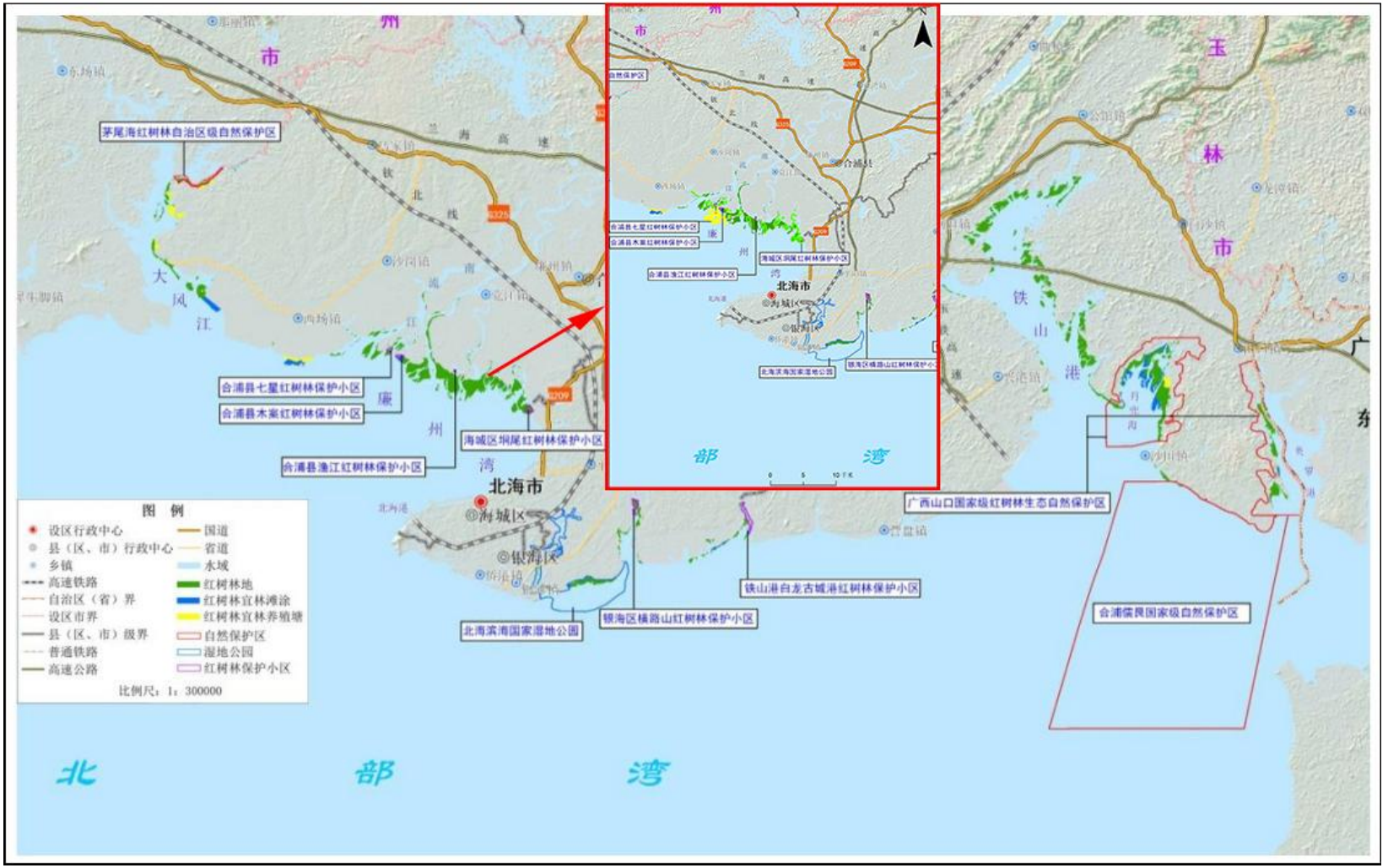


Figure 17 Current Situation of Mangrove Resources Distribution in Beihai City

(5) Coastal resources

Beihai City boasts rich coastal and mudflat resources, with a coastline stretching from Yingluo Bay, adjacent to Lianjiang County in Guangdong Province, to Dafeng River, bordering Qinzhou City, spanning a total length of 500.13 km. The coastal areas of Beihai have a shallow sea and mudflat area of 200,000 h ㎡ within the 10-meter isobath, with mudflats covering 55,300 h ㎡. The mudflat types are diverse, including sandy beaches, muddy beaches, rocky beaches, coral beaches, muddy beaches, and mangrove beaches.

7.1.7 Fauna and flora resources

In 2020, Beihai City had 858 species of vascular plants belonging to 594 genera and 157 families (including cultivated and wild plants), with the majority of families and genera having a tropical distribution. Among them, there were 15 species of mangroves and semi-mangroves belonging to 15 genera and 12 families in tropical coastal ecosystems, along with 8 species of salt marsh plants and 8 species of seagrasses. The diversity of animals in Beihai City includes 203 species from 53 families and 16 orders of birds, more than 20 species of mammals, and 15 species of reptiles, as well as 133 species from 68 families and 13 orders of insects. A total of 186 bird species have been recorded, including 117 migratory, 48 wintering, 14 resident, and 7 breeding species. Among them, 29 bird species are designated as national key protected species, with 93 species designated as China-Japanese migratory bird protection species and 30 species as China-Australian migratory bird protection species. The black stork and chinese merganser are classified as Class I key protected wild animals, while 27 species are classified as Class II key protected wild animals, including the baer's pochard, black-faced spoonbill, and tringa guttifer. The Beibu Gulf Fishery adjacent to Beihai City has abundant marine fishery resources, including over 500 species of fish (including more than 50 species of freshwater fish), over 200 species of shrimp, over 190 species of crabs, over 300 species of shellfish, over 50 species of cephalopods, and over 20 other animal species. The tropical marine

biological community of the coral reefs in Weizhou Island of Beihai City consist of class anthozoa of cnidaria, comprising 5 orders, 18 families, and 66 species.

7.1.8 Mineral resources

Beihai City has discovered 47 types of minerals, accounting for 33% of the total mineral types discovered in Guangxi. The mineral resources are mainly non-metallic minerals, including ilmenite, alluvial gold, gypsum, limestone for building stone, limestone for cement, sandstone for construction, natural quartz sand, construction sand, shale for bricks and tiles, kaolin, ceramic clay, bentonite, peat, mineral water, geothermal (hot water), oil shale, and rare earths. There are 22 large-scale mineral deposits, 10 medium-scale mineral deposits, and 60 small-scale mineral deposits or occurrences identified in Beihai City. Among them, kaolin and natural quartz sand hold the largest reserves in Beihai and rank first in Guangxi in terms of resources.

7.2 Survey and assessment of current environmental quality

7.2. 1 Topographic and geomorphic survey and evaluation of erosion and sedimentation environment

7.2.1.1 Topographical features

Lianzhou Bay is an estuarine bay, approximately semi-circular in shape, with the peninsula coastline on the eastern side and tidal channels developed along the coast. The northern shore of the bay is the entrance of the Nanliujiang River. The present coastal morphology of the Lianzhou Bay is mainly formed by the marine erosion during the Atlantic Period about 8000 years ago, and the long-term effects of various coastal dynamic factors such as waves, tidal currents, and rivers.

The project area is located on the northern shore of Lianzhou Bay, at the mouth of the Nanliujiang River. The terrain mainly belongs to the shallow beach of the Nanliujiang River estuary delta front, which is mainly formed by the deposition of silt carried by the Nanliujiang River and further deposited at the estuary under the action of tidal currents. The terrain is flat and open, with the ground elevation generally below 3 meters, and the overall slope gently inclined towards the sea, with an average slope of less than 0.03°.

7.2.1.2 Sedimentation and erosion environment

(1) Sedimentation environment

(i) Characteristics of sediment-laden rivers flowing into the sea

The main river discharging into the nearby waters of Lianzhou Bay is the Nanliujiang River, with a total length of 287 km and a drainage area of 8635 k ㎡. The basin vegetation cover is relatively good. According to statistics, the average annual river runoff into the sea is 5.13 billion m³. The Nanliujiang River also brings a certain amount of sediment into the estuary. The average annual sediment transport is 992,000 tons. The period from May to September is the peak period of river discharge and sediment transport into the sea, accounting for about 49.1% and 58.3% of the

total annual runoff and sediment transport, respectively. The sediment transported into the sea deposits near the estuary leads to the formation of the extensive river delta.

(ii) Distribution of sediment concentration

The spatial distribution of sediment concentration in the waters of Lianzhou Bay shows that the area near the mouth of the Nanliujiang River has a high sediment concentration, especially in the western part of the mouth, where the sediment concentration is at 0.03-0.05 kg/m³. The sediment concentration gradually decreases from the estuary area to the southwest bay, reaching the lowest point in the western sea area, at around 0.01 kg/m³. The sediment concentration in the southern part of the water body is lower than that in the northern part, and the concentration in the western part is lower than that in the eastern part. The distribution of sediment concentration in the bay water shows a decreasing trend from northeast to southwest and from north to south.

(iii) Sources of sediment

(i) River sediment

The Lianzhou Bay area is located in shallow waters between two rivers, the Nanliujiang River to the east and the Dafengjiang River to the west. The sediment in the project area mainly comes from the discharge of these two rivers, and the suspended sediment source is relatively abundant. According to the measured data from the Changle hydrological station on the Nanliujiang River (1953-2006), the average annual river runoff into the sea is 51.3 billion m³, with an average annual sediment transport of 992,000 tons. According to the measured data from the Polangping hydrological station on the Dafengjiang River (1959-2006), the average annual river runoff is 0.588 billion m³, with an average annual sediment transport of 117,700 tons. Because river sediment transport is charaterized by obvious seasonal variation, with more than 50% occurring during the flood season, the sediment transport from rivers has a significant impact on the project area during flood seasons.

(ii) Shallow water sediment

Due to the constraint of tidal currents, sediment deposited in the estuarine region is not easily transported to the open sea and accumulates in the Lianzhou Bay. Only a

small amount of suspended sediment is carried into the open sea by ebb and nearshore currents, resulting in the formation of extensive shallow areas near the estuary mouth.

During the dry season, the existing sediment in the waters near the project area is mainly replenished by the "wave-induced sand movement on shallow banks and tidal currents transporting sediments back and forth." Therefore, during the dry season, the impact on the project area mainly comes from the sediment transport induced by wave action.

(iv) Changes in topographic erosion and sedimentation

Ever since 7,000 years, the sea level has fluctuated around its present position in the Nanliujiang River Delta region, with the sedimentation rate gradually exceeding the rate of sea level rise. Currently, the main channel of the Nanliujiang River is located on the western side. Sediments transported by the Nanliujiang River are deposited in the vast area outside the coastline of Xichang to the estuary bay of the Nanliujiang River (Lianzhou Bay), forming a broad shallow area and underwater landforms of the Nanliujiang River Delta front. Over the past hundred years, the Nanliujiang River Delta has advanced outward by about 10 to 12km at an average horizontal speed of approximately 1.6 meters per year toward the sea. From recent changes in water depth, after the construction of dams on the Nanliujiang River, the rate of sedimentation in the project area has significantly decreased. However, from the changes in isobaths (with some outward movement), the area still shows a slight trend of sediment accumulation.

7.2.2 Survey and assessment of current seawater quality

The assessment of the current status of seawater quality within the scope of the Project is based on the relevant survey results outlined in the "Preliminary Investigation and Justification Report of Dredging Project in Lianzhou Bay" (January 2024, Fourth Institute of Oceanography, Ministry of Natural Resources).

7.2.2.1 Survey time and stations

On the basis of the "Preliminary Investigation and Justification Report of

Dredging Project in Lianzhou Bay" (January 2024, Fourth Institute of Oceanography, Ministry of Natural Resources), a survey on the current status of mangroves in Lianzhou Bay was conducted in July 2022. Totally 10 survey stations (H1 to H10) were set up, with each station having a 10m×10m sample plot, for monitoring mangrove vegetation, macrobenthic organisms, soil physicochemical properties, and other threatening factors. Additionally, 9 water quality stations (W1 to W9) were set up in the mangrove area.

Details of the survey stations are shown in Table 13 and Figure 18.

Table 13 Survey Stations and Monitoring Contents

Station location	**Coordinates**		**Monitoring contents**
	Longitude (E)	Latitude (N)	
H1	109°09'15"	21°30'25"	Sediments and biological communities
H2	109°09'19"	21°33'38"	Sediments and biological communities
H3	109°09'12"	21°33'31"	Sediments and biological communities
H4	109°09'02"	21°33'24"	Sediments and biological communities
H5	109°06'18"	21°34'58"	Sediments and biological communities
H6	109°06'15"	21°34'45"	Sediments and biological communities
H7	109°06'12"	21°34'12"	Sediments and biological communities
H8	109°03'57"	21°35'40"	Sediments and biological communities
H9	109°03'58"	21°35'36"	Sediments and biological communities
H10	109°03'57"	21°35'33"	Sediments and biological communities
W1	109°08′50″	21°30′40″	Water quality
W2	109°08′27″	21°33′50″	Water quality
W3	109°08′12″	21°33′11″	Water quality
W4	109°07′11″	21°34′26″	Water quality
W5	109°06′44″	21°33′52″	Water quality
W6	109°05′05″	21°34′5″4	Water quality
W7	109°04′57″	21°34′16″	Water quality
W8	109°03′18″	21°35′23″	Water quality
W9	109°02′59″	21°34′38″	Water quality

Figure 18 Distribution of Mangroves Monitoring Stations in Lianzhou Bay

7.2.2.2 Contents of survey and methodology

(1) contents of survey

The mangrove water environment survey covers ten elements: water temperature, salinity, pH value, dissolved oxygen (DO), chemical oxygen demand (COD), inorganic nitrogen (nitrite, nitrate, ammonia, active phosphate, and silicate) etc.

(2) Methodology

(i) Methods for survey and analysis

The collection, fixation, and analysis of water quality samples are conducted according to methods outlined in the Specifications for Ocean Monitoring (GB 17378.1~7-2007) and the Specifications for Marine Surveys (GB/T 12763.1 ~ 11 - 2007).

(ii) Assessment standards and methodology

(i) Assessment standards

According to the Functional Zoning of Marine Areas in Guangxi Zhuang Autonomous Region (2011-2020) , the survey stations W2, W4, and W5 are located

within the industrial and urban construction area of Lianzhou Bay, where the requirement for marine environmental protection is to maintain the current level. Survey stations W1, W3, W6, W7, W8, and W9 are within the tourism and leisure area of Lianzhou Bay, and water quality parameters are evaluated based on Category III water quality standards according to the Sea Water Quality Standards (GB 3097-1997). The parameters included in the evaluation of seawater quality in this assessment are pH, dissolved oxygen, inorganic nitrogen (the sum of nitrate, nitrite, and ammonia), and active phosphate, totaling 4 items.

(ii) Assessment methodology

The single-factor standard index method is adopted to evaluate the seawater quality.

7.2.2.3 Investigation results and assessment

The detailed results of the water environment survey at each station are presented in Table 14.

Table 14 Lianzhou Bay Mangroves Water Environment Investigation Results

Monitoring	**Sampling**	**Water temperature**	**pH**	**Salinity**	**Dissolved oxygen**	**Suspended substance**	**Phosphates**	**Nitrites**	**nitrate**	**Ammonia**	**Inorganic nitrogen**	**Silicate**
Station	layer	℃			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
W1	表	31.3	7.91	24.93	5.60	19.1	0.067	0.012	0.158	0.062	0.296	0.547
W2	Table	32.0	7.92	20.13	6.65	23.0	0.027	0.024	0.393	0.060	0.717	1.007
W3	Table	31.4	7.99	26.59	5.70	29.4	0.017	0.009	0.097	0.054	0.172	0.306
W4	Table	31.5	8.13	15.49	7.18	20.0	0.007	0.013	0.217	0.083	0.742	0.847
W5	Table	31.4	8.30	21.99	8.96	19.8	0.001	0.004	0.029	0.028	0.141	0.219
W6	Table	31.5	8.29	10.48	8.53	15.9	0.020	0.033	0.612	0.132	0.861	2.501
W7	Table	31.8	8.15	20.18	8.17	13.0	0.007	0.014	0.230	0.100	0.368	0.541
W8	Table	32.0	8.26	12.62	7.53	18.8	0.014	0.022	0.240	0.080	0.632	1.741
W9	Table	32.0	8.15	23.69	8.24	27.7	0.008	0.010	0.076	0.047	0.279	0.291
Maximum value		32.0	8.30	26.59	8.96	29.4	0.067	0.033	0.612	0.132	0.8610	2.501
Minimum value		31.3	7.91	10.48	5.60	13.0	0.001	0.004	0.029	0.028	0.1410	0.219
Average		31.7	8.12	19.6	7.40	20.7	0.019	0.016	0.228	0.072	0.4676	0.889

From the above table, it can be found that:

(1) pH: During the survey period, the pH of seawater at each survey station ranged from 7.91 to 8.30, with an average of 8.12. The maximum pH value was recorded at station W5, while the minimum was observed at station W1.

(2) Salinity: The salinity of seawater ranged from 10.48 to 26.59 psu, with an average of 19.57 psu. Stations W6 and W8, located near the mouth of the Nanliujiang estuary, had lower salinity levels of 10.48 psu and 12.62 psu, respectively. The highest salinity was recorded at station W3, while the lowest was at station W6.

(3) Dissolved Oxygen: Dissolved oxygen levels ranged from 5.60 to 8.96 mg/L, with an average of 7.40 mg/L. The highest dissolved oxygen level was observed at station W5, while the lowest was at station W1.

(4) Suspended substance: The concentration of suspended substance ranged from 13.0 to 29.4 mg/L, with an average of 22.70 mg/L. The highest concentration was recorded at station W3, while the lowest was at station W7.

(5) Phosphate: Phosphate levels ranged from 1.3 to 67.0 μg/L, with an average of 18.9 μg/L. The largest disparity between minimum and maximum values was observed, with the highest recorded at station W1 and the lowest at station W5.

(6) Nitrite: Nitrite levels ranged from 3.7 to 33.4 μg/L, with an average of 15.7 μg/L. The greatest difference between minimum and maximum values was observed, with the highest recorded at station W6 and the lowest at station W5.

(7) Nitrate: Nitrate levels ranged from 29.3 to 612.0 μg/L, with an average of 228.0 μg/L. The largest disparity between minimum and maximum values was observed, with the highest recorded at station W6 and the lowest at station W5.

(8) Ammonia: The concentration of ammonia ranged from 27.7 to 132 μg/L, with an average of 71.6 μg/L. The largest disparity between minimum and maximum values was observed, with the highest recorded at station W6 and the lowest at station W5.

(9) Inorganic Nitrogen: The concentration of inorganic nitrogen ranged from 141.0 to 861.0 μg/L, with an average of 467.6 μg/L. The greatest difference between minimum and maximum values was observed, with the highest recorded at station W6 and the lowest at station W5.

(10) Silicate: The concentration of silicate ranged from 219.0 to 2501.0 μg/L, with an average of 888.9 μg/L. The largest disparity between minimum and maximum values was observed, with the highest recorded at station W6 and the lowest at station

W5.

Assessment of the current water environment at each station are presented in Table 15.

Table 15 Assessment of the Current Water Environment of the Mangroves in Lianzhou Bay

Monitoring station	Sampling layer	Single factor index （Pi）				Current environmental status
		pH	Dissolved oxygen	Phosphates	Inorganic nitrogen	
W1	Table	0.11	0.53	1.49	0.58	Inferior Category IV
W2	Table	Category I	Category II	Category II	Category IV	Category IV
W3	Table	0.19	0.52	0.56	0.4	Conforming to Category III
W4	Table	Category I	Category II	Category I	Category III	Category III
W5	Table	Category I	Category II	Category I	Category I	Category II
W6	Table	0.49	0.35	0.68	1.94	Inferior Category IV
W7	Table	0.35	0.21	0.24	0.86	Conforming to Category III
W8	Table	0.46	0.05	0.48	0.86	Conforming to Category III
W9	Table	0.35	0.23	0.27	0.33	Conforming to Category III

From the table, it can be seen that monitoring stations W1 and W6 have single-factor indices greater than 1, indicating poor water quality falling into inferior Category IV. The parameters exceeding standards are reactive phosphate and inorganic nitrogen. Stations W3, W7, W8, and W9 meet the requirements of Category III seawater quality standards as stipulated in the marine functional zoning. Stations W2, W4, and W5 are located in the industrial and urban construction areas of Lianzhou Bay. The marine environmental protection requirements maintain the current level. Station W2 has Category IV water quality, station W4 has Category III water quality, and station W5 has Category II water quality.

7.2.3 Survey and assessment of current marine sediment environmental quality

The assessment of the current status of seawater of sediments with the scope of the Project is based on the relevant survey results outlined in the "Preliminary Investigation and Justification Report of Dredging Project in Lianzhou Bay" (January

2024, Fourth Institute of Oceanography, Ministry of Natural Resources).

7.2.3.1 Survey time and stations

Details of the survey stations are shown in Table 13, Table 16 and Figure 18, Figure 19.

Table 16 Survey Stations and Monitoring Contents

Station	Coordinates		Monitoring contents
	Longitude (E)	Latitude (N)	
S2	109°8′26.88″	21°33′50.15″	Sediment
S4	109°8′54.24″	21°33′06.41″	Sediment
S20	109°4′56.64″	21°34′16.39″	Sediment
S21	109°2′58.92″	21°34′38.28″	Sediment

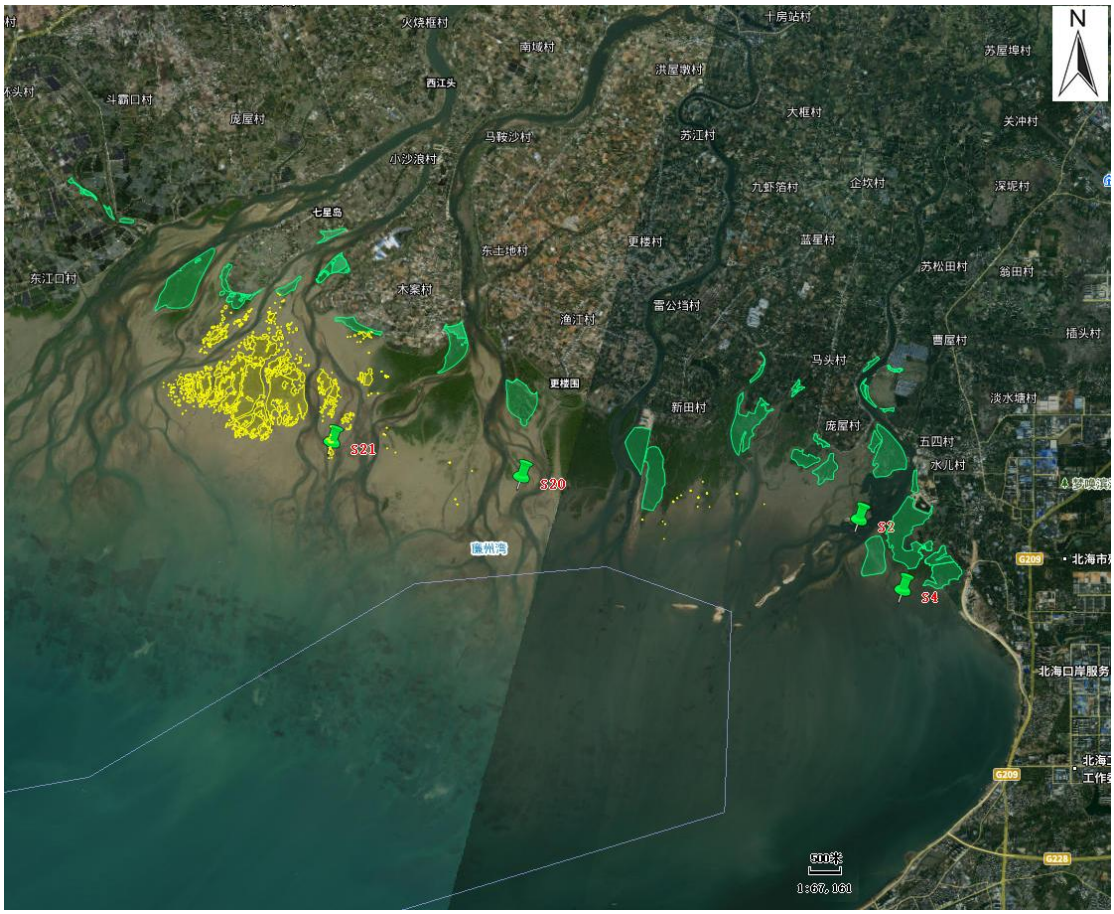


Figure 19 Map of Marine Sediment Survey Stations

7.2.3.2 Contents of survey and methodology

(1) contents of survey

The survey contents at H1~H10 survey stations cover 6 elements: particle size, soil salinity, organic carbon, sulfides, total nitrogen, and total phosphorus. S2, S4, S20,

and S21 survey stations cover 16 elements: organic carbon, sulfides, total phosphorus, total nitrogen, oils, particle size, heavy metals (mercury, cadmium, lead, zinc, copper, chromium, arsenic), polychlorinated biphenyls, hexachlorocyclohexane, and DDT.

(2) Methodology

(i) Methods for monitoring and analysis

The collection, fixation, and analysis of sediment samples are conducted according to methods outlined in the Specifications for Ocean Monitoring (GB 17378.1~7-2007) and the Specifications for Marine Surveys (GB/T 12763.1 ~ 11 - 2007).

(ii) Assessment standards and methodology

(a) Assessment standards

According to the Functional Zoning of Marine Areas in Guangxi Zhuang Autonomous Region (2011-2020), survey sites H1, H5, H6, H7, H8, H9, S20, and S21 are located in the leisure and entertainment area of Lianzhou Bay, the assessment for the sediment quality refers to the Category II sediment standards outlined in Quality of Marine Sediments (GB 18668-2002). Survey sites H2, H3, H4, S2, and S4 are located in the industrial and urban construction area of Lianzhou Bay, where the marine protection requirement is to maintain the current level of marine environmental quality in the area.

(b) Assessment methodology

The single-factor standard index method is adopted to evaluate the marine sediment environment.

7.2.3.3 Results of survey and assessment

1. Results of survey and assessment for sediment of mangroves in Lianzhou Bay

The survey results of surface sediment (0-5 cm) at each monitoring station in the mangroves of Lianzhou Bay are detailed in Table 17.

Table 17 Survey Results of Sediment of Mangroves in Lianzhou Bay

Monitoring station	pH	Organic carbon	Total Nitrogen	Total Phosphorus Sulfides		Oil
		%	%	%	$\times10^{-6}$	$\times10^{-6}$
H1	7.02	4.520	0.229	0.085	1.5	602.0
H2	6.88	4.810	0.266	0.072	86.0	646.0
H3	7.01	3.370	0.175	0.079	40.2	522.0
H4	7.04	2.930	0.140	0.076	10.6	92.6
H5	6.88	6.100	0.311	0.100	1.3	2228.0
H6	7.03	8.770	0.426	0.093	11.0	1410.0
H7	7.04	1.630	0.086	0.063	1.1	310.0
H8	6.87	3.140	0.157	0.073	no-detected	89.8
H9	6.78	4.270	0.223	0.082	1.7	571.0
H10	6.80	2.710	0.142	0.083	0.6	139.0
Max. value	7.04	8.770	0.426	0.100	86.0	2228.0
Min. value	6.78	1.630	0.086	0.063	no-detected	89.8
Average value	6.94	4.225	0.216	0.081	17.1	661.0

Grain size of sediment

Monitoring Station	Sand 2.0~0.05mm	Silt 0.05~0.002mm	Clay ＜0.002mm	Texture type
H1	77.11	10.11	12.78	Sandy loam
H2	54.96	21.21	23.83	Sandy clay loam
H3	68.88	11.12	20.00	Sandy clay loam
H4	66.98	9.00	24.02	Sandy clay loam
H5	61.74	19.36	18.90	Sandy loam
H6	77.37	13.09	9.55	Sandy loam
H7	62.92	17.22	19.86	Sandy loam
H8	75.26	15.18	9.57	Sandy loam
H9	44.27	33.77	21.96	Loam
H10	60.37	22.83	16.80	Sandy loam
Max. value	77.37	33.77	24.02	
Min. value	44.27	9.00	9.55	
Average value	64.99	17.29	17.73	

(1) pH: The pH of surface sediment in the mangroves ranges from 6.78 to 7.04, with an average of 6.94, indicating a neutral overall pH level.

(2) Organic Carbon: The organic carbon content in the surface sediment ranges from 16.3 to 87.7 g/kg, with an average of 42.3 g/kg. The highest value is recorded at station H6, while the lowest is at station H7.

(3) Total Nitrogen: Total nitrogen content in the surface sediment ranges from 0.086% to 0.426%, with an average of 0.216%. The highest value is at station H6, and the lowest is at station H7.

(4) Total Phosphorus: Total phosphorus content in the surface sediment ranges from 0.100% to 0.063%, with an average of 0.081%. The highest value is at station

H5, and the lowest is at station H7.

(5) Sulfides: Sulfide content in the surface sediment ranges from undetected to 86.0×10^{-6}, with an average of 17.11×10^{-6}. The highest value is at station H2, and the lowest is at station H8.

(6) Oil Content: Oil content in the surface sediment ranges from 89.8×10^{-6} to 2228.0×10^{-6}, with an average of 661.0×10^{-6}. The highest value is at station H5, and the lowest is at station H8.

(7) Grain Size: The surface sediment in the mangroves is primarily sandy loam, followed by loamy sand and loam. The variation in content for each item is as follows: Sand particles (2.0～0.05 mm), ranging from 44.27% to 77.37%, with an average of 64.99%; Silt particles (0.05～0.002 mm), ranging from 9.00% to 33.77%, with an average of 17.29%; Clay particles (<0.002 mm), ranging from 9.55% to 24.02%, with an average of 17.73%;

The sediment particle size composition indicates the following sediment types: Sediment at stations H1, H6, H7, H8, and H10 being classified as sandy loam; Sediment at stations H2, H3, and H4 being classified as silty clay loam; Sediment at station H9 being classified as loam.

Detailed assessment of the sediment environmental status for each station are provided in Table 18.

Table 18 Assessment of the Current Status Sediment of Mangroves in Lianzhou Bay

Station	**Single factor index (Pi)**		**Current environmental status**	
	Oil	**Sulfides**	**Organic carbon**	
H1	Category II	Category I	Category III and above	Category III and above
H2	0.65	0.29	1.2	Category III and above
H3	Category II	Category I	Category III	Category III
H4	0.19	0.04	0.98	Category II
H5	1.49	0.004	1.5	Category III and above
H6	Category III	Category I	Super Category III	Category III and above
H7	Category I	Category I	Category I	Category I
H8	Category I	Category I	Category III	Category III
H9	Category II	Category I	Category III and above	Category III and above
H10	Category I	Category I	Category II	Category II

The survey results indicate that for stations H2, H4, and H5, the marine

conservation requirement is to maintain the current level of marine environmental quality. Among them, the sediment quality at stations H2 and H5 exceeding Category III levels, while station H4 shows Category II current status. For stations H3 and H8, although sediment quality exceeds the Category II sediment standard required by marine functional zoning, it still meets Category III standards. The main factor causing the excess is organic carbon. Sediment quality at stations H7 and H10 meets the Category II sediment standard required by marine functional zoning. For stations H1, H6, and H9, sediment quality exceeds the Category II sediment standard required by marine functional zoning, reaching the Category III standard. The factors causing the excess are oil and organic carbon.

2. Results of survey and assessment for sediment of mangroves in Lianzhou Bay

Detailed results of survey and assessment of the marine sediments for each station in the project area are provided in Table 19, 20 and 21. The assessment results indicate that, for stations S2 and S4, the marine conservation requirement is to maintain the current level of marine environmental quality; the sediment quality at station S2 is classified as Category II, while at station S4 being classified as Category I. Stations S20 and S21 meet the requirements of Category II sediment standards as per marine functional zoning.

Table 19 Survey Results of Marine Sediment

Station	Sampling layer	Oil	Sulfides	Organic carbon	Total Hg	As	Cu	Cr	Pb	Cd	Zn	Total nitrogen	Total phosphorus	Polychlorinated biphenyl	Hexachlorocyclohexane	DDT	Redox potential
		$\times10^{-6}$	$\times10^{-6}$	%	$\times10^{-6}$	$\times10^{-6}$	$\times10^{-6}$	$\times10^{-6}$	$\times10^{-6}$	$\times10^{-6}$	$\times10^{-6}$	$\times10^{-6}$	$\times10^{-6}$	$\times10^{-6}$	$\times10^{-6}$	$\times10^{-6}$	mV
S2	Table	54.1	no-detected	0.81	0.153	11.6	38.4	52.6	28.8	0.19	157	1000	227	no-detected	no-detected	no-detected	/
S4	Table	75.8	no-detected	0.86	0.195	10.8	33	23.1	25.6	0.17	134	519	324	no-detected	no-detected	no-detected	/
S20	Table	18.4	8.2	0.18	0.126	7.82	no-detected	11.8	9.1	no-detected	193	416	80	no-detected	no-detected	no-detected	/
S21	Table	22.3	4.6	0.27	0.084	8.52	11.2	30.6	21.2	0.1	101	167	462	no-detected	no-detected	no-detected	/
S22	Table	97.6	20.3	0.29	0.109	7.06	14.4	30	20.5	0.07	106	351	345	no-detected	no-detected	no-detected	/
Max. value		97.6	20.3	0.86	0.195	11.6	38.4	52.6	28.8	0.19	193	1000	462	no-detected	no-detected	no-detected	-113.99
Min. value		18.4	no-detected	0.18	0.084	7.06	no-detected	11.8	9.1	no-detected	101	167	80	no-detected	no-detected	no-detected	-27.48
Average value		53.64	11.03	0.482	0.133	9.16	24.25	29.6	21.0	0.13	138	491	288	no-detected	no-detected	no-detected	-70.69

Table 20 Survey Results of Marine Sediment Grain Size

Station	Layer	Gravel (mm)	Sand (mm)					Silt (mm)				Clay (mm)			Grain group proportion (%)				Name	Code	Grain group coefficients			
		>2	2-1	1-0.5	0.5-0.25	0.25-0.125	0.125-0.063	0.063-0.032	0.032-0.016	0.016-0.008	0.008-0.004	0.004-0.002	0.002-0.001	<0.001	Gravel	Sand	Silt	Clay	-	-	Mdϕ	QDϕ	SKϕo	Do
S2	Table	22.82	18.73	16.56	21.09	6.39	5.7	8.68							22.82	68.46	8.68		With sand gravel	（G）S	0.59	2.08	0.05	1.07
S4	Table	0	0	0	0	0	0	1.34	18.2	24.6	25.1	15.1	7.23	8.42	0	0	69.24	30.75	Clay silt	YT	7.30	1.62	0.20	1.10
S20	Table	0	0	0	0	0	6.82	7.61	14.6	20.9	20.6	13.7	7.58	8.21	0	6.82	63.71	24.49	Clay silt	YT	7.00	1.99	0.06	1.09
S21	Table	0	0	0	27.1	53.7	9.21	0.02	0.77	2.59	2.59	1.52	0.99	1.18	0	90.01	6.28	3.69	Sand	S	2.54	1.25	0.79	2.68
S22	Table	0	0	0	2.82	44.5	16.9	2.54	3.11	8.66	8.66	4.57	2.45	3.56	0	64.22	25.21	10.58	Silt sand	TS	4.25	2.36	0.67	0.74

Table 21 Assessment Table for Marine Sediment Status at Stations

Station	Single factor index ($S_{i,j}$)													Assessment results
	Oil	**Sulfides**	**Organic carbon**	**Total Hg**	**As**	**Cu**	**Cr**	**Pb**	**Cd**	**Zn**	**Polychlorinated biphenyl**	**Hexachlorocyclohexane**	**DDT**	
S2	0.0541	0.0003	0.2700	0.3060	0.1785	0.3840	0.3507	0.2215	0.1267	0.4486	0.0005	0.0150	0.2000	Category II
S4	0.0758	0.0003	0.2867	0.3900	0.1662	0.3300	0.1540	0.1969	0.1133	0.3829	0.0005	0.0150	0.2000	Category II
S20	0.0368	0.0164	0.0900	0.6300	0.3910	0.0071	0.1475	0.1517	0.0400	**1.2867**	0.0050	0.0300	0.5000	Category I
S21	0.0446	0.0092	0.1350	0.4200	0.4260	0.0071	0.3825	0.3533	0.2000	0.6733	0.0050	0.0300	0.5000	Category I

7.2.4 Survey and assessment of status mangroves communities

7.2.4.1 Survey time and stations

Details of the survey stations are shown in Table 14 and Figure 18.

7.2.4.2 Contents of survey and methodology

(1) contents of survey

The mangrove community comprises eight elements, including species composition, canopy coverage, plant density, tree height, diameter at breast height (DBH), basal diameter, crown width, and seedling density. Meanwhile, the benthic animal community consists of three elements, respectively species composition, density, and biomass.

(2) Methodology

The survey and analysis of each community are conducted according to the requirements outlined in the Technical Specifications for Mangrove Ecological Monitoring (HY/T 081-2005).

7.2.4.3 Survey results

The assessment on the status of mangroves communities in Lianzhou Bay are shown in Table 22 and Table 23.

Table 22 Assessment Status of Mangroves in Lianzhou Bay

Type of community	Survey station	Mangrove species	Average basal diameter	Average tree height	Average crown		Quadrat density	Coverage degree
			cm	cm	Long axis（cm）	Short axis	Pieces /100㎡	%
Aegiceras corniculatum community	H1	Aegiceras corniculatum	1.8	88.6	47.7	37.4	444	92
	H5	Aegiceras corniculatum	5.5	263.8	253.8	187.5	200	90
	H6	Aegiceras corniculatum	4.5	238.6	223.6	161.4	175	87
	H8	Aegiceras corniculatum	4.4	205.0	136.0	104.0	445	92
	H9	Aegiceras corniculatum	4.5	225.0	124.1	85.0	489	93

Type of community	Survey station	Mangrove species	Average basal diameter	Average tree height	Average crown		Quadrat density	Coverage degree
			cm	cm	Long axis（cm）	Short axis	Pieces /100㎡	%
	H10	Aegiceras corniculatum	4.6	233.5	154.5	111.0	445	92
Kandelia obovata - Aegiceras corniculatum community	H7	Aegiceras corniculatum	7.4	150.0	245.0	195.0	25	83
Kandelia obovata community	H2	Kandelia obovata	4.3	141.3	141.9	110.6	200	89
Kandelia obovata - auicennia marina community	H3	Kandelia obovata	2.6	122.5	83.3	65.8	150	85
		Auicennia marina	4.3	161.3	177.5	150.0	100	
	H4	Auicennia marina	4.3	130.0	230.0	160.0	33	79
		Kandelia obovata	3.8	175.0	135.0	125.0	67	

Table 23 Mangrove Regeneration Layer in Lianzhou Bay

Type of community	Survey station	Mangrove species	Quantity	Max. height	Min. height	Average height
Aegiceras corniculatum community	H1	Aegiceras corniculatum	44	15.0	8.0	12.0
	H5	/	/	/	/	/
	H6	/	/	/	/	/
	H8	/	/	/	/	/
	H9	/	/	/	/	/
	H10	/	/	/	/	/
Kandelia obovata - Aegiceras corniculatum community	H7	/	/	/	/	/
Kandelia obovata community	H2	Kandelia obovata	325	30.0	15.0	17.0
Kandelia obovata - auicennia marina community	H3	Kandelia obovata	125	90.0	8.0	20.0
	H4	/	/	/	/	/

Notes: “—” stands for “not found”

(1) Type of mangroves communities in Lianzhou Bay

According to the on-site investigation results, there are four species of true mangroves found in 10 quadrats across three sections of Lianzhou Bay, respectively Aegiceras corniculatum, Kandelia obovata, Avicennia marina, and Acanthus ilicifolius etc. Among them, Aegiceras corniculatum and Kandelia obovata are widely distributed, while Avicennia marina is distributed in Dongwei, and Acanthus ilicifolius is scattered in the Aegiceras corniculatum community.

(2) Type of mangroves communities in Lianzhou Bay

There are four main types of communities, respectively aegiceras corniculatum community, Kandelia obovata - Aegiceras corniculatum community, kandelia candel - aegiceras corniculatum mixed community, Kandelia obovata community, Kandelia obovata + auicennia marina community.

(i) Aegiceras corniculatum community

H1, H5, H6, H8, H9, and H10 quadrats represent the Aegiceras corniculatum community, distributed on the inner and middle shores, with the dominant species of Aegiceras corniculatum, forming a single-layer shrub community. The average height of Aegiceras corniculatum is 209.1 cm, with an average base diameter of 4.2 cm, and an average crown width of 156.6 cm × 114.4 cm. The average coverage is 91%, with a quadrat density ranging from 175 to 489 plants per 100 ㎡, showing a significant clumped distribution. During field survey, the regeneration layer of Aegiceras corniculatum was only found in quadrat H1, mainly consisting of 0-1-year-old seedlings, with an average height of 12.0 cm.

(ii) Kandelia obovata－ Aegiceras corniculatum community

The survey data indicates that only quadrat H7 represents the Kandelia obovata - Aegiceras corniculatum community, located on the outer flat. The community coverage is 83%, with a quadrat density of 175 plants / 100㎡. The average height of Aegiceras corniculatum is 170.0 cm, and Kandelia obovata is 150.0 cm, both belonging to the shrub community. The average basal diameter of Aegiceras corniculatum is 3.3 cm, while Kandelia obovata is 7.4 cm. The average crown size of Aegiceras corniculatum is 187.5 cm × 124.2 cm, and Kandelia obovata is 245.0 cm × 195.0 cm, with Kandelia obovata exhibiting a larger canopy. No regeneration layer was found in quadrat H7.

(iii) Kandelia obovata community

Quadrat H2 represents the Kandelia obovata community, distributed on the inner flat, and being at the middle stage of succession. It is a single-layer shrub community dominated by Kandelia obovata, with a coverage of 89% and a density of 200 plants / 100 ㎡. The average height of Kandelia obovata is 141.3 cm, with an average basal diameter of 4.3 cm, and the canopy is continuous. The regeneration layer includes 0-1 year old Kandelia obovata seedlings, with an average height of 17.0 cm.

(iv) Kandelia obovata + auicennia marina community

Quadrat H3 and H4 represent the AKandelia obovata + auicennia marina community, consisting of the two dominant shrub species distributed on the inner and middle shores. It is a transitional community dominated by Kandelia obovata and auicennia marina, with an average coverage of 82%. The average height of auicennia marina is 145.6 cm, while that of Kandelia obovata is 148.8 cm. The average basal diameter of auicennia marina is 4.3 cm, and that of Kandelia obovata is 3.2 cm. The average canopy size of auicennia marina is 203.8 cm × 155.0 cm, and that of Kandelia obovata is 148.8 cm × 109.2 cm. The canopy density is on average 175 plants /100 ㎡. The regeneration layer mainly consists of 0-2 year old Kandelia obovata seedlings, with an average height of 20.0 cm.

(3) Status of threatening factors

The outer shores of Lianzhou Bay are extensively distributed with Spartina alterniflora which has encroached upon some mangrove gaps (Figure 20). The invasive species of sonneratia apetala is widely distributed in the mangrove area of Lianzhou Bay, with some mangroves on the inner shore being entangled with the derris (Figure 7.2-3). At station H2, the evidence of unauthorized use of the surrounding intertidal flats for establishing seedling nurseries was found.

Figure 20 Mangrove Regeneration Layer in Lianzhou Bay

Figure 21 Seedling Nursery Nearby H2 Station

7.2.5 Status of benthic communities in mangroves communities of Lianzhou Bay

(1) Composition of macrobenthic oranisms species

The survey conducted at the 10 mangrove monitoring stations in the Leizhou Bay obtained qualitative and quantitative samples of macrobenthic organisms. A total

of 14 species of large benthic organisms were identified (Table 24). Among them, the largest number of species belonged to the arthropoda, totally 7 species, accounting for 50.00% of the total species. This was followed by 4 species from the mollusca, accounting for 28.57% of the total species; 2 species from the annelida, accounting for 14.29% of the total species; and 1 species from the Echinodermata, accounting for 7.14% of the total species. The composition of species is shown in Figure 22. The macrobenthic organisms discovered in this survey are not classified as endangered or protected species.

Table 24 List of Species of Macrobenthic Organisms

Group	Chinese name	Latin name
I. Mollusca	1. 红树蚬 2. 紫游螺 3. 皱纹绿螂 4. 纵带滩栖螺	Geloina erosa Neritina violacea Glauconome corrugata Batillaria zonalis
II. Arthropoda	5. 扁平拟闭口蟹 6. 长足长方蟹 7. 弧边招潮 8. 宽身大眼蟹 9. 宁波泥蟹 10. 太平大眼蟹 11. 字纹弓蟹	Paracleistostomadepressum Metaplax longipes Ucaarcuata Macrophthalmus dilatatum Ilyoplaxningpoensis Macrophthalmus pacificus Varuna litterata
III. Sipuncula	12. 可口革囊星虫	Phascolosoma esculenta
IV. Annelida	13. 拟特须虫 14. 丝异须虫	Paralacydonia paradoxa Heteromastus filiformis

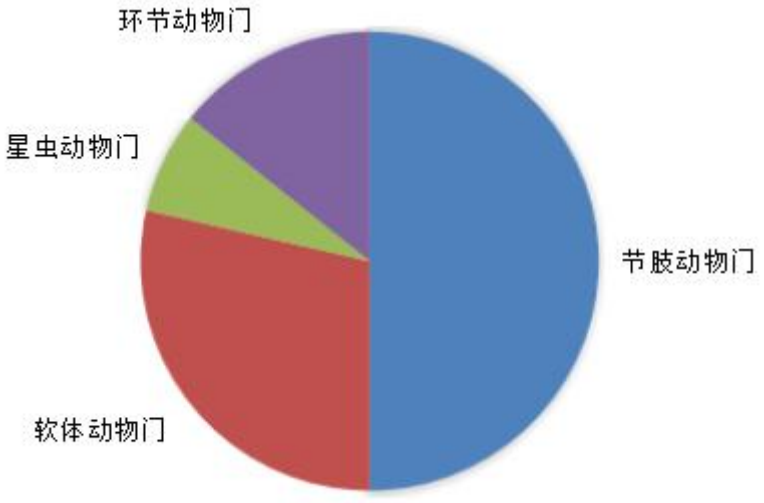


Figure 22 Composition of Macrobenthic Organism Species in Lianzhou Bay Mangroves

(2) Dominant species

According to the dominance index formula and the criterion of Y > 0.02, the

main dominant species among the 10 macrobenthic organism sampled are 扁平拟闭口蟹（Paracleistostoma depressum）、拟特须虫（Paralacydoniaparadoxa）和异丝须虫（Heteromastus filiformis）.

(3) Abundance density and biomass

Within the survey scope, the average density of macrobenthic organisms is 19.31 ind./㎡, with an average biomass of 18.07 g/㎡. Among these, the average density of arthropoda is 18.06 ind./㎡, with an average biomass of 6.81 g/㎡; the average density of mollusks is 4.00 ind./㎡, with an average biomass of 56.15 g/㎡.

(4) Community composition

In the 10 monitoring stations, the abundance density (d) ranges from 0.00 to 0.52, and the diversity index (H') ranges from 0.00 to 1.99 (Table 7.2-9). Stations H8, H9, and H10 are respectively located in the areas of high flat, mid flat and low flat of Mu'an, showing significant differences in the diversity index of macro benthic organisms and relatively low biodiversity. Stations H2, H3, and H4 are located in the high, mid, and low tidal zones of Dongwei, respectively. Station H3, in the mid-tide area, shows the highest diversity of macro benthic organisms, while stations H4 and H2, in the low and high tide zones respectively, show relatively lower biodiversity. Stations H5, H6, and H7 are situated in the high, mid, and low tidal zones of Zhenyudun, respectively. The uniformity of macro benthic organism among these three stations is relatively high. Station H6, in the mid-tide zone, exhibits the highest biodiversity, while station H5, in the high-tide zone, shows relatively lower diversity. Station H1, located in Gaode Ancient Town, exhibits a lower level of biodiversity.

(5) crab burrows

The burrowing activity of crabs in the mangrove area effectively increases the exchange of interstitial water, enhances the interaction between sediment and atmosphere, improves sediment ventilation conditions, and facilitates the respiratory function of mangrove roots. Among all the surveyed 10 stations, the number of crab burrows is relatively evenly distributed between stations H8, H9, and H10 in the high flat, mid flat and low flat of Mu'an. There are more crab burrows at station H4 in Dengwei low flat, while fewer crab burrows at stations H3 and H4 in the mid and high flats of Dengwei . Similarly, there are more crab burrows at station H7 in the low flat of Zhenyudun , and fewer crab burrows in the mid and high tide zones at stations H6 and H5. There are more crab burrows at station H1 in Gaode Ancient Town.

(Table 25).

Table 25 Community Composition of Macrobenthic Organisms

Monitoring station	Total individuals （ind./㎡）	Species	Abundance density (d)	Diversity index （H′）	Uniformity （J）	Crab burrows （ind./㎡）
H1	896	2	0.1	0.64	0.64	252
H2	224	4	0.38	1.29	0.65	18.67
H3	112	4	0.44	1.84	0.92	42.67
H4	208	3	0.26	1.24	0.78	106.67
H5	32	2	0.2	1	1	6.67
H6	208	5	0.52	1.99	0.86	4
H7	432	3	0.23	1.54	0.97	212
H8	192	1	0	0	/	42.67
H9	32	2	0.2	1	1	26.67
H10	176	2	0.13	0.44	0.44	56

7.2.6 Survey and assessment of status atmospheric environmental quality

In order to understand the current status of environmental air quality in the project area, this assessment is based on the Letter of the Department of Ecology and Environment of the Guangxi Zhuang Autonomous Region on the Notification of Environmental Air Quality of Prefecture-level Cities and Counties (Districts) in 2023 (GHH [2024] 58). According to the letter, the annual average concentrations of SO_2、NO_2、PM_{10}、P ㎡$_{.5}$, the 95th percentile of daily average CO concentration, and the 90th percentile of daily maximum 8-hour O_3 concentration in Beihai City in 2023, all meet the Category II standards of the Ambient Air Quality Standards（GB3095-2012）and its Category II amendments. Therefore, the project area is classified as an area meeting the air quality standards. Details are shown i Table 26.

Table 26 Current Environmental Air Quality Status of Basic Pollutants of Beihai City in 2023

Pollutants	Annual assessment indicators	Standard limit （μg/m³）	Current concentration （μg/m³）	Maximum concentration ratio (%)	Status of meeting standards
SO_2	Annual average	60	6	10.0	Meeting standards
NO_2	Annual average	40	9	22.5	Meeting standards

Pollutants	Annual assessment indicators	Standard limit（μg/m³）	Current concentration（μg/m³）	Maximum concentration ratio (%)	Status of meeting standards
PM_{10}	Annual average	70	35	50.0	Meeting standards
P ㎡.5	Annual average	35	20.9	59.7	Meeting standards
CO	Daily average 95% percentiles	4.0mg/m³	0.8mg/m³	20.0	Meeting standards
O_3	Daily maximum 8 hours value 90% percentiles	160	126	78.8	Meeting standards

7.2.7 Survey and assessment of acoustic environmental quality status

According to Report of Ecological Environment Status in 2022 in Beihai City, the current status of the acoustic environment in Beihai City is as follows:

(1) Regional acoustic environment

In 2022, the average equivalent sound level of environmental noise in the urban area of Beihai City during the daytime was 54.1dB(A), complying with the requirements of Level II standards stipulated in the Technical Specifications for Environmental Noise Monitoring/Conventional Monitoring of Urban Acoustic Environment (HJ64-2012), indicating a "good" level. Compared to the previous year, there was a decrease of 0.4dB(A). The primary sources affecting the urban daytime acoustic environment quality are the social life noise, accounting for 94.0%, followed by traffic noise at 4.0%, and industrial noise at 2.0%.

(2) Road traffic acoustic environment

In 2022, the average equivalent sound level of road traffic noise during the daytime was 65.6dB(A), meeting the Level I standards stipulated in the Technical Specifications for Environmental Noise Monitoring/Conventional Monitoring of Urban Acoustic Environment (HJ64-2012), indicating a "good" level. This level remained unchanged compared to the previous year.

(3) Acoustic environment in functional area

In 2022, there were 44 monitoring points each for daytime and nighttime noise

levels in the urban functional areas of Beihai City. Among them, the compliance rate for daytime noise monitoring points was 97.7%, while for nighttime noise monitoring points was 90.9%.

7.2.8 Survey and assessment of the status of environmental sensitive targets, key protected objects, and the environmental status of marine functional zones

7.2.8.1 Mangroves protection area

According to the Law of the People's Republic of China on Wetland Protection, it is stipuilated that, in Article 34, the“mangrove wetlands should be included in the list of important wetlands," and in Article 28, “the following activities are prohibited from damaging wetlands and their ecological functions: "(V) Other activities that damage wetlands and their ecological functions”. The Project covers Qixing Mangrove Conservation Area and Mu'an Mangrove Conservation Area in Hepu County, as well as the Dongwei Mangrove Conservation Area in Haicheng District. Among them, the existing mangrove area in Mu’an is 23.47 h ㎡, the existing mangrove area in Qixing is 47.4 h ㎡, and the mangrove conservation area in Dongwei covers an area of 131.73 h ㎡, with the protected species respectively of Aegiceras corniculatum, Kandelia obovata, Avicennia marina, and Acanthus ilicifolius. The mangrove restoration falls under the category of mangrove conservation measures and aligns with the conservation objectives of the mangrove conservation areas. According to the Plan for Protection of Mangrove Resources in Beihai City (2020-2030), the specific scope of the mangrove ecological restoration planning area includes: Forestland and aquaculture ponds suitable for mangrove afforestation within the natural reserves of Beihai City; forestland and aquaculture ponds suitable for mangrove afforestation outside the natural reserves, which are distributed across the bays of Beihai City; mangroves in the natural reserves, national important wetlands, provincial-level key wetlands, as well as contiguous distribution areas of less than 1 hectare outside mangrove protection areas, which are scattered across the bays of Beihai City. This subproject carries out mangrove restoration activities in Muan,

Qixing, and Dongwei mangrove conservation areas, as well as in the Yilin areas of the Nanliujiang River estuary and the Lianzhou Bay areas, which is in line with the relevant provisions of the Plan for Protection of Mangrove Resources in Beihai City (2020-2030). According to the The Environment Impact Assessment Law of the People's Republic of China (revised in 2018), if the environmental impact is minimal and does not require an environmental impact assessment, an environmental impact registration form should be completed. According to the Management Directory of EIA Categories of Construction Projects (2021 Edition), the mangrove afforestation projects are only required to submit Environmental Impact Registration Form. As such, this subproject is required to submit environmental impact registration form.

7.2.8.2 Guangxi Hepu Dangjiang Mangroves Provincial Level Key Wetland

Guangxi Hepu Dangjiang Mangroves Provincial Level Key Wetland was listed in the first batch of important provincial level wetlands Guangxi Forestry Bureau in 2020. The scope of the wetland park and the types of wetlands are shown in Figure 23.

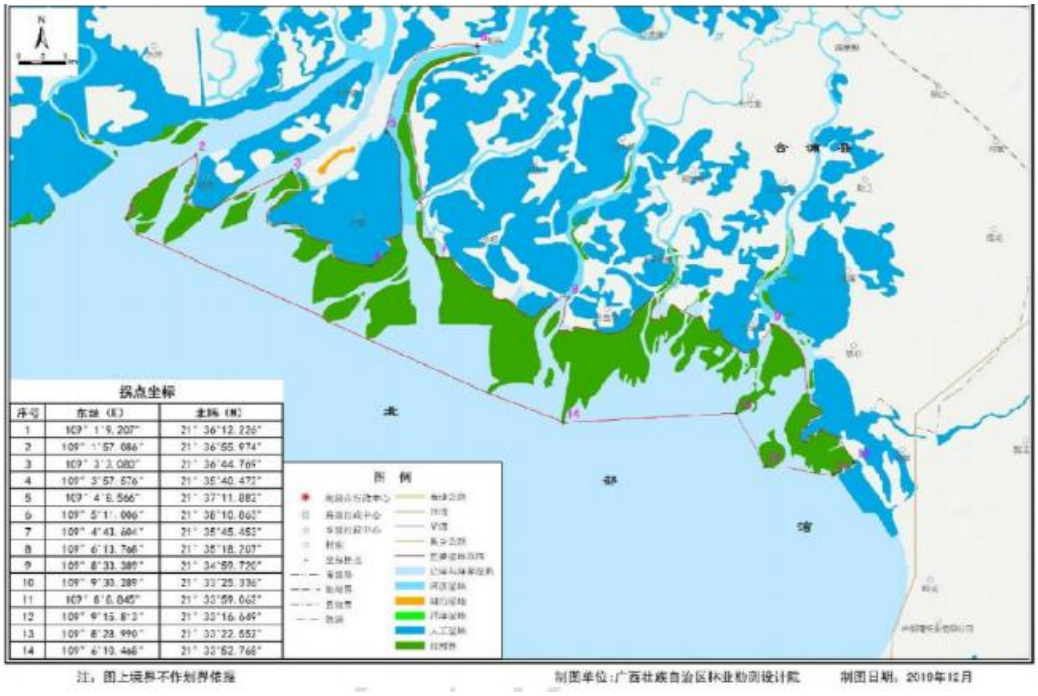


Figure 23 Scope and Distribution Map of Guangxi Hepu Dangjiang Mangroves Provincial Level Key Wetland

This Subproject is located within the important provincial-level wetland area of the Dangjiang Mangrove in Hepu County of Guangxi. The mangrove restoration is a

measure to protect mangroves, and the project construction will not cause adverse environmental impacts on the mangrove wetlands.

7.3. Social baseline analysis

Beihai City is the prefecture level city in Guangxi with largest mangrove resources, and Hepu County is also the county with the largest mangrove area in Guangxi, bearing significant responsibility for mangrove conservation. There exists a close relationship between mangrove conservation in Beihai City and local economic and social development. Mangroves not only provide abundant ecological services but also serve as a crucial support for economic and social development. Therefore, conducting a social baseline survey is an essential prerequisite for the sustainable development of mangrove restoration projects. A social baseline survey can help understand the socio-economic status of mangrove ecosystems, including the livelihoods of local residents, their dependence on mangrove resources, and the development of mangrove tourism. These information are crucial for analyzing the social impact of mangrove afforestation and restoration projects.

7.3.1 Socio-economic profile of project area

The areas involved in the mangroves restoration and Spartina alterniflora c learing are primarily located at Nanliujiang River estuary and Ximenjiang River estuary in Lianzhou Bay. Among them, there are 35 mangroves restoration sit es, involving Shandong Village and Qixing Village in Shagang Town, and Mu'a n Village, Yujiang Village, Shachong Village, Matou Village in Dangjiang Town, as well as Ma'an Village and Yanlou Village in Lianzhou Town. The spartina alterniflora cleaning is located in Hepu county within Lianzhou Bay, involving Qixing Village in Shagang Town and Mu'an Village, Shachong Village, and Yuj iang Village in Dangjiang Town.

7.3.1.1 General profile of Beihai City

Beihai City is an important coastal city in the Beibu Gulf and a renowned seaside tourist destination in China. It boasts four major categories of tourism resources: coastline, scenery, culture, and historical sites, forming a complete system of marine

characteristic tourism resources featured by beaches, islands, bays, seaports, coral reefs, marine pearls, coastal forests, maritime routes, and the Maritime Silk Road culture. The city has four administrative regions: Haicheng District, Yinhai District, Tieshangang District, and Hepu County, consisting of 22 towns, 1 township, 7 subdistricts, 95 community committees, and 336 village committees. The comprehensive economic and social profile for 2023 are shown in the follows (Table 27):

(1) The city achieved a regional gross domestic product (GDP) of CNY 175.091 billion, with a year-on-year growth of 5.8% at comparable prices, ranking the 7th among the 14 cities in Guangxi. Looking at the breakdown by industries, the added value of the primary industry was CNY 24.513 billion, an increase of 4.1%; the added value of the secondary industry was CNY 79.616 billion, a growth of 7.3%; the added value of the tertiary industry was CNY 70.962 billion, a growth of 5.0%. The structure of the three industries was 14:45:41.

(2) The total general public budgetary revenue of the city was CNY 2038.73 million, and the total general public budgetary expenditure of was CNY 1962.11 million, Revenue and expenditure offset each other, with an end-of-year rollover surplus of CNY 76.62 million. After deducting the rollover for next year's use of CNY 76.62 million, the net surplus was zero. Among them, the expenditure on people's livelihood was CNY14.532 billion, accounting for 75.0% of the total general public budgetary expenditure.

(3) The per-capita disposable income of residents in the city was CNY 34,355, with a nominal growth of 5.4%. Among them, the per-capita disposable income of urban residents was CNY 43,539, an increase of 4.4%; the per-capita disposable income of rural residents was CNY 20,936, an increase of 7.5%. The urban-rural income ratio was 2.08:1, a decrease of 0.06 compared to the previous year.

Table 27 Major Economic Indicators of Beihai City During 2017 - 2021.

Indicator Name	Unit	2018	2019	2020	2021	2022	2023
Land Area	k ㎡	3337	3337	3337	3337	3337	3337
County / district	Number	4	4	4	4	4	4

Regional GDP	100 million	1186.66	1300.80	1276.91	1504.43	1674.21	1750.91
Primary industry	100 million	195.49	211.70	206.60	225.31	239.55	245.13
Secondary	100 million	513.64	557.65	485.66	635.74	761.53	796.16
Tertiary	100 million	477.53	531.45	584.66	643.38	673.14	709.62
Grain output	10000t	30.66	30.05	30.37	31.01	31.78	32.10
Fruit output	10000t	12.80	13.80	14.60	16.21	18.58	19.66
Vegetable output	10000t	101.28	107.78	113.12	124.21	133.83	140.25
Meat output	10000t	12.57	11.03	11.01	12.71	12.80	13.43
Aquatic product output	10000t	110.17	113.85	114.14	117.83	121.35	121.79
Fiscal revenue	100 million	225.19	242.27	192.04	231.12	204.85	234.22
Per-capita towners' average disposable income	RMB	34325	36602	37956	40727	41704	43539
Farmer's per-capita average disposable income	CNY	14617	15510	16797	18460	19475	20936

Data source: Statistical Bulletin of the National Economic and Social Development of Beihai City during 2018-2023.

7.3.1.2 Comprehensive profile of Haicheng District

Haicheng District is situated in the southwestern part of the Beihai City mainland peninsula, located between 20°26′ to 21°55′ north latitude and 108°5′ to 109°47′ east longitude. It borders the Yinhai District to the southeast, faces the sea to the northwest, and shares a boundary with Hepu County to the north. The jurisdiction includes both mainland and island areas. The mainland section is situated on the northern coast of the Beihai Peninsula, while the islands include Weizhou Island and Xieyang Island, located south of the Beihai Peninsula. The total area under jurisdiction is 141.24 k ㎡. It comprises seven subdistricts, respectively Zhongjie, Dongjie, Xijie, Haijiao, Dijiao, Gaode, and Yima, along with Weizhou Town. There are 43 communities and 19 villages. In 2023, the comprehensive economic and social situation of Haicheng District is as follows:

(1) The gross domestic product (GDP) of Haicheng District was CNY 57.943 billion, with a year-on-year growth of 2.9%. The value added of the primary industry

was CNY 2.994 billion, with a year-on-year growth of 1.3%; the value added of the secondary industry was CNY 19.654 billion, with a year-on-year growth of 0.4%; and the value added of the tertiary industry was CNY 35.296 billion, with a year-on-year growth of 4.5%. The structure of the three industries was 5.2:33.9:60.9.

(2) In 2023, the financial general public budgetary revenue of Haicheng District was CNY 587 million, marking an increase of 11.6% compared to the previous year. The general public budgetary expenditure amounted to CNY 1.44 billion, showing a growth of 23.1% compared to the previous year. The per-capita disposable income of urban residents was CNY 44,719, with a nominal increase of 4.6%, while the per-capita disposable income of rural residents was CNY 22,472, showing a nominal increase of 8.0%. The major economic indicators of Haicheng District during 2018-2023 are detailed in Table 28.

Table 28 Major Economic Indicators of Haicheng District in 2018 - 2022.

Indicator Name	Unit	2018	2019	2020	2021	2022
Administrative area	k ㎡	190	190	190	190	190
Sub-district, Town	Number	8	8	8	8	8
Total population	10,000 person	49.01	50.80	52.86	54.34	54.56
Regional GDP	100 million	435.10	483.70	477.65	524.97	563.03
Primary industry	100 million	27.62	27.10	26.73	28.27	29.56
Secondary industry	100 million	189.88	192.01	153.60	172.53	195.67
Tertiary industry	100 million	217.60	264.60	297.31	324.17	337.79
Grain output	10000t	0.39	0.29	0.32	0.33	0.37
Fruit output	10000t	1.42	1.45	1.48	1.57	1.63
Vegetable output	10000t	5.27	5.11	4.98	5.39	5.63
Meat output	10000t	0.50	0.33	0.11	0.10	0.10
Aquatic product output	10000t	23.33	23.81	23.85	24.62	25.36
Per-capita towners' average disposable income	CNY	34811	37700	39057	41791	42752
Per-capita average disposable income of rural residents	CNY	15066	16633	17964	19760	20807

Data source: Statistical Yearbook of Guangxi Zhuang Autonomous Region 》(2018-2023)

7.3.1.3 Socio-economic status of Hepu County

Hepu County is located in the southern part of Guangxi, adjacent to the northern shore of the Beibu Gulf and the mouth of the Nanliujiang River. It is the starting point

of the ancient Maritime Silk Road and known as the birthplace of Chinese pearls, the hometown of Chinese mooncakes, the longevity town of China, and a coastal open county. It has six distinct characteristics: "a thousand-year Han County, the starting point of the Maritime Silk Road, a city of honest officials, the hometown of pearls, the frontier of opening up, and an ecological paradise". Hepu County covers an administrative area of 2784 k ㎡, and it administers 14 towns including Lianzhou, Dangjiang, Xichang, Shagang, Wujia, Zhakou, Gongguan, Baisha, Shankou, Shatian, Shiwan, Shikang, Changle, and Xingdaohu, as well as one township named Quzhang. There are a total of 241 village committees and 33 community committees. The county government is located in Lianzhou Town. In 2023, the comprehensive economic and social situation of Haicheng District is as follows:

(1) The total regional GDP of the county reached CNY 37.193 billion, with a growth rate of 6.2% compared to the previous year. Among them, the value added of the primary industry was CNY12.684 billion, an increase of 4.7%; the value added of the secondary industry was CNY8.891 billion, an increase of 10.5%; and the value added of the tertiary industry was CNY15.618 billion, an increase of 5.1%. The proportions of value added from the primary, secondary, and tertiary industries to the total regional GDP were 34.1%, 23.9%, and 42.1%, respectively.

(2) The general public budget revenue of the county amounted to 1.454 billion, an increase of 7.5% compared to the previous year. The per capita disposable income of urban residents was CNY 42,548, an increase of 3.9%; while the per capita disposable income of rural residents was CNY 20,679, an increase of 7.7%. The major economic indicators of Hepu County during 2018-2022 are detailed in Table 29.

Table 29 Major Economic Indicators of Hepu District in 2018 - 2022.

Indicator Name	Unit	2018	2019	2020	2021	2022
LAND AREA	K ㎡	2784	2784	2784	2784	2784
COMMUNITY, TOWN, TOWNSHIP	NUMBER	15	15	15	15	15
REGIONAL GDP	100 MILLION	262.28	301.06	301.69	351.43	350.87
PRIMARY INDUSTRY	100 MILLION	97.81	105.56	108.81	117.39	124.20
SECONDARY INDUSTRY	100 MILLION	64.44	65.93	60.42	86.85	79.09

TERTIARY INDUSTRY	100 MILLION	100.03	129.58	132.46	147.19	147.58
GRAIN OUTPUT	10000T	26.20	25.71	25.83	26.29	26.78
FRUIT OUTPUT	10000T	9.55	10.39	11.11	12.40	14.41
VEGETABLE OUTPUT	10000T	69.44	74.67	78.88	85.91	92.73
MEAT OUTPUT	10000T	9.38	8.72	8.94	10.04	10.15
AQUATIC PRODUCT OUTPUT	10000T	44.68	46.13	46.26	47.78	49.20
PER-CAPITA TOWNERS' AVERAGE DISPOSABLE INCOME	CNY	34339	35906	37127	39874	40951
PER-CAPITA AVERAGE DISPOSABLE INCOME OF RURAL RESIDENTS	CNY	14013	15263	16545	18183	19201

Data source: Statistical Yearbook of Guangxi Zhuang Autonomous Region 》(2018-2022)

7.3.2 Population structure of project area

7.3.2.1 Basic population situation

By the end of 2022, the total permanent population of Beihai City was 1.881 million, ranking 13th among the 14 cities in Guangxi. Among them, the urban permanent population was 1.117 million, and the rural permanent population was 764,300, with an urbanization rate of 59.37%. The birth rate was 8.58‰, the death rate was 6.34‰, and the natural population growth rate was 2.24‰. Compared with the results of the seventh national census in 2020, the permanent population in 2022 increased by 1.5%, and the urbanization rate increased by 6.53 percentage points.

In 2020, the permanent population of Haicheng District was 527,900, with males accounting for 50.43% and females accounting for 49.57%. The age structure showed that individuals aged 0-14 accounted for 19.54%, those aged 15-59 accounted for 66.8%, and those aged 60 and above accounted for 13.66%, with individuals aged 65 and above accounting for 9.37%. By the end of 2022, the total permanent population in the district was 535,600, an increase of 7,700 from 2020. The urbanization rate of the permanent population was 98%, which was 13.85 percentage points higher than that in 2020.

At the end of 2022, the total registered population of Hepu County was 1.1092

million, with males accounting for 53.6% and females accounting for 46.4%. The total permanent population was 876,800, with 334,000 permanent urban residents and a permanent population urbanization rate of 38.09%, an increase of 2.7 percentage points compared to 2020. The annual number of births was 9,000, with a birth rate of 8.13‰, while the number of deaths was 5,900, resulting in a death rate of 5.35‰. The natural population growth rate was 2.78‰. The detailed information on the basic population situation of these three project areas in the seventh national population census are shown in Table 30.

Table 30 Basic Population Situation in Project Area

Indicator Name	Unit	Beihai city		Haicheng District		Hepu County	
		2020	2022	2020	2022	2020	2022
PERMANENT RESIDENTS	10,000 PERSON	185.32	188.10	527895	53.56	864193	87.68
URBAN POPULATION	10,000 PERSON	97.93	111.67	444202	52.49	305844	33.40
URBANIZATION RATE	%	52.84	59.37	84.15	98.00	35.39	38.09
MALE	10,000 PERSON	96.43	95.74	266229	16.52	455507	59.42
FEMALE	10,000 PERSON	88.89	87.64	261666	16.99	408686	51.50
MALE TO FEMALE RATIO	%	108.48	109.24	101.74	97.23	111.46	115.38
PERCENTAGE OF ETHNIC MINORITIES	%	3.52	-	5.27	-	1.19	-

7.3.2.2 Population structure of the ethnic minorities

In the seventh national census, the permanent resident population of Beihai City consisted of 1,788,000 Han people, accounting for 96.48% of the total population. The various ethnic minority populations totaled 65,200 people, accounting for 3.52%, among which the Zhuang ethnic group accounted for 44,278 people, representing 2.39%. Compared to the sixth national population census in 2010, the proportion of ethnic minority populations increased by 1.58 percentage points. The Han population increased by 278,715 people, representing a growth of 18.47%, while the various ethnic minority populations increased by 35,261 people, a growth of 117.79%. Among them, the Zhuang population increased by 21,551 people, representing a growth of 94.83%.

In the seventh national population census, the ethnic minority population in

Haicheng District accounted for 5.27% of the total permanent population, approximately 28,000 people. Compared to the sixth national population census in 2010, the proportion of ethnic minority populations increased by 1.94 percentage points.

Among the three districts and one county under the jurisdiction of Beihai City, Hepu County has the lowest proportion of ethnic minority populations. According to the data from the seventh national population census, the permanent population of ethnic minorities in the county was 10,238, accounting for 1.19% of the total permanent population. In the sixth national population census of 2010, the ethnic minority population in the county accounted for only 0.66%.

7.3.3 Poverty alleviation and employment promotion

7.3.3.1 Low-income and special-difficulty groups

As of the end of December 2023, Beihai City had a total of 14,333 urban residents in 7,479 households receiving minimum living guarantee (MLG). Additionally, there were 41,244 rural residents in 18,585 households receiving MLG. Moreover, there were 6,652 people receiving special assistance, including 740 urban recipients and 5,912 rural recipients. Among these, Haicheng District had 3,421 urban residents and 602 rural residents receiving MLG. Hepu County had 8,433 urban residents and 28,789 rural residents receiving MLG.

7.3.3.2 Disability group

By the end of December 2023, Beihai City had a total of 14,446 people receiving subsidies for living difficulties among people with disabilities, and 22,758 people receiving subsidies for severe disability care. Over the past five years, the number of people receiving subsidies has grown rapidly and then stabilized. In September 2023, the number of people receiving subsidies for living difficulties among people with disabilities in Haicheng District was 1,309, and the number receiving subsidies for severe disability care was 2,956. In Hepu County, as of December 2023, the number of people receiving subsidies for living difficulties among people with disabilities was

9,768, and the number receiving subsidies for severe disability care was 14,547.

Table 31 Low-income Population in Project Counties

INDICATOR NAME	2019	2020	2021	2022	2023
NOS OF URBAN RESIDENTS RECEIVING MLG	6627	12832	13083	13987	14333
NOS OF RURAL RESIDENTS RECEIVING MLG	40513	40796	38833	41079	41244
NOS OF URBAN RESIDENTS RECEIVING SPECIAL POVERTY ASSISTANCE	350	452	481	670	740
NOS OF RURAL RESIDENTS RECEIVING SPECIAL POVERTY ASSISTANCE	6098	6046	5859	6002	5912
NOS OF DISABILITY PEOPLE RECEIVING LIVING SUBSIDIES	13037	14521	14273	14423	14446
NOS OF SEVERE DISABILITY PEOPLE RECEIVING NURSING SUBSIDIES	19473	21842	22278	22393	22758

7.3.3.3 Overview of employment and poverty alleviation monitoring

In 2023, Beihai City saw the addition of 15,300 urban employment, surpassing the task target by 127.65%; 3,275 unemployed urban individuals found reemployment, exceeding the task target by 131%; and 1,346 individuals of employment difficulties getting jobs, surpassing the task target by 149.56%. Moreover, more than 380,000 rural laborers sought employment opportunities outside their hometowns, while approximately 24,000 laborers who have shaken off poverty (including monitoring subjects) migrated for work, representing a 116.22% increase compared to the level at the end of 2020 (20,815 individuals). The average net income per capita for poverty-eliminated individuals in the city reached CNY 18,657, showing a growth of 12.2%. Efforts were made to consolidate and enhance achievements in the "Three Guarantees" and water safety. Measures to prevent dropouts and ensure access to education were actively maintained, resulting in a dynamic dropout rate of zero. Additionally, the participation rate in basic medical insurance for poverty-eliminated individuals and those under monitoring reached a dynamic rate of 100%.

In 2023, Haicheng District saw the addition of 6,384 urban employment; 1450 unemployed urban individuals found reemployment, and 599 individuals of employment difficulties getting jobs. Moreover, in terms of poverty alleviation monitoring, a "online-networked, offline-grid" model was implemented, bolstering dynamic management of monitoring subjects. Totally 3 households with 12 persons

deemed at risk of falling back into poverty were promptly included in the monitoring system. Efforts were also intensified to enhance the "Three Guarantees" and ensure water safety. The medical insurance participation rate among households lifted out of poverty and those under monitoring reached 100%, while there were no school dropouts among age-appropriate children in these households. The "Haicheng District Major Medical Assistance Fund" played a vital role by providing CNY 90,000 in additional medical aid to 18 households under monitoring, effectively alleviating the medical burdens of local residents.

By the end of 2020, Hepu County had a total of 511,100 employed individuals, reflecting a 1.43% increase from the previous year. Throughout the year, there were 3,300 new urban job additions, with 6,400 rural laborers securing employment opportunities. The urban registered unemployment rate was 2.7%. In 2021, there were 4,200 new urban job additions, with 11,100 rural laborers The urban registered unemployment rate was 2.3%; in 2022, the total number of new urban employed individuals was 4,600, with an urban registered unemployment rate of 2.46%.

7.3.4 Profile of representative communities / villages

The project is located within the Lianzhou Bay in Hepu County of Beihai City. The construction area involves Shandong Village and Qixing Village in Shagang Town, and Mu'an Village, Yujiang Village, Shachong Village, Matou Village in Dangjiang Town, as well as Ma'an Village and Yanlou Village in Lianzhou Town.

Dangjiang Town is situated in the southwestern part of Hepu County, approximately 8 km away from the county seat. It is located at the top of Lianzhou Bay, only 6 nautical miles away from Beihai City across the sea. The town is adjacent to the river and faces the sea, with flat terrain and fertile land, earning it the reputation of being the "base of rice and eggs" and the "land of fish and rice". The Qinzhou-Beihai Express Railway passes through, and the Nanliujiang River flows through. The total area of the town is 81.5 k ㎡, with 1,000 h ㎡ of arable land and 2,000 h ㎡ of beach and mudflat area. The total length of the seawall along the river is 102.5km, with three large enclosures, namely Baiqu, Gengluo, and Nanyu, covering

tens of thousands of hectares. There are 188 sluices and 24km of standard seawall along the river. In 2022, Dangjiang Town administered 1 community and 17 administrative villages, with a total population of 53,860 people, including 51,235 agricultural population. The permanent resident population of the town is around 6,000. There are 16 enterprises in the jurisdiction, including one large-scale enterprise. The pillar industry is shipbuilding. The main industrial products include steel ships and wooden fishing boats. The main agricultural products are rice and water chestnuts, while the main aquatic products include whiteleg shrimp and oysters.

Shagang Town is located in the northwest of Hepu County, 20km away from the county seat. The Qinzhou-Beihai Express Railway runs through the area, and the Nanliujiang River flows along the border. The total area of the town is 108 k ㎡, with a coastline of 15.7km. There are 3,892 h ㎡ of arable land, 600 h ㎡ of forest land, and 866 h ㎡ of beach and mudflat area. In 2022, Shagang Town administered 1 community and 15 administrative villages, with a total of 10,281 households and 41,762 people. The town covers an area of 1 k ㎡, with 1 main street and 1 new area. Each village has public service comprehensive buildings and cultural and sports facilities, as well as mass cultural and artistic groups such as the Elderly Sports Association. The main agricultural products include rice, sugarcane, cassava, whiteleg shrimp, mudskipper fish, clams, and sea duck eggs. The pillar industry is sugarcane planting, and the branded product is "Qixing Hongren Sea Duck Egg". The main industrial products include fireworks and firecrackers.

Lianzhou Town is under the administration of Hepu county of Beihai City and located in the northern suburbs of Beihai City. It serves as the seat of the People's Government of Hepu County and is the political, economic, cultural, and trade center of Hepu. It borders Shikang Town and Fucheng Town of Yinhai District of Beihai City to the east, Gaode Town of Yinhai District to the southeast, Xingdaohu Town and Dangjiang Town to the west, and faces the Beibu Gulf to the southwest. It is adjacent to Shiwan Town to the north. With a total area of 206 k ㎡, it is the largest town in the county. There are 4,274 h ㎡ of arable land, 200 h ㎡ of forest land, and 1,726 h ㎡ of beaches and mudflats. In 2022, Lianzhou Town administered 16 communities and

16 administrative villages. According to the data from the 7th National Census in 2020, the total permanent population of Lianzhou Town was 246,064 people. Lianzhou Town has a long history, simple folk customs, and a rich cultural heritage. It is rich in mineral resources, with the Qingjiang kaolin ore area being the largest known kaolin reserve in China. The main agricultural products include rice, sugarcane, corn, peanuts, jute, and vegetables. The main industrial products include fireworks, machinery, minerals, building materials, hardwares, and leather goods.

In order to better understand the population and socio-economic conditions of the project area, the social consultants selected the most representative villages for on-site investigations. The survey results to some extent reflect the level of economic and social development in Hepu County. The basic profiles of these representative villages and their comprehensive population and social data are shown in Tables 32 and 33.

Table 32 Basic Profile of Representative Communities / Villages

District / County	Township / Subdistrict Office	Village / Community	Basic information
Hepu County	Dangjiang Town	Shachong Village	(1) Shachong Village is located in the southeast of Dangjiang Town, about 7km away from the town government. It covers a total area of 2.66 k ㎡, with a total arable land area of 2980 mu (all of which are paddy fields) and a mudflat area of 370 mu. It administers 10 natural villages and 31 villagers' groups. (2) The village relies on shrimp farming and marine fishing as its main industries, using the primary industry to drive the secondary and tertiary industries, thereby absorbing the idle labor force in the entire village. The village promotes economic development through multiple channels and industries to increase income. In 2020, the GDP reached CNY 43.12 million, with agricultural income accounting for 13%, animal husbandry 9%, fisheries 74%, and other industries 4%. (3) The village has a main pipeline for drinking water supply extending for 8 km, and the electricity grid covers the entire village and most of the farmland. All natural villages are connected with each other by village roads, facilitating the entry and exit of agricultural vehicles and cars. The information network is smooth. (4) There are 2 cooperative medical care stations in the village, with 3,723 people participating in the new rural cooperative medical care, with a participation rate of 93.96%, and 1,412 people participating in the new rural insurance, with a participation rate of 81.6%. (5) There are 71 households with 137 people benefiting from poverty alleviation and disaster relief, as well as five-guarantee

			households and low-income households. Basic living subsidies are provided by the government's civil affairs department. (6) The village fully implements the working procedures of "Four Discussions and Two Openness", establishing a complete system of villagers' conference and formulating and posting village rules and regulations. In recent years, no criminal cases have occurred, indicating a good public security situation.
		Mu'an Village	(1) Mu'an Village is located 10km away from the government of Dangjiang Town and consists of 12 natural villages and 25 villagers' groups. (2) The village has a total arable land area of 2899.3 mu, all of which are paddy fields, without dry land. It also has approximately 145 mu of ponds. The per capita arable land area is 0.9 mu, indicating a high population density and limited land resources. (3) The main source of income for villagers comes from migrant work, business, and aquaculture. The primary economic industry is aquaculture, focusing on shrimp and oyster farming, with secondary activities including raising geese, ducks, and freshwater fish. There is no cultivation of crops in the entire village. (4) The main sources of collective economic income are market management, pond leasing, and rental income from houses, totaling around CNY 70,000. (5) More than 70% of the village's roads are hardened, significantly improving transportation conditions for farmers. Information technology development has progressed rapidly, with broadband networks covering the entire village. (6) The living conditions of impoverished elderly individuals and low-income families are ensured, and various agricultural policies are effectively promoted. Nearly 99% of the villagers participate in the rural cooperative medical care, with 3,975 participants, and 3,618 participants in the new rural insurance, reaching a participation rate of 90.1%.
		Yujiang Village	(1) Yujiang Village is located in the southern part of Dangjiang Town, 8km away from the town government, surrounded by rivers on two sides and facing the sea on one side. (2) The total area of the village is 6.5 k ㎡, consisting of 7 natural villages and 14 village groups. The total arable land area is 4713 mu, with a river embankment of 7km. (3) The village mainly relies on marine aquaculture, with shrimp farming, clam stocking, and sea duck eggs being well-known locally. The collective economic income of the village includes land contracting, shares in the Changle Town Agricultural Trade Comprehensive Market project, and shares in the Hepu An'ong Agricultural Co., Ltd., with an income of 53,000 yuan in 2020. (4) Infrastructure construction is continuously improving, with every household having access to water and electricity. There are 34 biogas tanks built, and information networks cover every household. However, the living environment in some natural villages remains poor. (5) Rural cooperative medical care and social insurance are fully covered, with 3574 villagers participating in rural cooperative medical insurance, with a participation rate of 96.19%, and 1306 people participating in social insurance, with a coverage rate of 82%. (6) The village committee earnestly implements the procedures

			of "Four Discussions and Two Openness" , adheres to the system of villagers' conference, regularly convenes meetings of village representatives, and publicly announces major matters for discussion by the whole village.
	Shagang Town	Qixing Village	(1) Located 6.8km south of Shagang Town in Hepu County, on the east side of the mouth of the main stream of the Nanliu River, covering an area of 2.34 k ㎡. The coastline is 9.5km long, with an island embankment of about 12km long and an altitude of 3.6 meters. (2) The village administers seven natural villages: Xiaoshalang, Dashalang, Goududou, Zhongjianshe, Dingtou, Donglang, and Xilang. There are 571 households with a total population of 2402 people, with approximately 10% of the registered population migrating out. (3) The village is located on an island at the mouth to sea, surrounded by dry beaches during low tide. The nearby sea area produces coilia, yellow croakers, sandworms, crabs, etc. Residents make a living mainly through marine aquaculture and shallow-sea fishing, with sea duck farming being particularly well-known. (4) The infrastructure construction on the island is relatively weak, and transportation is inconvenient, mainly relying on ships to connect with the mainland. (5) In recent years, relying on the county's tourism development trend, the village has focused on the construction of Qixing Island and opened up eco-tourism routes. (6) The village committee earnestly implements the procedures of "Four Discussions and Two Openness", adheres to the system of villagers' congresses, and maintains good public security.
	Lianzhou Town	Yanlou Village	(1) Located on the coast of the Beibu Gulf, east of the Hepu Industrial Park, west of Lianzhou Bay (the mouth of the Nanliujiang River), adjacent to Tangwei Village Committee of Gaode subdistrict, Haicheng District to the south, and to Ma'an Village Committee to the north. It is 8km away from the town government and 20km from Beihai City. (2) The area covers 4.6 k ㎡ with a coastline of 6.3km. It has 1700 mu of arable land and encompasses six natural villages: Yanlou, Tianliao, Shui'er, Poxin, Danshuitang, and Shadun. There are 20 villagers' groups. The main industries include aquaculture and tourism. (3) At the end of 2022, the population of the area was 4329, with a village collective economic income of CNY 670,000 and fixed assets of the village totaling CNY 3.4934 million. (4) There is one primary school, three kindergartens, one clinic, one AAAA-level tourist attraction, and complete public service facilities such as a village-level government service station, communication facilities, bank, pier, agricultural market, and bus station. (5) Since 2001, the village has been awarded honors such as "National Civilized Village," "National Rural Governance Demonstration Village," "National Democratic and Legal Governance Demonstration Village," and "National Village-level Governance and Consultation Innovation Experimental Unit." In 2023, it was named a key village for rural tourism in Guangxi.

Table 33 Comprehensive Data of Representative Villages

Items		Shachong Village	Yujiang Village	Mu'an Village	Yanlou Village	Qixing Village
Population	Total households (number)	1136	789	438	743	571
	Total Population (person)	3900	2924	2791	2861	2402
	Incl.: Male (person)	2008	1754	1507	1516	1369
Age	Age 0- 16 (person)	693	670	560	445	576
	Age 17- 60 (person)	2356	1800	1701	1876	1441
	Age above 60 (person)	851	454	530	540	384
Education	Illiterates and semi-illiterates (person)	256	217	358	267	292
	Primary school education (person)	286	280	537	585	427
	Secondary education (person)	1523	1100	890	871	770
	High school or technical school (person)	1420	890	670	747	613
	College or above (person)	415	437	336	391	300
Nationality	Han	3989	2917	2783	2857	2397
	Other ethnic groups (person)	1	7	8	4	5
Labor	Total labors (person)	2356	1800	1907	1900	1441
	Female labors (person)	1130	720	1025	967	763
Income	Farmer's average per-capita met income (CNY)	12000	10500	10780	30000	12500

7.3.5 Economic and social conditions of the representative village households

With the organization and support of the Villagers' Committee, the survey group carried out the household survey. Totally 114 valid sheets were returned. In the survey, the respondents were in normal distribution in terms of age distribution. Most of them were the middle-aged,with less elderly and young people. All the respondents are Han.

(1) Gender composition

Among the 114 interviewees, there were 74 male, accounting for 64.9%; 40

female, accounting for 35.09%. The gender composition of samples are shown in Figure 24.

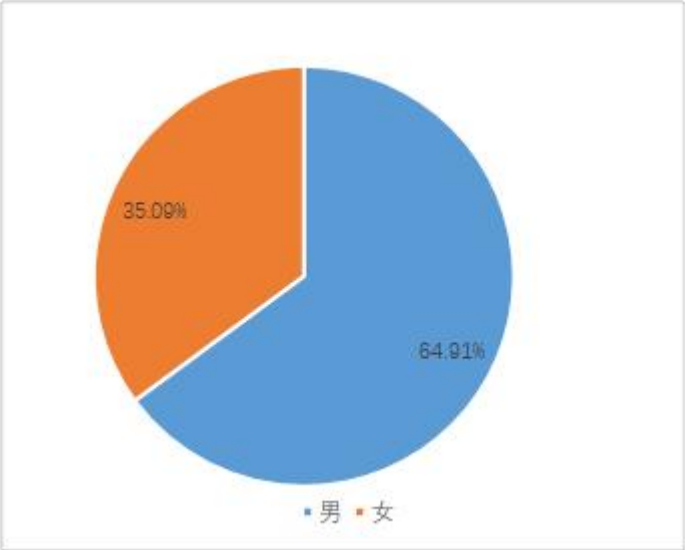


Figure 24 Gender Composition of Samples

(2) Education background

In terms of education background, among the 114 households with 468 persons surveyed, there were 128 persons of or below primary education, accounting for 27.35% of the total population; 205 persons of secondary school education, accounting for 43.80%; 109 persons of high (technical school) school, accounting for 23.29%; 26 persons of college or above, only accounting for 5.56%. Details of education background of the sampled households are shown in Table 34. It can be inferred that, among the project affected households, the proportion of secondary school education was the highest, followed by the primary school or below, both totally accounting for 67.09%.

Table 34 Education Background of the Sampled Affected Households

ITEMS	GRANT TOTAL (PERSONS)	PROPORTION (%)	AVERAGE PER HOUSEHOLD
TOTAL	468	100	4.1
PRIMARY SCHOOL OR BELOW	128	27.35%	1.1
SECONDARY SCHOOL	205	43.80%	1.8
HIGH SCHOOL (TECHNICAL) SCHOOL	109	23.29%	1.0
COLLEGE OR ABOVE	26	5.56%	0.2

(3) Population structure

There were 114 affected households with 468 persons affected by the project under the random sampling. The average size of the family was 4.1 persons.

From the perspective of age distribution, there are 94 individuals aged 0-17 years, accounting for 20.09% of the population; 140 individuals aged 17-35 years, representing 29.91%; 161 individuals aged 36-60 years, making up 34.40%; and 73 individuals aged 61 and above, comprising 15.60% (Table 35). It can be inferred that among the population of the affected households in the project, the age group of 36-60 years old has the highest proportion, followed by the age group of 17-35 years old, which accounts for a slightly lower percentage. Together, these two age groups make up 64.32% of the total population.

Table 35 Age Structure for the Sampled Project Affected Households

POPULATION STRUCTURE	GRANT TOTAL (PERSONS)	PROPORTION (%)	AVERAGE PER HOUSEHOLD
TOTAL POPULATION	468	100%	4.11
LABOR POPULATION.	300	64.10%	2.63
DISABLED POPULATION	7	1.50%	0.06
AGE 0- 16	94	20.09%	0.82
AGE 17 - 35	140	29.91%	1.23
AGE 36- 60	161	34.40%	1.41
AGE ABOVE 61	73	15.60%	0.64

From the labor force structure of the sampled households affected by the project, out of 468 individuals in 114 households, there are 300 laborers, with an average of 2.63 persons per household. Among the labor force, 94 individuals are primarily engaged in agricultural activities, with an average of 0.82 persons per household; 23 individuals are involved in business, averaging 0.20 persons per household; and 182 individuals are migrant workers, averaging 1.760 persons per household. As shown in Table 36）.

From the labor force structure, it can be inferred that, the out-going-work labor force has the largest proportion of the affected households, which also exceeded proportion of the agricultural-based labor force. Such means that the importance of agricultural income has fallen to the secondary position.

Table 36 Labor Force Structure in the Sampled Households

Population Structure	Grand total	Proportion (%)	Average household
Total population	468	100	4.11
Labor population.	300	64.10%	2.63
Agriculture-headed labor	94	31.33%	0.82
Labor in running business	23	7.67%	0.20
Administrative institutions	1	0.33%	0.01
Out-going labor	182	60.67%	1.60

4. Vulnerable groups

For the 7 households disabled persons, they will enjoy treatment for disabled persons upon getting the certificate of the disable. And, in terms of technical training and provision of job opportunities, the government, the village committee and the implementing agency will give them more care and assistance.

5. Income structure

Among sampled affected households during survey, the annual average per-capita income was CNY 13,459, with the income sources mostly of agricultural production, out-going work, business and other operations. The primary source of income, accounting for 56% of the total, is derived from wages earned through labor services, with an average of CNY 7536 per person. Following this, agricultural income constitutes 34.6% of the total income, with an average of CNY4653 per person (Table 37). It can be inferred that the main sources of income for households affected by the project are wages earned through labor services and agricultural income, while income from wages and business activities represents a relatively smaller proportion of household income sources.

Table 37 Annual Income Structure of Affected Sampled Households (2022)

Items	Average per household (CNY)	Average per-capita (CNY)
Household annual net income	55253	13459
1. Agricultural income	19103	4653
2. Migrant out-working income	30936	7536
3. Salary incomes of institutions	185	45
4. Business income	3793	924
5. Rent income	66	16
6. Annual pension income	1170	285

6. Expenditure structure

According to the sampled survey of the affected households, the annual average per-capita expenditure was CNY 7355. In terms of structure, which were mostly used for family living expenses and education, respectively 52.0% with average per-capita CNY 3826 and 9.8% with average per-capita CNY 724. Details are shown in Table 38.

Table 38 Annual Expenditure Structure of Affected Sampled Households

ITEMS	AVERAGE PER HOUSEHOLD (CNY)	AVERAGE PER-CAPITA (CNY)
WHOLE FAMILY CONSUMPTION EXPENDITURE	30194	7355
FOOD	15707	3826
WEARING	2500	609
ELECTRICITY	1334	325
GAS	1995	486
TRANSPORT	1351	329
COMMUNICATION	969	236
HUMAN RELATIONSHIP	1872	456
MEDICAL CARE	1494	364
EDUCATION	2972	724

7. Key properties

From the sampled survey of households affected by the project, it is evident that mobile phones, motorcycles, electric bicycles, and air conditioners are commonly found in households within the project area. Mobile phones are the most prevalent, with an average of 3.87 units per household, followed by motorcycles and electric bicycles at 2.1 units per household, and air conditioners at 1.8 units per household. Even household cars are prevalent, with one car for every two households. As shown in Table 39.

Table 39 Key Properties of Affected Sampled Households

NAME OF PROPERTIES	GRAND TOTAL	AVERAGE HOUSEHOLD
PRIVATE CAR	93	0.82
CONSTRUCTION EQUIPMENT SUCH AS TRUCK, EXCAVATOR ETC.	7	0.06
AGRICULTURAL EQUIPMENT SUCH AS TRACTOR, CULTIVATOR	27	0.24
MOTORCYCLE, ELECTRIC MOBILE	239	2.1
COLOR TV	182	1.6
REFRIGERATOR	160	1.4
WASHING MACHINE	111	0.97

AIR CONDITIONER	205	1.8
COMPUTER	72	0.63
KITCHEN VENTILATOR	72	0.63
STERILIZATION CABINET	71	0.62
CELL PHONE	441	3.87

8. EIA and Mitigation measures

8.1 Engineering impact identification and assessment scope

8.1.1 Environmental impact identification and assessment scope

8.1.1.1 Environmental impact identification

The main construction content under assessment includes the restoration of mangroves and Spartina alterniflora clearing. Based on the characteristics of the engineering construction, potential environmental impacts have been identified, as detailed in Table 40.

Table 40 Project Activities and Identification of Potential Environmental Impacts

Sl.	Activities	Components	Potential environmental impacts
Subproject 2: Blue Carbon Sink Actions			
1.1	Mangrove afforestation and restoration	Mangrove restoration 442.49 h㎡; Cleaning of spartina alterniflora 229.04h㎡. The implementation area is concentrated in Nanliujiang estuary and Lianzhou Bay area (excluding the Shankou area).	Construction stage: The impact of suspended solids generated from tidal disturbance on seawater quality, marine ecology, and biological resources; the impact of Spartina alterniflora and mangrove clearance on marine sediment and noise; the impact of solid waste generated from derris and Spartina alterniflora clearing; the impact of construction camp wastewater and solid waste; the impact of construction machinery exhaust, vehicle and vessel exhaust, and noise. Operational stage: The impact of replanting seedlings on seawater quality and marine ecological environment; the impact of solid wastes generated from clearing enteromorpha, marine debris, and Balanus albicostatus; the impact of pest control involving pesticide exposure on human health.

Table 41 Identification of Degree of Project Impacts

Assessment period	Environmental elements	Assessment factors	Production sources	Degree of impacts and analysis
Construction	Marine ecology and biological resources.	Benthic organisms	Sea area occupied by construction	++
		fish egg, larval and juvenile	The dispersion of suspended sediment caused by construction	+

n peri od		Plankton	The dispersion of suspended sediment caused by construction	+
		Nektonic organism	The dispersion of suspended sediment caused by construction	+
		Chlorophyll a	The dispersion of suspended sediment caused by construction	+
		Primary productivity	The dispersion of suspended sediment caused by construction	+
	Marine water quality	SS	The dispersion of suspended sediment caused by construction	+
	Marine sediment.	Grain size, soil salinity, organic carbon, sulfides, total nitrogen, total phosphorus, oil, heavy metals (Hg, Cd, Ld, Zn, Cu, Cr, As), polychlorinated biphenyls, hexachlorocyclohexane, and DDT.	Excavation and leveling of mudflats during the clearing of derris and Spartina alterniflora	++
	Marine topography and sedimentation environment.	Mudsand	Excavation of the deep plowing areas of spartina and derris, burying the spartina plants deeply, and compacting and leveling the mudflats.	+
	Acoustic environment	Noise	Construction machinery, equipment, tranport vehicle, ship	+
	Atmospheric environment	TSP	Vehicle transportation	+
		NOx、CO、THC etc.	Tail gas from construction machinery, equipment, vehicle, ship	+
	Solid wastes	Domestic garbages	Construction personnel	+
		Plants of Spartina alterniflora and derris	Spartina alterniflora and derris clearing	+
Ope ratio nal peri od	Solid wastes	marine debris, Enteromorpha, balanus albicostatus, Spartina alterniflora and derris	Clearing of marine debris, Enteromorpha, balanus albicostatus, Spartina alterniflora and derris	+
	Human health	Human health	Pesticide contact	+
"+" represents minor or slight impacts on environmental impact elements and assessment factors, necessitating a brief analysis and impact projection. “++" represents moderate impacts on environmental impact elements and assessment factors, necessitating a normal impact projection. "+++" represents relatively substantial or sensitive environmental impact elements and assessment factors, necessitating a prudent analysis and impact projection.				

8.1.1.2 Scope of environmental assessment

To ensure a more scientifically grounded evaluation in line with local environmental sensitivities, the assessment considered the project's engineering nature, regional environmental characteristics, and impact features. It adhered to the AIIB's relevant policies, referenced EIA technical guidelines, and drew from EIA experiences and practices in similar domestic construction projects. This approach facilitated the determination of the spatial scope for investigating the current status, predictive assessment, and cumulative impact assessment of various environmental elements within the project implementation area, as detailed in Table 42.

The assessment timeframe encompasses both the construction and operation periods for each element.

Table 42 Spatial Scope of Assessment

Environmental elements		**Scope of Evaluation**
Marine environment	Marine ecology	Sea area extending outward for 3km
	Marine water quality	Sea area extending outward for 3km
	Marine sediment.	Sea area extending outward for 3km
	Marine topography and sedimentation	Sea area extending outward for 3km
Environmental air		Surrounding area within 200 meters of the project site.
Acoustic environment		Area 200m outwards the construction site boundary

8.1. 8.1 Identification of major targets for environmental protection

According to the laws and regulations of domestic EIA and AIIB's environmental and social policies, the principles for selecting environmental protection targets (sensitive points) for the EIA of this subproject are as follows:

(1) Special protected areas: National parks, nature reserves, scenic spots, world cultural and natural heritage sites, marine special protection areas, and drinking water source protection areas.

(2) Ecologically sensitive areas: Ecological protection red line control areas, permanent basic farmland, basic grassland, natural parks (forest parks, geological parks, marine parks, etc.), important wetlands, natural forests, key protected habitats for wildlife, key protected areas for wild plant growth and reproduction, natural spawning grounds, bait grounds, wintering grounds, and migration channels for important aquatic organisms, natural fishing grounds, key prevention and control areas for soil erosion, areas for the protection of desertified land, and closed or semi-closed sea areas.

(3) Areas with population agglomeration: Areas mainly for residential, medical and health care, cultural education, scientific research, administrative offices, as well as cultural heritage conservation units.

Based on the above principles, environmental protection targets for this subproject have been selected, with the focus on nearshore marine functional areas, marine functional areas, and mangroves.

As such, the objects potentially impacted by the project implementation are screened and identified for environmental protection, as shown in Table 43.

Table 43 Summary of Major Environmental Protection Targets

<table>
<tr><th>Subproject</th><th>Major Environmental protection targets</th></tr>
<tr><td>Mangrove afforestation and restoration</td><td>
(1) Nearshore marine function area
<table>
<tr><td>Protection objects</td><td>Protection targets</td></tr>
<tr><td>Protecting important tidal flats, shallow marine areas, and significant wetland ecosystems.</td><td>Tidal flats and shallow marine waters of Lianzhou Bay（GX029BⅡ）</td></tr>
</table>
(2) Marine functional zone
<table>
<tr><td colspan="2">Marine environment protection</td><td rowspan="2">Protection targets</td></tr>
<tr><td>Key objectives of ecological conservation</td><td>Environmental protection</td></tr>
<tr><td>Maintain the basic morphology of the coastline and preserve the integrity of significant natural and cultural landscapes.</td><td>Urban sewage discharge should be controlled to reduce tourism pollution; seawater quality should meet no less than Category III standards, and marine sediment and marine organisms should meet Category II standards</td><td>Lianzhou Bay Tourism and Leisure Entertainment Area（A5-11）</td></tr>
<tr><td>Strengthen dynamic monitoring and tracking management of reclamation activities.</td><td>Before the development of the sea area, the environmental quality of the area should be maintained at its current state.</td><td>Lianzhou Bay Industrial and Urban Sea Area Use Zone (A3-7):</td></tr>
</table>
(3) Mangrove
<table>
<tr><td>Protection objects</td><td>Protection targets</td></tr>
<tr><td>Mangroves</td><td>Dongwei Mangrove Conservation Area</td></tr>
<tr><td>Mangroves</td><td>Hepu County Mu’an Mangrove Conservation Area</td></tr>
<tr><td>Mangroves</td><td>Hepu County Qixing Mangroves Conservation Area</td></tr>
<tr><td>Mangroves</td><td>Guangxi Hepu Dangjiang Mangroves Provincial Level Key Wetland</td></tr>
<tr><td>Mangroves</td><td>Nearshore mangroves of Lianzhou Bay in Hepu County</td></tr>
</table>
</td></tr>
</table>

8.2 EIA and mitigation measures during construction period

8.2.1 Hydrodynamic environmental impact prediction and assessment

The mangrove restoration of this subproject is located at Nanliujiang Estuary and Lianzhou Bay area. The construction contents include environmental restoration of the places through clearing the invasive species such as Spartina alterniflora and derris, and plant mangroves in the suitable places.

The component of mangrove restoration belongs to marine use which does not alter the natural attributes of the sea. The construction mainly takes place on intertidal flats after the ebb tide, and the construction process has minimal impact on hydrodynamic conditions.

Based on the long-term wind and wave observation data from the local meteorological department and the Beihai Marine Environment Monitoring Center of the State Oceanic Administration, in the Beibu Gulf waters, the prevailing wind direction is northward, with the dominant wind direction being southeastward. Similarly, the predominant wave direction is northward, with the dominant wave direction also being southeastward. Due to the relatively short length of the prevailing wave direction wind region, significant waves are not typically generated. The strong wave direction, on the other hand, is hindered by the obstruction of the Beibu Gulf and Hainan Island, resulting in generally small waves under normal conditions. According to seven years of data from the Beihai Dijiao wave measurement station, the frequency of H1/10 $\leq$ 0.6m in each direction throughout the year is 94%, with strong waves mainly caused by tropical cyclones. In the sea area where the subproject is located within the Lianzhou Bay, waves are even smaller, typically less than 0.3m, and strong waves have minimal impact on this area. Therefore, wave effects on the construction of this subproject, particularly the mangrove restoration, are considered minimal, as there will be no significant changes in wave dynamics. Therefore, the mangrove restoration projects has minimal impact on the hydrodynamic environment and tidal flow field in the area.

8.2.2 Topography and sedimentation environment prediction and assessment

The restoration of mangroves can increase regional mangrove resources and contribute to the establishment of a healthy mangrove ecosystem. It is considered as a marine ecological restoration project and does not constitute exclusive marine activities, thus maintaining the original natural attributes of the marine area.

The clearing of Spartina alterniflora and derris, as well the mangrove restoration, are conducted on the intertidal flats after the ebb tide. The depth of mechanical removal of Spartina alterniflora is about 100cm, while the burial depth of derris is approximately 60cm. These activities are unlikely to significantly impact the topography and geomorphology of the marine area. Therefore, the impact of mangrove restoration on the topography, geomorphology, and sedimentation dynamics of the marine area is minimal.

8.2.3 Marine water quality impact prediction and assessment

8.2.3.1 Impact analysis of marine water quality by mangrove restoration

The main impact of mangrove restoration on seawater quality is the dispersion of suspended solids. According to the design, the removal of Spartina alterniflora and derris in the subproject is carried out using a combination of mechanical and manual methods. Mechanical clearance is employed in concentrated contiguous areas, while manual clearance is used in areas where mangroves are mixed. The removed derris are collected ashore and transported to nearby town waste transfer stations. The cut stems of Spartina alterniflora are transported by boats to the mechanical clearance area and buried together. For the re-sprouted Spartina alterniflora and derris in the following year, manual removal will continue for three consecutive years. The construction will be carried out on the inter-tidal flats during low tide, minimizing the production of suspended solids. In the rising tide, a small amount of suspended solids may gradually spread along the edge of the embankment, but with limited negative impacts.

8.2.3.2 Impact analysis of marine water quality by construction wastewater

(1) Oily wastewater machinery equipment

Auxiliary facilities such as machinery repair shops, vehicle maintenance stations, and automobile repair shops will use the local facilities in nearby towns and villages, and the temporary construction site will not produce machinery oily wastewater.

During the removal of the Spartina alterniflora, any oil leaks from the machinery or vessels could lead to an increase in petroleum substances in the water, resulting in a decline in water quality and impacting the marine ecosystem. Therefore, it is necessary to strengthen the maintenance of construction machinery and transport vessels to prevent oil leaks from contaminating the water environment. This measure ensures that the marine ecological environment in the evaluation area will not be significantly affected.

(2) Domestic sewage

The construction activities are relatively concentrated within this scope. It is proposed to lease existing residential buildings near the construction area to serve as workers camps. There is no need for temporary land occupation for workers camps. The domestic sewage from construction camp is treated in septic tanks of the rented to construct, which will be used for irrigation in the surrounding woodland areas, without direct discharge into the water body, resulting in minimal impact on the nearby marine environment.

8.2.3.3 Protection measures for marine water quality

(1) Work schedules should be arranged rationally, and construction should be conducted during low tide to ensure that the tidal flats are exposed.

(2) Domestic sewage from construction personnel should be treated in septic tanks built near residential houses, and the treated effluent can be used as organic fertilizer for irrigation in nearby forests, without being discharged into water bodies. Additionally, the contractors should provide training for construction personnel and implement environmental monitoring during the construction process. Environmental protection clauses should be included in the construction contract, and the contractor must strictly adhere to them.

(3) Maintenance and upkeep of construction machinery and vessels should be intensified to prevent oil spills.

(4) The IA should cooperate with local supervisory authorities to monitor the environmental impact during the construction process and conduct regular checks on water quality. Environmental protection clauses should also be incorporated into the construction contract, and the contractor must adhere to them strictly.

(5) During the bidding process for construction contracts, the IA and the contractor should sign agreements that clearly outline construction techniques and specify the responsible party for any environmental pollution caused during the construction process.

8.2. 4 Impact analysis for marine Sediments environment

8.2.4.1 Impact analysis of marine sediment environment by mangrove restoration

Removal of Spartina alterniflora and derris before the mangrove restoration would disrupt the existing sediment environment, exposing the bottom sediment caused by excavation to the surface. Additionally, during construction breaks, tidal inundation causes the slow migration of bottom sediment to the surrounding soil mounds. Over the construction period, the sediment environment gradually transitions to that of the excavation layer. With the completion of construction, the sedimentation-promoting effect of Spartina alterniflora diminishes. Initially, sediment in the construction area settles with slightly larger particle sizes due to natural sediment transport, resulting in sediment retention and settling. As a result, the degree of sediment muddiness in the area gradually diminishes. Following the clearing of Spartina alterniflora, biodegradable films can be used to cover the area to ensure efficient clearing. The black film is a fully biodegradable film, primarily made from starch, cellulose, chitosan, and other natural polysaccharide materials, which can be 100% naturally degraded by microorganisms. The degradation period is six months. After covering with the black film, holes need to be punched in the film to ensure a 35% light transmittance rate, ensuring the need of organisms for

survival within Spartina alterniflora. After the clearing Spartina alterniflora and film degradation, the area where Spartina alterniflora was cleared will temporarily exhibit characteristics of bare sediment areas. Following the planting of mangroves, unique sediment characteristics typical of mangrove habitats will gradually develop as the mangroves grow.

The mangrove restoration is an ecological rehabilitation process, which can gradually alleviate the degree of sediment siltation, thus benefiting the sediment environment in the region.

8.2.4.2 Impact analysis for marine sediment environment by construction domestic wastewater

Domestic wastewater produced by construction personnel is treated in septic tanks built in rented houses and then used as organic fertilizer for irrigation in nearby forest land, avoiding discharge into the sea. This practice minimizes the impact on the marine sediment environment in the surrounding area.

8.2.4.3 Protection measures for marine sediment environment

(1) Control the excavation depth during the clearing of Spartina alterniflora and derris, as well as the planting depth of mangroves.

(2) The area after clearing Spartina alterniflora will be covered by biodegradable films to ensure the clearing efficiency.

(3) After treatment in septic tanks, sewage from construction camps is used as agricultural fertilizer to irrigate nearby forests instead of being discharged into the sea, thus avoiding any impact on marine sediment environments. Additionally, the contractors should provide training for construction personnel and implement environmental monitoring during the construction process. Environmental protection clauses should be included in the construction contract, and the contractor must strictly adhere to them.

(4) The IA should cooperate with local supervisory authorities to monitor the environmental impact and marine sediment during the construction process. Environmental protection clauses should also be incorporated into the construction contract, and the contractor must adhere to them strictly.

(5) During the bidding process for construction contracts, the IA and the contractor should sign agreements that clearly outline construction techniques and specify the responsible party for any environmental pollution caused during the construction process.

8.2.5 Impact analysis for marine ecological environment and marine biology

8.2.5.1 Impact analysis for marine ecological environment by mangrove restoration

(1) Analysis and assessment of the impacts on phytoplankton

Based on the analysis of the construction process for this subproject, the primary impact during construction on phytoplankton is the increase in suspended solids in the water, which affects water transparency and consequently impacts the photosynthesis of phytoplankton. Numerous domestic and foreign scholars have studied the relationship between light intensity and the photosynthesis of phytoplankton, demonstrating that light intensity strongly promotes the photosynthesis of phytoplankton. However, the increase in suspended solids concentration and the reduction in water transparency during the project construction process will decrease light intensity, thereby hindering the photosynthesis of phytoplankton.

Generally, when the concentration of suspended solids increases to below 10 mg/L, phytoplankton in the water are not significantly affected. However, when the concentration exceeds 50 mg/L, phytoplankton are greatly impacted, especially in central areas where suspended solids are highly concentrated, leading to poor water transparency and making it nearly impossible for phytoplankton to survive. When the increase in suspended solids concentration ranges from 10 to 50 mg/L, phytoplankton will experience minor effects.

In the case of the mangrove restoration in this subproject, construction is scheduled during low tide, resulting in minimal suspended solids generated during excavation. Only during the rising tide process, a small amount of suspended solids

may slowly diffuse at the edge of the embankment, with limited impact. With suspended solids concentration remaining below 10 mg/L, the incremental effect on phytoplankton in surrounding waters is negligible.

(2) Analysis and assessment of the impact on zooplankton:

The primary impact of mangrove restoration on zooplankton is the increased turbidity of the water due to the presence of suspended solids. The effect of suspended solids on zooplankton is dependent on factors such as particle size and concentration. As the concentration of suspended particles increases, filter-feeding zooplankton ingest sediment particles of suitable size, leading to internal system disruption and starvation, ultimately resulting in death. Certain zooplankton, such as copepods, exhibit vertical migration based on changes in light intensity between day and night. A decrease in water transparency can disrupt these animals' behavioral patterns and impair their physiological functions. This impact is specifically reflected in aspects such as the growth rate, survival rate, feeding rate, density, production, and community structure of zooplankton. In the case of mangrove restoration in this subproject, construction is scheduled during low tide, resulting in minimal suspended solids generated during excavation. Only during the rising tide process, a small amount of suspended solids may slowly diffuse at the edge of the embankment, with limited impact. Consequently, the incremental effect of suspended solids on zooplankton in surrounding waters is minimal.

(3) Analysis and assessment of the impact on Nektonic organisms like fish

Nektonic organisms represent a significant category within marine life, with marine fish being their typical representatives. They often possess well-developed locomotor organs and strong swimming abilities, enabling them to effectively evade pollution. High levels of suspended solid matter in water can cause fish gills to accumulate mud particles, reducing their ability to filter water for respiration and potentially leading to suffocation and death. Additionally, high concentrations of suspended sediment can also affect fish eggs, larval and juvenile, and juvenile shrimp. Different fish species have varying tolerances to different concentrations of suspended solids. Indoor ecological experiments have shown that fish can only

survive for 3 to 4 weeks when exposed to suspended solid levels of 300 mg/L with brief daily agitation. Short-term exposure to suspended solid levels below 200 mg/L does not result in fish mortality. Data indicates that the impact of suspended solids generated during construction on water quality diminishes after 4 to 5 hours, with its effects largely dissipating.

Given the relatively short duration of construction for this subproject, after construction ends, the self-purification of seawater will gradually reduce turbidity, and water quality will gradually improve. This will be followed by the reestablishment of planktonic and swimming organism communities. The reestablishment of planktonic and swimming organism communities typically occurs relatively quickly. Planktonic organisms usually take only a few weeks, while Nektonic organisms, due to their strong mobility, quickly populate the operational area. The reestablishment of planktonic organism communities primarily relies on the movement of seawater, which carries planktonic organisms from other areas into the operational area and its surrounding marine areas. These communities may quickly recover to levels similar to those in surrounding areas.

Because the mangrove restoration of this subproject is scheduled during low tide, resulting in minimal suspended solids generated during excavation. Only during the rising tide process, a small amount of suspended solids may slowly diffuse at the edge of the embankment, with limited impact. While the rising tide process may affect water quality in the vicinity of the construction area and have some impact on certain planktonic organisms within that range, it may reduce the density of fish in that area. However, marine organisms with strong swimming abilities, such as fish, shrimp, and crabs, will actively avoid these areas. The avoidance effect of nektonic organisms may lead to a decrease in biomass in the affected marine area, thereby affecting the species composition and distribution of the biological community within that area. However, since the construction area is not a fish breeding ground, the construction activities are not expected to significantly impact the breeding activities and reproductive capacity of fish. Once construction is completed, the suspended solids content in the waters near the

construction area can return to their original state, and the types and quantities of nektonic organisms will gradually recover, thereby ending the impact on nektonic organisms.

(4) Analysis and assessment of the impacts on benthic organisms

Shallow marine benthic organisms comprise a group of marine organisms that inhabit the shallow seabed, including burrowing, creeping, attaching, or swimming species. In fisheries, some benthic species are important targets for fishing, while others serve as crucial prey for economically valuable fish species.

The invasion of Spartina alterniflora crowds out other plant species, disrupts the habitat of benthic organisms, fish, and birds, alters the structure of coastal intertidal ecosystems, leads to degradation of coastal wetland ecosystems, reduces biodiversity, and poses a serious threat to the ecological security of coastal wetland ecosystems in China. Additionally, it impedes the normal flow of tides and reduces the flood discharge capacity of river estuaries. According to the study "Effects of Spartina Alterniflora Expansion on Macro Benthic Organism in Jiangsu Coastal Wetlands" (Qiu Le, Liu Jine, Chen Jianqin, Wang Guoxiang, Chang Qing, Ocean Science, 2010), it has been shown that with the prolonged invasion of Spartina alterniflora, the organic matter and total nitrogen content in the soil increase while the total phosphorus content decreases. Initially, the invasion of Spartina alterniflora can increase the species richness and abundance of benthic organism in the invaded areas. However, as the Spartina alterniflora community matures, the reduction in wave action and sediment accumulation caused by Spartina alterniflora reduces the frequency and duration of soil inundation by tides, making it impossible for bivalves and gastropods to survive there. As the Spartina alterniflora vegetation cover reaches 100%, the dense Spartina alterniflora community and its extensive root system inhibit the growth and habitat of large benthic organism, leading to a decrease in the number, diversity, and abundance of benthic species.

As for the area of clearing Spartina alterniflora, which initially disrupts the stability of the Spartina alterniflora ecological community and affects the habitat of benthic organisms within the Spartina alterniflora. However, as mangroves grow in

the area, they will establish a more stable coastal wetland ecosystem. This will improve the habitat for benthic organisms, fish, and birds, enhancing the overall ecosystem. Additionally, it will increase the number, diversity, and abundance of benthic organism species. In the long term, the removal of spartina alterniflora in this subproject is beneficial to benthic organisms.

(5) Analysis and assessment of the impacts on benthic organisms

Intertidal zone organisms exhibit various forms of habitat, including crawling, attaching, burrowing, dwelling in holes, and swimming along the bottom. Fish and crustaceans, due to their agile movement, can swiftly escape from adverse stimuli, experiencing relatively minor impacts. However, other taxonomic groups are typically less active or sedentary, making them more vulnerable to disturbances.

In this subproject, the mangrove restoration primarily occurs in the intertidal zone on tidal flats. The construction stage affects two distinct types of areas for intertidal zone organisms: Type I: Excavation for mangrove planting and removal of Spartina alterniflora roots lead to temporary loss of intertidal zone organisms within the excavation area. However, as mangroves grow, the intertidal zone organisms will gradually recover to their original levels, and in some cases, their numbers and diversity may even increase. Type II: Increased suspended solids in the water can reduce water transparency, impacting the normal physiological processes of marine organisms. In sparsely distributed mangrove areas, where with concentrated clearing of dense patches of Spartina alterniflora by using floating dredger to directly dig out the hyacinth along with its roots, the excavated material, including the hyacinth and sediment, was then backfilled into the excavated pits in a reverse manner. This process disturbed the intertidal zone to some extent, resulting in a small amount of suspended sediment. Since the excavation was conducted during low tide, the generation of suspended solids was minimal, with only a small amount spreading slowly at the edge of the soil during high tide inundation. The impact on intertidal zone organisms was therefore limited. Furthermore, once the project construction is ceased, seawater quality could gradually return to near-normal levels.

Through the above analysis, it can be seen that the impact of the mangrove

restoration on intertidal zone organisms is minimal and can gradually recover to its original state without causing a sustained impact on the entire intertidal zone community.

(6) Loss of biological resources

According to the Technical Specification for the Impact Assessment of Construction Projects on Marine Biological Resources (SCT 9110-2007), this subproject does not occupy fishery waters, so there is no need to calculate the loss of marine biological resources in fishery waters. During project construction, excavation is carried out during low tide, resulting in minimal generation of suspended solids. Only during the rising tide process, a small amount of suspended solids may slowly diffuse at the edge of the soil. The impact is extremely limited. Therefore, there is virtually no damage to marine biological resources within the pollution dispersion range. Hence, this report does not calculate the loss of marine biological resources within the pollution dispersion range.

8.2.5.e Impact analysis for marine ecological environment by construction wastewater

(1) Oily wastewater machinery equipment

Auxiliary facilities such as machinery repair shops, vehicle maintenance stations, and automobile repair shops will use the local facilities in nearby towns and villages, and the temporary constuction site will not produce machinery oily wastewater.

During the removal of the Spartina alterniflora, any oil leaks from the machinery or transportation vessels could lead to an increase in petroleum substances in the water, resulting in a decline in water quality and impacting the marine ecosystem. Therefore, it is necessary to strengthen the maintenance of construction machinery to prevent oil leaks from contaminating the water environment. This measure ensures that the marine ecological environment in the evaluation area will not be significantly affected.

(2) Domestic sewage

The domestic sewage from construction camp is treated in septic tanks of the

rented houses, which will be used for irrigation in the surrounding woodland areas, without direct discharge into the water body, resulting in minimal and marine biology impact on the marine ecology environment.

8.1.5.3 Protection measures for marine ecology

(1) The construction should schedule work times reasonably, avoiding operation during high tide periods, and preferably choosing ebbing tide periods. It is best to conduct construction after the tidal flats have dried out.

(2) The construction area must be controlled, with strict prohibition on construction beyond the designated boundaries. When clearing Spartina alterniflora, caution must be taken not to damage surrounding mangroves. Spartina alterniflora on the tidal flats should be turned over to a depth of around 100cm, with excavation depth strictly controlled to prevent exceeding this limit.

(3) When signing contracts with contractors, the implementing agency should clearly define the responsibilities and obligations of both parties in pollution prevention in the contract. Select teams with good qualifications and relevant construction experience. Conduct civilized construction education, introduce knowledge about the protection of marine animals, and enhance awareness of marine animal protection among workers.

8.2.6 Impact analysis and mitigation measures for construction waste exhaust

8.2.6.1 Impacts of construction dusting

During the construction period, dusting is mainly generated from the transportation of mangrove seedlings and removed derris. Dust from vehicle transportation during construction accounts for 60% of the total dust emissions. The amount of this dust is influenced by factors such as the dryness of the weather, road conditions, vehicle speed, and wind speed. Under natural wind conditions, the range of dust influence is generally within 100 meters According to relevant statistics, the proportion of particulate matter sizes that can generate dust is as follows: particles <5μm account for 8%, particles ranging 5 - 20μm account for 24%, and particles >20μm account for 68%. The settling velocity of dust particles of different

sizes is shown in Table 44.

Table 44 Settling Velocity of Dust Particles at Different Particle Sizes

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
Grain size(μm)	80	90	100	150	200	250	350
Settling velocity (m/s)	0.158	0.17	0.182	0.239	0.804	1.005	1.829
Grain size(μm)	450	550	650	750	850	950	1050
Settling velocity (m/s)	2.211	2.614	3.016	3.418	3.82	4.222	4.624

From Table 45, it is evident that the settling velocity of dust particles increases rapidly with the increase in particle size. When the particle size is 250μm, the settling velocity is 1.005m/s. Therefore, it can be assumed that when the particle size is larger than 250μm, the main impact range is within a close distance downwind of the dust source, while the truly impactful particles on the external environment are the smaller ones. During clear weather conditions, implementing dust suppression by sprinkling water 4 to 5 times a day can reduce dust by around 70%. The experimental results of dust suppression by sprinkling water at the construction site are shown in Table 45.

Table 45 Experimental Results of Dust Suppression by Sprinkling Water at Construction Sites Unit：mg/m³

Distance (m)		**5**	**20**	**50**	**100**
TSP hourly average concentration	Without water sprinkling	10.14	2.89	1.15	0.86
	With water sprinkling	2.01	1.4	0.68	0.4

From Table 45, it is evident that implementing dust suppression by sprinkling water 4 to 5 times a day effectively controls dust emissions during construction, and the Total Suspended Particulate (TSP) pollution distance is reduced to a range of 20 to 100 meters. The project needs to strengthen road cleaning and sprinkling to reduce dust emissions.

8.2.6.2 Impacts of waste gas from construction machinery

During construction, construction machinery, transportation vehicles, and ships may emit atmospheric pollutants such as CO, THC, and NO_2. However, these

sources of pollution are relatively dispersed, with minimal pollutant emissions, and they are intermittent. Similar project monitoring indicates that at a distance of 50 meters from the site, the 1-hour average concentrations of CO and NO_2 are 0.2mg/m³ and 0.13mg/m³ respectively. The daily average concentrations are 0.13mg/m³ and 0.062mg/m³ respectively. These values meet the requirements of the Ambient Air Quality Standards (GB 3095-2012) and its amendments, which are set at Category II standards. Therefore, the impact on the air quality in the construction area and along the transportation routes is minimal. During project construction, machinery and transportation vehicles must comply with national standards for pollutant emissions. Maintenance of machinery, vehicles, and ships should be strengthened to ensure they are in good working condition. The use of scrapped vehicles and ships is strictly prohibited to minimize the impact of vehicle and ship exhaust emissions on the surrounding environment.

8.2.6.3 Measures for Prevention and Control of Air Pollution

The impact of this subproject on the atmospheric environment mainly manifests in the dust generated during material transportation and the exhaust emissions from construction machinery, transportation vehicles, and shipping vessels. The measures for prevention and control of air pollution are as follows:

(1) The thickness and strength of transportation roads should meet the requirements for the passage of transportation vehicles, ensuring smooth and flat surfaces to reduce material jolting and spillage.

(2) Before entering and leaving the site, transportation vehicles should be washed, and road cleaning and sprinkling should be strengthened to reduce dust emissions.

(3) Limit the driving speed of transportation vehicles.

(4) Use machinery, equipment, transportation vehicles, and ships that comply with national standards for pollutant emissions. Strengthen maintenance of machinery, vehicles, and ships to ensure they are in good working condition. Prohibit the use of scrapped vehicles and ships.

8.2.7 Construction noise impact analysis and mitigation

During construction, the operation of transport vehicles, construction machinery will generate certain noise pollution.

The predicted results of construction machinery noise are shown in Table 46.

Table 46 Predicted Results of Construction Machinery Noise Unit：dB（A）

Name of equipment	5m	10m	20m	40m	50m	100m	150m	200m	300m
Excavator	86	78	71	63	61	53	49	45	41
Pay loader	85	77	70	62	60	52	48	44	40
Transportation vehicles	92	84	77	69	67	59	55	51	47

From Table 47, it can be seen that the noise levels from construction machinery are relatively high. During the daytime, noise exceeds the standards specified in the Emission Standards for Noise of Construction Site at Boundary （GB 12523-2011） within a range of 40 meters from the noise source. At nighttime, the noise exceeds the standard within a range of 150 meters. It is evident that construction noise, especially nighttime construction noise, has a significant impact on the environment. To reduce the impact of project construction on surrounding residential areas, the project should implement a reasonable construction plan and adopt strict management measures. After implementing the following noise reduction measures, the impact of construction noise on the surrounding environment is minimized:

(1) Use low-noise construction equipment as much as possible. Install soundproofing and vibration reduction devices on individual noisy equipment, and regularly maintain and operate mechanical equipment according to specifications to minimize noise impact.

(2) Layout construction equipment reasonably, shut down unused equipment promptly, and regularly maintain and service equipment to keep it in good operating condition.

(3) Schedule construction operations reasonably, strictly adhere to the standards specified in the Emission Standards for Noise of Construction Site at Boundary （GB 12523-2011） during the construction period, i.e., 70dB(A) during the daytime and 55dB(A) at nighttime. Construction is strictly prohibited between 12:00 and 14:30 during the day and between 22:00 and 6:00 the next day at night, and continuous construction is not allowed. If continuous construction is necessary due to the workflow, approval must be obtained from the relevant supervisory and

management authorities, and construction can only proceed after notifying the surrounding residents.

(4) During civilized construction, especially nighttime construction, loud noise should be avoided, and efforts should be made to minimize mechanical and material impacts to reduce the impact of artificial noise.

(5) Enhanced management of vehicle transportation is required, ensuring that vehicle noise emissions comply with the national standards for motor vehicle noise emissions. Material transportation should avoid passing through residential areas, schools, hospitals, and other sensitive areas as much as possible. When passing through sensitive areas, vehicles should reduce speed, and horn honking should be prohibited.

The impact of construction noise will cease with the completion of construction, and its effect on the environment is temporary. After implementing control measures, the impact of project construction noise on the surrounding acoustic environment is minimal.

8.2.8 Solid wastes impact analysis and mitigation measures

（ 1） Plants of Spartina alterniflora

The process of removing spartina alterniflora mainly includes manual cutting, mechanical excavation, deep-rooting, and covering with a film. The spartina alterniflora excavated by machinery will be buried in place, generating no solid waste. After the area is cleared, biodegradable film will be used to cover it, producing no film waste. Grass stems formed by manual cutting will be bundled and collected onto boats. When the tide rises, the boats loaded with grass stems will be moved to the mechanical clearing area. After the tide recedes again, the grass stems will be evenly distributed in the spartina alterniflora area designated for mechanical clearing. Before the next high tide, timely mechanical clearing operations using floating dredgers will be conducted, burying both mechanically excavated and manually cut grass stems without generating solid waste.

(2) Derris

The removed derris are collected ashore and transported to nearby town waste transfer stations. The garbage transfer station in the town is responsible for receiving

non-construction waste and non-hazardous waste generated by nearby places and individuals. Fees are charged based on the weight of the waste directly upon disposal, without the need for or the signing of disposal agreements with the waste generators.

(3) Domestic garbages

The collected domestic garbages generated by construction workers are centrally collected and transported by contractor to nearby town waste transfer stations.

In summary, during the construction period, solid waste is effectively managed, resulting in minimal impact on the surrounding environment, which ceases at the conclusion of the construction period.

8.2.9 Environmental impact analysis and assessment for major environmental sensitive areas

(1) Analysis of the impact on important mangrove wetlands and intertidal wetlands

According to the Ramsar Convention on Wetlands, "Wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters."

Intertidal wetlands are the foundation of marine ecosystems, boasting the highest biodiversity, the most comprehensive ecological functions, and the highest productivity in nature. They are favored habitats for certain marine organisms and birds, absorb and purify seawater, and serve multiple functions such as scientific research, education, and aesthetic appreciation. They are among the most important natural resources on Earth. Through the metabolic processes of wetland flora and fauna, as well as the physical and chemical processes of soil biota, various organic and inorganic dissolved and suspended substances in seawater are retained. Some toxic compounds are decomposed and transformed into harmless or even useful substances, resulting in water clarity. Natural wetlands invisibly provide significant economic, social, and health benefits through the purifying function of ecosystems. In wetland ecosystems, fish and various mollusks are important food sources for migratory birds. The excrement of fish and birds can promote the growth of aquatic

plants, which in turn provide food for migratory birds, creating a favorable ecological environment conducive to the habitat and reproduction of waterfowl. Additionally, coastal wetlands also have the potential for environmental purification. Rare waterfowl, a unique biological community, depends on wetlands for survival, demonstrating the value of wetlands.

The project involves mangrove restoration, and the process of clearing contiguous areas of Spartina alterniflora and and derris will require the use of floating dredger. Improper operation could damage the mangroves, potentially leading to their death. Accidental removal of mangroves during construction could result in losses to the mangrove ecosystem. If the mangrove population decreases due to improper operations during construction, the impact on the mangroves within the construction area would be significant. Therefore, strict requirements must be imposed on construction personnel to ensure the protection of mangroves and prevent damage caused by human activities during construction. The construction activities will result in an increase in suspended solids concentration in the surrounding water bodies. These suspended solids will cause turbidity in the sea water around the mangrove growth area, adhering to the leaves and branches of mangrove plants. This will block the plant's breathing pores, leading to difficulties in respiration and severe impacts on photosynthesis. Prolonged exposure to suspended solids can ultimately lead to the death of mangrove plants. Given the short duration of the construction period and the preference for working during low tide, close monitoring of the surrounding mangroves is necessary during construction. If significant accumulation of suspended solids on the mangroves occurs, prompt cleaning of the mangroves is required to prevent irreversible damage caused by the suspended solids.

The construction within the important mangrove wetland will directly or indirectly impact the ecological system of the mangrove wetlands and intertidal wetlands. The emission of exhaust gases from machinery will affect the functionality of the wetland ecosystem, while the noise generated by construction machinery will disturb and scare away nearby crustaceans, reptiles, and birds.

Therefore, it is imperative to schedule construction activities rationally, implement strict construction management, and minimize the impact of wastewater, exhaust gases, noise, and solid waste on the nearby wetland ecosystem. Inadequate pollution control measures during construction will have adverse effects on the important mangrove wetlands.

(2) Analysis of impacts on the adjacent sea areas

The adjacent sea area surrounding the subproject is the agricultural and fishery zone of Lianzhou Bay. The construction site of the project is located at a considerable distance from adjacent marine functional zones. The project adopts a combination of manual and mechanical methods to clear the Spartina alterniflora and derris, and manual methods are used for planting mangroves. Construction is scheduled during low tide, resulting in minimal suspended solids generated during excavation. Only during the rising tide process, a small amount of suspended solids may slowly diffuse at the edge of the embankment, with limited impact. Consequently, the impacts of suspended solids from construction on the adjacent sea areas is minimal.

8.3 Environmental impact analysis and mitigation measures during operation period

8.3.1 Environmental impact during operation period

(1) Active impacts

The project aims to restore mangroves and clear Spartina alterniflora in the Nanliujiang River estuary and Lianzhou Bay area, thereby enhancing the quantity and health of mangroves in Beihai City. This initiative brings positive impacts on the regional ecological environment.

(i) Maintaining biodiversity Mangroves serve as ideal habitats for various species due to their unique characteristics and ecological environment of tropical and subtropical estuarine wetlands with the overlap of saline and fresh water. They provide shelter and food for numerous fish, shrimp, waterfowl, and migratory birds, thus harboring rich biological resources and species diversity. Additionally,

mangroves are crucial stopover and wintering sites for migratory birds.

(ii) Disaster resistance Mangroves act as natural coastal protection forests. Their extensive root systems provide strong resistance to the impact of waves and tides, helping to protect embankments, mitigate wind and wave erosion, safeguard farmland, and reduce salt intrusion. They serve as natural barriers inland and are often referred to as "coastal guardians."

(iii) Environmental purification Mangroves play a vital role in purifying seawater by absorbing pollutants, thus reducing the degree of eutrophication and effectively preventing the occurrence of red tides.

(iv) Promoting sedimentation and land formation The extensive root systems of mangroves accelerate the deposition of silt, gradually expanding the land area as the mangrove community develops towards the outer edge.

(v) Carbon sink Mangroves play a crucial role in carbon sequestration and mitigating climate change. Coastal wetlands with mangroves can absorb atmospheric carbon dioxide and facilitate the deposition of particulate organic carbon in tidal waters.

(2) Environmental impact of replanting mangroves

During the operational stage of the project, mangrove nurturing primarily involves closely monitoring the growth of mangrove trees. Regular inspections are carried out to promptly address issues such as lodging, exposed roots, and damaged seedlings, saplings, and sparse areas. These measures include repositioning and replanting with the intended tree species to prevent the formation of "canopy gaps." Mangrove nurturing will not bring about any negative impacts on the environment.

(3) Environmental impacts caused by clearing of marine debris, Enteromorpha, balanus albicostatus, Spartina alterniflora and derris

During the operational stage of the project, regular manual cleaning of marine debris entering the restoration area is conducted. Continuous management and cleaning for over three years are carried out for invasive species such as Enteromorpha, balanus albicostatus, Spartina alterniflora and derris, as well as for balanus albicostatus attached to mangroves. The solid wastes generated, including

marine debris, Enteromorpha, balanus albicostatus, Spartina alterniflora and derris, are collected ashore and transported to nearby town waste transfer stations, resulting in minimal environmental impact. Such will help to create a clean growth environment for the healthy growth of mangroves.

(4) Impacts on the human health by diseases control

The measures for pest control of the project include: install traps to lure and kill common pests in the mangrove forest, such as olive fruit tortrix moth, auicennia marina leaf-eating moth, lasiognatha cellifera, parasa lepida, pseudaulacaspis cockerelli, tussock moth, Buzura suppressaria Guenee, Guangzhou Microlepidoptera, and Erebus macrops etc. Occasional use of pesticides to control pests, using Bt biopesticide (Bacillus thuringiensis), with a dosage of 1500~2000g/h ㎡, diluted in 1500~2000kg of water. Bacillus thuringiensis is currently one of the most widely used microbial insecticides globally. It can effectively control more than 30 types of agricultural and forestry pests. It has the advantages of being safe for humans and animals, environmentally friendly, and not disrupting ecological balance. After taking effective protective measures, the minimal exposure of mangrove caretakers to Bt biopesticide has little impact on their health.

8.3. 2 Environmental protection measures during operation period

During the operational period, the environmental impact is minimal. In order to improve the survival rate of the mangroves, relevant measures have been designed the mangroves.

(1) Closely monitoring the growth of mangrove trees. Regular inspections are carried out to promptly address issues such as lodging, exposed roots, and damaged seedlings, saplings, and sparse areas. These measures include repositioning and replanting with the intended tree species to prevent the formation of "canopy gaps.”

(2) Arrange patrol personnel to conduct regular patrols in the restoration area along designated routes. The main focus of patrol work is to inspect the forest area, eliminate human disturbances, promptly identify and eliminate threats, and ensure

that the mangrove forest in the restoration area remains undamaged. In the event of forest destruction or damage, take immediate action to stop it, report it promptly, and ensure early detection and intervention. The patrols and maintenance will continue for a duration of 3 years, with 7 patrols per month, 1 workday per patrol for each site plot. Each patrol should fill out a patrol log sheet during every patrol, documenting the patrol time and inspection findings thoroughly.

(3) Timely clearing of the marine debris, Enteromorpha, balanus albicostatus, Spartina alterniflora and derris. (3) The marine debris, Enteromorpha, balanus albicostatus, Spartina alterniflora and derris etc. are collected ashore and transported to nearby town waste transfer stations.

(4) Install pest trap lights, to lure and kill common pests in the mangrove forest, such as olive fruit tortrix moth, auicennia marina leaf-eating moth, lasiognatha cellifera, parasa lepida, pseudaulacaspis cockerelli, tussock moth, Buzura suppressaria Guenee, Guangzhou Microlepidoptera, and Erebus macrops etc.

(5) Before using pesticides, mangrove maintenance workers should take appropriate protective measures, such as wearing long-sleeved clothing and pants, masks, refraining from smoking or eating, and avoiding wiping sweat with their hands. Pesticides should be sprayed during suitable times, preferably in the early morning or late afternoon, avoiding the midday heat. Ensure that spraying equipment is properly adjusted, and pesticide concentration and dosage are correctly calibrated. When preparing and mixing pesticides, wear rubber gloves, a respirator, and protective goggles. Stand upwind while spraying pesticides to prevent exposure to the spray. After spraying, promptly change clothes and wash your face and hands before eating.

8.4 Cumulative and induced impact assessment

In recent years, rapid development of the marine economy in coastal cities of Guangxi, such as Beihai, has placed significant pressure on marine ecological conservation efforts in the region. Beihai, being one of the most important coastal cities in southwestern and southern China, serves as a vital gateway for the region to

access international markets and acts as a bridge for Southeast Asian countries to enter China. Consequently, Beihai faces even greater pressure, higher demands, and more urgent requirements for marine ecological conservation. To address these challenges and improve the regional marine ecological environment, Beihai has focused on controlling land-based pollution and protecting the ecological integrity of river basins, with particular emphasis on controlling pollution from marine and river estuaries. Additionally, efforts have been made to tackle issues such as damage to natural coastlines and the invasion of exotic species through systematic ecological restoration and comprehensive protection measures.

Given that the area where the project is located already has existing, ongoing, or planned initiatives such as mangrove restoration, coastal ecological rehabilitation, and other conservation projects, there is a potential for cumulative impacts that could affect valuable environmental elements in the region.

Therefore, the process of cumulative impact assessment involves identifying and selecting key environmental factors, determining the scope of cumulative impact assessment, evaluating indicators and their thresholds, and conducting an analysis of the cumulative impacts on the selected environmental elements.

8.4.1 Scope of cumulative impact assessment

Based on the characteristics of the project, the impacts after implementation primarily manifest in terms of ecological environment protection benefits.

8.4.2 Spatial and temporal scope for assessment

For this cumulative impact assessment, the focus is on screening relevant activities planned in the following two plans, The 14th Five-Year Plan for Ecological Environment Protection in Beihai City, and the Plan for Protection of Mangrove Resources in Beihai City (2020-2030). By comparing the scopes of each plan and considering the impact range of the project, the scope of this cumulative environmental impact assessment will be determined.

Table 47 Relevant Development Planning Activities and Scope of Impacts

Name	Year of planning	Scope of planning	Environmental elements impact scope

Name	Year of planning	Scope of planning	Environmental elements impact scope
This subproject	2024	/	Sea area extending outward for 3km by mangroves restoration component
The 14th Five-Year Plan for Ecological Environment Protection of Beihai City	Baseline year: 2021 Short-term plan year: 2025 Long-term plan year: 2035	Administrative district of Beihai City	Nanliujiang River Basin, Fuchengjiang River Basin, Downtown Area of Beihai City
Plan for Protection of Mangrove Resources in Beihai City (2020-2030);	Baseline year: 2020 Short-term plan year: 2025 Long-term plan: 2030	The entire area of Shankou National Mangrove Ecological Nature Reserve in Guangxi, and Beihai Coastal National Wetland Park in Guangxi; the entire area of Maoweihe Mangrove Nature Reserve (part of Beihai City) in Guangxi; the mangroves within Hepu Dugong Nature Reserve and Weizhou Island Provincial level Nature Reserve; Six existing mangrove protection areas; all mangroves and suitable restoration areas outside existing nature reserves and mangrove protection areas.	The entire area of Shankou National Mangrove Ecological Nature Reserve in Guangxi, and Beihai Coastal National Wetland Park in Guangxi; the entire area of Maoweihe Mangrove Nature Reserve (part of Beihai City) in Guangxi; the mangroves within Hepu Dugong Nature Reserve and Weizhou Island Provincial level Nature Reserve; Six existing mangrove protection areas; all mangroves and suitable restoration areas outside existing nature reserves and mangrove protection areas.

Based on the project and related plans, the scope of cumulative impact assessment considers the Lianzhou Bay sea area and the Nanliujiang River basin.

The baseline year for cumulative impact assessment is 2024. Considering the completion time of the project and related activities, the predicted analysis timeframe is from 2024 to 2030.

8.4.3 Relevant development activities

This assessment primarily relies on the The 14th Five-Year Plan for Ecological Environment Protection in Beihai City and the Plan for Protection of Mangrove Resources in Beihai City (2020-2030) to identify ongoing and planned construction components within the scope of the cumulative impact assessment. The identification matrix is shown in Table 48.

Table 48 Identification Matrix for Relevant Planned Components

Sl.	Relevant planned components			Impact identification
	Construction component	**Construction contents**	**Scheduled completion date**	**Ecological and environmental protection benefits**
1	Construction of sewage and garbage treatment facilities in towns and townships in Beihai City.	Contents: Includes the construction of sewage and garbage treatment facilities in towns and townships in Hepu County, Haicheng District, Yinhai District, and Tieshangang District of Beihai City.	2025	Positive impacts
2	Nanliujiang River Ecological Restoration Project (Beihai Section)	Contents: Mainly includes river channel upgrading, dredging, ecological water supplementation, protection and restoration of riparian zones, protection of important water sources, pollution interception and control, soil erosion control, construction of artificial wetlands, and the establishment of a classified and segmented ecological corridor along the Nanliujiang River. (Towns: Quzhang, Changle, Shikang, Shiwan, Lianzhou, Xingdaohu, and Dangjiang)	2025	Positive impacts
3	Comprehensive treatment for rivers entering the sea	Contents: The comprehensive treatment includes the Nanliujiang River, Baishajiang River, Nankangjiang River, and Ximenjiang River, ensuring that water quality at five monitoring sections along these four rivers consistently meets the standards.	2025	Positive impacts
4	Comprehensive treatment project for Lianzhou Bay and Tieshangang Port	Contents: conduct continuous cleaning, monitoring, and supervision of direct discharge outlets into the sea to prevent additional illegal or improperly located discharge outlets, ensuring that discharge outlets into Lianzhou Bay and Tieshangang Port consistently meet discharge standards; conduct investigating, monitoring and regulating the industrial, municipal (including domestic sewage), aquaculture, and livestock drainage outlets and channels discharging directly into Lianzhou Bay and Tieshangang Port; strengthen the cleaning of illegal aquaculture activities on beaches and in offshore areas; conduct	2025	Positive impacts

Sl.	Relevant planned components			Impact identification
	Construction component	Construction contents	Scheduled completion date	Ecological and environmental protection benefits
		dredging and shoreline restoration in the marine area.		
5	Protection and restoration of estuaries and coastal wetlands	Contents: focus on the protection and restoration of important estuarine wetlands such as the mouth of the Nanliujiang River and the mouth of the Dafengjiang River, as well as coastal wetlands in Weizhou Island, Tieshangang Port, Yinluogang Port, and Xicungong Port; replant wetland vegetation such as mangroves, restore wetland vegetation communities, habitat conservation, and clearing of invasive species.	2025	Positive impacts
6	Construction of mangrove conservation areas	Conduct foundational activities such as baseline resource survey, overall planning, and boundary demarcation for seven conservation areas: Henglushan Mangrove Conservation Area in Pingyang Town, Yinhai District; Dongwei Mangrove Conservation Area in Gaode Street Office, Haicheng District; Bailongguchen Mangrove Conservation Area in Tieshangang District; Qixing Mangrove Conservation Area in Shagang Town, Hepu County; Muan Mangrove Conservation Area in Dangjiang Town, Hepu County; Yujiang Mangrove Conservation Area in Dangjiang Town, Hepu County; and Tieshangangwan Mangrove Conservation Area in Hepu County.	2025	Positive impacts
7	Construction of mangrove seedling breeding base at Beihai Protection Forest Farm	Construct one seedling breeding base with an annual production capacity of 3 million mangrove seedlings at Beihai Protection Forest Farm.	2025	Positive impacts
8	Performance evaluation for mangroves restoration	Conduct performance evaluation for mangroves restoration respectively in 2025 and 2030.	2030	Positive impacts

Sl.	Relevant planned components			Impact identification
	Construction component	Construction contents	Scheduled completion date	Ecological and environmental protection benefits
9	Conduct performance evaluation for mangroves restoration respectively in 2025 and 2030	Conduct annual surveys of mangrove resources and monitor ecological conditions, releasing reports annually on the changes in mangrove resources and ecological status.		Positive impacts
10	Facilitate the maintenance equipment and facilities	Facilitate the maintenance equipment and facilities	2025	Positive impacts
11	Subsidies and Training for full-time mangrove conservation officers	Hiring 50 full-time mangrove conservation officers and providing training for the mangrove conservation team to enhance their professional skills.	2030	Positive impacts
12	Coastal mangrove wetland ecological and economic demonstration park	Construct the coastal mangrove wetland ecological and economic demonstration park in the Nanliujiang river delta of Hepu County,, covering an area of 100 hectares, aiming to explore a sustainable integrated utilization model where mangroves coexist harmoniously with aquaculture, and thus providing valuable experience for the future establishment of a Sino-ASEAN Mangrove Coastal Wetland Ecological Economic Zone.	2025	Positive impacts

8.4.4 Environmental status

The current status of mangrove conservation in Beihai is as follows:

(i) The contradiction between protection and utilization remains prominent. The phenomenon of mangrove damage caused by project construction has not been thoroughly curbed, and the protection situation remains grim.

(ii) The trend of ecosystem degradation has not been significantly reversed. The degradation trend of mangrove ecosystems in Beihai has not been effectively

halted.

(iii) Control of harmful biological invasions has not been effectively addressed.

(iv) The problem of low afforestation retention rate has not been fundamentally resolved.

8.4.5 Analysis of cumulative impacts

The current protection of mangrove resources in Beihai City faces sharp conflicts between protection and utilization. There is still a gap between the management and basic support capabilities and the current resource management requirements. There are also difficulties in mangrove afforestation and restoration. The projects, including construction of sewage and garbage treatment facilities in towns and townships in Beihai City, Nanliujiang River Ecological Restoration Project (Beihai Section), Comprehensive treatment for rivers entering the sea, Comprehensive treatment project for Lianzhou Bay and Tieshangang Port etc., can improve the water environment in the upstream and surrounding areas of the project area, which is conducive to the growth of mangroves in this subproject. The implementation of other planned projects, including wetland protection and restoration, construction of mangrove conservation areas, construction of seedling breeding base, performance evaluation for mangroves restoration, evaluation of mangrove protection and restoration effectiveness, improvement of the maintenance equipment and facilities, subsidies and training for full-time mangrove conservation officers, as well as the construction of coastal mangrove wetland ecological and economic demonstration park, along with the implementation of mangrove restoration components of this subproject, will ensure the strict protection of mangrove resources in Beihai City. This will optimize the layout and system of mangrove protection, steadily increase mangrove area, enhance biodiversity in Beihai City, and leverage the role of mangroves in wave prevention, disaster reduction, and pollution reduction, additionally, facilitate the generation of significant blue carbon sink benefits.

The implementation of these relevant projects may also generate similar negative environmental impacts as this subproject. During concurrent construction periods with this subproject, the increase in transportation vehicles may exacerbate the impact on regional noise and air quality. The use of construction equipment and transportation

vehicles can produce noise, adversely affecting the quality of the regional acoustic environment and causing disturbance to the daily lives of nearby residents. Therefore, measures to protect the acoustic environment, such as using sound barriers and low-noise equipment, should be implemented to mitigate the cumulative impact of noise during the construction period.

Additionally, during concurrent construction periods with relevant projects, the stacking of earthworks and the increase in transportation vehicles may compound the impact on traffic. The construction period of this subproject may lead to reduced road capacity around the project area. If relevant projects nearby are also carried out concurrently, it could exacerbate traffic congestion and even blockages, leading to socio-economic impacts and affecting the mobility of surrounding communities. Therefore, it is necessary to implement reasonable traffic organization and management measures to mitigate the cumulative impact during the construction period.

8.4.6 Analysis of induced impacts

The implementation of this subproject plays a crucial role in maintaining regional biodiversity, contributing to the enhancement of biodiversity. The improvement of the ecological environment also positively impacts the development of regional tourism. However, the tourism industry has both positive and negative impacts on the natural environment. Negative impacts include the effects of tourism facilities and the discharge of sewage, solid waste, noise, and other pollutants from tourists on the region's water bodies, air quality, acoustic environment, and flora and fauna. Positive impacts include the establishment of natural reserves, the protection of marine environments, vegetation, and wetlands, and the promotion of sustainable land development and public education.

9. Social impact assessment and mitigation measures

9.1 Contents and scope of social impact assessment

According to the AIIB's ESF, the objective of social impact assessment is to avoid or minimize adverse environmental and social (ES) risks and impacts. In unavoidable circumstances, these risks and impacts are identified based on relevant Chinese laws and regulations and the AIIB's environmental and social policies (ESP), and necessary mitigation measures are formulated and implemented.

9.1.1 Content of social impact assessment

The social impact assessment for this subproject is to identify both positive and negative impacts through literature review, site surveys, questionnaires, workshops, in-depth interviews, and stakeholder consultations. Through participatory methods, such as social management plans, potential social risks of the project are mitigated, project design is improved, and the basic rights of all stakeholders are safeguarded, thereby promoting fair participation of all stakeholders in the project.

The main contents of the social impact assessment include:

(1) Understanding the interests and needs of various stakeholders through extensive participation.

(2) Identifying potential social risks of the project based on the requirements of the AIIB's ESF, including both positive and negative impacts:

Assessing the impact on surrounding communities, such as temporary traffic restrictions and disruptions to transportation and other public facilities during construction.

Analyzing labor health and safety, as well as the impact of labor influx on the community, and developing measures to manage interactions between the community and workers.

Analyzing the risks to community health and safety during the construction and operation stages.

(3) Identifying the stakeholders at different levels, describing key expectations,

and analyzing the impacts, issues, and concerns associated with each stakeholder subgroup.

(4) Identifying risks and impacts faced by vulnerable groups, understanding the attitudes of women, impoverished groups, etc., towards the project, and devising measures to mitigate the risks posed by the project to them.

(5) Assessing the positive and negative social impacts that project interventions may have on different subgroups of stakeholders or beneficiaries, prioritizing and ranking these impacts based on their importance, and proposing measures to minimize negative impacts while maximizing benefits from positive impacts.

(6) Enhancing broad public participation, solicit suggestions for optimizing project design, and establish mechanisms for information disclosure and complaint resolution.

(8) Identifying the potentially adverse specific risks and impacts of the project and develop mitigation measures to reduce these risks and impacts, thus facilitating the realization of the goals of the project. . (9) Utilizing the gender-disaggregated data and analysis, and enhancing the project design to promote equal opportunities and socioeconomic empowerment for women, especially in terms of service provision and employment.

9.1.2 Scope of social assessment

The targets of the social impact assessment of this subproject are the primary stakeholders, mainly including the direct beneficiaries within the project's scope and the groups adversely affected by the project construction. These groups comprise residents, vulnerable populations, women, ethnic minorities, tourists, merchants, and others.

The scope of social impact assessment is Subproject 2, covering the communities directly affected by the construction components of mangrove afforestation and restoration, respectively Dangjiang Town, Shagang Town, Lianzhou Town in Hepu County, as well as stakeholders of enterprises, institutions, villages / communities in the adjacent areas.

9.2 Identification of social demand and risks

In order to comprehensively understand the needs and suggestions of the affected population in the project area, including urban and rural residents, women, low-income groups, and vulnerable populations, as well as to gather information on comments regarding the environmental and social impacts, and the expectations and concerns for the project implementation from neighboring residents, the social consultants conducted online surveys, focus group discussions, and face-to-face interviews in the project area from February to April 2024 to gather stakeholders' perspectives. Specifically, online surveys were distributed primarily to residents of Gaode subdistrict of Haicheng District and Hepu County. Totally 553 completed questionnaires were returned, with 276 from female respondents and 277 from male respondents.

9.2.1 Project focus and significance perception

Table 49 presents the results of the online questionnaire survey regarding the needs of female and male residents and the potential impacts of the project identified through the sampling survey. It can be seen that the gender factors tend to align in certain focal points, but there are also slight differences.

Table 49 Focus Concerns of Survey Samples on Construction Contents

Focus concerns / questions	**Choices**	Female sample		Male sample	
		No. of Persons	Proportion (%)	No. of Persons	Proportion (%)
Which of the following information are you mainly concerned about?	Seafood purchase information	210	76.06%	194	70.04%
	Information on project employment	136	49.28%	157	56.68%
	Program Training Information	123	44.57%	123	44.40%
	Information of construction	129	46.74%	151	54.51%
	GRM during during implementing	25	20.49%	36	13.00%
Select the potential benefits of the project you agree with	Promote green and efficient development (fishing / livestock)	132	47.83%	124	44.77%
	Increase job opportunities	143	51.81%	129	46.57%
	Improving the processing capacity of local sea products	115	41.67%	112	40.43%
	Income increase	97	35.14%	124	35.13%
	Improving the marine ecological environment	99	35.87%	118	42.60%
	Improving the breeding of aquaculture quality and seed production	84	30.43%	83	29.96%

	Boosting local economic development	55	19.93%	57	20.58%
	Promoting low-carbon green development	8	6.56%	32	11.55%

(1) In terms of concerns on information of the project, female respondents are mostly concerned about the same information as male respondents, which includes information about the purchase of seafood and job opportunities provided by the project construction.

(2) Regarding the potential benefits of the project, the top three concerns for female respondents are “promote green and efficient development (fishing / livestock)”, “increase job opportunities” and “improving the processing capacity of local sea products”. Male respondents are more concerned about “increase job opportunities” , “income increase” and “promote green and efficient development (fishing / livestock)”.

Additionally, through field research, it was found that the stakeholders have a clear demand for “income increase” and “increase job opportunities”. Since the establishment of the mangrove conservation area, the the municipal government of Beihai City has implemented stricter protection and management measures, which to some extent have restricted the traditional livelihood activities of surrounding villagers, such as fishing, aquaculture, and beach combing. Therefore, villagers urgently need to find new economic sources and job opportunities to maintain and improve their living standards.

The mangroves in Beihai are strictly controlled. Even during the fishing-off period, some people may secretly go out to sea, but accessing the mangroves is very difficult, it is not allowed. After the protection measures were implemented, everyone became poorer. Previously, people could earn money by digging sandworms or catching mudworms, but now it's not allowed. In the past, people used to pick mangrove fruits and olives, but now it's also prohibited. Many fishermen have gone out to find other jobs, and the fishing industry has declined. Look at me now, I even run a homestay business. **(Interview record 14: ZJC, 36 years old, from Yujiang Village, Dangjiang Town.)**

9.2.2 Demand for job opportunities during project construction

Regarding the employment opportunities during the project construction, female respondents tend to prioritize “unskilled labor work, such as temporary labor workers, loading and unloading”, followed by “work requiring certain technical requirements, such as masons, transportation, intelligent system installation or management, etc.”. Lastly, they prefer unskilled labor work. On the other hand, male respondents prioritize unskilled jobs like temporary laborers and loading/unloading, skilled workers such as machinery operators and forklift drivers, and jobs “requiring certain technical requirements, such as masons, transportation, intelligent system installation or management, etc.”.

Table 50 Demand for Job Opportunities during Construction

Choices	Female sample		Male sample	
	No. of Persons	Proportion (%)	No. of Persons	Proportion (%)
Unskilled labor work, such as temporary labor workers, loading and unloading, etc.	109	39.49%	127	45.85%
Work requiring certain technical requirements, such as masons, transportation, intelligent system installation or management, etc.	115	41.67%	113	40.79%
Professional technicians such as technical operators, forklift drivers etc.	83	30.07%	116	41.88%
Auxiliary jobs such as cleaners, cooks, etc.	135	48.91%	97	35.02%
Don't need	43	15.58%	56	20.22%

In the field survey, it was found that in the villages, it is generally the middle-aged and elderly people who are engaged in fishing and agricultural activities at home. Among them, men mainly tend to shrimp ponds, especially during the initial breeding period when they need to handle materials and pump water. Women, on the other hand, are more likely to do some part-time shrimp peeling at nearby shrimp farms or collect seafood while clamming at the beach. They basically do not leave their hometowns.

Nowadays, oyster farming is also prohibited. My oyster farm has been banned and demolished, and there is no subsidy. They asked us to demolish it, so we did it

quickly. Since last year, most of the oyster farms have been demolished. Anyway, many people have started to work outside. Everyone feels that it is very difficult to do fishing now, so they have all gone out to work as casual laborers. People in Beihai are originally lazy and won't go too far. They won't go to places like Guangdong. Moreover, they are getting older. **(Interview record 50: CZL, 56 years old, from Mu'an Village, Dangjiang Town.)**

9.2.3 Expectations rating for benefits from project construction and operation

For the positive impacts of the project, as shown in Table 51, it can be observed that over 80% of the respondents are highly anticipating the benefits brought about during the construction and operation of the project. Regarding the expectations for the potential benefits of the project, there are slight differences between women and men. Women are more inclined towards the better development of the seafood industry in their own families, while men are more hopeful for increased job opportunities and improvements in the marine environment.

Table 51 Expectations Rating for Benefits from Project Construction and Operation

Type of project benefits	**High anticipation**		**Slight anticipation**		**Without anticipation**	
	Female	Male	Female	Male	Female	Male
Improve quality of sea products	229 82.97%	237 85.56%	41 14.86%	31 11.19%	0	1 0.04%
Improvement quality of sea products	227 82.25%	228 82.31%	42 15.22%	41 14.80%	1 0.04%	0
Promote sale of sea products	222 80.43%	234 84.48%	45 16.30%	33 11.91%	1 0.04%	2 0.07%
Improve marine environment	226 81.88%	242 87.36%	42 15.22%	28 10.11%	1 0.04%	0
Increased job opportunities	222 80.43%	240 86.64%	47 17.03%	32 11.55%	1 0.04%	0
Opportunities of getting training	210 76.09%	223 80.51%	57 20.65%	46 16.61%	2 0.07%	0
Enhance self capabilities for business running	213 77.17%	220 79.42%	55 19.93%	47 16.97%	1 0.04%	1 0.04%

In the survey conducted in the coastal villages near Lianzhou Bay, widespread

awareness was observed regarding the relationship between marine environmental pollution and aquaculture of seafood products. In recent years, both shrimp farming and oyster farming have suffered significant losses. Villagers attribute this issue to the dual impact of intensified marine pollution and a sluggish market, showing high expectations for improvement in the marine environment.

9.2.4 Ratings for negative impacts during construction and operation

Regarding the negative impact rating of the project, as shown in Table 52, over 60% of female respondents believe that environmental pollution during project construction and operation may affect their lives. Their perception of negative impacts is stronger compared to male respondents. Additionally, they are more concerned about the solid waste generated during construction and the impact of an influx of construction workers on the health of local residents during the construction period.

Table 52 Ratings for Negative Impacts during Construction and Operation

Type of impacts	Most probably		Slight probable		Without impact	
	Female	Male	Female	Male	Female	Male
Noise caused by construction	82 29.71%	96 34.66%	86 31.16%	63 22.74%	108 39.13%	118 42.6%
Solid waste produced in the construction	84 30.43%	96 34.66%	85 30.8%	63 22.74%	107 38.77%	118 42.6%
Air and water pollution during construction	83 30.07%	94 33.94%	85 30.8%	64 23.1%	108 39.13%	119 42.96%
Impact on the health of local residents caused by the influx of construction workers during the construction period	84 30.43%	92 33.21%	84 30.43%	63 22.74%	108 39.13%	122 44.04%
Traffic risk	80 28.99%	95 34.3%	89 32.25%	61 22.02%	107 38.77%	121 43.68%

9.3 Social gender awareness of the female group

In the previous analysis on the overall project demand and risks, it was observed that women in the project area exhibit a certain degree of division of labor within households, with men primarily focused on job opportunities and income generation. In comparison to men, women have a relatively lower rate of migration for work and are more likely to engage in agricultural labor while also taking on additional responsibilities for family care (such as childcare and elderly care).

Given this social gender context, the results of online surveys of the impact on women indicate a strong sense of participation among women in rural industrial development and the developmental impacts brought by the project. These are particularly evident in:

(1) As for the question of “How do you think women can contribute to improving the marine environment ?”, 84.42% of respondents believe that women should have more opportunities for training in production technology skills and environmental protection expertise to enhance their capabilities. Additionally, 87.32% of respondents affirm that women can make contributions to labor production and environmental protection comparable to men, or even more significant.

(2) For the benefits of female in the project, "gain more job opportunities in project construction and operation, resulting in increased income," "with the improvement of the rural environment, women can have a better living environment ," and "acquire higher agricultural (animal husbandry/fishery) production and management skills” were the top three.

(3) For the negative impacts of the project on women, the majority of women are uncertain about the specific negative effects the project may bring to them. However, " lack of care for families leads to family conflicts" is one of the concerns expressed by respondents. The inconvenience caused to women during the construction period is also considered by respondents as one of the factors to be taken into account.

Table 53 Women's Views on Project and Female Development

Focus concerns / questions	Choices	No. of Persons	Proportion (%)
How do you think women can contribute to improving the marine environment?	Women should have more opportunities to receive training in technical skills of production management, professional knowledge of environmental protection so as to improve their ability.	233	84.42%
	Women can only participate in non-skilled activities or provide services	48	17.39%
	Through actively participating in decision-making, consultation and project implementation, women can make the same (if not more significant) contribution to agricultural production and environmental protection as men.	192	69.57%
	I've never been invited to this kind of activity, so I don't know what to do.	43	15.58%
	Women cannot make any contributions in the field of marine environmental protection.	16	5.8%
How do your think women can be benefited from the project?	Women can gain more job opportunities in project construction and operation, thus increase their income.	241	87.32%
	Women can acquire higher agricultural (animal husbandry/fishery) production and management skills during project construction.	174	63.04%
	With the improvement of the rural environment, women can have a better living environment.	186	67.39%
	I don't think women can benefit from this subproject.	15	5.43%
What negative impacts do you believe women will experience from this subproject?	Lack of care for families leads to family conflicts	84	30.43%
	Adding pressure on women	56	20.29%
	The project will cause inconvenience to women during construction.	47	17.03%
	I'm not sure what kind of negative impact from the project will have on women.	190	68.84%

The feedback from the online survey was further validated during the on-site focus group interviews. In the daily life, the women in the project area (laborers) and men have no big differences in social status but are generally inferior to men in

education, employment, income etc. In addition, due to the social responsibility of taking care of children and the elderly, more women have to stay home doing agricultural / domestic work or engage in local non-farm work, and the project is more relevant to their development, so they show great enthusiasm for the project.

Specifically, their needs align mostly with those of the male group, focusing on technical training and employment opportunities provided by the project. The only difference lies in their greater consideration of conflicts between family care and future work time. They tend to favor opportunities that allow for a balance between family and work, such as flexible and temporary employment.

9.4 Social impact analysis and mitigation measures

Based on the survey assessment of social needs and risk identification of residents in the project area, as well as the awareness of gender capabilities, the impact of the subproject and local social needs have a strong complementarity. The project's output to some extent can help resolve the current contradictions between local economic and social development.

9.4.1 Enriching employment opportunities

The main engineering components of this subproject mainly includes mangrove restoration and removal of invasive Spartina alterniflora. Based on the current selected alternatives, it directly involves 442.49 h ㎡ of mangrove restoration and 229.04 h ㎡ of Spartina alterniflora clearing. The mangrove restoration and Spartina alterniflora clearing will create ample employment opportunities.

In the process of mangrove afforestation, tasks such as seedling breeding, land preparation, planting, and initial maintenance are required, all of which require a certain number of workers to complete. The restoration component involves replenishing damaged mangroves, nurturing them, and restoring the ecosystem, all of which also require human resources. Spartina alterniflora clearing is another labor-intensive task, involving physical removal, chemical treatment, or biological control of the invasive species, all of which require workers to operate on-site. Furthermore, considering that land plots may need to be tidied up and utilized after

the clearing Spartina alterniflora, this will further increase employment opportunities. In this regard, the subproject will provide the surrounding villagers with:

(1) Temporary, low-skilled job opportunities during the construction and operation stages

Including: afforestation workers, cleaners, logistics personnel, transportation workers, and catering support staff. These jobs are recruited by the construction unit, with wages ranging mostly from CNY 150-300 per day, with flexible working hours. The implementation of this subproject will increase the income opportunities for surrounding residents, reflected in the improvement of wage levels. In recent years, the fishing and aquaculture industries have faced multiple challenges, with limited employment opportunities and relatively low wages, averaging around CNY 3,000 per month. As a result, there has been a significant increase in the number of migrant workers.

2. Maintenance and management personnel

Currently, there are 1,271.34 h ㎡ of mangroves in Beihai City under natural reserve management, accounting for 30.3% of the total mangrove area. At this scale, there are already 97 forest rangers in charge of public welfare forests, with 18 professional teams equipped with institutional positions for mangrove resource management established in nine coastal townships. Based on the current management baseline, this subproject will continue to employ 50 full-time mangrove rangers and provide operational training to enhance their professional skills. Full-time mangrove rangers will have more comprehensive job security.

To safeguard the rights of women, the contractors are required to prioritize the hiring of female employees for these positions. The proportion of female workers should not be less than 20%. At the same time, this subproject should be integrated into efforts to consolidate and expand the achievements of poverty alleviation, effectively linking with rural revitalization initiatives.

9.3.2 Indirect economic and social benefits

Mangroves grow in the intertidal zone where land meets the sea, representing a

unique ecological system with immeasurable ecological value. These ecological values are further translated into economic and social benefits, manifested in the following aspects:

(1) Sustainable support for fisheries resources. Mangrove afforestation and restoration will promote the recovery and protection of fisheries resources through various means such as improving water quality, providing food sources, offering shelter and spawning grounds, and preserving biodiversity.

(2) Coastal protection and disaster risk reduction. The developed root systems and dense vegetation of mangroves effectively mitigate the impact of waves, protecting the coastline from erosion. During extreme weather events like typhoons, mangroves serve as crucial barriers, reducing the damage caused by storm surges to coastal areas and lowering disaster risks. This is essential for the safety of coastal residents and the protection of infrastructure.

(3) Promotion of ecotourism industry. The unique ecological environment and abundant biodiversity of mangroves make them popular destinations for ecotourism. Tourists can observe rare flora and fauna and experience unique natural scenery here. The Jinhai Bay Mangrove Ecotourism Area in Beihai has become a popular spot for coastal tourism, receiving over 400,000 visitors annually. It exemplifies an innovative model combining "tourism + ecology + culture", driving local economic growth, creating job opportunities, and improving residents' living standards.

(4) Promotion of education and scientific research. Mangroves serve as natural classrooms and laboratories, providing valuable research subjects for education and scientific research.

To further realize these social effects, it is essential for stakeholders such as AIIB, Beihai Municipal Government, PMO, IA to effectively fulfill their supervisory and coordination responsibilities. Such will include: conducting annual surveys on mangrove resources, monitoring their ecological conditions, establishing a mangrove resource information management system to support annual surveys and ecological monitoring, and innovatively exploring sustainable integrated utilization models for coexistence of mangroves and aquaculture.

9.3.3 Tense relationship with the community caused by influx of workers

Given the intensity and constraints of mangrove planting and restoration work, this subproject is expected to require approximately 200 laborers. However, due to the heavy planting tasks and short construction period, there is a possibility of hiring a large number of migrant workers. Upon arrival, most workers will reside in surrounding villages and communities near the project area, which may have certain implications for these local communities.

On one hand, migrant workers arriving in the project area are likely to choose to rent housing in the surrounding communities near the construction site. Their daily activities, apart from work, will also be concentrated in these surrounding communities. Due to language barriers and unfamiliarity with local village rules and customs, social interactions may be hindered, leading to social conflicts and issues. However, within the mangrove conservation area, construction projects are rare, resulting in few reports of an influx of migrant workers affecting local communities. Additionally, according to the director of Dakuang Village in Dangjiang Town, during the upgrading project for Baiquwei embankment, there were instances of migrant workers entering nearby villages, but few social conflicts arose between local and non-local workers.

On the other hand, during the construction period, the influx of migrant workers from other areas to the project area for extended periods may increase the intensity of interaction with local residents, potentially leading to the spread of communicable or epidemic diseases and other health risks. For example, in terms of residents' health and hygiene, conditions may arise for the spread and transmission of communicable diseases, including HIV/AIDS, COVID-19, and influenza.. To mitigate the risks caused by the influx of labor, it is necessary for village/community committees, IA, and contractors to effectively communicate, coordinate, and manage migrant workers

9.3.4 Traffic safety risks

The traffic safety risks of this subproject are divided into construction period traffic safety risks and operational period traffic safety risks. Based on the on-site survey, it is observed that the routes to the mangrove conservation area need to pass through villages. The roads leading to these villages are relatively narrow, with some sections only allowing one vehicle to pass at a time. When two vehicles meet, they must stop and yield to each other to pass. Furthermore, the roads connecting the villages to the mangrove areas are often unpaved and muddy during rainy days, increasing the risk of vehicle accidents such as skidding and getting stuck. Therefore, during the construction period, with a large number of vehicles frequently transporting seedlings, tools, solid waste, and workers, there is a certain risk of traffic safety. On one hand, the frequent passage of large vehicles may cause damage to the existing roads around the community, reducing the safety coefficient of the roads and potentially increasing safety hazards. On the other hand, some villages lack traffic signs, which may lead to traffic safety accidents.

During the operational period, as the number of people involved in mangrove conservation, visiting tourists, and vehicles in the project area increases, conflicts such as minor collisions and disorderly parking are likely to occur for a certain period of time.

To address this, it is important to strengthen the management of vehicle transportation. Material transportation should avoid passing through residential areas, schools, hospitals, and other sensitive areas as much as possible. When passing near sensitive areas, vehicles should slow down and refrain from honking. Proper traffic signs should be installed on village roads.

9.3.5 Labor health and safety issues

Mangroves are located in subtropical coastal areas, characterized by high temperatures and humidity, influenced by tidal patterns. The period from May to June each year, during the hot summer days with low tides, is considered favorable for planting mangroves. However, the planting process is extremely arduous. This subproject involves physical labor and machinery operation, posing certain occupational health and safety risks in such environments.

(1) Environmental risks during operations. The tidal flats offer no shelter, exposing workers to extreme heat and sun exposure. The high temperatures and tidal environment during construction may lead to heatstroke, fatigue, incidents of workers getting stuck in mud, or drowning.

(2) Risks of machinery operation accidents. During the Spartina alterniflora clearing, heavy machinery such as excavators and forklifts are used. Improper operation or equipment failure may result in injuries to personnel.

(3) Pests and animal intrusion. The construction area may be inhabited by mosquitoes, snakes, and other wildlife, posing potential threats to the health of construction workers.

To achieve this, establishing a sound safety management system and emergency response plan, and implementing a series of security measures such as sun protection, heatstroke prevention, anti-slip measures, drowning prevention, labor protection, and safety management, can minimize the safety production risks in the mangrove planting project. This ensures the smooth progress of the project and the safety of personnel.

9.3.6 Labor management risk analysis

The types of workers required for mangrove planting and restoration may include tree planters, caregivers, and maintenance workers, who will be responsible for the entire process from planting to later-stage maintenance. On the other hand, the Spartina alterniflora clearing may require a specialized team, including operators, machinery drivers, and relevant supervisory and management personnel. During both the construction and operation stages of the project, there are various types of workers involved, leading to a certain level of complexity in labor management. The main risks faced include:

(1) Labor contract disputes. If labor contracts are signed improperly or contain ambiguous terms, it may lead to disputes between employees and employers.

(2) Wage arrears. Due to issues with cash flow or poor management, employers may face difficulties in paying employees' wages on time;

(3) Legality of employment risks. During the construction period, there may be a shortage of local labor, leading to issues such as hiring child labor, gender discrimination, forced labor, and other illegal employment practices.

By comparing the legal framework of labor protection in China with the key requirements of ESS1 outlined in AIIB's ESF regarding labor and working conditions standards, it is found that China's legal framework aligns with the requirements of the AIIB, and in some aspects, even exceeds them, such as the statutory age requirement for employing child labor. Therefore, it can be concluded that China's existing legal framework is consistent with the key requirements of AIIB's ESS1.

The norms for labor management by contractors include:

(1) Based on the principles of equal opportunity and fair treatment, project personnel should be hired without discrimination against specific groups such as women, persons with disabilities, migrant workers, and young workers with statutory working age.

(2) Adequate protection and assistance measures should be provided, including establishing limits on working hours and rest periods, stipulating vacation systems to protect the safety and health of workers from a time perspective. Additionally, sufficient and complete labor protection equipment should be reasonably provided based on construction needs, hazards in the construction site, and labor safety and health requirements. Specific attention should be paid to certain groups of workers, such as women, persons with disabilities, migrant workers, and young workers with statutory working age.

(3) Following national legal provisions, workers have the right to establish and join worker organizations of their choice and ensure that their collective bargaining is not interfered with.

(4) To prevent incidents of sexual harassment, contractors will provide adequate separate toilet facilities for men and women at construction sites based on the number of female workers; formulate relevant regulations to prevent sexual harassment and assign dedicated personnel to be responsible, clearly informing all

personnel of the relevant requirements; daily management training for contractors will include relevant content on preventing sexual harassment.

(5) Establish and clarify mechanisms for handling labor complaints and reports, establish a labor protection supervision mechanism, and protect individual privacy in handling complaints of sexual harassment in accordance with the law.

Based on the identification of potential labor management risks concerning migrant construction workers during the construction period, the social consultants, through consultations with the PMO, various implementing agencies, and design institute, have formulated relevant design optimization and mitigation measures. For detailed information, please refer to Chapter Ten of the Environmental and Social Management Plan.

10. Environmental and Social Management Plan

The Environmental and Social Management Plan (ESMP) is prepared for Subproject 2 of Guangxi Beihai Lianzhou Bay Marine Ecological Restoration and Protection Project, namely Blue Carbon Sink Actions. The ESMP is prepared based on the following documents: ESIA prepared by Guangxi Huachuan Environmental Protection Consulting Services Co., Ltd. and Guangxi Guoye Project Management Consulting Co., Ltd. (2023); Feasibility Study Report of AIIB-financed Guangxi Beihai Lianzhou Bay Marine Ecological Restoration and Protection Project, prepared by Shenzhen Water Planning and Design Institute in January 2024; Operation Plan for Spartina alterniflora Cleaning - Beihai Marine Ecological Protection and Restoration Project in 2024, prepared by Beihai Yisen Forestry Design Co., Ltd. in April 2024; Operation Plan for Mangrove Restoration - Beihai Marine Ecological Protection and Restoration Project in 2024, prepared by Beihai Yisen Forestry Design Co., Ltd. in April 2024).

The ESMP identifies appropriate mitigation measures for potential environmental and social impacts, and specifies the responsibilities and management mechanisms for compliance with the environmental and social laws and regulations of the People's Republic of China and the AIIB's ESP framework. Contractors are responsible for implementing the relevant requirements outlined in the ESMP and listing cost estimates in the bidding documents. The results of environmental and social monitoring will be used to assess the effectiveness of mitigation measures and determine whether additional improvement measures are necessary.

10.1 Institutional responsibilities for ESMP implementation

The executive agency for this subproject is Beihai Municipal Government, with Beihai DRC serving as the institutional supervising entity and the Beihai Urban Development Investment Group Co., Ltd. as the project implementing agency. The PMO is set under Beihai DRC, responsible for the daily implementation of the project and communication with the AIIB.

Due to the significant differences in environmental management between the construction and operation stages of the project, and the temporary and long-term nature of their work timelines, contractors and operators establish separate organizational structures according to the different stages and operate in a staged responsibility manner. Upon the completion of the construction period, the corresponding management organization is dissolved, and the management body for the operation stage begins operations. Depending on the work situation, there may be a certain period of overlap between the two stages. Beihai Urban Development Investment Group Co., Ltd. is responsible for the environmental and social management work during both the construction and operation stages.

The construction environmental management process of this subproject is shown in Figure 25. During the operational stage, the project implementing unit, Beihai Urban Development Investment Group Co., Ltd., will manage according to the prevailing management mechanism.

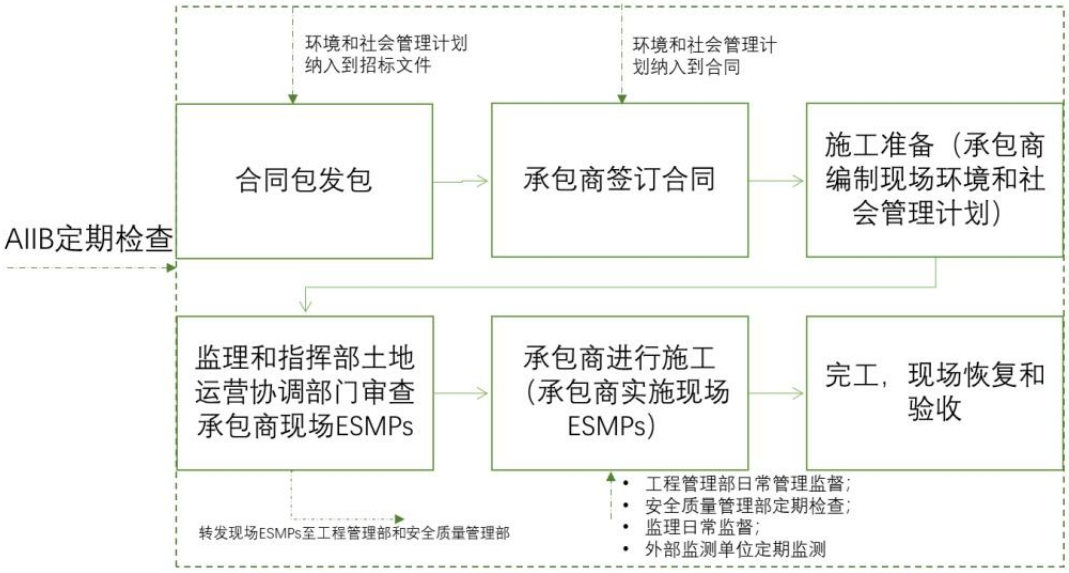


Figure 25 Construction Environmental Management Process

The IA's management command center should establish the departments such as finance, procurement, engineering management, and safety and quality

management, responsible for coordinating and managing various professional fields during the construction period. The management command center will be fully responsible for supervising the implementation of th ESMP during the construction period, coordinating the GRM operation, and reporting to AIIB through the PMO.

A designated Environmental and Social Officer within the management command center will be responsible for: (i) coordinating with the procurement department to ensure that environmental and social mitigation measures are included in tender documents and construction contracts; (ii) reviewing the contractor's on-site environmental and social management plans, including but not limited to dust and noise reduction plans, civilized construction plans, and on-site wastewater management plans; (iii) coordinating the operation of the appeals mechanism; (iv) organizing supplementary assessments and implementing corresponding mitigation measures for any unforeseen environmental and social negative impacts as per the ESIA and ESMP, and promptly reporting to the AIIB through the PMO; (v) submitting regular environmental and social monitoring reports to the AIIB through the PMO.

The engineering management department of the management command center will assign 1-2 environmental and social officers for each construction section to oversee the implementation of environmental protection measures and safety production measures, inspection and acceptance of environmental components, coordination of the GRM operation, and collection and archiving of environmental and social monitoring data at the construction site.

Contractors should: (i) ensure that there are adequate funds and manpower to implement mitigation measures and monitoring plans outlined in the ESMP throughout the construction stage; (ii) be responsible for the operation of the GRM during the construction stage.

Construction supervisors should: (i) ensure that there are sufficient funds and manpower to supervise and guide the contractors, requiring them to implement

mitigation measures and monitoring according to the ESMP; (ii) supervise and record the implementation of environmental protection measures and safety production measures on a daily basis, submit monthly supervision reports to the Engineering Management Department, and organize meetings to discuss the supervision results.

10.2 Summary of environmental and social impacts and mitigation measures

Mitigation measures have been developed based on identified environmental and social impacts. Design institute and contractors, under the supervision of the IA and construction supervisor, will incorporate mitigation measures into design, bidding documents, construction contracts, and operational management. The effectiveness of these measures will be evaluated based on monitoring results from construction supervisor and the external monitoring agencies to determine if adjustments and improvements are necessary.

10.2.1 Environmental impacts and mitigation measures

10.2.1.1 Responsibilities and contents of environmental management

There are significant differences in environmental management content in the construction and operation stages of the project, with different departments responsible for implementing ESMP. The responsibilities and personnel allocation for environmental management at each stage are outlined in Table 54.

Table 54 Contents of Environmental Management at Different Stages

Stage	Concerned agencies	Major environmental management contents	Personnel arrangement
Design and preparation	PMO	Responsible for liaising and coordinating with the government's environmental regulatory authorities to implement environmental management matters.	2
	IA	(1) Responsible for a series of environmental protection management work during the project design and preparation stage. (2) Ensure funds for environmental protection work. (3) Coordinating with the government's environmental regulatory authorities to implement environmental	2

Stage	Concerned agencies	Major environmental management contents	Personnel arrangement
		management matters. (4) Hiring supervisory units and collecting records. (5) Supervising the EIA consulting agency to complete the filling of EIA registration form before the construction commencement.	
	Design institute	(1) Incorporate environmental protection measures into the design scheme and budget. (2) Include the mitigation measures from ESMP into the technical specifications of the tender documents.	3
	EIA agency	(1) Provide technical support for environmental protection in engineering design. (2) Fill out the environmental impact registration form. (3) Develop the EMP.	5
	Beihai Ecology and Environment Bureau	(1) Responsible for receiving the project's environmental impact registration form for filing. (2) Guide the district and county ecological environment bureaus in carrying out daily environmental supervision and management work for the project.	2
Construction period	IA	(1) Responsible for a series of environmental protection management tasks during the project construction period, ensuring environmental protection funding. (2) Manage and supervise environmental protection work during the construction period, investigate and address disturbances or pollution issues that arise during construction. (3) Coordinate with the government's ecological and environmental management departments to implement environmental management matters. (4) Track the EMP implementation and regularly report to relevant government departments, PMO and AIIB. (5) Receive and handle public complaints.	2
	Contractors	(1) Implement environmental protection measures and various tasks during the construction period in accordance with the bidding documents, contract agreements, and the EMP. (2) Accept guidance and supervision from the IA's environmental management personnel, construction supervision engineers, and relevant government departments. (3) Receive technical support from environmental consulting agencies. (4) Implement safety protection measures, such as setting up warning signs at construction sites, establishing communication channels with the public, and ensuring construction safety. (5) Implement the EMP.	3
	Construction supervisor	(1) Supervise the contractor's EMP implementation and the environmental mitigation measures specified in the contract. (2) Conduct on-site supervision of the contractor's implementation status.	5

Stage	Concerned agencies	Major environmental management contents	Personnel arrangement
		(3) Cooperate with the IA in environmental management efforts. (4) Document the implementation status of EMP, prepare reports, and regularly submit them to the IA.	
	External monitoring agency	(1) Complete environmental monitoring assignment during the construction and operation stages according to the IA's commission and the EMP proposed in this assessment. (2) Conduct monitoring if anything unusual are detected during construction, as commissioned by the IA,	based on the scope of the commissioned tasks.
	Beihai Ecology and Environment Bureau	(1) Supervise and inspect the environmental protection measures of the IA and contractors. (2) Receive and review reports on the EMP implementation submitted by the IA and the PMO, and take administrative actions based on the reports. (3) Arrange emergency measures if abnormal environmental conditions occur during construction. (4) Accept public complaints and coordinate their resolution.	2
	Technical assistance / consultancy	(1) Provide technical support for environmental protection work during the construction stage according to the commission from the IA, the environmental impact report, and the results of environmental protection design. (2) Offer technical guidance on environmental protection work to the contractors and conduct environmental protection training during the construction stage.	Without requirement
Operational period	IA or operation entity	(1) Responsible for environmental protection management work during the operation stage, implementing the mitigation measures and monitoring outlined in the EMP for the operational period. (2) Responsible for contacting and coordinating with government regulatory authorities to implement environmental management matters. (3) Handle environmental emergencies. (4) Conduct regular training for staff to enhance their capabilities, and actively engage in knowledge share activities on environmental protection technology and experiences to further improve environmental management work.	3
	External monitoring agency	(1) Complete environmental monitoring work during the operational stage of the project according to the environmental monitoring plan, as commissioned by the IA. 2． Conduct routine regular monitoring related to the project,	based on the scope of the commissioned tasks.
	Local Ecology and Environment Bureau	(1) Manage and supervise environmental compliance during the operation period. (2) Conduct daily inspections to monitor the operation of completed environmental facilities.	2
	The public or organizations	Social supervision	Without requirement

10.2.1.2 Environmental protection supervision plan

According to the characteristics of this project, the implementation of environmental protection measures will be subject to the supervision not only from the Beihai Ecology and Environment Bureau but also from relevant departments of the AIIB. During the construction period, construction supervision personnel should be appointed to assist the IA in on-site inspections, while during the operation period, an environmental protection department should be established to supervise the project.

The project's environmental protection supervision plan (EPSP) is outlined in Table 55.

Table 55 Project Environmental Protection Supervision Plan

Stage	Institutions	Supervision contents	Objectives of supervision
Feasibility study stage	Beihai Ecology and Environment Bureau, AIIB	(1) Review the environmental impact registration form. (2) Review the EMP.	(1) Ensure comprehensive coverage and appropriate focus areas in the EIA. (2) Ensure that major and potential issues arising from the project are adequately addressed. (3) Ensure that there are specific and feasible implementation plans for mitigating environmental impacts.
Design and construction Construction stage	Beihai Municipal Government Beihai Ecology and Environment Bureau Hepu Ecology and Environment Bureau Beihai Water Conservancy Bureau Beihai Forestry	(1) Review the preliminary environmental design and EMP. (2) Inspect measures for controlling emissions of air pollutants, wastewater, noise, and solid waste, and determine construction schedules accordingly. (3) Verify compliance with emission standards for environmental pollutants. (4) Monitor the disposal of solid waste. (5) Strengthen supervision	(1) Strictly adhere to the "three simultaneous" environmental protection system. (2) Ensure that all construction sites meet environmental requirements. (3) Minimize the impact of construction on the surrounding environment by adhering to relevant environmental regulations and standards. (4) Ensure that the water quality of Lianzhou Bay is not polluted. (5) Ensure that the landscape and ecological environment are not

Stage	Institutions	Supervision contents	Objectives of supervision
	Bureau Beihai Municipal Engineering Administration Bureau. Beihai Natural Resources Bureau	to prevent accidents, develop emergency response plans in advance, and promptly mitigate environmental risks in the event of an accident.	damaged. (6) Ensure the proper and rational disposal of solid waste. (7) Prevent environmental accidents by developing targeted and actionable emergency plans.
Operation stage	Beihai Ecology and Environment Bureau Hepu Ecology and Environment Bureau Beihai Forestry Bureau Municipal Public Security and Fire Prevention Departments	(1) Verify the implementation of the monitoring plan. (2) Assess the necessity for further environmental protection measures (in case of unforeseen environmental issues). (3) Ensure that the environmental quality of various elements meets their respective standard requirements. (4) Strengthen supervision to prevent emergencies. Develop contingency plans for sudden environmental events to promptly mitigate environmental risks in the event of an accident.	(1) Implement the monitoring plans. (2) Take efforts to protect the environment.

10.2.1.3 Environmental impacts and mitigation measures

According to identified environmental impacts, corresponding mitigation measures have been developed (see Table 56). Design institute and contractors will incorporate environmental mitigation measures into design, bidding documents, construction contracts, and construction and operational management under the supervision of the IA and construction supervisor. The performance and effectiveness of these measures will be evaluated based on monitoring results from

supervisory and external monitoring agencies to determine if adjustments and improvements are necessary.

Table 56 Environmental Impacts and Mitigation Measures

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
Construction period	Mangrove restoration and Spartina alterniflora clearing	Marine water quality	Suspended substance dispersion	(1) Work schedules should be arranged rationally, and construction should be conducted during low tide to ensure that the tidal flats are exposed. (2) Domestic sewage from construction personnel should be treated in septic tanks built near residential houses, and the treated effluent can be used as organic fertilizer for irrigation in nearby forests, without being discharged into water bodies. Additionally, the contractors should provide training for construction personnel and implement environmental monitoring during the construction process. Environmental protection clauses should be included in the construction contract, and the contractor must strictly adhere to them. (3) Maintenance and upkeep of	Sea Water Quality Standards (GB 3097-1997), Category II Quality Standards	Contractor, IA	Beihai Ecology and Environment Bureau, AIIB	Project budget

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
				construction machinery should be intensified to prevent oil spills. (4) The IA should cooperate with local supervisory authorities to monitor the environmental impact during the construction process and conduct regular checks on water quality. Environmental protection clauses should also be incorporated into the construction contract, and the contractor must adhere to them strictly. (5) During the bidding process for construction contracts, the IA and the contractor should sign agreements that clearly outline construction techniques and specify the responsible party for any environmental pollution caused during the construction process.				
		Marine sediment.	Clearing of Spartina	(1) Control the excavation depth during the clearing of Spartina alterniflora and	Marine Sediment Quality	Contractor, IA	Beihai Ecology and	Project budget

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
			alterniflora and derris	derris, as well as the planting depth of mangroves. (2) The area after clearing Spartina alterniflora will be covered by biodegradable films to ensure efficiency. (3) After treatment in septic tanks, sewage from construction camps is used as agricultural fertilizer to irrigate nearby forests instead of being discharged into the sea, thus avoiding any impact on marine sediment environments. Additionally, the contractors should provide training for construction personnel and implement environmental monitoring during the construction process. Environmental protection clauses should be included in the construction contract, and the contractor must strictly adhere to them.	（GB18668-2002）, Category II sediment standards		Environment Bureau, AIIB	

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
				(4) The IA should cooperate with local supervisory authorities to monitor the environmental impact and marine sediment during the construction process. Environmental protection clauses should also be incorporated into the construction contract, and the contractor must adhere to them strictly. (5) During the bidding process for construction contracts, the IA and the contractor should sign agreements that clearly outline construction techniques and specify the responsible party for any environmental pollution caused during the construction process.				
		Marine ecological environment and marine	Increase suspended substance caused by construction	(1) The construction should schedule work times reasonably, avoiding operation during high tide periods, and preferably choosing ebbing tide periods. It is best to conduct	Without causing damages to the marine ecology	Contractor, IA	Beihai Ecology and Environment Bureau, AIIB	Project budget

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
		biology.		construction after the tidal flats have dried out. (2) The construction area must be controlled, with strict prohibition on construction beyond the designated boundaries. When clearing Spartina alterniflora and derris, caution must be taken not to damage surrounding mangroves. Spartina alterniflora on the tidal flats should be turned over to a depth of around 100cm, with excavation depth strictly controlled to prevent exceeding this limit. (3) When signing contracts with contractors, the implementing agency should clearly define the responsibilities and obligations of both parties in pollution prevention in the contract. Select teams with good qualifications and relevant construction				

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
				experience. Conduct civilized construction education, introduce knowledge about the protection of marine animals, and enhance awareness of marine animal protection among workers.				
		Emissions	Construction dusting, machinery exhaust	(1) Timely sweep and water the transportation roads. Increase the frequency of sprinkling on windy days to reduce dust emissions. (2) The thickness and strength of transportation roads should meet the requirements for the passage of transportation vehicles, ensuring smooth and flat surfaces to reduce material jolting and spillage. (3) Before entering and leaving the site, transportation vehicles should be washed, and road cleaning and sprinkling should be strengthened to	Integrated Emission Standards of Air Pollutants (GB 16297 - 1996)	Contractor, IA	Beihai Ecology and Environment Bureau, AIIB	Project budget

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
				reduce dust emissions. (4) Limit the driving speed of transportation vehicles. (5) Use machinery, equipment, transportation vehicles, and ships that comply with national standards for pollutant emissions. Strengthen maintenance of machinery, vehicles, and ships to ensure they are in good working condition. Prohibit the use of scrapped vehicles.				
		Noise	Transportation vehicles, construction machinery	(1) Use low-noise construction equipment as much as possible. Install soundproofing and vibration reduction devices on individual noisy equipment, and regularly maintain and operate mechanical equipment according to specifications to minimize noise impact. (2) Layout construction equipment	Emission Standards for Noise of Construction Site at Boundary （GB 12523-2011)	Contractor, IA	Beihai Ecology and Environment Bureau, AIIB	Project budget

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
				reasonably, shut down unused equipment promptly, and regularly maintain and service equipment to keep it in good operating condition. (3) Schedule construction operations reasonably, strictly adhere to the standards specified in the Emission Standards for Noise of Construction Site at Boundary （GB 12523-2011） during the construction period, i.e., 70dB(A) during the daytime and 55dB(A) at nighttime. Construction is strictly prohibited between 12:00 and 14:30 during the day and between 22:00 and 6:00 the next day at night, and continuous construction is not allowed. If continuous construction is necessary due to the workflow, approval must be obtained from the relevant supervisory and management authorities, and				

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
				construction can only proceed after notifying the surrounding residents. (4) During civilized construction, especially nighttime construction, loud noise should be avoided, and efforts should be made to minimize mechanical and material impacts to reduce the impact of artificial noise. (5) Enhanced management of vehicle transportation is required, ensuring that vehicle noise emissions comply with the national standards for motor vehicle noise emissions. Material transportation should avoid passing through residential areas, schools, hospitals, and other sensitive areas as much as possible. When passing through sensitive areas, vehicles should reduce speed, and horn honking should be prohibited.				

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
		Solid wastes	Spartina alterniflora and derris clearing	(1) After the area is cleared, biodegradable film will be used to cover it, producing no film waste. Grass stems formed by manual cutting will be bundled and collected onto boats. When the tide rises, the boats loaded with grass stems will be moved to the mechanical clearing area. After the tide recedes again, the grass stems will be evenly distributed in the spartina alterniflora area designated for mechanical clearing. Before the next high tide, timely mechanical clearing operations using floating dredgers will be conducted, burying both mechanically excavated and manually	Standards for General Industrial Solid Waste Storage and Landfill Pollution Control（GB18599-2020）	Contractor, IA	Beihai Ecology and Environment Bureau, AIIB	Project budget

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
				cut grass stems. (2) The derris are collected ashore and transported to nearby town waste transfer stations. (3) The collected domestic garbages generated by construction workers are centrally collected and transported by contractor to nearby town waste transfer stations.				
Operation Period	Mangroves nursing	Solid wastes, human health.	Clearing of marine debris, Enteromorpha, balanus albicostatus, Spartina alterniflora and derris, pest control.	(1) Closely monitoring the growth of mangrove trees. Regular inspections are carried out to promptly address issues such as lodging, exposed roots, and damaged seedlings, saplings, and sparse areas. These measures include repositioning and replanting with the intended tree species to prevent the formation of "canopy gaps." (2) Arrange patrol personnel to conduct regular patrols in the restoration area	According to the Guidelines for Mangrove Afforestation and Restoration Techniques in Guangxi (Trial), after 1 year of mangrove afforestation, the survival index of	IA	Beihai Forestry Environment Bureau, AIIB	Project budget

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
				along designated routes. The main focus of patrol work is to inspect the forest area, eliminate human disturbances, promptly identify and eliminate threats, and ensure that the mangrove forest in the restoration area remains undamaged. In the event of forest destruction or damage, take immediate action to stop it, report it promptly, and ensure early detection and intervention. The patrols and maintenance will continue for a duration of 3 years, with 7 patrols per month, 1 workday per patrol for each site plot. Each patrol should fill out a patrol log sheet during every patrol, documenting the patrol time and inspection findings thoroughly. (3) Timely clearing of the marine debris, Enteromorpha, balanus	aegiceras corniculatum species should be ≥7000 plants / h ㎡ e, and the survival index of Kandelia obovata should also be ≥7000 /h ㎡. The number of surviving plants per hectare should meet or exceed the survival index to be considered qualified. After 3 years of afforestation, the number of surviving aegiceras corniculatum and Kandelia obovata			

Stage	Activities	Environ mental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
				albicostatus, Spartina alterniflora and derris. The marine debris, Enteromorpha, balanus albicostatus, Spartina alterniflora and derris etc. are collected ashore and transported to nearby town waste transfer stations. (4) Install pest trap lights, to lure and kill common pests in the mangrove forest, such as olive fruit tortrix moth, auicennia marina leaf-eating moth, lasiognatha cellifera, parasa lepida, pseudaulacaspis cockerelli, tussock moth, Buzura suppressaria Guenee, Guangzhou Microlepidoptera, and Erebus macrops etc. (5) Before using pesticides, mangrove maintenance workers should take appropriate protective measures, such as wearing long-sleeved clothing and pants, masks, refraining from smoking	should be ≥4500 plants / h ㎡, and the proportion of trees aged 5 years or older (including seedling age) should be ≥70% to be considered qualified.			

Stage	Activities	Environmental elements	Potential impact	Mitigative / prevention measures	Handling results, implementation standards or performance standards	Responsible implementing units	Supervising institutions	Sources of funds
				or eating, and avoiding wiping sweat with their hands. Pesticides should be sprayed during suitable times, preferably in the early morning or late afternoon, avoiding the midday heat. Ensure that spraying equipment is properly adjusted, and pesticide concentration and dosage are correctly calibrated. When preparing and mixing pesticides, wear rubber gloves, a respirator, and protective goggles. Stand upwind while spraying pesticides to prevent exposure to the spray. After spraying, promptly change clothes and wash your face and hands before eating.				

10.2.2 Social Management Action Plan

10.2.2.1 Social impacts and mitigation measures

（1） Reduce the noise pollution risk

The noise impact shall be managed in accordance with the Noise Management Framework outlined in the appendix of this ESMP.

(2) Reduce potential environmental and social risks

Address impacts related to air quality, dust, wastewater, solid waste, etc., by following the EMP action plan.

(3) Minimize the impact of an influx of construction workers on local residents during the construction period

(i) Implement community management, adopt a shift rotation system, and ensure timely registration of incoming residents to ensure the safety of community members.

(ii) Improve the planning of electrical circuit facilities to reduce pressure on electricity and water usage. Increase the number of garbage stations, the frequency of sanitation vehicle operations, and the number of sanitation workers.

(iii) Invite respected elders or knowledgeable community leaders from the project area to conduct awareness campaigns on local social and cultural customs, such as through brochures, posters, photo albums, etc.

(iv) Strengthen health education and awareness campaigns on HIV/AIDS, COVID-19 prevention, and other infectious diseases. These should be included in the contractual documents.

(4) Reduce traffic safety risks

The mitigation measures for traffic risks during construction period include:

(i) Properly plan the routes for the operation of large construction vehicles, stagger their travel times, and reduce the impact of large trucks on residents' travel and the damage to relevant road sections.

(ii) Increase traffic safety awareness campaigns and install traffic signs and alternative travel routes in village sections.

(5) Mitigation measures for traffic during operation period

(i) Implement a rational road traffic plan and encourage residents to travel at different times to reduce the risk of traffic congestion and collisions.

(ii) Strengthen traffic safety awareness campaigns, deploy traffic counselors, and set up traffic control stations to better maintain traffic order.

6. Labors management

(1) Measures for management of influx workers during construction

(i) Clearly stipulate adherence to the principles of equal opportunity and fair treatment during the hiring process for project staff. Furthermore, discrimination based on personal characteristics unrelated to inherent job requirements, such as age or gender restrictions for applicants, is prohibited.

(ii) Improve the GRM operation for employees (including direct workers and contract workers).

(iii) Enhance employee training programs.

(iv) Provide appropriate protection and assistance measures for specific groups of workers, such as women, people with disabilities, migrant workers, and legally aged children, to address any deficiencies among project staff.

(v) Specific occupational health and safety measures are detailed in the EMP.

(2) Management measures for personnel during construction and operation periods

(i) Clearly stipulate adherence to the principles of equal opportunity and fair treatment during the hiring process for project staff. Furthermore, discrimination based on personal characteristics unrelated to inherent job requirements, such as age or gender restrictions for applicants, is prohibited.

(ii) Provide appropriate protection and assistance measures for specific groups of workers, such as women, people with disabilities, migrant workers, and legally aged children, to address any deficiencies among project staff.

(iii) The occupational health safety related to noise is detailed in the EMP.

(iv) Guidelines for addressing gender-based violence are outlined in the Social Gender Management Plan.

7. Social Gender Action Plan

(1) Increase job opportunities for women

(i) During the construction and operation periods of the project, the women in the affected villages of the project area shall be offered non-skilled jobs in priority.

(ii) As for the jobs without special requirement of high physical strength, the recruitment will extend the age limit and recruit on priority to the women in age category of 40-55 years, such as cleaning, cooking and patrolling.

(2) Promote the development capacities of women.

(i) Enhance women's employment and entrepreneurship skills, knowledge, and opportunities by organizing employment knowledge lectures, skills training workshops, and employment and entrepreneurship seminars.

(ii) In sustainable information disclosure capacity-building training, tailor the skills training content to women's physiological and psychological qualities, educational levels, personal needs, and other factors. Set appropriate training times to further ensure that women have equal opportunities to improve their skills alongside men.

(3) Increase participation in decision-making for women

(i) Increase the participation of women in decision-making regarding community affairs.

(ii) Increase the proportion of women signing or co-signing land acquisition or relocation compensation agreements, either individually or jointly with their spouses.

(4) reduce the risk of gender-based violence

(i) Strengthen the protection of women workers' rights by providing regular psychological consultation and training on the protection of women workers' rights.

(ii) Enhance supervision of construction sites to prevent harmful behaviors such as gender-based violence, sexual exploitation and abuse, and sexual harassment.

(II) Establish clear channels for complaints and grievances, set up a site complaints and grievances committee comprising at least two female members, and ensure the safety of committee members to prevent prejudice and fear of retaliation.

In consultation with the PMO, IA and related project implementing entities and organizations, as well as the residents of the project area, a feasible Social Management Plan and Gender Action Plan have been developed to address the impacts and potential risks of the project on the environment, society, and women. As shown in the Table 57.

10.2.2.2 Social Management Plan and Gender Action Plan

Based on the identified social impacts, in consultation with the PMO, IA and related project implementing entities and organizations, as well as the residents of the project area, a feasible Social Management Plan and Gender Action Plan have been developed to address the impacts and potential risks of the project on the environment, society, and women. As shown in Table 58. Design institute and contractors will incorporate mitigation measures into design, bidding documents, construction contracts, and construction and operational management under the supervision of the IA and construction supervisor.

Table 57 Social Management Plan and Gender Action Plans

Stage	Risk / impacts	Specific measures / actions	Responsible institutions / departments	Sources of funds	Monitoring indicators
Social Management Plan					
Construction period	Noise pollution risk	Cumulative noise impacts will be addressed according to the Noise Management Framework.			(i) Implementation and monitoring of the noise management plan.
	Impacts on livelihood activities	(i) Construction roads, material storage, vehicle parking, and construction enclosures will be minimized to reduce the impact on the marine access of residents in the project area. (ii) Reasonable planning of construction timing and methods should be carried out to avoid conflicts with residents' fishing activities.	IA, Urban and Rural Construction Bureau, contractors, mangrove conservation stations, community/village committees, etc.	project budget, government budget	(i) Establish temporary convenient access channels for marine livelihood activities for residents in the project area. (ii) Strengthen communication and publicity with residents of nearby villages, distribute brochures on mangrove conservation laws, and organize village meetings for public education.
	Other potential natural and social risks	Address impacts related to air quality, dust, wastewater, solid waste, etc., by following the EMP action plan.	Urban and Rural Construction Bureau, village groups, external social and environmental monitoring agencies	project bud get, govern ment budget	EMP implementation monitoring
	Risks on residents caused by the influx of construction workers	(i) Implement community management, adopt a shift rotation system, and ensure timely registration of incoming residents to ensure the safety of community members. (ii) Improve the planning of electrical circuit facilities to reduce pressure on electricity and water usage. Increase the number of garbage stations, the frequency of sanitation vehicle operations, and the number of sanitation workers. (iii) Invite respected elders or knowledgeable community	IA, Finance Bureau, Urban and Rural Construction Bureau, external monitoring agencies	project budget, government budget	(i) Strengthen information management and updates for construction personnel, ensuring effective communication between the construction team and the community to maintain the security of community information. (ii) Plan the scope and maintenance frequency of electrical circuits; determine the number of community garbage stations, frequency of sanitation vehicle cleaning, and the

		leaders from the project area to conduct awareness campaigns on local social and cultural customs, such as through brochures, posters, photo albums, etc. (iv) Strengthen health education and awareness campaigns on HIV/AIDS, COVID-19 prevention, and other infectious diseases. These should be included in the contractual documents.			number of sanitation workers. (iii) Conduct education and awareness campaigns on local social and cultural customs, including the distribution of pamphlets, posters, and photo albums. (iv)Promote public safety, HIV/AIDS epidemic disease prevention, and COVID-19 prevention knowledge through the distribution of pamphlets, posters, and photo albums; organize prevention training courses and determine the number of participants.
	Traffic risk	(i) Properly plan the routes for the operation of large construction vehicles, stagger their travel times, and reduce the impact of large trucks on residents' travel and the damage to relevant road sections. (ii) Increase traffic safety awareness campaigns and install traffic signs and alternative travel routes in village sections.	IA, Emergency Management Bureau, Human Resources and Social Security Bureau, Urban Management Bureau, Township/Subdistrict Office, Community/Village Committee, Women in Project Areas, Contractors	project budget, government budget	(i) Planning for sections involving large truck vehicles includes staggered travel road signs, detour plans, and notices on unit and community bulletin boards. (ii) Traffic safety promotion and education include the quantity of promotional brochures, posters, and photo albums; the number of training lectures and participants; and the distribution locations and photos of village road signs.
	Risks on residents caused by the influx of construction workers	Management of migrant workers during the construction period. (i) Clearly stipulate the principle of equal opportunities and fair treatment in the hiring process of project staff, and ensure no discrimination based on irrelevant personal characteristics such as age and gender of applicants; (ii) Improve the GRM operation for	IA, Human Resources and Social Security Bureau, women's federations, contractors.	Cost for Project Labor Management Plan	Management of migrant workers during the construction period. (i) Proportions of special groups such as women, people with disabilities, and other demographics among the hired workers; (ii) Grievance handling mechanism; (iii) Employee training plan; (iv) Protection measures and regulations

		employees (including direct workers and contract workers); (iii) Enhance employee training programs; (iv) Provide appropriate protection and assistance measures for specific groups of workers, such as women, people with disabilities, migrant workers, and legally aged children, to address any deficiencies among project staff. (v) Specific occupational health and safety measures are detailed in the EMP. Employee management. (i) Clearly stipulate adherence to the principles of equal opportunity and fair treatment during the hiring process for project staff. Furthermore, discrimination based on personal characteristics unrelated to inherent job requirements, such as age or gender restrictions for applicants, is prohibited. (ii) Provide appropriate protection and assistance measures for specific groups of workers, such as women, people with disabilities, migrant workers, and legally aged children, to address any deficiencies among project staff. (iii) The occupational health safety related to noise is detailed in the EMP. (iv) Implementation of Gender Action Plan.			for women, people with disabilities, and child labor; (v) Implementation status of the EMP. Employee management. (i) Proportions of special groups such as women, people with disabilities, and other demographics among the hired workers; (ii) Protection measures and regulations for women, people with disabilities, and child labor; (iii) Implementation status of the EMP. (iv) Status of Implementation of Gender Action Plan.
Operational period	Impact on coastal livelihood activities.	(i) Reasonably plan convenient channels for coastal livelihood activities; (ii) Guide alternative livelihoods, directing residents towards other industries or professions related to the ocean.	IA, Urban and Rural Construction Bureau, Township/Subdistrict Office, Mangrove Conservation Station, Community/Village	Project budget, government budget	(i) Establish convenient access channels for coastal livelihood activities for residents in the project area; (ii) Continuously strengthen the popularization of mangrove conservation area management; (iii) Organize relevant skills training to enhance residents' employment capabilities, such as

			Committee		ecological tourism services skills, seafood processing technology, aquaculture technology, etc., and record the number of training lectures and participants.
	Traffic risk	(i) Implement a rational road traffic plan and encourage residents to travel at different times to reduce the risk of traffic congestion and collisions. (ii) Strengthen traffic safety awareness campaigns, deploy traffic counselors, and set up traffic control stations to better maintain traffic order.	Subdistrict, IA, contractor	Project budget, government budget	(i) Planning for sections for vehicles, including staggered travel road signs, detour and notices on unit and community bulletin boards. (ii) Traffic safety promotion and education include the quantity of promotional brochures, posters, and photo albums; the number of training lectures and participants; and the distribution locations and photos of village road signs; number of traffic control stations and traffic counselors.
	Labor management risk.	Employee management. (i) Clearly stipulate adherence to the principles of equal opportunity and fair treatment during the hiring process for project staff. Furthermore, discrimination based on personal characteristics unrelated to inherent job requirements, such as age or gender restrictions for applicants, is prohibited. (ii) Provide appropriate protection and assistance measures for specific groups of workers, such as women, people with disabilities, migrant workers, and legally aged children, to address any deficiencies among project staff. (iii) Implementation of Gender Action Plan	IA, PMO	Cost for Project Labor Management Plan	Employee management. (i) Proportions of special groups such as women, people with disabilities, and other demographics among the hired workers; (ii) Protection measures and regulations for women, people with disabilities, and child labor; (iii) Status of Implementation of Gender Action Plan.
Social Gender Action Plan					
Increase job opportunities for women.		(i) During the construction and operation periods of the project, the women of the project area shall be offered non-skilled jobs in	PMO, contractors	Cost for Project Labor	A.1 Priority of employment opportunities of the project will be given to women (the baseline proportion of women in

	priority. (ii) As for the jobs without special requirement of high physical strength, the recruitment will extend the age limit and recruit on priority to the women in age category of 40-55 years; (iii) Enhancing opportunities for women in management and nursing through training.		Management Plan	mangrove planting and Spartina alterniflora clearing workers is approximately 40%, with a target of 50%); A.2 Increase opportunities for women in management work (the baseline Spartina alterniflora clearing management work is approximately 10%, with a target of 20%).
Promote the women's development capacities.	(i) Enhance women's employment and entrepreneurship skills, knowledge, and opportunities by organizing employment knowledge lectures, skills training workshops, and employment and entrepreneurship seminars. (ii) In sustainable information disclosure capacity-building training, tailor the skills training content to women's physiological and psychological qualities, educational levels, personal needs, and other factors. Set appropriate training times to further ensure that women have equal opportunities to improve their skills alongside men.	IA, Women's Federation at all levels, Human Resources and Social Security Bureau, Rural Affairs Bureau etc.	Project budget, government budget	B.1 Proportion of women participating in various training programs, including noise control, promotion of women's rights, employment skills training, etc. (baseline 20%, target 30%). B.2 Increase training for women participating in project information disclosure and management (baseline 25%, target 50%).
Increase participation in decision-making for women	(i) Increase the participation of women in decision-making regarding community affairs.	IA, community / village groups, PMO, contractors	Project budget, government budget	C.1 Proportion of women participating in project mobilization, information disclosure, policy advocacy, and consultation (baseline 20%, target 30%).
Reduce the risk of gender-based violence.	(i) Strengthen the protection of women workers' rights by providing regular psychological consultation and training on the protection of women workers' rights.(ii) Enhance supervision of construction sites to	IA, Women Federation, PMO, contractors	Project budget, government budget	D.1 100% of female workers received training on labor rights protection. D.2 Ensure equal pay for equal work for 100% of female and male workers, with 0 incidents of gender-based violence.

	prevent harmful behaviors such as gender-based violence, sexual exploitation and abuse, and sexual harassment. (iii) Establish clear channels for complaints and grievances, set up a site complaints and grievances committee comprising at least two female members, and ensure the safety of committee members to prevent prejudice and fear of retaliation.			D.3 Establishment GRM channels, number of female members

10.3 Environmental monitoring and social monitoring

10.3.1 Environmental monitoring

Environmental monitoring includes two stages: the construction stage and the operation stage of the project. Its purpose is to comprehensively and timely understand the pollution dynamics of the proposed project, understand the degree of environmental quality change in the area where the project is located, the scope of influence of project construction, the dynamic of environmental quality during the operation stage, and timely feedback information to the competent authority to provide scientific basis for the environmental management of the project.

External environmental monitoring during the construction and operation stages is conducted by an independent monitoring agency hired by the PMO and recognized by the AIIB, with experience in environmental monitoring and assessment of projects financed by international financial organizations, to carry out external monitoring of the EMP. The independent monitoring and assessment unit regularly tracks, monitors, and evaluates the EMP implementation activities, provides consultation opinions, and submits monitoring and assessment reports to the AIIB.

Based on the predicted results of environmental impact, the sensitive focus points with potentially significant pollution are selected as monitoring points to track and monitor pollution during the construction and operation stages of the project. The monitoring content includes marine water quality, marine sediments, marine ecology and biology, noise, and air quality. The monitoring factors are determined based on the characteristics of engineering pollution factors. The methodology will align with those outlined in the "Technical Specifications for Environmental Monitoring". The evaluation standards adhere to the national standards confirmed by the EIA for the project.

The IA will organize the preparation of the environmental monitoring report and submit it to the AIIB. The contents of the report shall include: (i) EMP implementation status; (ii) Overall effectiveness of the EMP implementation; (iii) Environmental monitoring and results conducted; (iv) Problems encountered during construction and operation periods and actions

taken. The IA is required to regularly report on the ESMP implementation of the project. The environmental and social monitoring report shall be submitted on semi-annual basis.

Table 58 Requirements on Monitoring Reporting

Report	Preparing Unit	Submission to	Frequency
A. Construction period			
Internal monitoring report	Supervision company	IA	Monthly
External Environmental monitoring report	Environmental monitoring agency	IA, AIIB	Semi-annual
B. Operation period			
External Environmental monitoring report	Environmental monitoring agency	IA, AIIB	Semi-annual

The environmental monitoring plan during construction and operation periods are shown in Table 59.

Table 59 Environmental Monitoring Schedule in Construction and Operation Periods

Stage	Monitoring object	Monitoring items	Monitoring frequency	Monitoring points	Monitoring agency	Applicable standards
Construction period	Marine water quality	Water temperature, salinity, pH value, dissolved oxygen (DO), chemical oxygen demand (COD), inorganic nitrogen (nitrite, nitrate, ammonia, active phosphate, and silicate) , SS, Oil, totally 12 elements	1 time / quarter, 2 days / time, 1 time / day	Area for construction, the adjacent sea area extending 3km outward to sea, totally 8 stations	Qualified agencies	Sea Water Quality Standards （GB3097-1997）
	Marine sediment.	Totally 17 items, respectively: particle size, soil salinity, organic carbon, sulfides, total nitrogen, total phosphorus, oils, heavy metals (Hg, Cd, Ld, Zn, Cu, Cr, As), polychlorinated biphenyls, hexachlorocyclohexane, and DDT.	1 time / quarter, 2 days / time, 1 time / day	Area for construction, the adjacent sea area extending 3km outward to sea, totally 4 stations	Qualified agencies	Marine Sediment Quality （GB18668-2002）
	Benthic organisms of inter-tidal flats	Group composition, density, biomass	1 time / quarter, 2 days / time, 1 time / day	Area for construction, the adjacent sea area extending 3km outward to sea, totally 5 stations	Qualified agencies	/
	Noise	Leq (A)	1 time / quarter, 2 days / time, 2 times / day, respectively in daytime and nighttime.	One sensitive point is designated within a 200-meter radius around the construction area.	Qualified agencies	Standards outlined in the Emission Standard for Noise of Construction Site at Boundary (GB 12523-2011)
Operation Period	Mangrove communities	Species composition, canopy coverage, plant density, tree height, diameter at breast height (DBH), basal diameter, crown width, and seedling density.	1 time / quarter, 1 days / time, 1 time / day	Totally 32 designated stations in the mangrove restoration area, 1 site plot with 1 station.	Qualified monitoring agencies	/

Stage	Monitoring object	Monitoring items	Monitoring frequency	Monitoring points	Monitoring agency	Applicable standards
	Benthic communities of mangroves	Group composition, density, biomass	1 time / quarter, 1 days / time, 1 time / day	Totally 32 designated stations in the mangrove restoration area, 1 site plot with 1 station.	Qualified monitoring agencies	/

10.3.2 Social monitoring

Monitoring and evaluation are crucial steps to ensure that this project is implemented according to its objectives, to ensure transparency of project information, public participation, and the implementation of the social management action plan proposed in the social impact assessment report. It serves as an important mechanism for correction and participation in the proposed project. To this end, the proposed project establish a real-time supervising and evaluation mechanism, including internal and external monitoring and evaluation.

The internal supervision shall be conducted by the IA on the project progress, implementation of social management action plan, information disclosure, public participation, funds utilization, compliance with laws and regulations etc.

The external independent monitoring and evaluation will be conducted by an independent monitoring agency hired by the PMO and approved by AIIB, and with ten years or above of experience in social and resettlement monitoring and evaluation for projects financed by international financial organizations such as the AIIB, World Bank, and ADB. The independent monitoring and evaluation agency will regularly track, monitor, and evaluate the implementation activities of the social management action plan, and provide consultation opinions. They will submit monitoring and evaluation reports to AIIB.

10.4 Reporting

The IA will retain records of all stakeholders' participation, information disclosure, complaints, appeals, and resolutions. These records will be reported to the PMO through daily monitoring and reporting mechanisms. The PMO will

incorporate the implementation of SEP into the real-time monitoring in construction period, and also into the semi-annual environmental and social performance monitoring and reports.

10.5 Institutional capacity building and trainings

During the implementation of this project, the PMO will invite specialists to provide initial training on the ESMP implementation for the IA's environmental and social commissioners, contractors, supervision units, and Ia's staff. The training content will cover the AIIB's ESP, good management practices during construction, monitoring and reporting, GRM , etc. The indicative training plan is shown in in Table 60. Adjustments will be made during the implementation process based on the capabilities and needs of each participating party.

Table 60 Indicative Training Plan

Subject of training	**Training Contents**	**Participants**	**Frequency and timing**
AIIB's environmental and social policies, requirements of ESMP of the project.	AIIB's environmental and social policies; ESMP of the project; preparation of site ESMP; site environmental management; labors management; prevention of gender-related violence; good practices etc.	PMO, IA, contractors, construction supervisor	From the beginning of project implementation
Strengthening ESMP	The process of implementing and monitoring of the ESMP; determine whether to update and adopt further measures based on the results of performance assessment.	PMO, IA, contractors, construction supervisor	If necessary, increase the frequency of monitoring and supervision halfway through the project implementation.
Information disclosure, GRM	Personnel, responsibilities and process of the GRM; requirements of on-site information disclosure	PMO, IA, contractors, construction supervisor	Upon commencement of project implementation, and one year after.
Environmental, health, and	Best practices and approaches for noise management; wastewater and waste	Relevant operation personnel of IA.	The first year upon operation

safety	management; occupational health and safety.		
Emergency response and exercises	Organize emergency response drills for firefighting, natural disasters, and other emergencies.		Incorporate them into the routine training plan after implementation.

10.6 Cost estimates

The total cost of implementing and managing environmental and social mitigation measures for the project is CNY 3.08 million, including: (i) Measures during the construction period, such as safety and civilized construction, including road watering, material transportation covering, traffic signs, labor occupational health and safety measures, totaling CNY 1.68 million, borne by the contractor (as part of the construction contract); (ii) Environmental and social monitoring costs, CNY 1.0 million; (iii) Capacity building and training costs, CNY 200,000. The costs required by the routine maintenance during operation period will be borne by the operating unit. (iv) Costs for the public participation, implementation mobilization and GRM operation, CNY 200,000.

11 Stakeholder information disclosure and engagement plan

11.1. Objectives of stakeholder engagement and information disclosure

According to the requirements outlined in AIIB's ESF, the ESS1– Environmental and Social Assessment and Management, and the MOU of the AIIB's Mission. This subproject is classified as an "Category A" project for Environmental and Social safeguards. Based on the AIIB's requirements for public consultation, information disclosure and stakeholder engagement for investment projects, stakeholder engagement is an inclusive process that spans the project lifecycle. The primary objectives of stakeholder engagement include, but not limited to:

(1) Establishing systematic stakeholder engagement methods to assist the project implementing agencies in identifying stakeholders, and establishing and maintaining constructive relationships with them, especially those affected by the project.

(2) Informing stakeholders about the project, including its purpose, nature, scale, duration of project activities, and any potential project-related impacts and mitigation plans.

(3) Identifying issues, needs, complaints, and grievances of stakeholders and considering stakeholders' opinions in project design and environmental and social management.

(4) Obtaining feedback from stakeholders on project impacts, particularly environmental and social impacts, and mitigation measures.

(5) Providing feedback to the community on the handling of complaints and grievances.

(6) Fully considering stakeholders' preferences in project decision-making and implementation processes, and avoiding and resolving potential conflicts.

11.2 Identification of stakeholders

Stakeholders refer to the individuals or groups who may affect or benefit from the realization of the project's objectives or who may be affected by the realization of the project's objectives. The stakeholders can be divided into the main

stakeholders and secondary stakeholders. Based on the nature of the project, on-site investigations, and interviews with relevant institutions, the direct beneficiaries and groups negatively affected by the project construction can be identified.

11.1.1 Direct stakeholders

The direct beneficiaries and groups negatively affected by the project construction mainly include: (i) Project construction employees: laborers engaged in mangrove restoration and Spartina alterniflora clearing; (ii) Residents directly affected by the project construction: Shandong Village and Qixing Village in Shagang Town, Mu'an Village, Yujiang Village, Shachong Village, Shayong Village, Matou Village in Dangjiang Town, and Ma'an Village and Yanlou Village in Lianzhou Town; (iii) Surrounding residents in the project area: residents and tourists within the scope of Dangjiang Town, Shagang Town, and Lianzhou Town in Hepu County.

(1) Direct beneficiaries of the project area.

The direct beneficiaries of the project are the residents within the scope of Dangjiang Town, Shagang Town, and Lianzhou Town in Hepu County. This mainly includes residents within the project area, women, vulnerable groups, employees of enterprises and institutions, and the floating population. The project implementation will directly benefit approximately 64,000 people locally, including approximately 26,000 women, accounting for approximately 40.62% of the population, and approximately 389 vulnerable individuals, accounting for approximately 0.61%.

(2) Tourists.

In addition to the residents of the project area, Beihai City is also a famous coastal tourist city. In 2022, the city received a total of 34.0284 million domestic tourists throughout the year, of which 15.6241 million tourists visited Haicheng District, and Hepu County received 9.6491 million tourists in 2023. Among them, mangrove tourism has great potential for future development.

(3) Groups negatively affected by the project construction.

This includes a group of people whose normal production and livelihood are negatively affected by factors such as project construction and land acquisition. They mainly consist of residents affected by permanent land acquisition, including vulnerable groups within the project area, such as some low-income individuals and women. According to the survey on the resettlement impact, it was found that the project does not involve land acquisition or housing demolition.

The social impacts faced by direct stakeholders are shown in the following table.

Table 61 Analysis of the Social Impacts on Direct Stakeholders

Type of social impacts	**Contents of social impacts**
Social benefits	(1) Good job opportunities； (2) Improve ecological farming conditions to increase residents' income; (3) Drive the development of related industries such as tourism; (4) Enhance public environmental awareness and scientific literacy.
Social risks	(1) Occupational health risks **The mangrove forest is located in a subtropical coastal area characterized by high temperatures and humidity, which poses certain physical labor and machinery operation risks during afforestation and restoration projects.** ①Environmental risks during operations. During construction, the hot and humid environment may lead to heatstroke among construction workers, fatigue-induced accidents such as getting stuck in mud or drowning; machinery operation risks; .② During construction, the use of heavy machinery such as excavators and forklifts may result in personal injuries if operated improperly or if equipment malfunctions; insect and animal infestations.③ The construction area may be inhabited by mosquitoes, snakes, and other wildlife, posing potential threats to the health of construction workers. (2) Community security risks. ①Tense relationship with the community. The construction may have certain impacts on the local environment, transportation, etc., which could lead to dissatisfaction and protests from the community residents. **Mishandling of these issues could result in tense community relations and even conflicts；② Cultural conflicts and integration issues. Cultural differences may lead**

	to communication barriers, misunderstandings, and conflicts； ③ **risk of spreading infectious diseases.** Increased interaction between migrant workers and local residents can lead to the transmission of infectious or communicable diseases; ④ there is also a risk of traffic accidents; During construction operations, the movement of transportation and machinery vehicles may damage existing roads in the community and pose a risk of traffic accidents in villages due to the lack of proper traffic signs. (3) Labor-management relations and employment risks. ① Labor contract disputes. **If labor contracts are signed improperly or contain ambiguous terms, it may lead to disputes between employees and employers;** ② **Wage arrears. Due to issues with cash flow or poor management, employers may face difficulties in paying employees' wages on time;** ③**Legality of employment risks.** During the construction period, there may be a shortage of local labor, leading to issues such as hiring child labor, gender discrimination, forced labor, and other illegal employment practices.

11.1.2 Secondary stakeholders

Secondary stakeholder of the project includes: PMO, IA, Government and its competent departments. Specifically: PMO, IA; Hepu Oceanic Bureau, Bureau of Natural Resources and Planning, Comprehensive Law Enforcement Bureau, Transportation Bureau, Emergency Management Bureau, Health and Health Committee, Human Resources and Social Security Bureau, Disabled Persons' Federation, Women's Federation, sub-district office, town governments; design institutes (FSR / EIA agency), supervision unit, contractors, media etc.

(1) AIIB Having the abundant expertise and influence, capable of assisting the PMO in designing and implementing the project, with significant impact on the project.

(2) Project Leading Group (Beihai Municipal Government) The main responsibilities include: making decisions related to the Project, approving the overall project plan and implementation schedule, providing policy guidance, coordinating the resolution of project-related issues, and guiding and supervising the implementation of the project. Relevant key departments representing the

government will actively participate in project implementation.

(3) PMO Responsible for overall organization, guidance, coordination, management, and supervision of projects utilizing loans from AIIB across the city.

(4) IA Specifically responsible for organizing project implementation and daily management work, dedicated to contributing to the government's ecological, social, and economic development goals.

Table 62 details the impact of these major stakeholders on the project and the project's impact on them.

Table 62 Analysis of the Impacts on Main Stakeholders

Main Stakeholders	Impacts on the project	Impacts caused by the project	Priority
AIIB	Substantial	Low	Yes
Beihai Municipal Government	Substantial	Low	Yes
Government departs of project area	Substantial	Substantial	Yes
Implementation Unit of subproject (SOE)	Moderate	Substantial	Yes
Beneficial	Low	Low	Yes

11.3 Summary of stakeholders' demand

Based on the different roles of various stakeholders in this Subproject, environmental and social impact assessments were conducted using methods such as focus group discussions, key informant interviews, and questionnaires. The preliminary identification of the needs of different stakeholders in this subproject has been made, along with their requirements for project information disclosure and consultation at different stages of project implementation.

11.3.1 Needs of village residents near the mangrove conservation area

(i) Understanding the social benefits of mangroves. Villagers hope to gain a deeper understanding of the ecological and social benefits of mangroves. The establishment of the mangrove conservation area has imposed certain restrictions on traditional livelihood activities in surrounding villages, such as prohibiting activities like duck and pig farming within the mangrove area. While residents comply with

the regulations for mangrove protection, they still have doubts about the relationship between aquaculture activities in the mangrove conservation area, buffer zones, and the mangroves themselves. There is a lack of understanding of the social benefits of mangroves among residents.

(ii) Ensuring local employment opportunities. Mangrove planting work is mainly organized through bidding processes by the mangrove conservation entities, while the labor recruitment is often done by contractors from outside the local area. In most cases, this does not provide employment opportunities for local residents. Residents hope that during the project construction, there will be more opportunities for local employment.

(iii) Safeguarding the labor rights of female workers. There are social gender disparities in the local labor market, mainly reflected in the nature of work and remuneration. Most of the work available to women involves simple physical labor, such as mangrove planting and fertilization, with harsh working conditions and lower pay compared to male counterparts. Female respondents express their desires for equal pay for equal work, as well the desires for the protection of their occupational health and safety.

(iv) Ensuring job opportunities for vulnerable groups. Elderly people, persons with disabilities, and other vulnerable groups have traditionally relied on nearshore fishing and aquaculture for their livelihoods. Due to age or physical limitations, they find it challenging to make transition to other livelihood activities and thus need more job opportunities during project implementation.

(v) Minimizing the impact of construction on community livelihoods. The mangrove restoration and Spartina alterniflora clearing require the use of transportation vehicles. Since most areas require access through village roads, the concentrated stage of construction will impact the daily lives and traffic convenience of villagers. Residents hope to minimize the impact of construction activities on noise, dust, and traffic convenience during the construction period.

(vi) Understanding of project information and feedback channels.

Residents in the project area primarily depend on government departments (including community committees/village committees) for project information and to provide feedback. They have limited awareness of the information disclosure channels of AIIB and other domestic organizations. Hence, they desire multiple avenues for accessing information and lodging complaints.

11.3.2 Analysis of tourists needs

(i) Information access. Tourists wish to acquire more knowledge about mangroves, including their ecological functions, restoration processes, and post-restoration effects. Therefore, it is essential to provide adequate information displays and interpretation services to satisfy tourists' curiosity.

(ii) Participatory experience. Tourists desire to actively participate in the mangrove restoration process, engaging in activities such as planting mangroves and monitoring the ecosystem.

(iii) Leisure and entertainment. In addition to environmental education, tourists also seek leisure and entertainment during their visit, such as observation decks, walking trails, and areas for relaxation and scenic viewing. They also wish to experience activities like clam digging during low tide.

11.4 Stakeholders consultation and public participation

The current assessment adheres to the AIIB's ESF for public consultation and information disclosure requirements, as well as the requirements of stakeholder engagement plan. Additionally, it follows domestic regulations regarding public participation. Specific domestic policy requirements are outlined in Chapter 3 of this report— "Policy, Legal, and Administrative Framework."

11.4.1 Objectives of public participation and information disclosure

Public participation in ESIA aims to enhance the quality of these assessments by providing more information and suggestions. It aims to democratize and involve

the public in the assessment of environmental and social impacts of construction projects, ensuring transparency and credibility in decision-making processes. It allows individuals directly or indirectly affected by the project to participate in the assessment, ensuring transparency and credibility in decision-making processes.

Public participation allows individuals to express their opinions and views, ultimately leading to more comprehensive and fair assessments. Public participation is an integral part of ESIA process, and serves as an effective means to improve scientific decision-making. It facilitates two-way communication between the public with the ESIA agencies and the IA. Through extensive public participation, members of the public who may be directly or indirectly affected by the project can fully understand the potential environmental and social impacts, mitigation measures, as well as the economic and social benefits of the project. They can also provide feedback, suggestions, and ideas to actively contribute to the project, collectively find solutions to problems, minimize the project's environmental and social impacts, and avoid disputes during construction and operation. Ultimately, it helps to harmonize development with environmental protection. The main purposes of public participation include:

(1) Integrating public opinions and implementing them in environmental protection and social management measures. Public opinions should also be used as guidelines for future project construction.

(2) Facilitating two-way communication between the public and the IA by providing detailed information to the public about project overviews, pollution situations, mitigating measures, and the predicted ESIA results. Feedback from the public, such as opinions and suggestions, should be communicated to the IA for consideration and adjustment, serving as a bridge for mutual understanding between the public and the IA.

(3) Obtaining various opinions and suggestions from the public through their participation, which serve as a basis for safeguarding the public's interests. Feasible

suggestions should be fully adopted during the ESIA process to reduce public worries arising from the lack of communication between stakeholders. Efforts should be made to minimize adverse impacts on public interests and ensure necessary compensation.

(4) The evaluation conducted after environmental and social impact assessments will substantially rely on the function of public supervision and the active public participation, constituting an essential part of the environmental and social management mechanism. Such will help protect the ecological environment, enhance environmental and socioeconomic benefits of projects, improve environmental quality, and ensure the implementation of sustainable development strategies.

11.4.2 Information disclosure activities to be completed during the preparatory period

During the project preparation stage, a series of information disclosure an d public disclosure activities were carried out by the Beihai Municipal Gover nment, Beihai DRC, PMO, IA, Haicheng District Government, Hepu County Government, Dangjiang Town Government, Lianzhou Town Government, Shag ang Town Government, and other relevant government departments. The publi cly disclosed information in the project area includes:

(1) Public announcement of the project identification information;

(2) Environmental Impact Assessment Report of the project;

(3) Social stability risk analysis and assessment report of the project;

(4) The environmental and social documents of the project include: ESIA report (including the environmental,social and gender action plans) etc.

The completed and upcoming information disclosure information are shown in Table 63 below.

Time	Leading party	Stakeholders / participants	General contents	Means
September 2022	NDRC, MOF	Guangxi DRC, Guangxi DOF, Beihai DRC, Beihai Finance Bureau, IA	The Project was enlisted in the plan of candidate projects in China for utilizing AIIB loans during 2022~ 2024, with loan amount of US Dollar 300 million.	**Government website of Guangxi Zhuang Autonomous Region** : http://www.gxzf.gov.cn/html/gxyw/t13124652.shtml
November 19 ~ 24 , 2022	PMO	AIIB, Guangxi DRC, Guangxi DOF, Beihai DRC, Beihai Finance Bureau, IA	AIIB Mission conducted site inspection and organize meetings.	Website of Guangxi DRC: http://fgw.gxzf.gov.cn/fzgggz/lywz/t14100633.shtml
July 26, 2023.	IA	Governments, enterprise and institutions, the public	**Disclosure of Project Social Stability Risk Investigation.**	**Website of Beihai Municipal Government**:http://www.beihai.gov.cn/xxgkbm/bhsrmzfgyzcjdglwyh/tzgg_62/t16842655.shtml
February 2023 – May 2024	IA	AIIB, Beihai Ecology and Environment Bureau, Oceanic Bureau, EIA consultant, community residents etc.	Fill out the environmental impact registration form.	The Project is required to fill out the environmental impact registration form. According to Guideline on Public Participation in EIA (Decree No.16, Ministry of Ecology and Environment, promulgated on January 1, 2021), it is not required to disclose t

				o the public.
February 2023 – May 2024	IA	AIIB, PMO, government departments of Haicheng District and Hepu County, EIA consultant, community residents etc.	(4) ESIA report (including the environmental,social and gender action plans)	Reports under preparation, and will be disclosed on the websites of Beihai Municipal Government / AIIB.

Table 63 Status of Project Information Disclosure

11.4.3 Consultation activities completed during the preparatory period

During the project preparation stage, the environmental and social team s trictly adhered to the AIIB's ESF for public consultation and information disc losure requirements, as well as the stakeholder engagement plan. Additionally, they followed domestic regulations regarding public participation. They condu cted a social impact assessment for the project and engaged in extensive publ ic participation and consultation, thereby preliminarily identifying the project's stakeholders. Subsequently, based on the preliminary identification of stakehol ders, a series of seminars and interviews with key informants were organized with the support of the PMO and relevant departments.

(1) Institutions and personnel participating in seminars and interview s.

(1) Government agencies of Beihai City and Hepu County, including the Women's Federation, Civil Affairs Bureau, Religious Affairs Bureau, Marine B ureau, Natural Resources Bureau, and relevant staff members;

(2) Government offices of Dangjiang Town, Shagang Town, and Lianzho u Town in Hepu County, and relevant staff members;

(3) Officials such as CCP secretaries, village directors, and women's dire ctors from villages affected by the project;

(4) Residents of affected communities and villages in the project area. In cluding Qixing Village in Shagang Town, Mu'an Village, Yujiang Village, Sha chong Village, Matou Village in Dangjiang Town, and Ma'an Village and Yanl ou Village in Lianzhou Town.

2. Process of public participation activities

(1) Introduce the objectives and the construction components of the Proje ct (subproject: Blue Carbon Sink Actions);

(2) Introduce the purposes of the study on project environmental and social impacts, public participation, and the AIIB's requirements regarding public participation and its environmental and social policies;

(3) Communicate with relevant government departments, subdistrict, community offices, villages, etc., to obtain social baseline data and information;

(4) Solicit the concerns, opinions, and suggestions of the stakeholders regarding the project construction.

3. Main results of public participation

(1) Participants from various stakeholders expressed their consent of the project and supported the concept and implementation of mangrove restoration components.

(2) Meaningful consultations with various stakeholders are essential during the project preparation stage. Based on the results and findings of these consultations, the design of the project should be optimized to minimize impacts on surrounding communities as much as possible. Throughout the project lifecycle, particular attention should be paid to inclusive arrangements for vulnerable groups, such as low-income groups and women.

(3) The entire sub-project does not involve land requisition or resettlement issues. The mangrove restoration does not involve permanent land acquisition or temporary land use. The stems of the Spartina alterniflora will be buried together in the mechanical cleaning area without additional land occupation.

(4) Regarding the potential noise pollution caused by the Spartina alterniflora clearing, villagers in the project area believe that the noise generated on the beach will not have a significant impact due to the open space and relatively short construction period.

(5) Concerning the potential human interference during the mangrove restoration, the return of encroached nurseries may lead to some dissatisfaction among villagers. However, the human interference and encroachment in the

mangrove area violate the relevant provisions of the Guangxi Mangrove Resource Protection Regulations, constituting illegal behavior. (6) Due to the stringent legal provisions govering mangrove protection, the public has generally developed a certain awareness and consciousness of mangrove conservation. Even if there are very few instances of human interference and encroachment, they are usually corrected promptly after persuasion by relevant departments.

(6) Mangrove afforestation and restoration components require the employment of a large number of temporary workers. Local villagers think that these job opportunities as mostly temporary, while the routine maintenance work will be generally not accessible to villagers. There is also a gender disparity in local employment, with women predominantly engaged in mangrove planting work while men undertake driving and managerial tasks. Female workers interviewed expressed a desire for better job opportunities and renumeration.

(7) The establishment of mangrove protection areas has imposed restrictions on shallow-sea fishing and aquaculture activities, which have had a certain impact on the traditional livelihood activities of local villagers. Due to the decline in aquaculture profits in recent years, there has been a significant reduction in nearshore aquaculture activities, with residents relying more on wage labor for income. However, this impact is more pronounced among elderly individuals, women, and disabled individuals who lack the skills and conditions for out-of-home employment. (8) The expansion of mangrove areas has to some extent restricted the livelihood activities of local residents and affected the convenience of their livelihood activities. They hope the government can provide a more humane management system.

(8) GRM mechanism is effective. Residents can provide feedback through residents' groups, communities, and village committees. Additionally, when residents encounter project-related issues, they can directly report them to local community cadres, as well as community, subdistrict, and town governments.

Relevant departments such as street and town governments will then take necessary actions for the corresponding solutions.

11.5 Objectives of stakeholder engagement plan

11.5.1 Purpose and timeline of stakeholder engagement plan

This Plan is developed based on stakeholder analysis, particularly the analysis of stakeholder engagement needs. Consultation activities with different stakeholders are conducted at three stages: project preparation, implementation, and operation. According to the analysis, during the project implementation and operation stages, the participation needs of various stakeholders are generally consistent. The purpose of the project stakeholder engagement plan is:

(i) To regularly consult with key stakeholder organizations to inform them about the project's purpose, design, content, and activities.

(ii) To establish transparent communication mechanisms to ensure that stakeholders' needs and requirements are met.

During the project preparation stage (or feasibility study stage), the environmental and social consultants conducted an environmental and social impact assessment survey of the project, and also conducted extensive public consultations and participation. Feedback from stakeholders will be considered in the project design.

During the project implementation and operation stages, the PMO, in conjunction with the IA, will quarterly publish project progress information, environmental and social performance information, etc., on government websites for public access. Additionally, at least on semi-annual basis, stakeholder consultation activities will be held in the subdistrict offices of the project area to communicate with the public on project goals, implementation information, environmental and social impacts, and the measures taken. etc. Relevant information regarding project progress and achievements will be disseminated, and public concerns and questions will be addressed.

11.2.2 Strategies of stakeholder engagement plan

The information to be disclosed and the methods of disclosure need to be tailored according to the different stages of the project. The project should timely release environmental and social information in locations accessible to affected parties and other stakeholders, using language that they can understand. This will enable stakeholders to provide comprehensive feedback on project design and implementation.

The methods of information disclosure mainly include:

(1) Government websites

(2) Street bulletin boards

(3) Community bulletin boards

(4) Mobile apps or public WeChat accounts

During stakeholder engagement, the PMO and IA will adopt the following strategies: (i) Initiate stakeholder engagement early and maintain it throughout the entire project cycle; (ii) Foster cooperation among various government departments; (iii) Timely disclose project and environmental and social information; (iv) Establish cooperative relationships with communities; (v) Monitor the relationship between contractors and communities; (vi) Promptly and appropriately address complaints and appeals from stakeholders, while stakeholder engagement is a two-way process that will continue throughout the entire project cycle.

The overall principles of stakeholder engagement are as follows: (i) Gather initial feedback from stakeholders regarding the proposed project at the early stages of project planning and integrate it into project design; (ii) Encourage stakeholders to provide feedback, particularly as a means of negotiating and addressing environmental and social risks and impacts, and respond to the feedback accordingly.

11.5.3 Proposed stakeholder engagement plan

Based on the activities and characteristics of the project and stakeholder identification, the proposed stakeholder engagement plan is outlined in Table 64. The stakeholder engagement plan is a living document which will be subject to updates by the PMO and IA throughout the project cycle. The PMO and IA must maintain comprehensive records of all publicly disclosed information.

Table 64 Proposed Stakeholder Engagement Plan

Stage	Disclosure information	Means of disclosure	Location / time	Targeted stakeholders	Responsible agencies
Preparation stage	Project information (including objectives, nature, scope and duration)	Internet, bulletin board, discussion meeting	Government website, street bulletin board, community bulletin board, project area bulletin board May 2024	Municipal / district / county government agencies, community residents, consulting and design institute.	Persons in-charge of PMO, subdistrict, community
	The construction schedule of this subproject, the promotion and popularization of the "Blue Carbon Initiative" concept.	Internet, bulletin Workshops, training materials, pocket guides, and promotional brochures.	Street bulletin board, community bulletin board, project area bulletin board May - October 2024	Community residents	Persons in-charge of IA, subdistrict, community
	The environmental and social documents include: ESIA report (including the environmental,social and gender action plans)	Internet, bulletin Discussion meeting	AIIB's website, community bulletin board, project area bulletin board May - June 2024	Beihai DRC, AIIB Community residents, consulting and design institute.	PMO, IA
	Disclosure of results of stakeholders consultation	Internet, bulletin board, discussion meeting, household communication.	Government website, community bulletin board May - June 2024	Community residents, enterprises, institutions, consulting and design institute.	Responsible persons of PMO, IA, Subdistrict, community.
Construction	Project information	Internet,	Government	Beihai DRC,	Designated

and operation stages	(including project approval information, significant design change information, bidding and tendering information, construction-related information, quality and safety supervision information, etc.)	bulletin board, discussion meeting	website, street bulletin board, community bulletin board, contractor's site office. June - October 2024	subdistrict, community residents, contractors, consulting and design institute	environmental and social person in-charge of PMO, IA, contractor, Subdistrict, community.
	Community safety, worker working conditions and occupational health policies, work procedures, personal protective facilities, etc.	Internet, bulletin board, discussion meeting, household communication.	Government website, street bulletin board, community bulletin board, contractor's site office. June - October 2024	Persons in-charge of contractor, subdistrict, community.	Persons in-charge of contractor, subdistrict, community.
	Disclosure of noise monitoring results for affected communities during operation stage.	Internet, bulletin board, discussion meeting	Community bulletin board, project area bulletin board. June - December, 2024	Community residents, contractors, EIA agency.	Responsible persons of subdistrict, community.
	Lectures on road traffic safety, HIV prevention, and sexual violence awareness.	Knowledge share lectures	Contractor's site office, community office August 2024	Community residents, construction workers	Responsible persons of IA, contractors, subdistrict, community.
	GRM of the project	Internet, bulletin Discussion meeting	Government website, project Area bulletin board, community bulletin board, contractor's site office.	Beihai DRC, subdistrict office, community, IA, contractor site office	Responsible persons of IA, contractors, subdistrict, community.

			June - October 2024		
	Monitoring Report	Internet Discussion meeting	Government website June - October 2024	Beihai DRC, IA, AIIB	PMO, IA
	Disclosure of results of stakeholders consultation	Internet, bulletin board, discussion meeting, household communication.	Government website, project area bulletin board, community bulletin board. June - October 2024	Community residents, enterprises, institutions, consulting and design institute, construction workers etc.	IA, subdistrict, community, enterprises, institutions, contractors.

11.5.4 Resources and responsibilities for conducting stakeholder engagement activities

This information disclosure plan is dynamic which is and subject to updates by the PMO and IA throughout the project cycle. The PMO and IA must maintain comprehensive records of all publicly disclosed information. Figure 2 provides the template for recording information disclosure.

1. Project Leading Group

The Project Leading Group (PLG) serves as the highest leadership body for the Project. It is chaired by a leading official appointed by the Beihai Municipal Government, with the member representatives from relevant government departments such as the Beihai Urban Development Investment Group Co., Ltd., Beihai Oceanic Administration, Water Resources Bureau, Forestry Bureau, Urban Management Bureau, Natural Resources Bureau, Ecological Environment Bureau, Transportation Bureau, and Hepu County.

The specific responsibilities include: Provide policy guidance for project implementation, coordinate and support project implementation at the municipal level.

2. PMO

Under the PLG, the Project Management Office (PMO) is responsible for the daily operations of the PLG. The PMO is set within the Beihai Development and Reform Commission and is responsible for overseeing the overall planning of the project and providing management guidance. The specific responsibilities include:

(1) Follow the AIIB's policy guidance to carry out the SEP and report relevant information to the AIIB.

(2) Coordinate with government agencies at all levels and relevant functional departments to assist in information disclosure for stakeholders and implementing SEP.

(iii) Conduct pre-review of the SEP submitted by the IA and submit it for approval by the AIIB and the Municipal Government.

(iv) Monitor the SEP implementation progress and report to the AIIB.

(v) Carry out the internal monitoring within the project.

3. IA

Beihai Urban Development and Investment Group Co. Ltd. is the project

implementing agency (IA) of the Project. Under the guidance of the PMO, the IA shall be responsible for:

(1)Implementing and executing major decisions made by the PLG regarding the project.

(2) Providing specific organization, management, coordination, supervision, and guidance of the overall project.

(3) Regularly reporting project progress to the PMO, AIIB and other relevant entities.

(4) Developing stakeholders participation plan and coordinating the implementation progress of the plan.

(5) Handling the complaints and appeals during project implementation and operation.

(6) Cooperating with external monitoring agencies.

(7) Collecting and organizing various data required for internal monitoring reports within the project.

11.6 Monitoring and reporting of SEP

11.6.1 Stakeholder engagement in supervising activities

The IA will retain records of all stakeholders' participation, information disclosure, complaints, appeals, and resolutions. These records will be reported to the PMO through daily monitoring and reporting mechanisms. The PMO will incorporate the implementation of Stakeholders Participation Plan into the real-time monitoring, and also into the semi-annual environmental and social performance monitoring and reports. The indicative indicators for stakeholder engagement in implementation monitoring and related responsible agencies are shown in Table 65.

Table 65 Indicative Indicators for Stakeholder Engagement in Implementation of Monitoring

Sl.	Indicators	Unit	Frequency	Responsible agencies
1	Number of times of public participation in preparation stage	Number of times	Real-time monitoring/ Semi-annual reporting	PMO, IA

2	Number of times of public participation during project construction and/or operation periods	Number of times	Real-time monitoring/ Semi-annual reporting	PMO, IA
3	Number of participants in the public participation activities.	Number of persons	Real-time monitoring/ Semi-annual reporting	PMO, IA
3.1	Including numbers of women	Number of persons	Real-time monitoring/ Semi-annual reporting	PMO, IA
3.2	Number of vulnerable groups	Number of persons	Real-time monitoring/ Semi-annual reporting	PMO, IA
4	Number of feedback received	Number	Real-time monitoring/ Semi-annual reporting	PMO, IA
5	Number of complaints received	Number	Real-time monitoring/ Semi-annual reporting	PMO, IA
6	Number of complaints resolved	Number	Real-time monitoring/ Semi-annual reporting	PMO, IA

11.6.2 Feedback to stakeholder groups

The results of stakeholder engagement activities for the Project will be communicated to the affected stakeholders, or even to a wider audience of stakeholders in accordance with the information disclosure strategies outlined above. Throughout the project lifecycle, the PMO and the IA will ensure the effective operation of GRM to facilitate timely communication with stakeholders and provide feedback on their concerns.

12. Grievance Redressing Mechanism

12.1 Grievance redressing mechanism arrangements

Throughout the preparation, construction and operation stages of the subproject, in order to promptly understand and address the impacts and issues brought to stakeholders by the subproject, and to ensure residents' demand for information disclosure and broad community participation as much as possible, a project-level grievances redressing mechanism will be established, taking into account the current situation of residents' complaints in the project area. All complaint records and resolutions arising from them will be documented and reported to AIIB through the semi-annual environmental and social monitoring report.

The GRM of the project mainly is divided into two types:

(i) a project-level grievance redressing mechanism, providing a channel for affected residents, social groups, and entities operating in the project area to file complaints during the project implementation and operation;

(ii) a worker-level grievance redressing mechanism, including direct workers, contract workers, and project staff, providing a channel for them to lodge complaints.

12.1.1 Establishment of GRM for affected persons

The GRM addresses complaints primarily related to the impacts caused by the project, such as dust generated by construction activities,

construction noise, improper disposal of construction waste, safety measures for protecting the public and construction workers, and solid waste generated during operations. Currently, residents mainly report issues through the 12345 government service hotline. The improved GRM this project complies with the regulatory standards of the People's Republic of China, which protect citizens' rights from environmental and social impacts associated with construction. According to the Regulations on Letters and Visits (No. 431) issued by the State Council of the People's Republic of China in 2005, complaint handling mechanisms at all levels of

government are established, and protections are provided against retaliation. In accordance with these regulations, the Ministry of Ecology and Environment issued the Measures for Environmental Petitions and Visits (Decree No. 15) in December 2010.

The entities relevant to the GRM include the IA, the PMO and IA, of which, the relevant personnel shall be responsible for its operation. Upon receiving a complaint, the responsible person from the PMO should first verify whether such complaint is related to the project. If the complain is related to the project, regardless of whether it concerns environmental or social issues, the responsible person should initiate coordination to address the complaint. If the complaint is unrelated to the project, the responsible person should represent the appellant and submit the appeal to the relevant competent authority. All appeals and complaints should be documented, and the entire process of handling should be communicated to relevant personnel. The basic steps and timeframe of the GRM operation are as follows:

Stage 1 (5 days): If the appellants are dissatisfied with the project design or have concerns about safety and environmental issues during construction and operation, they can orally or in writing submit the appeal to the community committee or contractor. If it is an oral appeal, the community committee or contractor should make a written record. The village committee or contractor should: (i) immediately request the party being complained to cease relevant activities after confirming the issue (e.g. Noise impacts on nearby residents); (ii) relevant activities cannot be resumed until the complaint is resolved; (iii) promptly inform the IA of the received complaint and the proposed solution; (iv) provide a clear response to the affected parties within two days; (v) endeavor to resolve the issue within five days upon receiving the complaint.

Stage 2 (15 days): If the appellants are dissatisfied with the handling results of the community committee or contractor, they may orally, by phone, or in writing appeal to the subdistrict office or the IA. The IA or the subdistrict office shall: (i)

Retrieve the original appeal records and organize a meeting within five days with key stakeholders (the party being complained and the appellant) to devise a mutually acceptable solution, including key steps to address the issue. (ii) The party being complained shall promptly execute the resolution and resolve the issue within 15 days. All measures and results should be documented.

Stage 3 (15 days): If the appellant is dissatisfied with the handling results of the subdistrict office or the IA, they may orally, by phone, or in writing appeal to the PMO, or directly file a lawsuit with the People's Court after receiving the handling results. The PMO shall organize a stakeholders' consultation meeting within two weeks (the appellant, the party being complained , and relevant competent departments such as the local natural resources and planning bureau, resettlement command headquarters, human resources and social security bureau, women's federation, agriculture and rural affairs bureau, etc.). A solution acceptable to all parties, including clear steps, shall be determined at the meeting. The party being complained shall immediately implement the agreed-upon solution and fully resolve the issue within 15 days. All actions and results at each stage will be documented. At the conclusion of Stage 3, the PMO shall inform the AIIB of the results.

Stage 4: If the appellant remains dissatisfied with the decision above, they may, upon receipt of the decision, file a lawsuit in accordance with the Civil Procedure Law of the People's Republic of China.

12.1.2 Establishment of GRM for workers

The PMO shall establish a dedicated complaints handling center to address complaints raised by workers employed at construction sites against the contractors. These complaints include issues related to wages, overtime pay, timely payment of wages, accommodation problems, or facilities related to drinking water, sanitation, and medical services.

In the management of workers, with the guidance and coordination of the PMO, subdistrict, women's federations, during the construction or operation of the project,

the IA and the contractors should, in accordance with the Law of the People's Republic of China on the Protection of Women's Rights and Interests, the Special Provisions on the Protection of Labor Rights for Female Workers, the Regulations on Health Protection for Female Workers, the Special Labor Protection System for Female Workers in Workplaces (reference), the System for Eliminating Workplace Sexual Harassment (reference) etc., sign labor (employment) contracts with female workers in compliance with the law and implement equal pay for equal work for men and women. Additionally, by leveraging the respective institutional unique characteristics, effective measures such as appointing a dedicated officer responsible for safeguarding women's rights are implemented to prevent and address instances of sexual harassment against female employees in the workplace.

Furthermore, there should be a rapid response mechanism for female workers on-site and women in the project area to file complaints or provide suggestions. If there are instances of female workers being subjected to behaviors such as sexual harassment that jeopardize their personal safety in the workplace, the affected individuals can promptly report or lodge complaints with the employer. The employer should handle the matter promptly and protect the personal privacy of female workers in accordance with the law.

In addition, the AIIB has established a Project-affected People Mechanism (PPM). When project-affected people believe that AIIB projects have failed to implement their Environmental and Social Policy (ESP) and may or have adversely affected them, and their concerns cannot be satisfactorily resolved through the project's GRM or AIIB management mechanisms, the PPM provides an independent and impartial review opportunity. PPM-related information can be accessed on the following link: Policy on the Project-affected People's Mechanism - Operational Policies & Directives - AIIB.

Table 66 Personnel Contact Information

County	Name	Contact Number	Responsibility

Beihai DRC	Huang Min	13907864421	Receive, record and handle complaints and grievances
Beihai Urban Development and Investment Group Co. Ltd	Zhang Kang	17376086686	
Dangjiang Township Government, Hepu County, Beihai	Liao Xiongqing	15907898318	
Liangzhou Township Government, Hepu County, Beihai	Yang Fan	13617894433	
Shagang Township Government, Hepu County, Beihai	Cen Wubo	13367797725	
Shachong village, Dangjiang Town	Mo Chuanlian	17307795857	
Yujiang village, Dangjiang Town	Mo Zuchuan	18107893229	
Mu'an village, Dangjiang Town	Wang Zhenfeng	13878916180	
Matou village, Dangjiang Town	Mo Renjun	13878913039	
Yanlou village, Lianzhou Town	Su Huisan	13517799959	
Qixing village, Shagang Town	Lu Zhuheng	13367896696	

12.2 Record and follow-up feedback for complaints and grievances

During the implementation of the ESMP, all entry points of the GRM must ensure proper registration and management of complaint data and handling results. A written report should be submitted to the PMO on semi-annual basis.

The PMO will conduct regular checks on the registration of complaint handling. To ensure a comprehensive record of complaints from affected populations and the handling of related issues, the PMO has developed a registration form for complaints and appeals from affected populations.

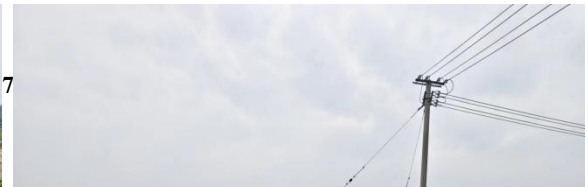
Name of grievant		Accepting unit	
Time		Location	

Contents of grievance			
Problems to be resolved			
Proposed means of settlement			
Result of handling			
Grievant (signature)		Recorder (signature)	
Notes: 1. The recording person shall truthfully record the complaints and demand of the grievant. 2. The whole process of making grievance shall not be hampered or interfered with. 3. The proposed solution to the grievance shall be feedback to the grievant on time.			

Figure 26 Template of Registry Form for Complaints and Grievances

13. Appendices

Appendix A: Field Survey - Current Environmental Conditions of Villages Surrounding the Mangrove Conservation Area



Appendix B: Photos of Stakeholder Consultation

Photo 1: Economic and Social Baseline Survey and Interviews with Key Groups

Photo 2: Discussions with Government Competent Departments

Photo 3: Interviews with Key Informants and Village Focus Groups

Photo 4: In-depth Interviews with Villagers

Appendix C: Completed Public Consultation and Major Findings

Time	Location / Method	Issues (discussion)	Organized by	Participating department, village, group	Number of participants	Number of female participants	Major findings
November 19-24 , 2022	Beihai City / site inspection, discussion meeting	Discussion focus on preliminary work for project preparation, procurement packaging of all subprojects, resettlement and EIA, as well as the work plan for the next steps.	PMO	Guangxi DRC, Guangxi DOF, Beihai DRC, Beihai Finance Bureau, IA, consultants	16 persons	5 persons	Various government departments and industry organizations have expressed support for the project and have undertaken preliminary planning for the specific implementation schemes of the project.
February - July 2023	Beihai City / questionnaire survey, site survey	Household surveys for social and economic baseline assessment and online surveys for project social impact assessment.	Social assessment consultants	Affected residents in Gaode subdistrict, Dangjiang Town, Lianzhou Town, Shagang Town, and Shankou Town.	667 persons	316 persons	(1) Residents' livelihoods mainly rely on the sea, with a predominant characteristic of "relying on the sea for sustenance." The main occupations include shallow-sea fishing, shallow-sea aquaculture, and out-of-town labor work and doing business. The economic development level is relatively high locally. (2) Local residents hope the project can provide employment opportunities and job training. (3) There exists a certain social gender division of labor in local livelihood activities and household management, characterized by a traditional "men working outside, women working inside" .

February, July 2023	Dangjiang Town / discussion meeting, site inspection, key informant interview	Attitudes towards the impacts of project construction.	Social assessment consultants	Cadres of related villages (communities) , villagers' representatives (representatives of women and vulnerable groups)	19 persons	7 persons	(1) Village committees (communities) express unanimous support for the project construction and endorse the concept and practice of mangrove restoration. (2) Believe that the construction and operation of this project will not have a significant impact on the surrounding communities. (3) The negative impacts mainly include poorly-managed construction processes may potentially affect the daily lives of villagers. (4) The main suggestions from village leaders and representatives focus on maintaining environmental hygiene, practicing civilized and safe construction during the construction phase. 5. (5) The expansion of mangrove restoration areas somewhat restricts the livelihood activities of vulnerable groups such as the elderly, women, and disabled individuals. The convenience of engaging in livelihood activities is affected, and they hope the government will provide more humane management.

March, July 2023	Shagang Town meeting, site inspection, key informant interview	Attitudes towards the impacts of project construction.	Social assessment consultants	Cadres of related villages (communities) , mangroves protection institutions, villagers' representatives (representatives of women and vulnerable groups)	9 persons	2 persons	(1) Village committees (communities) express unanimous support for the project construction and endorse the concept and practice of mangrove restoration. (2) Believe that the construction and operation of this project will not have a significant impact on the surrounding communities. (3) The negative impacts mainly include poorly-managed construction processes may potentially affect the daily lives of villagers. (4) The main suggestions from village leaders and representatives focus on maintaining environmental hygiene, practicing civilized and safe construction during the construction phase. (5) Due to the declining profits from aquaculture in recent years, there has been a significant reduction in nearshore aquaculture activities. As a result, residents rely primarily on wage labor for income. The impact of mangrove restoration on residents' income is minimal. (6) Women and men enjoy basic equality in family status, with slight differences in their division of labor. Men typically engage in fishing, while women are involved in selling fish, resulting in a reasonable complementarity between the genders.

March 11, 2023.	Online discussion meeting	Progress and discussions regarding project feasibility study, environmental and social assessment.	PMO	AIIB task manager, environmental and social experts; PMO, IA, FSR institute, environmental and social consultants.	15 persons	5 persons	(1) The environmental and social consultants have completed on-site surveys and baseline investigations. (2) The AIIB's social and environmental specialists have proposed the next steps in the work plan.
March 29, 2023.	Beihai City / discussion meeting	Environmental baseline survey of the project, basic information and policies for groups such as women, low-income communities, persons with disabilities, and ethnic minorities.	PMO	Government competent departments of Beihai City, Haicheng District and Hepu County, including the Ocean Bureau, Civil Affairs Bureau, Women's Federation, Ethnic and Religious Affairs Bureau, Forestry Bureau, Gaode Street Office, and Dangjiang Town Government, Haicheng District, and Hepu County; PMO, IA and environmental and social consultants.	15 persons	4 persons	(1) Collected environmental governance policies and relevant data materials for Haicheng District and Hepu County. (2) Gathered basic information and policies regarding women, disabled individuals, and ethnic minority groups in Haicheng District and Hepu County. Gender equality is generally observed locally, although isolated cases of domestic violence have been reported in rural areas of Hepu County.

April 2024	Phone interview	Management of individual disturbances during the mangrove restoration, noise impact issues caused by Spartina alterniflora clearing component.	Social assessment consultants	The mangrove conservation areas, conservation station, village cadres, and representatives of villagers in Lianzhou Town and Shagang Town.	6	3	(1) Human interference and encroachment on the mangrove reserves violate the relevant regulations of the Guangxi Mangrove Resource Protection Measures, constituting illegal activities. Due to the stringent legal provisions govering mangrove protection, the public has generally developed a certain awareness and consciousness of mangrove conservation. Even if there are very few instances of human interference and encroachment, they are usually corrected promptly after persuasion. More efforts will continue to be made to enhance legal awareness among the public. (2) Residents of Qixing Village in Shagang Town believe that noise generated on the beach, due to the open space and relatively short duration of construction activities, will have minimal impact. Women also hope to get job opportunities in Spartina alterniflora clearing. (3) Villagers of Yanlou Village in Lianzhou Town acknowledge mangrove conservation efforts but hope for a more humane management approach.

Appendix D：Management Measures for Shankou Mangrove Ecological Nature Reserves and Beilun River Estuary National Nature Reserves in Guangxi

广西壮族自治区山口红树林生态自然保护区和北仑河口国家级自然保护区管理办法

（2018 年 1 月 24 日广西壮族自治区人民政府令第 125 号公布 2021 年 3 月 12 日广西壮族自治区人民政府令第 139 号修正 自 2021 年 3 月 12 日起施行）

第一条 为了加强山口红树林生态自然保护区和北仑河口国家级自然保护区的建设和管理，保护红树林生态系统，维护生态平衡，根据《中华人民共和国自然保护区条例》和有关法律、法规，结合本自治区实际，制定本办法。

第二条 在山口红树林生态自然保护区和北仑河口国家级自然保护区范围内从事各项活动的单位和个人，应当遵守本办法。

第三条 山口红树林生态自然保护区位于合浦县东南部的沙田半岛东西两侧，自然保护区海域和陆域总面积为 80 平方公里。具体范围以国家依法批复的界线为准。

北仑河口国家级自然保护区位于防城港市东西沿海地带，四至坐标为东经 108° 02′ ～108° 16′ ，北纬 21° 28′ ～21°

广西壮族自治区人民政府发布

37′，总面积为30平方公里。具体范围以国家依法批复的界线为准。

山口红树林生态自然保护区和北仑河口国家级自然保护区（以下统称保护区）是经国务院批准的国家级自然保护区，保护区的保护对象是红树林生态系统。

第四条 自治区林业主管部门负责保护区的管理工作。

保护区所在市县人民政府应当采取有效措施加强和支持保护区的保护管理。

保护区所在市县公安、林业、农业农村、生态环境、自然资源、水利、文化和旅游、交通运输以及海洋等部门，应当在各自的职责范围内做好保护区的保护工作。

第五条 自治区林业主管部门设立的保护区管理机构具体负责保护区的保护管理工作，其主要职责是：

（一）贯彻执行国家有关保护区的法律、法规和方针、政策；

（二）制定保护区的各项管理制度，统一管理保护区；

（三）调查自然资源并建立档案，组织环境监测，保护保护区内的自然环境和自然资源；

（四）组织或者协助有关部门开展保护区的科学研究工作；

（五）进行保护区的宣传教育；

（六）在不影响保护保护区的自然环境和自然资源的前提下，组织开展参观、旅游等活动。

第六条 任何单位和个人都有保护保护区内自然环境和自然资源的义务，有对破坏、侵占保护区的单位和个人进行检举、控告的权利。

第七条 保护区的撤销及其性质、范围、界线的调整或者改变，应当报国务院批准。

第八条 保护区划分为核心区、缓冲区和实验区三部分。

核心区禁止任何单位和个人进入；除依照《中华人民共和国自然保护区条例》第二十七条的规定经批准外，也不允许进入从事科学研究活动。

缓冲区只准进入从事非破坏性的科学研究观测活动。

实验区可以进入从事科学试验、教学实习、参观考察、旅游以及驯化、繁殖珍稀、濒危野生动植物等活动。

第九条 保护区边界以及核心区、缓冲区和实验区边界应当设置界标。

任何单位和个人不得擅自移动或者破坏保护区界标及其保护设施。

第十条 在保护区内的单位、居民和经批准进入保护区的人员，必须遵守保护区的各项管理制度，接受保护区管理机构的管理。

第十一条 禁止在保护区内进行砍伐、放牧、狩猎、捕捞、采药、开垦、烧荒、开矿、采石、挖沙等活动；但是，法律、行政法规另有规定的除外。

第十二条 禁止任何人进入保护区的核心区。因科学研究的需要，必须进入核心区从事科学研究观测、调查活动的，应当事先向保护区管理机构提交申请和活动计划，并经自治区林业主管部门批准。

保护区核心区内原有居民确有必要迁出的，由保护区所在市县人民政府予以妥善安置。

第十三条 禁止在保护区的缓冲区开展旅游和生产经营活动。因教学科研的目的，需要进入保护区的缓冲区从事非破坏性的科学研究、教学实习和标本采集活动的单位和个人，应当事先向保护区管理机构申请，提交活动计划，经批准后方可进行。

从事前款活动的单位和个人，应当将其活动成果（包括图表、照片、录像、资料、论文等）的副本提交保护区管理机构存档。

第十四条 在保护区的实验区内开展参观、旅游活动的，由保护区管理机构编制方案，方案应当符合保护区管理目标。

在保护区组织参观、旅游活动的，应当严格按照前款规定的方案进行，并加强管理；进入保护区参观、旅游的单位和个人，应当服从保护区管理机构的管理。

严禁开设与保护区保护方向不一致的参观、旅游项目。

第十五条 进入保护区的外国人，应当遵守有关保护区的法律、法规和规定，未经批准不得在保护区内从事采集标本等活动。

第十六条 在保护区的核心区和缓冲区内，不得建设任何生产设施。在保护区的实验区内，不得建设污染环境、破坏资源或者景观的生产设施；建设其他项目，其污染物排放不得超过国家和自治区规定的污染物排放标准。在保护区的实验区内已经建成的设施，其污染物排放超过国家和自治区规定的排放标准的，应当限期治理；造成损害的，必须采取补救措施。

第十七条 因发生事故或者其他突发性事件，造成或者可能造成保护区污染或者破坏的单位和个人，必须立即采取措施处理，及时通报可能受到危害的单位和居民，并向保护区管理机构、当地生态环境主管部门和自治区林业主管部门报告，接受调查处理。

第十八条 违反本办法规定，有下列行为之一的单位和个人，由保护区管理机构责令其改正，并可以根据不同情节处以100元以上5000元以下的罚款：

（一）擅自移动或者破坏保护区界标的；

（二）未经批准进入保护区或者在保护区内不服从管理机构管理的；

（三）经批准在保护区的缓冲区内从事科学研究、教学实习和标本采集的单位和个人，不向保护区管理机构提交活动成果（包括图表、照片、录像、资料、论文等）副本的。

第十九条 违反本办法规定，在保护区进行砍伐、放牧、狩猎、捕捞、采药、开垦、烧荒、开矿、采石、挖沙等活动的单位和个人，除可以依照有关法律、行政法规规定给予处罚外，由自治区林业主管部门或者其授权的保护区管理机构没收违法所得，责令停止违法行为，限期恢复原状或者采取其他补救措施；对保护区造成破坏的，可以处以300元以上1万元以下的罚款。

第二十条 保护区管理机构违反本办法规定，拒绝生态环境主管部门或者自治区林业主管部门监督检查，或者在被检查时弄虚作假的，由保护区所在市县生态环境主管部门或者自治区林业主管部门给予300元以上3000元以下的罚款。

第二十一条 保护区管理机构违反本办法规定，有下列行为之一的，由自治区林业主管部门责令限期改正；对直接责任人员，由其所在单位或者上级机关给予处分：

（一）开展参观、旅游活动未编制方案或者编制的方案不符合保护区管理目标的；

（二）开设与保护区保护方向不一致的参观、旅游项目的；

（三）不按照编制的方案开展参观、旅游活动的；

（四）违法批准人员进入保护区的核心区的；

（五）有其他滥用职权、玩忽职守、徇私舞弊行为的。

第二十二条 违反本办法规定，给保护区造成损失的，由自治区林业主管部门责令赔偿损失。

第二十三条 妨碍保护区管理人员执行公务的，由公安机关依照《中华人民共和国治安管理处罚法》的规定给予处罚；情节严重，涉嫌犯罪的，依法移送司法机关处理。

第二十四条 违反本办法规定，造成保护区重大污染或者破坏事故，导致公私财产重大损失或者人身伤亡的严重后果，涉嫌犯罪的，对直接负责的主管人员和其他直接责任人员依法移送司法机关处理。

第二十五条 保护区管理人员滥用职权、玩忽职守、徇私舞弊，涉嫌犯罪的，依法移送司法机关处理；情节轻微，尚不构成犯罪的，由其所在单位或者上级机关给予处分。

第二十六条 违反本办法规定的其他行为，法律、法规已有法律责任规定的，从其规定。

第二十七条 本办法自2018年3月1日起施行。1994年7月1日发布、1997年12月25日第一次修正、2004年6月29日第二次修正、2010年11月15日第三次修正的《广西壮族自治区山口红树林生态自然保护区管理办法》和《广西壮族自治区北仑河口海洋自然保护区管理办法》同时废止。