Environmental Impact Assessment (DRAFT)

January 2014

People's Republic of China: Hubei Huanggang Urban Environment Improvement Project

Prepared by Huanggang Municipal Government for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 1 November 2013)

Currency unit	–	yuan (CNY)
CNY1.00	=	$0.16260
$1.00	=	CNY6.15

In this report, “$” refers to US dollars.

ABBREVIATIONS

ADB	Asian Development Bank
AQG	Air quality guideline
As	Arsenic
B	Boron
BOD_5	5-day biochemical oxygen demand
$CaCO_3$	Calcium carbonate
C&D	Construction and demolition
Cd	Cadmium
Cl^-	Chloride
CO	Carbon monoxide
COD	Chemical oxygen demand
CN	Cyanide
CNY	Chinese yuan
CR	Critically endangered
Cr	Chromium
Cr^{6+}	Hexavalent chromium
Cu	Copper
DDT	Dichloro-diphenyl-trichloroethane
DO	Dissolved oxygen
E	East
EA	Executing agency
EHS	Environmental Health and Safety
EIA	Environmental impact assessment
EIR	Environmental impact report
EIRF	Environmental impact registration form
EIT	Environmental impact table
EMP	Environmental management plan
EMS	Environmental Monitoring Station

EN	Endangered
EPB	Environmental Protection Bureau
EPD	Environmental Protection Department
EW	Extinct in the wild
F^-	Fluoride
Fe	Iron
FSR	Feasibility study report
FSW	Free surface water
FYP	Five Year Plan
GDP	Gross domestic product
GRM	Grievance redress mechanism
HAPB	Huanggang Aquatic Products Bureau
HEPB	Huanggang Environmental Protection Bureau
HEPD	Hubei Environmental Protection Department
HESB	Huanggang Environmental Sanitation Bureau
Hg	Mercury
HLB	Huanggang Landscaping Bureau
HLR	Hydraulic loading rate
HMG	Huanggang Municipal Government
HPG	Hubei Provincial Government
HPLG	Huanggang Project Leading Group
HPMO	Huanggang Project Management Office
H_2S	Hydrogen sulfide
HUCIC	Huanggang Urban Construction Investment Company
HWB	Huanggang Water Bureau
IA	Implementing agency
I_{Mn}	Permanganate index
IUCN	International Union for Conservation of Nature
LAS	Linear alkylbenzene sulfonate
LC	Least concern
LIC	Loan implementation consultant
LIEC	Loan implementation environmental consultant
MEP	Ministry of Environmental Protection
MSW	Municipal solid waste
N	Nitrogen

N	North
NBES	Nationally Protected Wild Animal with Beneficial, Economic and Scientific Research Value
NDRC	National Development and Reform Commission
NE	Northeast
NED	New Eastern District
NH_3	Ammonia
NH_3-N	Ammonia nitrogen
Ni	Nickel
NMT	Non-motorized traffic
NO_2	Nitrogen dioxide
NO_2^-	Nitrite
NO_3^-	Nitrate
NO_x	Nitrogen oxides
NT	Near threatened
NW	Northwest
O&M	Operation and maintenance
P	Phosphorus
PAM	Project administration manual
Pb	Lead
PLC	Prefecture-level city
$PM_{2.5}$	Particulate matter with diameter <2.5 μ
PM_{10}	Particulate matter with diameter <10μ
PME	Power mechanical equipment
PMO	Project management office
PO_4	Phosphate
PPTA	Project preparation technical assistance
PRC	People's Republic of China
REA	Rapid environmental assessment
RP	Resettlement plan
S	South
SE	Southeast
Se	Selenium
SEPP	Soil erosion prevention plan
SO_2	Sulfur dioxide
SO_4^{2-}	Sulfate

SPS	Safeguard Policy Statement
SS	Suspended solids
SSF	Sub-surface flow
SW	Southwest
TN	Total nitrogen
TP	Total phosphorus
TPH	Total petroleum hydrocarbon
TSP	Total suspended particulates
VU	Vulnerable
W	West
WBG	World Bank Group
WHO	World Health Organization
WTP	Water treatment plant
WWTP	Wastewater treatment plant
Zn	Zinc

WEIGHTS AND MEASURES

^{o}C	degree centigrade
dB	decibel
ha	hectare
hr	hour
kg/d	kilogram per day
km	kilometer
km^2	square kilometer
km/hr	kilometer per hour
L	liter
L_{Aeq}	Equivalent sound level
m	meter
m/s	meter per second
m^2	square meter
m^3	cubic meter
m^3/d	cubic meter per day
m^3/s	cubic meter per second
mg/kg	milligram per kilogram
mg/L	milligram per liter

mg/m^3	milligram per cubic meter
mL	milliliter
mm	millimeter
pH	measure of alkalinity and acidity
t	metric ton
t/a	metric ton per annum
t/d	metric ton per day
µ	micron
$µg/m^3$	microgram per cubic meter

NOTE

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

Contents

I. EXECUTIVE SUMMARY

A. Background

1. This draft environmental impact assessment (EIA) is an environmental safeguard report for the proposed Hubei Huanggang Urban Environment Improvement Project. This report was prepared based on two domestic Environmental Impact Reports (EIR) prepared for this project: a planning EIR and a construction project EIR; and supplemented with information from the domestic Feasibility Study Report (FSR) and the Soil Erosion Prevention Plan (SEPP) for the project.

2. Huanggang Municipality is a prefecture-level city (PLC) located in eastern Hubei Province (**Figure I.1**), south of the Dabie Mountain, bordering the northern shore of the mid-section of the Yangtze River. It is approximately 170 km wide from east to west, and 200 km long from north to south. It borders Anhui Province to the east, the cities of Wuhan and Xiaogan to the west, and Henan Province to the north.

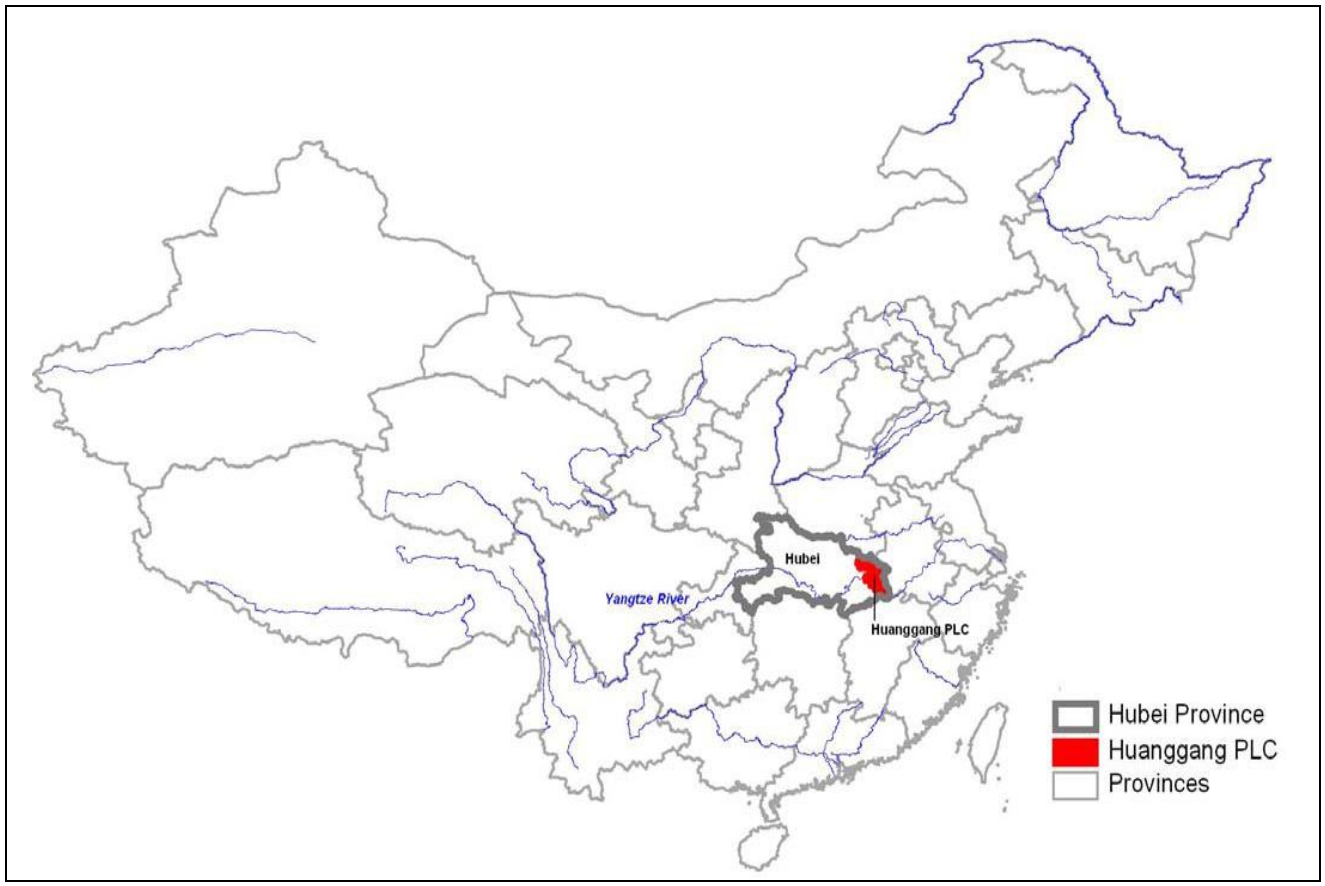

Figure I.1: Location of Huanggang Municipality in the PRC

3. Huanggang is the second largest municipality in Hubei province after Wuhan, with a population of over 7.4 million. Its urban center is located in the Huangzhou District with a population of approximately 0.35 million in a built up area of approximately 36 km^2. Huanggang's economic development is benefiting from national policies and support such as "The Rise of Central China Plan", as well as provincial policies such as the "Wuhan 1+8 City Cluster". The completion of the Wuhan inter-city

railway to Huanggang and the integration of the Wuhan New Port and the Huanggang Lin Port Economic Zone will expand the Wuhan circle to include Huanggang in forming a future metropolis.

4. Despite the above, Huanggang is lagging behind in economic development compared to other municipalities in Hubei, and has become a bottleneck in the economic development of the province. Its per capita GDP in 2010 was less than half of the provincial average. Year 2010 statistics show that its GDP increase, urban per capita disposable income and rural per capita net income were ranked 13th or 14th among the cities in the province, despite its 2nd largest population in the province. Huangzhou District, being the urban center of Huanggang, was described in the *Huanggang Urban Master Plan (2011-2030)* as being ineffective in driving the growth of other cities and counties in the municipality. The main constraint is space limitation for growth in the existing aging urban center.

5. Huanggang is at a cross road. It urgently needs to improve the urban function of Huangzhou District to drive socio-economic development of other cities and counties in the municipality and to make full use of and to reap benefits from supporting national and provincial policies. Otherwise, it will fall behind and will never be able to catch up. One of the key actions in the *Huanggang Urban Master Plan (2011-2030)* is to develop a 63 km^2 New Eastern District (NED) which will allow expansion of the existing urban center to the east (**Figure I.2**). The NED will become the new urban center with administrative, residential, commerce and trade, logistics, recreational and aesthetics functions.

Figure I.2: Location of the New Eastern District in Huanggang Municipality

B. Project Design

6. This project is part of the early phase of NED development within the 25.27 km^2 of the Baitan Lake planning area, and is in accordance with the *Huanggang Urban Master Plan (2011-2030)* and the *Baitan Lake Area Control Plan*.

7. Interventions from this project will contribute to enhancing the rivers and lakes environment as well

as improving the flood control functions of these water bodies. This will improve the quality of living conditions and reduce potential flooding and water logging risks for the projected future population of 200,000 in the Baitan Lake planning area. This project will improve the water and ecological quality as well as scenic and aesthetic values of these water bodies and surrounding areas for the enjoyment of the residents.

8. **Impact and outcome.** The stated project impact is environmentally and socio-economically more sustainable urban development in Huanggang. The intended project outcome is improved urban environment infrastructure and management services in Huanggang. The three indicative outputs are:

Component 1: Urban lake and river enhancement. This component consists of two sub-components:

(i) Lake enhancement. This output will enhance the Baitan Lake and Chiye Lake by constructing a 13.3 km ring road for non-motorized traffic (NMT) around these lakes; constructing 14 km ecological embankment with approximately 89 ha of vegetated buffer strips; dredging of approximately 540,000 m^3 nutrient laden unconsolidated sediment; constructing four sub-surface flow wetlands totaling 3.84 ha with 4 detention ponds totaling 1.53 ha, and one 80 ha surface flow wetland for water quality improvement; planting approximately 126 ha aquatic vegetation; stocking approximately 27 t fish species and 145 t benthic mollusks; purchasing 4 boats for collecting water borne solid waste; and purchasing water quality monitoring and maintenance equipment.

(ii) River enhancement. Seven rivers (Linglong Bay, Jinshui River, Dongtai River, Qingshui River, Canglang River, Dongchang River and Chushui River) totaling 10.78 km will be enhanced to re-establish hydraulic circulation between rivers and lakes. Specific output will include: dredging approximately 200,000 m^3 nutrient laden sediment and excavating approximately 343,000 m^3 channel soil; constructing approximately 24 km ecological embankment; planting approximately 18 ha aquatic vegetation; planting approximately 48 ha vegetation strips along the river banks; constructing 2 sluice gates and 3 bridge walkways across the rivers; and providing supplementary water to Baitan Lake at an average rate of 1.1 m^3/s.

Component 2: Solid waste management. This output will consist of constructing a solid waste collection pier and a 30 t/d capacity solid waste transfer station on the southeastern bank of Baitan Lake; and purchasing 2 trucks for waste transfer and 260 garbage bins for waste collection.

Component 3: Capacity development and institutional strengthening. This output will provide (i) project implementation support for smooth and timely implementation of the project in line with ADB procedures and guidelines; (ii) consulting services for initial project implementation support; (iii) consulting services for external resettlement, social and environmental monitoring; (iv) solid waste management public awareness campaign; and (v) development of water quality monitoring and forecasting system for Xingfu River, Baitan Lake and Chiye Lake.

C. Project Benefits

9. This project will improve the environmental and living conditions of the Baitan Lake planning area, directly benefiting the existing population of approximately 12,000 and the future population of approximately 100,000 by 2020; and indirectly benefiting the projected population of approximately 500,000 in the Huanzhou District of Huanggang.

10. Through dredging, approximately 740,000 m^3 of nutrient laden sediment will be removed from these lakes and rivers. This would result in a one-off removal of 486 t total phosphorus (TP) and 1,920 t total nitrogen (TN) from the water system, thereby reducing the eutrophication potential of these lakes and rivers. Removal of the sediment will also increase the normal lake storage by 9%, leading to reduction in pollution loadings releasing from sediment deposits by 20% (estimated to be TN 21.6 t/year and TP 2.6 t/year, approximately).

11. The 4 sub-surface flow wetlands in conjunction with the 4 detention ponds will treat an annual average volume of 7,390 m^3 of storm water runoff (which equals to about 38% of the first flush flow volume). The surface flow wetland will reduce the pollution loads from the upstream catchment. The estimated annual total pollutant reductions by these wetlands are COD 171 t, TN 49 t and TP 1.1 t.

12. River enhancement will improve flood control against 1-in-20 year storm events, thus alleviating water-logging risk in the Baitan Lake planning area and protecting its residents against economic loss. By connecting the river-lake network and providing supplementary water at 1.1 m^3/s, the water flow within the system will be improved and the water level in Baitan Lake will be controlled at a level that is conducive to maintaining its scenic function and value.

13. The scenic and aesthetic values of Baitan Lake would be enhanced for the enjoyment of residents in the Baitan Lake planning area as well as the Huanggang Municipality urban population through the surface flow wetland in Chiye Lake, the NMT ring road, and landscaping of the surrounding areas and river banks. The surface flow wetland in Chiye Lake will also provide approximately 80 ha of wetland habitat for wildlife, thus enhancing the ecological value of the area.

14. The provision of the pier, solid waste collection and transfer boats and vehicles, and a solid waste transfer station would improve the collection, transfer and disposal of solid waste floating in the lakes and rivers as well as vegetation from wetland maintenance would also reduce lake pollution and improve public health and the scenic and aesthetic values of the Baitan Lake planning area.

D. Baseline Environment

15. Approximately 93% of the existing land use within the 25.27 km^2 Baitan Lake planning area is dominated by agricultural and wooded land (43%), ponds and ditches (32%) and natural water bodies (18%). The remaining 7% is constructed land dominated by 4% of scattered suburban townships and villages with 2,963 households and approximately 12,000 in population.

16. The water system within the Baitan Lake planning area is dominated by Baitan Lake, which is located approximately 4 km east of the urban center in Huangzhou District. The original water surface

was approximately 1,053 ha but has shrunk to 352 ha due to formation of fish ponds and reclamation for development. Its function includes irrigation, aquaculture and flood retention. Approximately 267 ha of the lake surface area have been used for aquaculture which has been a pollution source to lake water quality. It has a water storage capacity of 8.28 million m^3 and an average depth of 2 m. Baitan Lake gets its water mainly from Xingfu Reservoir (for irrigation and is not a drinking water source) and the Ba River approximately 12 km to the north-northeast. It drains into the Santai River to the west which eventually flows to the Yangtze River to the south either directly or through the Ba River.

17. Wastewater generated within the Baitan Lake planning area includes industrial and domestic wastewater. There were 9 industrial enterprises in the planning area and 4 have been relocated outside the planning area as of March 2012. The remaining 5 will be relocated and the control plan for the Baitan Lake planning area has no industrial land use and therefore no industrial wastewater will be generated in the future. Domestic wastewater generated by existing residents has been estimated to be approximately 556 m^3/d. There is no centralized wastewater collection and treatment for wastewater generated by existing residents. Wastewater is either treated by individual septic systems or discharged directly into nearby water bodies.

18. Besides wastewater, Baitan Lake water quality has also been affected by non-point source pollution from agricultural sources and fish farming in and around the lake. Baseline surface water quality monitoring undertaken for this project showed that the water quality in Baitan Lake on the days of monitoring exceeded Category V standards due to high levels of total nitrogen. The water quality standard targets (for scenic water function) for Baitan Lake is Category IV in the near term (year 2020) and Category III in the long term (year 2030).

19. Baseline air quality monitoring showed compliance with applicable PRC and the World Bank Group's (WBG) Environmental Health and Safety (EHS) standards. Baseline noise monitoring also showed compliance with applicable PRC standards except at one location near a trunk road which was influenced by road traffic noise. However, baseline noise levels at a few locations exceeded the more stringent WBG EHS standards especially in the night time.

20. Baseline sediment quality monitoring showed that the sediments to be dredged in Baitan Lake, Chiye Lake and Jinshui River were not contaminated with heavy metals. However, these sediments were laden with high nutrient levels. Baitan Lake had TP and TN levels ranging from 1,272~1,410 mg/kg and 5,280~5,955 mg/kg respectively. Chiye Lake had TP and TN levels ranging from 928~1,093 mg/kg and 4,027~4,114 mg/kg respectively. The project EIR assessed that both lakes were in a mild eutrophic state.

21. Baseline information on the ecological resources in the planning area was compiled based on both ecological surveys and literature review. The vegetation in the planning area was categorized into 42 types by the project EIR consisting of trees, shrubs, vines and aquatic plants occurring in and around water bodies, ponds and ditches, as well as on agricultural land, vacant land and in constructed areas adjacent to village households. Of the 487 plant species, 135 (30%) were cultivated species. Phytoplankton in Baitan Lake and Chiye Lake showed low diversity with domination by a few species of blue-green algae and green algae, indicative of eutrophication in these water bodies. Benthic fauna

were dominated by insect larvae, with worms, crustaceans and mollusks making up the benthic communities. Eight amphibian species consisting of toads and frogs, and 20 reptile species dominated by snakes have been recorded in the Baitan Lake area. The 14 species of terrestrial mammals recorded included carnivores, hedgehogs, hares and rabbits, and rodents.

22. Forty-nine fish species have been recorded in Baitan Lake and carps and minnows accounted for 33 of the 49 fish species. Nine species belonged to the Yangtze River water system, indicating potential migration from the Yangtze River into the lakes in the Yangtze River basin.

23. Of the 126 bird species recorded to have occurred in the Baitan Lake area in literature, 64 species (51%) were observed during bird surveys conducted for this project. Bird species were dominated by winter migrants (45%) followed by resident species (35%). The dominance of winter migrants indicates that the Baitan Lake area is a popular wintering ground for birds, Of the wintering migrants, the water birds are most important because they feed in and around Baitan Lake. Wintering water birds include the Anseriformes (ducks, geese, swans), Podicipediformes (grebes), Charadriiformes (the waders), Ciconiiformes (storks, herons, egrets, ibises, spoonbills, etc.) and Lariformes (gulls and terns). Winter migrants usually arrive in late October to early November and stay in the area until the following March. Due to the bird surveys being undertaken outside the winter migration period, only 5 of the 57 winter migrant species recorded in the area were observed during the surveys. Despite this, literature has provided a comprehensive record of potential wintering migrants in the planning area.

24. Among the above flora and fauna recorded in the Baitan Lake planning area, 84 species are under national, provincial and/or International Union for Conservation of Nature (IUCN) protection status. These species were made up of 7 plants, 2 benthic bivalve mollusks, 4 fishes, 6 amphibians, 8 reptiles, 2 terrestrial mammals and 55 birds. Among these, 11 species are on the IUCN red list with 4 species assessed as Endangered (EN) and 7 species Vulnerable (VU); 25 species are on the national protection list with 4 species in Class I and 21 species in Class II; and 53 species on the provincial protection list. None of these species is native to the Baitan Lake area.

25. Ecologically protected areas include the Lijiazhou Egretry Nature Reserve in Huangzhou District located approximately 16 km to the northwest of the project area, and the Longgan Lake Nature Reserve in Huanggang Municipality, a major wintering ground for water birds, located approximately 120 km to the southeast of the project area. The Huangzhou Binjiang Forest Park and the Dongpo Red Cliff Scenic Area are located approximately 6 km to the southwest of the project area. These protected areas are all located outside the project area of influence.

E. Project Impacts and Mitigation Measures

26. Construction and operation of the project components do have potential impacts to the environment. Permanent and temporary land take in this project would total 179.92 ha. Ninety percent of the existing land uses within the land take areas are ponds and ditches (61.8%), dry farmland (19.8%)

and shrub land (8.9%)[1]. These land uses to be taken up by this project make up less than 0.1% of same land use types in the Huanggang Municipality Construction of wetland and river-lake connection network would account for approximately 85% of the permanent land take.

27. During construction, dust and noise generated by construction activities will be a nuisance to nearby residents. Sediment dredging in the lakes and rivers and wastewater discharge from construction sites could potentially cause water pollution. Dust impact has been estimated to affect an area within 150 m downwind of the construction site. Construction noise would impact distances of 50 m and 280 m from the notional noise source in day time and night time respectively. During dredging, elevated suspended solids (SS) levels together with released nitrogen and phosphorus from the sediment would mostly be confined to within 30 m down current of the dredger, and that SS and other pollutants would reach ambient levels within a distance of 50 m down current of the dredger. According to predictions in the project EIR, these impacts should be acceptable with the provision of mitigation measures and sound environmental management during the construction stage of the project.

28. Dredged sediment will be treated at treatment sites established in the project area using chemical flocculation, solidification and dewatering technology. The volume reduction would be approximately 53% and the dewatered product is odorless and will undergo leaching tests prior to re-use for landscaping or site formation in NED development. Approximately 97% of the 1.23 million m^3 earth cut materials would be re-used on site. Imported fill would total approximately 1.68 million m^3 for construction of embankments and landscaped strips. A borrow area has been identified for acquiring the earth fill materials.

29. The habitats in the Baitan Lake area have been influenced by human activities, dominated by man-made fish ponds and farmland. Baitan Lake has been decreasing in surface area, from 1,053 ha to 352 ha, due to continual development in the area and lake water quality has been adversely affected by point and non-point source pollution and aquaculture in the lake. The project area of influence is unlikely to sustain any natural habitat that would be deemed large enough to be of ecological significance. The project area of influence is also unlikely to have any habitat critical to the survival of ecologically important floral and faunal species. Dredging will remove benthic fauna in the dredged areas. Benthic fauna are ubiquitous and upon completion of dredging, they will recolonize the area. The impact is temporary and reversible.

30. Of the 84 species under protection status, none of them is native to the Baitan Lake area. They are either cultivated species (plants) in the Baitan Lake area or widely distributed in many provinces in the PRC (both plants and animals). Four species (2 plants and 2 reptiles) are deemed by IUCN as Endangered. These are *Ginkgo biloba* (Maidenhair Tree), *Metasequoia glyptostroboides* (Dawn Redwood), *Chinemys reevesii* (Chinese Pond Turtle), and *Mauremys mutica* (Yellow Pond Turtle). The Maidenhair Tree is a living fossil with no close relative. It is native to the PRC and is widely cultivated and used in traditional medicine and as a source of food. The Dawn Redwood is a fast growing deciduous tree. It is the sole living species of the genus *Metasequoia* and is one of three species of

[1] Land use classifications are based on PRC's *Current Land Use Classification* (GB/T 21010-2007)

conifers known as redwoods. According to IUCN it is endemic to central China: Chongqing (Shizhu), Hubei (Lichuan, Zhonglu), and Hunan (Longshan, Sangzhi). Both species are cultivated species in the Baitan Lake planning area and according to the *Catalogue of Life China 2012 Annual Checklist*, widely occur in numerous provinces in the PRC. According to IUCN, *the* Chinese Pond Turtle has become subject to intensive exploitation for food and medicine and to supply the aquaculture industry with breeding animals, as well as being extensively impacted by habitat degradation and loss, and a decline has been observed in the market supply of the Yellow Pond Turtle. *Catalogue of Life China 2012 Annual Checklist* describes that both turtle species are widely distributed in many provinces in the PRC.

31. The 7 species deemed Vulnerable by IUCN include two species of benthic freshwater mussels *Lamprotula rochechouartii* and *Lamprotula tortuosa*; one fish *Cyprinus carpio* (Wild Carp); one reptile *Pelodiscus sinensis* (Chinese Soft-shell Turtle); and 3 bird species *Anser cygnoides* (Swan Goose), *Emberiza aureola* (Yellow-breasted Bunting), and *Grus monacha* (Hooded Crane).

32. According to IUCN, both freshwater mussels are native to and have wide distribution in the PRC in lakes and associated waterways with deeper, fast or slow, clear water and silt sediments. They are vulnerable and warrant protection because of population decline due to destruction of habitat from pollution and damming for *Lamprotula rochechouartii* and heavy harvesting and pollution for *Lamprotula tortuosa*. The Wild Carp has a cosmopolitan distribution and IUCN's concern is on the decline in its native populations due to river regulation (in the Black, Caspian and Aral Sea basins) and hybridization with domesticated introduced stocks. IUCN describes the Chinese Soft-shell Turtle to be vulnerable because the wild populations continue to be exploited for food and possibly farm founder stock, resulting in a decline in abundance throughout its wide range despite this species is commercially farmed in vast numbers (several millions per year) for the food trade. *Catalogue of Life China 2012 Annual Checklist* describes that the Chinese Soft-shell Turtle is distributed in more than 20 provinces in the PRC. The Swan Goose is suspected to be undergoing a rapid population decline owing to poor breeding success in recent years as a result of drought and considerable pressure from habitat loss, particularly owing to agricultural development, as well as unsustainable levels of hunting. The Yellow-breasted Bunting overall has undergone a very rapid population decline owing mainly to trapping on wintering grounds despite its being locally abundant. The Hooded Crane is suffering declining population and wintering grounds due to wetland loss and degradation. All 3 bird species have been described in the *Catalogue of Life China 2012 Annual Checklist* as having wide distribution in many provinces in the PRC.

33. The protected species especially those under IUCN protection status are widely distributed in the PRC and that the Baitan Lake planning area is not the 'type locality' of any of the protected species. However, although the Longgan Lake is the major wintering ground for water birds in Huanggang Muncipality, Baitan Lake is a popular wintering ground for water birds. Mitigation measure in the EMP will include restricting the hours of construction activities to prevent disturbance to wintering migrant dawn and dusk feeding during the wintering period from November to March, and no wetland maintenance during the water bird wintering period. The EMP also includes water bird monitoring around Baitan Lake and Chiye Lake.

34. **Resettlement**. The project would affect a population of 1,324 from 360 households and entities. House demolition will involve 4,736.5 m^2 of residential houses and 11,038 m^2 of non-residential houses. Compensation will be in accordance with the Resettlement Plan. Since most of the land acquisition will involve fish ponds and most fishpond lessees were formerly workers of Baitan Lake Fish Farm, and were converted into urban residents after the restructuring and liquidation of the farm in 2007, the New Eastern District construction headquarters has developed livelihood restoration measures to protect their livelihoods. One of the measures is to provide 2,000 mu of fish ponds for rent near the Xingfu Village downstream of the Xingfu Reservoir. According to the planning EIR, of the existing 2,963 households and 12,045 population in the Baitan Lake planning area, development of the planning area will eventually require the resettlement of some 10,000 residents (including the above affected by this project). To date, 825 HHs with 2,987 persons have signed land acquisition and resettlement agreements with Huangzhou District government. The 10,000 residents are expected to have signed land acquisition and resettlement agreements before the end of 2014. Four resettlement communities have been planned within the Baitan Lake planning area to accommodate the resettlement of these affected households and population. All the 4 resettlement communities have commenced construction in 2012 or 2013 and will complete the civil works by July 2014. The relocated HHs will start moving into the resettlement houses before September 2014.

35. Major **impacts during operation** include changes in water quality resulting from river-lake connection, and impacts to fish migration from Baitan Lake to Santai River due to the installation of sluice gates on Jinshui River and Linglong Bay at their confluences with Santai River. Numerical modeling undertaken by the PPTA consultant indicates water quality improvement with the implementation of removal of nutrient laden sediment through dredging and construction of sub-surface flow and surface flow wetlands. These interventions would improve Baitan Lake water quality to meet its near term target of Category IV standards for scenic water function. The extraction of 1.1 m^3/s from the Ba River would constitute less than 4% of the dry season flow in the Ba River and should not affect downstream water users. Nine fish species are associated with the Yangtze River water system and might migrate in and out of Baitan Lake. Fish generally migrate upstream to spawn in shallow areas before the wet season and return to deeper waters in the lake in autumn. The two sluice gates will be deployed during the winter season to retain the water level in Baitan Lake and only occasionally at other times when the Santai River water level is higher than the Baitan Lake water level during storm events. This will only occur intermittently and only during the summer months, before which the migrating fish would already have left the lake and after which they would be able to return to the lake to feed and winter. Further, Dongtai River and Dongchang River also provide migration routes to the fish.

36. This project will rehabilitate Baitan Lake, Chiye Lake and seven river channels, improving the water quality and creating wetland habitats. The recently promulgated *Hubei Province Lake Protection Regulation* will provide administrative and enforcement measures to prevent and control pollution in Baitan Lake, including aquaculture activities in the lake. In the long term all these improvements and actions will enhance the ecological value of Baitan Lake, benefiting nearby biota especially wintering water birds. HMG also has ongoing and planned programs for protecting and improving the water quality of the water bodies in the Huangzhou District. These programs include improvement and

rehabilitation of the Chang River (including the Santai River section) and Yiai Lake, interception of untreated discharges and overflows in the urban area, and construction of pump stations to facilitate water flow and storm water drainage. Under the capacity building component, this project will transfer the hydraulic and water quality numerical models developed for the Baitan Lake planning area to the Huanggang Environmental Protection Bureau (HEPB), where these models will be used by HEPB for water quality modeling and forecasting as a tool to manage the water quality of water bodies in the area.

37. To facilitate sound environmental management, this report provides an Environmental Management Plan (EMP) with 4 major components: mitigation, monitoring, public consultation and training. The EMP provides a plan for training and capacity building of the Huanggang Project Management Office (HPMO) and the Implementing Agency (IA) so that they will be able to perform environmental management, to implement all the mitigation measures and to conduct environmental monitoring. Mitigation measures listed in the EMP covers the design, construction and operational stages of the project, because some measures that will become permanent features of the facilities will need to be designed into the facilities. It is also important that the mitigation measures are included in tender documents so that they could be implemented during the construction and operational stages. Environmental monitoring is important to measuring the impact during construction and operation, as well as quantifying the benefits of this project during operation.

F. Information Disclosure, Consultation and Participation

38. Both the planning EIR and the project EIR have undergone information disclosure and public consultation. Information related to the planning EIR was disclosed twice. The first time was on the Huanggang Municipality Government (HMG) web-site in May 2012 upon commencement of the planning EIR. The second time was in June 2013 on the Hubei Environmental Protection Department (HEPD) web-site after completion of the planning EIR. Information related to the project EIR was disclosed twice on the HEPD web-site. The first time was in December 2012 upon commencement of the project EIR. The second time was in July 2013 after completion of the draft project EIR.

39. The planning EIR also conducted a questionnaire survey of 100 people in July 2012 targeting the affected persons, households, and industries in and adjacent to the Baitan Lake planning area. Noise and air pollution were deemed as the major existing environmental problems in the Baitan Lake planning area, followed by water pollution. Approximately two-third of the respondents viewed that development of the Baitan Lake planning area would bring positive impacts to the area and 7% viewed that it would bring negative impacts. Resulting major environmental impacts would include water quality degradation and noise disturbance, and that preventing and controlling water pollution and providing solid waste collection and transfer would be the key environmental protection measures. Approximately 86% of the respondents would agree or would not mind to be resettled, with the majority preferring to be resettled nearby within the NED or compensated by one off cash payment.

40. The planning EIR also held a discussion forum on 25 October 2012 involving representatives from relevant government departments. During the discussion, the planning EIR proposed 6

recommendations for adjusting the planning of the Baitan Lake area, which were accepted by the Huanggang NED Command Center and later reinforced in the planning EIR approval document by the Hubei Environmental Protection Department. These recommendations were related to establishing safety protection zones along the inter-city railway line, establishing a water pollution prevention plan, measures to protect Baitan Lake, speeding up implementation of the drainage plan and other basic facilities, and preventing external industrial pollution to the planning area.

41. The project EIR conducted a questionnaire survey of 50 people in June 2013 targeting the affected persons in the Baitan Lake planning area. Water pollution was deemed to be the major existing environmental problem in the Baitan Lake planning area, followed by air pollution. Wastewater was deemed to be the major environmental problem during and after construction of the project. The project was deemed by 86% to result in obvious improvement to the water environment of the rivers and lakes, and almost all the respondents viewed that this project would promote economic development and improve their living standard.

42. The project EIR also held a discussion forum on 7 June 2013 participated by representatives of the affected communities in the planning area and representatives from relevant government agencies. Discussion centered around project EIR findings on potential environmental impacts during construction and operation of the project and corresponding mitigation measures. All representatives accepted the findings and supported the project.

G. Grievance Redress Mechanism

43. People who are affected by the impacts of this project will have a channel to register their grievance. This report and the EMP describe a grievance redress mechanism (GRM) to document and resolve complaints from affected people. The proposed GRM was explained to the attendees of the discussion forum on 7 June 2013. The GRM will be coordinated by HPMO, who will set up a complaint center with hotline for receiving environmental and resettlement grievances, and will be accessible to diverse members of the community, including more vulnerable groups such as women and youth. Multiple points of entry and modes of access, including face-to-face meetings, written complaints, telephone conversations, or e-mail, will be available.

H. Key EMP Implementation Responsibilities

44. The Huanggang Municipal Government (HMG) is the **Executing Agency (EA)** and has established the Huanggang Project Management Office (HPMO), who on behalf of the EA will be responsible for the day-to-day management of the project. The HPMO will have the overall responsibility to supervise the implementation of environment mitigation measures, coordinate the project level GRM and report to ADB. The HPMO will appoint environment specialists on its staff to supervise the effective implementation of the EMP and to coordinate the project level GRM. The HPMO will engage the technical engineering design institutes (DI), hire the loan implementation consultants (LIC) and the external envirionmental monitor (EEM), and manage the procurement process. To ensure

that the contractors comply with the EMP provisions, HPMO with the help and technical support of Loan Implementation Environmental Consultant (LIEC) and the Tender Agent, will prepare and provide the following specification clauses for incorporation into the bidding procedures: (i) a list of environmental management requirements to be budgeted by the bidders in their proposals; (ii) environmental clauses for contractual terms and conditions; and (iii) major items in the EIA and EMP. The HPMO will prepare semi-annual environment progress reports and submit them to ADB.

45. The Huanggang Urban Construction Investment Company, Ltd. (HUCIC) will be the **Implementing Agency (IA)** for the Project. HUCIC will assume the debt servicing responsibility as the end-user of the ADB loan. It will implement project components, administer and monitor contractors and suppliers, and be responsible for construction supervision and quality control. HUCIC will appoint on its staff at least one qualified environment specialist to (i) supervise contractors and their compliance with the EMP; (ii) conduct regular site inspections; and (iii) act as local entry point for the project GRM.

46. For implementing environmental impact monitoring, HUCIC or HPMO will contract (i) a licensed external environmental monitoring entity (via contractor tender), (ii) experienced ornithologist(s), and (iii) a qualified soil erosion monitoring entity to conduct environmental impact monitoring during the construction and operational stages of the project in accordance with the environmental monitoring program described in the EMP.

47. During the operational phase, the HUCIC will supervise the environmental management and implementation of mitigation measures by the operators (**O&M Units**) of the project components. The cost of mitigation measures in this phase will be borne by the relevant O&M Units, including: (i) Huanggang Aquatic Products Bureau (HAPB) for the management of aquaculture and stocking of fish and benthic mollusk species in Baitan Lake and Chiye Lake; (ii) Huanggang Environmental Sanitation Bureau (HESB) for the operation and maintenance of the solid waste collection boats and vehicles and the solid waste transfer station; (iii) Huanggang Landscaping Bureau (HLB) for the operation and management of the sub-surface flow and surface flow wetlands and aquatic planting and landscaped areas; (iv) the Huanggang Water Bureau (HWB) for managing and maintaining the flood control works; and (v) the HEPB for the operation and maintenance of the hydraulic and water quality numerical models.

I. Risks and Key Assurances

48. The main project risks include the low institutional capacity and/or failure of the HPMO, HUCIC and O&M units to d implement the EMP during construction and operational stages, and for the associated and linked projects such as the Nanhu Wastewater Treatment Plant expansion, the Hongqi pump station and the Nanhu pump station to be built on time. These risks will be mitigated by (i) providing training in environmental management and monitoring; (ii) appointing qualified project implementation consultants, (iii) following appropriate project implementation monitoring and mitigation arrangements, and (iv) ADB conducting project reviews.

49. Key assurances cover ADB requirements in environmental safeguards during project

implementation.

J. Overall Conclusion

50. Impact assessment results show that potential impacts can be mitigated to acceptable levels. The EMP has specified what mitigation measures are to be implemented and by whom, and how the impacts are to be monitored during construction and operation. The project will have positive benefits to the Baitan Lake planning area, enhancing the rivers and lakes and improving the environmental conditions and living quality of existing and future populations in the area.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK AND STANDARDS

A. Policy Framework

51. The project is located in Huanggang Municipality, Hubei Province. Hubei is one of six provinces benefiting from the central government's "The Rise of Central China Plan", announced in 2006 by the State Council. The Plan aims at reducing inter-regional economic disparities by upgrading the central region's industrial structure and boosting industrialization and urbanization through better use of its geographic and industrial advantages.

52. Due to its close proximity to Wuhan, Huanggang is an important component of the "Wuhan City Circle": the so called "Wuhan 1 + 8 City Cluster" (**Figure II.1**), a provincial policy approved by the National Development and Reform Commission (NDRC) in December 2007 which is being promoted by the central government as an experimental administrative zone for the piloting of urban development strategies and urban sustainable development in the PRC.

Figure II.1: Wuhan 1+8 City Cluster

53. ADB intervention in Huanggang fits well with ADB's goal of poverty reduction in its member countries. This project is aligned with key thrusts of ADB's assistance to the PRC under the *PRC*

Country Partnership Strategy (CPS) 2011-2015[2] in environmentally sustainable growth, sustainable urbanization in the interior regions, and demonstration projects that contribute to sound land, water and natural resources management. It furthers ADB's *Strategy 2020* [3] which emphasizes sustainable urban development, infrastructure efficiency, better environmental management, inclusive growth and balanced development. The project also conforms to ADB's Water Operational Plan (2012-2030), which encourages expanded wastewater management and integrated water resources management. It supports ADB's urban sector strategy and the PRC's urbanization strategy, which promote strengthening environmental management, supporting inclusive growth and well-balanced development.

54. **Local requirements and rationale.** The following Huanggang plans are relevant to this project. These requirements also form the basis and rationale for this project.

(i) *Huanggang 12th Five-Year Plan for Social and Economic Development*

(ii) *Huanggang 12th Five-Year Plan for Environmental Protection*

(iii) *Huanggang Urban Master Plan (2011-2030)*[4]

(iv) *Conceptual Plan for New Eastern District, Huanggang*[5]

(v) *Huanggang New Eastern District Plan-Baitan Lake Area Detail Control Plan*

(vi) *Huanggang New Eastern District Plan-Baitan Lake Area Water System Rehabilitation Plan*[6]

(vii) *Hubei Province Lake Protection Regulation* (30 May 2012)

55. The *Huanggang 12th Five Year Plan (FYP) for Social and Economic Development* described the 12th five-year period (2011 to 2015) to be a key period for Huanggang to increase the urbanization rate, improve the structure of industrial composition, increase improvements on basic municipal infrastructure, and improve all facets of urban and rural living quality and standards. The urbanization rate was targeted to increase from the present 35.7% to 46%, with an urban population of 4 million of which 500,000 would be in the urban center in Huangzhou District. The FYP also set binding targets (based on allocation from the provincial government) for energy efficiency and pollutant reduction. This project supports improving urban living quality and standards, and pollutant reduction through urban environment improvement interventions.

56. The *Huanggang 12th FYP for Environmental Protection* set environmental quality standards and pollution prevention targets for 2015, and indicated that one of the key actions in this period would be the rehabilitation of lakes and the surrounding ecological belt and to make use of wetlands and aquatic plants to polish and improve the water quality of these lakes.

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[2] ADB. 2012. PRC Country Partnership Strategy 2011-2015. Manila.

[3] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020*. Manila.

[4] Prepared by the Hubei Institute of Urban Planning and Design

[5] Prepared by Singapore SCP Consultants Pte Ltd., September 2012

[6] Prepared by the Hubei Water and Hydropower Planning and Survey Design Institute, May 2012.

57. The *Huanggang Urban Master Plan (2011-2030)* identified the lack of a strong urban center to be the major obstacle in driving the development of other cities and counties in the Municipality. Among the cities and counties in the Municipality, the Huangzhou District ranked 5th in GDP, 8th in added value from sizable industries and 7th in budgeted revenue, indicating that the urban center had been ineffective in functioning as a Municipality center. In eastern Hubei Province, Huanggang accounts for 9.38% of provincial territory and 10.77% of provincial population, indicating its high proportion and potential influence in the province. Yet its development has been among the slowest, becoming a bottleneck to the province. The slow pace in economic development would slow down its urbanization pace, resulting in being sidelined from main stream developments in the province. To combat such shortfall, the Plan identified the following development opportunities:

(i) The provincial development strategy for modern urbanization describes "two circles and one belt", which will expand the Wuhan Circle to include Huanggang in forming a future metropolis;

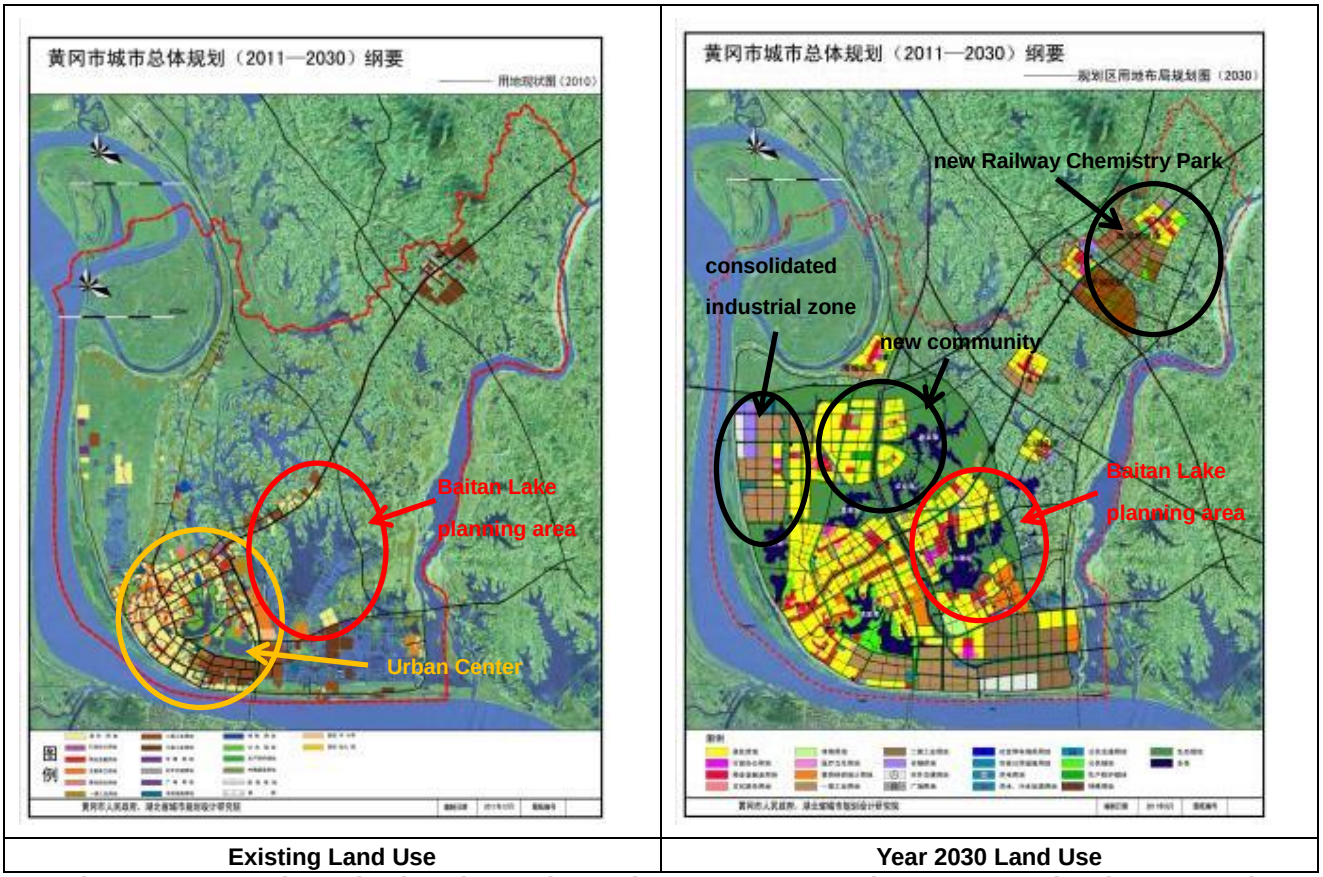
(ii) The Wuhan New Port and the Huanggang Lin Port Economic Zone, integrating the facilities and services of the two ports;

(iii) Completion of the Wuhan inter-city railway will merge Huanggang to within the 1-hr economic circle of Wuhan. Completion of the Huanggang Yangtze River Bridge will improve the inter-city road network among Huanggang, Ezhou and Wuhan;

(iv) Development of the urban New Eastern District (NED) in Huanggang and eastward relocation of the administration center will provide infrastructure and public services that cannot now be provided in the old urban center due to space constraint. The development of the New Eastern District is important in perfecting integrated city functions, bringing in new enterprises, creating new communities and driving the development of primary, secondary and tertiary industries.

58. The *Hubei Province Lake Protection Regulation* was promulgated on 30 May 2012 to strengthen the protection of lakes and their functions, to protect and improve their ecological environment, and to promote sustainable socio-economic development. The regulation calls for a list of lakes in the province that warrant the implementation of protection measures and delineates the duties and responsibilities of relevant government agencies for implementing the protection measures. Subsequently, the Hubei Provincial Government (HPG) on 12 December 2012 issued Document No. [2012]81, which listed 308 lakes in the province. The list includes 38 lakes in the Huanggang Municipality. Baitan Lake, which is included in the project, is on the list.

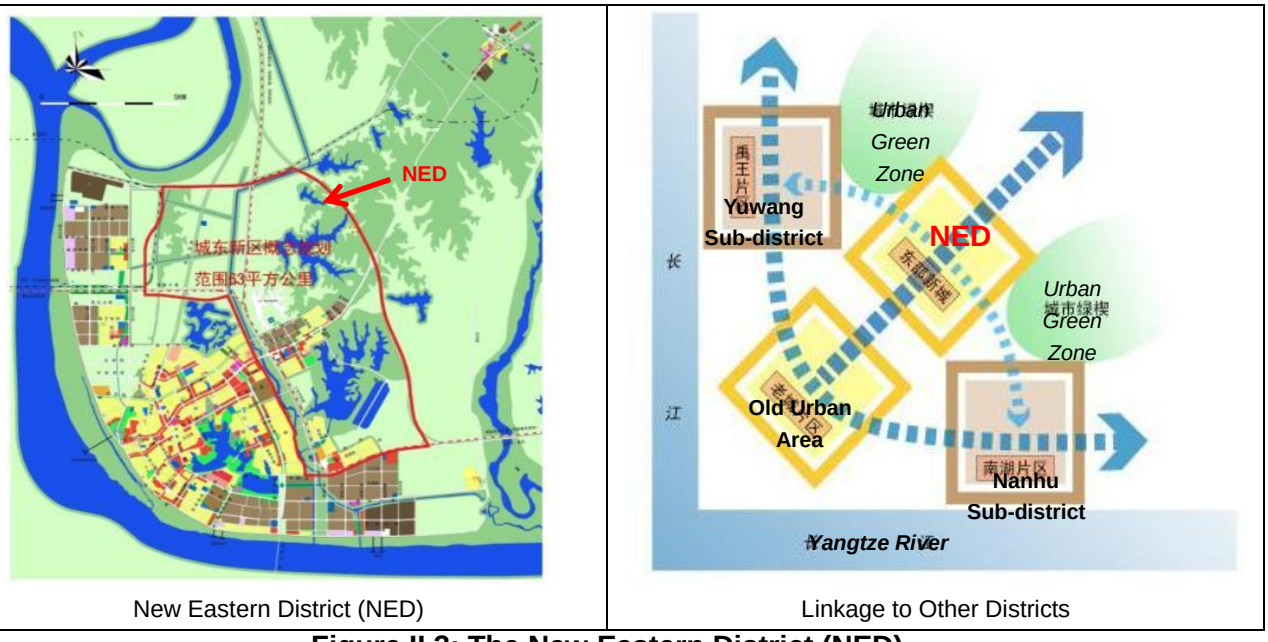
59. **New Eastern District (NED).** This project provides urban environment improvement to the NED, which is a key opportunity and action described in the *Huanggang Urban Master Plan (2011-2030)*. **Figure II.2** shows the existing and future land use according to the *Huanggang Urban Master Plan (2011-2030)*, illustrating the growth of the urban area.



Existing Land Use	Year 2030 Land Use

Figure II.2: Land use in the planned area in *Huanggang Urban Master Plan* (2011-2030)

60. The Conceptual Plan for NED was completed in September 2012. The NED covers 63 km^2 to be developed in three phases. **Figure II.3** shows the NED and its linkage to the old urban center. It will become the new urban center of Huanggang urban area.



New Eastern District (NED) | Linkage to Other Districts

Figure II.3: The New Eastern District (NED)

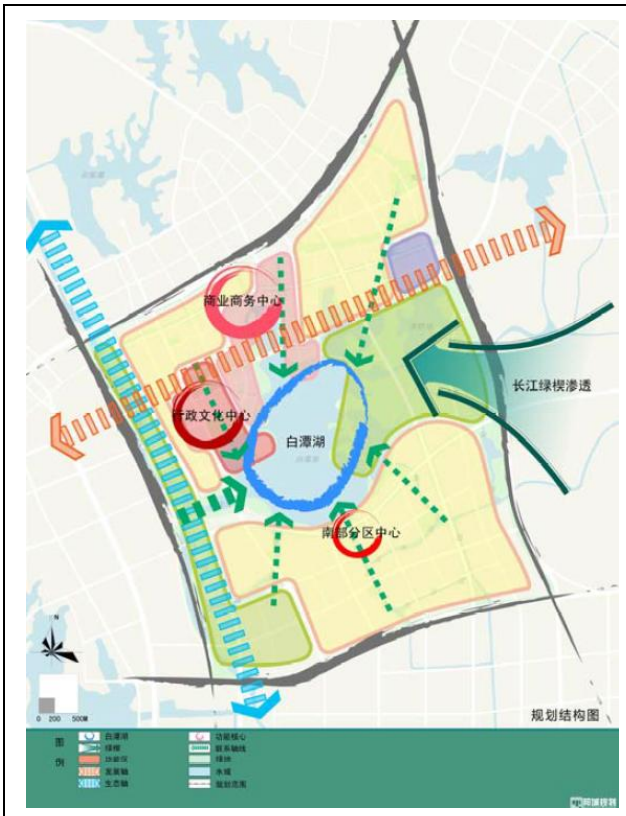
61. **Baitan Lake planning area.** A control plan has been prepared (**Figure II.4**) for 25.27 km^2 around Baitan Lake (hereafter referred to as the Baitan Lake planning area), within which the project is located. This project forms a key component of the plan in improving the water and ecological environment of Baitan Lake and nearby water bodies, and is also consistent with the *Huanggang New Eastern District Pan-Baitan Lake Area Water System Rehabilitation Plan* for improving flood prevention and control through connecting the river-lake water network.

NED and 25 km^2 Baitan Lake control plan area

Baitan Lake control plan

Figure II.4: Baitan Lake control plan for the New Eastern District

62. The Baitan Lake planning area integrates well with the existing city, incorporates a major green wedge in the eastern area, calls for the rehabilitation of Baitan Lake as the unifying element of the District, and incorporates new commercial and institutional hubs in the northeastern quadrant and an educational hub in the south. The road network plan integrates well with the existing city and surrounding areas (**Figure II.5**). The Baitan Lake planning area will have three principal hubs: a new government/institutional center in the northwest; a new commercial and business center to the north; and a new research and development and educational hub in the south (**Figure II.6**). All will be integrated with a revitalized Baitan Lake and new and restored wetlands to the east. The Baitan Lake planning area, comprising 25.27 km^2, will accommodate 180,000-200,000 people on 18.7 km^2 of constructed land in the longterm. HMG's HUCIC will finance and manage investments in the lake revitalization and all infrastructure; HMG will then lease serviced plots to residential and commercial developers, and will finance public buildings and facilities.



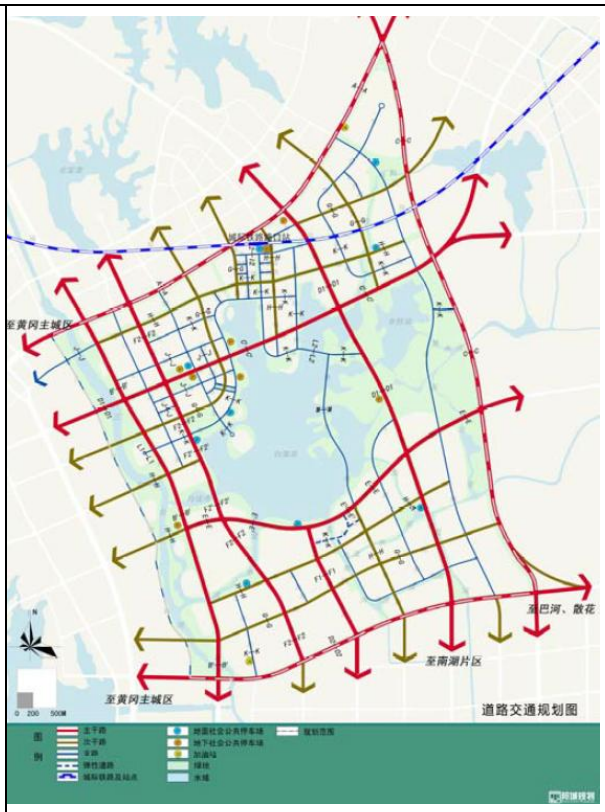


Figure II.5: Key planning principles and transport plan for Baitan Lake planning area

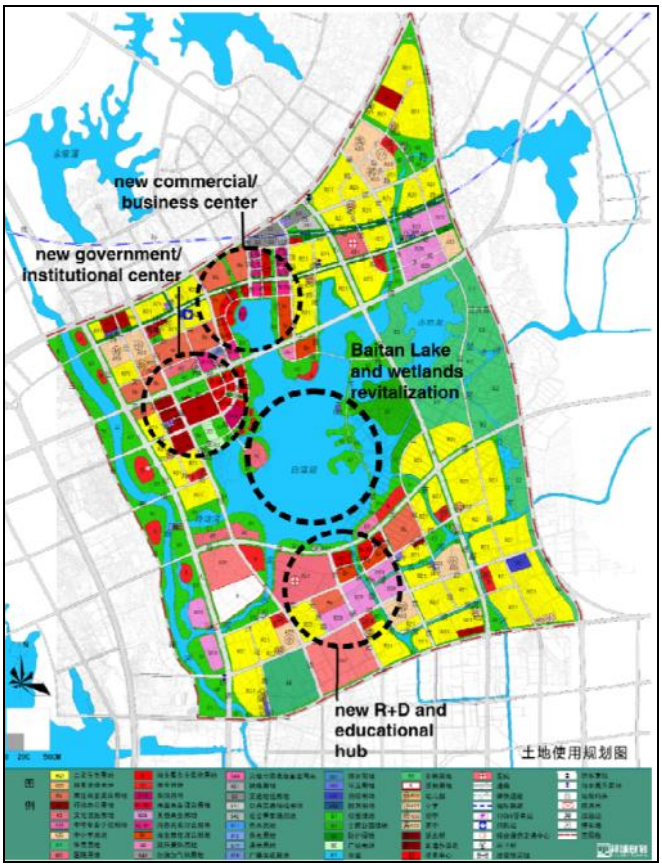


Figure II.6: Control plan for Baitan Lake planning area

B. Legal and Administrative Framework for Environmental Impact Assessment

63. The administrative framework for environmental impact assessment in the PRC consists of national, provincial and local (city) environmental protection authorities. The national authority is the Ministry of Environmental Protection (MEP), who promulgates laws, regulations and technical guidelines on environmental impact assessment and pollution prevention and control. On the provincial level are the Departments of Environmental Protection (DEP), acting as the gate-keeper for environmental impact assessment and pollution prevention and control in the province. They are often delegated the authority by MEP to approve environmental impact assessment reports for development planning and construction projects in the provinces, except those with national interest and those that cross provincial boundaries that would need MEP approval. The local or city-level Environmental Protection Bureaus (EPB) enforce environmental laws and conduct environmental monitoring within city limits. Local EPBs could be delegated the authority to approve environmental impact assessments by the provincial DEPs. For this project, the Hubei Provincial DEP has approval authority for the domestic environmental impact assessment reports for this project.

64. The release of the *Environmental Impact Assessment Public Participation Interim Guideline* in 2006 also requires that the public be involved in the EIA process. This was further clarified under *Technical Guidelines for Environmental Impact Assessment: Public Participation* (public comment

version, January 2011).

C. Laws, Regulations, Guidelines and Standards

65. **PRC requirements**. The following requirements of the PRC govern the way in which environmental protection and environmental impact assessment must be implemented. The suite of laws, regulations, guidelines and standards relevant to this project is shown in **Table II.1**, indicating the comprehensive coverage on PRC's environmental safeguard. These requirements cover pollution prevention and control on air, noise, water, ecology and solid waste. These requirements also provide technical guidelines on assessing atmospheric, noise, water and ecological impacts.

Table II.1: Relevant PRC laws, regulations, guidelines and standards

Laws and regulations	
1	*Environmental Protection Law*, December 26, 1989
2	*Atmospheric Pollution Prevention and Control Law*, September 1, 2000
3	*Noise Pollution Prevention and Control Law*, March 1, 1997
4	*Water Pollution Prevention and Control Law*, June 1, 2008
5	*Solid Waste Environmental Pollution Prevention and Control Law*, April 1, 2005
6	*Water Law*, October 1, 2002
7	*Water and Soil Conservation Law*, June 29, 1991, amended December 25, 2010
8	*Promotion of Clean Production Law*, January 1 2003
9	*Environmental Impact Assessment Law*, September 1, 2003
10	*Energy Conservation Law*, January 1, 1998
11	*Wild Animal Protection Law*, August, 2004
12	*Water and Soil Conservation Law,* March 1, 2011
13	*Cultural Relics Protection Law*, October 2002
14	*Cultural Relics Protection Implementation Regulation,* July 1, 2003
15	*Construction Project Environmental Protection and Management Regulation*, (State Department Order No. 253), November 29, 1998
16	*Plan Environmental Impact Assessment Regulation*, (State Department Order 559), October 1, 2009
Guidelines	
1	*Technical Guidelines for Plan Environmental Impact Assessment (on trial)* (HJ/T 130-2003)
2	*Technical Guidelines for Environmental Impact Assessment of Development Area* (HJ/T 131-2003)
3	*Directory for the Management of Different Categories of Construction Project Environmental Impact Assessment*, (MEP Order No. 2), October 1, 2008
4	*Circular on Strengthening the Management of Environmental Impact Assessment for Construction Projects Financed by International Financial Organizations*, (MEP Announcement No. [1993]324)
5	*Guidelines for Technical Review of Environmental Impact Assessment on Construction Projects* (HJ 616-2011)
6	*Technical Guidelines for Environmental Impact Assessment: General Program* (HJ 2.1-2011)
7	*Guidelines for Environmental Impact Assessment: Atmospheric Environment* (HJ 2.2-2008)
8	*Technical Guidelines for Noise Impact Assessment* (HJ 2.4-2009)
9	*Technical Guidelines for Environmental Impact Assessment: Surface Water Environment* (HJ/T 2.3-93)
10	*Technical Guidelines for Environmental Impact Assessment: Ground Water Environment* (HJ 610-2011)
11	*Technical Guideline for Environmental Impact Assessment: Ecological Impact* (HJ 19-2011)
12	*Environmental Impact Assessment Public Participation Interim Guideline*, (MEP Announcement No. [2006]28)
13	*Technical Guidelines for Environmental Impact Assessment: Public Participation (public comment version)*, (January 2011)

14	*Technical Guideline for Construction Project Environmental Risk Assessment* (HJ/T 169-2004)
15	*Technical Guideline on Environmental Monitoring Quality Management* (HJ 630-2011)
16	*Environmental Supervision Method* (MEP Order No. [2012] 21)
17	*National regulation for public disclosure of EIAs (NDRC, 2012)*
Standards	
1	*Ambient Air Quality Standard (GB 3095-1996) and Amendment* (MEP Announcement No. [2000]1)
2	*Ambient Air Quality Standards (GB 3095-2012)* [to replace GB 3095-1996 on January 1, 2016]
3	*Air Pollutant Integrated Emission Standard (GB 16297-1996)*
4	*Emission Standard for Odor Pollutants (GB 14554-93)*
5	*Environmental Quality Standard for Noise (GB 3096-2008)*
6	*Emission Standard for Community Noise (GB 22337-2008)*
7	*Emission Standard of Environmental Noise for Boundary of Construction Site (GB 12523-2011)*
8	*Technical Specifications to Determine the Suitable Areas for Environmental Noise of Urban Area, (GB/T 15190-94)*
9	*Environmental Quality Standards for Surface Water (GB 3838-2002)*
10	*Quality Standard for Ground Water (GB/T 14848-93)*
11	*Integrated Wastewater Discharge Standard (GB 8978-1996)*
12	*Environmental Quality Standard for Soils (GB 15618-1995)*
13	*Control Standard for Pollutants in Sludge for Agricultural Use (GB 4284-84)*
14	*The Classification Signs for Municipal Solid Waste (GB/T 19095-2008)*
15	*Classification and Assessment Standards for Municipal Solid Waste (CJJ/T 102-2004)*
16	*Technical Specification of Constructed Wetlands for Wastewater Treatment Engineering (HJ 2005-2010)*

66. There are two types of environmental impact assessment under PRC's *Environmental Impact Assessment Law* of 2003, for assessing environmental impacts due to planning of new development areas and due to project-specific activities respectively.

67. Two domestic environmental impact assessment reports have been prepared for this project:

(i) A planning environmental impact assessment report: *Planning Environmental Impact Report for the Huanggang New Eastern District Baitan Lake Area*, was prepared by the Hubei Environmental Science Research Institute (HESRI). This report was approved by the Hubei EPD on 4 December 2013.

(ii) For assessing project-specific environmental impacts, a construction project environmental impact report (EIR)[7]: *Environmental Impact Report for Rehabilitation of Urban Lakes and Rivers*, was prepared by the Hubei Gimbol Environmental Technology Co. Ltd. (Gimbol). The EIR [will be] approved in January 2013.

68. In addition to the above EIRs, a Soil Erosion Prevention Plan (SEPP) and a Feasibility Study Report (FSR) were also prepared for this project. This project EIA is based on information and findings provided in the planning and construction project EIRs, the SEPP and the FSR.

[7] The *Directory for the Management of Different Categories of Construction Project Environmental Impact Assessment* classifies environmental impact assessments for construction projects into 3 categories with different reporting requirements, based on the 'significance' of potential environmental impact due to the project and the environmental sensitivity of the project site as described in this Directory. An Environmental Impact Report (EIR) is required for construction projects with potential significant environmental impacts. An Environmental Impact Table (EIT) is required for construction projects with less significant environmental impacts. An Environmental Impact Registration Form (EIRF) is required for construction projects with the least significant environmental impacts.

69. **Hubei requirements (external supervision)**. Following the issue in July 2012 of MEP Order No. 21: *Environmental Supervision Method* which became effective on September 1, 2012, the Hubei EPD issued the *Temporary Method for Implementation of Environmental Supervision* (HEPD Document No. [2012] 319), to require environmental supervision by a qualified third party entity during the construction stage of projects in the province with potentially significant environmental impacts. This requirement, which is compatible with ADB's policy requirement for external environment monitoring for category A projects, is applicable to this project.

70. **ADB environmental safeguard requirements.** This project is classified as Category A for environment on the basis of ADB's Rapid Environmental Assessment (REA), requiring the submission of a comprehensive environmental impact assessment (EIA) report. This project EIA has been prepared under the provisions of the ADB's safeguard policy statement[8] which requires a number of critical considerations, including: (i) a project-specific GRM; (ii) assessment of direct, indirect, induced and cumulative impacts; (iii) due diligence of project associated facilities; (iv) protection of physical cultural resources; (v) climate change mitigation and adaptation; (vi) occupational and community health and safety requirements (including emergency preparedness and response); (vii) impacts on livelihoods through environmental media; (viii) biodiversity conservation; and (ix) ensuring that the EMP includes an implementation schedule and measurable performance indicators, these requirements are usually weak in PRC EIAs.

71. **Relevant international agreements.** The PRC is a signatory to a number of international agreements relevant to environment protection. Those relevant to the project, along with the date of signing by the PRC, are listed in **Table II.2**.

Table II.2: International agreements with the PRC as a signatory

No.	Name of Agreement	PRC Signing Date	Agreement Objective
1	*Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat*	December 21, 1975	To stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the wetlands' ecological functions and their economic, cultural, scientific, and recreational values
2	*Montreal Protocol on Substances That Deplete the Ozone Layer*	January 1, 1989	To protect the ozone layer by controlling emissions of substances that deplete it
3	*Convention on Biological Diversity*	December 29, 1993	To develop national strategies for the conservation and sustainable use of biological diversity
4	*United Nations Framework Convention on Climate Change*	March 21, 1994	To achieve stabilization of greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system
5	*United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification*	December 26, 1996	To combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements
6	*Kyoto Protocol to the United Nations Framework Convention*	February 23, 2005	To further reduce greenhouse gas emissions by enhancing the national programs of developed countries aimed at this

[8] ADB. 2009. *Safeguard Policy Statement.* Manila.

No.	Name of Agreement	PRC Signing Date	Agreement Objective
	on Climate Change		goal and by establishing percentage reduction targets for the developed countries

D. Evaluation Standards

72. In PRC's EIA requirements listed in Table II.1 above, ambient conditions of air, noise and water quality in the project area determine the appropriate category of emissions and effluent standards for the construction and operational phases of built infrastructure. However, the World Bank Group (WBG) Environmental Health and Safety (EHS) guidelines[9] (see below) are based on best practice construction and operational procedures. Both the PRC standards and EHS guidelines are used in the assessments and the PRC standards are used for compliance checking of potential impacts from this project.

73. **Air quality.** The PRC ranks air quality into three classes according to its *Ambient Air Quality Standard* (GB 3095-1996 and amendment in 2000), with Class I having the best air quality and Class III the worst air quality. The ambient air quality in the assessment area of this project has been assigned to meet GB 3095-1996 Class II standards. A new standard has been issued in 2012 (GB 3095-2012), which will become effective on January 1, 2016, replacing GB 3095-1996. GB 3095-2012 combines Classes II and III and therefore will only have two air quality classes: Class I and Class II. It also introduces $PM_{2.5}$ standards and makes more stringent the NO_2 standards. The WBG adopted the WHO standards for its EHS standards for air quality.

74. On 10 September 2013, the State Council announced the *Air Pollution Prevention Action Plan* for the PRC (State Council [2013] No. 37). The action plan sets 2017 targets on reducing PM_{10} emissions in prefecture level cities by more than 10%; $PM_{2.5}$ emissions by approximately 25%, 20% and 15% in Beijing-Tianjin-Hebei region, Yangtze River Delta and Pearl River Delta respectively; and controlling annual average $PM_{2.5}$ levels in Beijing at around 60 μg/m^3. Among the 35 actions identified and described in the plan, the following are deemed to be applicable to the development of Baitan Lake planning area:

- Strengthen control on areal source pollution including controlling dust pollution during construction;
- Strengthen control on point source pollution including traffic management and prioritizing public and non-motorized modes of transportation;
- Strictly implement total emission pollution control, with compliance with such controls on SO_2, NO_x, dust and volatile organics as a pre-requisite in approving construction project Environmental Impact Reports;
- Optimize spatial pattern in urban and new district planning to facilitate better air pollutant dispersion;

[9] World Bank Group. 2007. Environmental, health and safety guidelines - General EHS guidelines. Washington D.C.

- Strengthen laws, regulations and standards on controlling air pollution;
- Strengthen capacities in environmental management and supervision system;
- Increase environmental regulatory enforcement;
- Implement environmental information disclosure;
- Strictly enforce accountability;
- Establish monitoring warning system;
- Develop contingency plan;
- Adopt timely contingency measures for public health protection during serious air pollution events

75. The WHO sets up AQG standards for various air quality parameters for the protection of public health. Yet recognizing that progressive actions are needed to achieve these standards and the financial and technological limitations of some countries, cities or localities especially in developing countries, the WHO also established interim targets as intermediate milestones towards achieving the AQG.

76. **Table II.3** compares the PRC's GB 3095-1996 Class II standards with the GB 3095-2012 standards and the World Bank Group's EHS standards.

Table II.3: Comparison of PRC and WBG ambient air quality standards

Air Quality Parameter	Averaging Period	PRC Class II (μg/m^3)		World Bank Group EHS[10] (μg/m^3)	
		GB 3095-1996	GB 3095-2012	Interim Targets	AQG
SO_2	1-year	60	60	n/a	n/a
	24-hour	150	150	50-125	20
	1-hour	500	500	n/a	n/a
TSP	1-year	200	200	n/a	n/a
	24-hour	300	300	n/a	n/a
PM_{10}	1-year	100	100	30-70	20
	24-hour	150	150	75-150	50
$PM_{2.5}$	1-year	n/a	n/a	15-35	10
	24-hr	n/a	150	37.5-75	25
	1-hour	n/a	350	n/a	n/a
NO_2	1-year	80	40	n/a	40
	24-hour	120	80	n/a	n/a
	1-hour	240	200	n/a	200
CO	24-hour	4,000	4,000	n/a	n/a
	1-hour	10,000	10,000	n/a	n/a

[10] World Bank Group 2007, ibid.

Note: n/a = not available

77. Longer averaging period such as 1-year as shown in **Table II.3** is more applicable to assessing impacts from multiple as well as regional sources; while shorter averaging periods such as 24-hour and 1-hour are more applicable to assessing short term impacts from project related activities, such as from peak hour traffic or daily or peak construction activities.

78. Comparing the PRC Class II standards with the WBG's EHS standards, **Table II.3** shows that for 24-hr SO_2, both GB 3095-1996 and 3095-2012 standards (150 μg/m^3) are less stringent than the upper limit of the Interim Target (125 μg/m^3); for 24-hr PM_{10}, both GB 3095-1996 and 3095-2012 standards (150 μg/m^3) are the same as the upper limit of the Interim Target (125 μg/m^3); for 24-hr $PM_{2.5}$, the GB 3095-2012 standard is twice the upper limit of the Interim Target (75 μg/m^3); and for 24-hr NO_2, the GB 3095-1996 standard (240 μg/m^3) is less stringent than, while the GB 3095-2012 standard (200 μg/m^3) is the same as, the AQG (200 μg/m^3).

79. Fugitive emission of particulate matter (such as dust from construction sites) is regulated under PRC's *Air Pollutant Integrated Emission Standard* (GB 16297-1996), which sets 120 mg/m^3 as the maximum allowable emission concentration and ≤ 1.0 mg/m^3 as the concentration limit at the boundary of construction sites, with no specification on the particular matter's particle diameter.

80. **Noise.** According to the *Technical Specifications to Determine the Suitable Areas for Environmental Noise of Urban Area* (GB/T 15190-94), the area within 200 m on both sides of road or road junction should comply with the corresponding provisions in *Environmental Quality Standard for Noise* (GB 3096-2008). GB 3096-2008 categorizes five functional areas based on their tolerance to noise pollution: from Category 0 to Category 4. Category 0 is for areas with convalescent facilities that are the least tolerant to noisy environment and therefore has the most stringent day and night time noise standards. Category 1 is for areas predominated by residential areas, hospitals and clinics, educational institutions and research centers. Category 2 is for areas with mixed residential and commercial functions. Category 3 is for areas with industrial production and storage and logistics functions. Category 4 is for regions adjacent to traffic noise sources such as major roads and highways, and is subdivided into 4a and 4b with the former applicable to road and marine traffic noise and the latter applicable to rail noise. Standards for various functional area categories and in comparison with the WBG's EHS guidelines are listed in **Table II.4,** showing that the EHS guidelines have lower noise limits for residential, commercial and industrial mixed areas but higher noise limits for industrial areas and night time noise near trunk roads.

Table II.4: Environmental quality standards for noise (equivalent sound level L_{Aeq}: dB)

Noise Functional Area Category	Applicable Area	GB 3096-2008 Standards		WBG EHS[11] Standards	
		Day 06:00-22:00	Night 22:00-06:00	Day 07:00-22:00	Night 22:00-07:00
0	Areas needing extreme quiet, such as convalescence areas	50	40	55	45
1	Areas mainly for residence, hospitals, cultural and educational institutions, administration offices	55	45		
2	Residential, commercial and industrial mixed areas	60	50		
3	Industrial areas, warehouses and logistic parks	65	55	70	70
4a	Area on both sides of urban trunk road	70	55		

Note: Functional Area 4 is divided into 4a for trunk roads and 4b for railway lines.

81. PRC's *Emission Standard of Environmental Noise for Boundary of Construction Site* (GB 12523-2011) regulates construction noise, limiting construction noise levels at the construction site boundary to 70 dB(A) in the day time (06:00 to 22:00) and 55 dB(A) at night (22:00 – 06:00). The WBG does not have standards for construction noise per se, but applies the same noise standards listed in **Table II.4** above to the receptors during construction activities.

82. **Surface water quality.** For water quality assessment, the determining standard is PRC's *Environmental Quality Standards for Surface Water* (GB 3838-2002). It defines five water quality categories for different environmental functions. Category I is the best, suitable for head waters and National Nature Reserves. Category II is suitable for drinking water sources in Class I protection areas, habitats for rare aquatic organisms, breeding grounds for fish and crustaceans, and feeding grounds for fish fries. Category III is suitable for drinking water sources in Class II protection areas, wintering grounds for fish and crustaceans, migration routes, water bodies for aquaculture and capture fishery, and swimming activities. Category IV is suitable for general industrial use and non-contact recreational activities. Category V is the worst which is only suitable for agricultural and scenic water uses. These standards are set out in **Table II.5**. The WBG has guidelines on effluent quality standards but not ambient water quality, and recognizes the use of local ambient water quality criteria for EHS purpose.

Table II.5: Environmental quality standards for surface water GB 3838-2002

Parameter	Category				
	I	II	III	IV	V
pH	6 ~ 9	6 ~ 9	6 ~ 9	6 ~ 9	6 ~ 9
Dissolved oxygen (DO) [mg/L]	90% saturation or ≥7.5	≥6	≥5	≥3	≥2
Permanganate index (I_{Mn}) [mg/L]	≤2	≤4	≤6	≤10	≤15

[11] World Bank Group 2007, ibid.

Parameter	Category				
	I	II	III	IV	V
Chemical oxygen demand (COD) [mg/L]	≤15	≤15	≤20	≤30	≤40
5-day Biochemical oxygen demand (BOD_5) [mg/L]	≤3	≤3	≤4	≤6	≤10
Ammonia nitrogen (NH_3-N) [mg/L]	≤0.15	≤0.5	≤1.0	≤1.5	≤2.0
Total phosphorus (as P) [mg/L]	≤0.02	≤0.1	≤0.2	≤0.3	≤0.4
Lakes & reservoirs	≤0.01	≤0.025	≤0.05	≤0.1	≤0.2
Total nitrogen (lakes, reservoirs, as N) [mg/L]	≤0.2	≤0.5	≤1.0	≤1.5	≤2.0
Copper (Cu) [mg/L]	≤0.01	≤1.0	≤1.0	≤1.0	≤1.0
Zinc (Zn) [mg/L]	≤0.05	≤1.0	≤1.0	≤2.0	≤2.0
Fluoride (as F^-) [mg/L]	≤1.0	≤1.0	≤1.0	≤1.5	≤1.5
Selenium (Se) [mg/L]	≤0.01	≤0.01	≤0.01	≤0.02	≤0.02
Arsenic (As) [mg/L]	≤0.05	≤0.05	≤0.05	≤0.1	≤0.1
Mercury (Hg) [mg/L]	≤0.0005	≤0.0005	≤0.0001	≤0.001	≤0.001
Cadmium (Cd) [mg/L]	≤0.001	≤0.005	≤0.005	≤0.005	≤0.01
Chromium (Cr, hexavalent) [mg/L]	≤0.01	≤0.05	≤0.05	≤0.05	≤0.1
Lead (Pb) [mg/L]	≤0.01	≤0.01	≤0.05	≤0.05	≤0.1
Cyanide (CN) [mg/L]	≤0.005	≤0.05	≤0.2	≤0.2	≤0.2
Volatile phenol [mg/L]	≤0.002	≤0.002	≤0.005	≤0.01	≤0.1
Total petroleum hydrocarbon (TPH) [mg/L]	≤0.05	≤0.05	≤0.05	≤0.5	≤1.0
Anionic surfactant [mg/L]	≤0.2	≤0.2	≤0.2	≤0.3	≤0.3
Sulfide [mg/L]	≤0.05	≤0.1	≤0.2	≤0.5	≤1.0
Fecal coliform bacteria [number/L]	≤200	≤2000	≤10000	≤20000	≤40000

83. Discharge of wastewater from construction sites and supernatant water from dredged sediment disposal sites is regulated under PRC's *Integrated Wastewater Discharge Standard* (GB 8978-1996). Class I standards apply to discharges into Category III water bodies under GB 3838-2002. Class II standards apply to discharges into Categories IV and V water bodies. Class III standards apply to discharges into municipal sewers going to municipal WWTPs with secondary treatment. **Table II.6** shows these standards.

Table II.6: Wastewater discharge standards for construction sites and dredged sediment disposal Sites according to GB 8978-1996

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

84. **Soil and river sediment quality.** Soil quality in the PRC is divided into three classes according to the *Environmental Quality Standard for Soils* (GB 15618-1995). Class 1 represents the best and Class 3 the worst. The PRC does not have quality standards for sediments in waterways such as rivers, lakes, reservoirs and the sea. It is acceptable for EIRs to adopt the *Control Standards for Pollutants in Sludges from Agricultural Use* (GB 4284-84) for assessing sediment quality. The rationale being that the physical nature of river sediment is similar to sludge and that the dredged sediment in this project would be used as wetland construction materials for planting of wetland vegetation. **Table II.7** presents both GB 15618-1995 (soil) and GB 4284-84 (sludge for agricultural use) standards. The WBG does not have EHS standards for soil and sediment quality.

Table II.7: Comparison of environmental quality standards for soil and control standards for pollutants in sludge for agricultural use

Parameter	Soil pH	Maximum Allowable Concentration (mg/kg dry weight)						
		GB 15618-1995 (Soil)					GB 4284-84 (Sludge for Agricultural Use)	
		Class 1	Class 2			Class 3		
		Back ground	<6.5	6.5~7.5	>7.5	>6.5	<6.5	≥6.5
Cadmium (Cd)		0.20	0.30	0.30	0.60	1.0	5	20
Mercury (Hg)		0.15	0.30	0.50	1.0	1.5	5	15
Arsenic (As)	Paddy	15	30	25	20	30	75	75
	Dry land	15	40	30	25	40		
Copper (Cu)	Farm land	35	50	100	100	400	250	500
	Orchard	---	150	200	200	400		
Lead (Pb)		35	250	300	350	500	300	1000
Chromium (Cr)	Paddy	90	250	300	350	400	600	1000
	Dry land	90	150	200	250	300		
Zinc (Zn)		100	200	250	300	500	500	1000
Nickel (Ni)		40	40	50	60	200	100	200
Boron (B, soluable)		---	---	---	---	---	150	150
DDT		0.05	0.50			1.0	---	---
666 (Lindane)		0.05	0.50			1.0	---	---
Mineral oil		---	---	---	---	---	3000	3000
Benzo(a)pyrene		---	---	---	---	---	3	3

85. **Assessment areas and evaluation standards for the project.** The following assessment areas and PRC evaluation standards were adopted for this project in the domestic planning EIR and project EIR in accordance with the requirements set forth by the Huanggang EPB (**Table II.8**). The assessment area for the planning EIR covers the whole 25.27 km^2 of the Baitan Lake planning area while the project EIR covers the project area of influence. In this report, the use of "**planning area**" refers to the 25.27 km^2 Baitan Lake planning area included in the planning EIR, while the use of "**project area of influence**" refers to the area identified in the project EIR that would potentially be affected by this project, as shown in Table II.8.

Table II.8: Assessment areas and PRC evaluation standards adopted for this project

Type of Standard	Environmental Media	Applicable PRC Standard	Planning EIR Assessment Area	Project EIR Project Area of Influence
Environmental Quality Standard	Ambient air quality	Class II standards in *Ambient Air Quality Standard* (GB 3095-1996 and its revision for before 1 January 2016; and GB 3095-2012 for after 1 January 2016)	25.27 km^2 of the Baitan Lake planning area	Up to 200 m beyond the permanent and temporary engineering land take areas
	Noise	*Environmental Quality Standard for Noise* (GB 3096-2008) • Functional Area Category 4a standards for areas within 35 m of road red line • Functional Area Category 2 standards for areas beyond 35 m of road red line	25.27 km^2 of the Baitan Lake planning area	Up to 200 m beyond the permanent and temporary engineering land take areas
	Surface water quality	*Environmental Quality Standards for Surface Water* (GB 3838-2002), Category III standards	• 5.5 km of the Huanggang section of the Yangtze River from the Jiangbei Shipyard to the Ba River confluence • Ba River downstream section • Santai River • Baitan Lake	• Ba River • Santai River • Xingfu Reservoir • Baitan Lake
		Environmental Quality Standards for Surface Water (GB 3838-2002), Category IV standards	Not applicable	• Chiye Lake • Linglong Bay • Jinshui River • Qingshui River • Canglang River • Dongtai River • Dongchang River • Chushui River
	Ground water quality	*Quality Standard for Ground Water* (GB/T 14848-93), Category II standards	25.27 km^2 of the Baitan Lake planning area	Not applicable
	Ecology	No applicable standards	25.27 km^2 of the Baitan Lake planning area	"Footprint" of the permanent and temporary engineering land take areas
	Soil quality	*Environmental Quality Standard for Soils* (GB 15618-1995), Class 1 standards	25.27 km^2 of the Baitan Lake planning area	Not applicable
	Lake and river sediment quality	*Control Standards for Pollutants in Sludges from Agricultural Use* (GB 4284-84)	Not applicable	Dredged sediment from lakes and rivers
	Physical cultural resources	No applicable standard but controlled under PRC's *Cultural Relics Protection Law*	Not applicable	"Footprint" of the permanent and temporary engineering land take areas
	Occupational health	No applicable standard but	Not applicable	Construction sites within the

Type of Standard	Environmental Media	Applicable PRC Standard	Planning EIR Assessment Area	Project EIR Project Area of Influence
	and safety	controlled under PRC's *Labor Law*		"footprint" of the permanent and temporary engineering land take areas
	Community health and safety	No applicable standard	Not applicable	Up to 200 m beyond the "footprint" of the permanent and temporary engineering land take areas
Pollutant Emission Standard	Air pollutant	Air Pollutant Integrated Emission Standard (GB 16297-1996), Class II and fugitive emission standards	25.27 km^2 of the Baitan Lake planning area	Construction sites within the "footprint" of the permanent and temporary engineering land take areas
	Noise	Emission Standard of Environmental Noise for Boundary of Construction Site (GB 12523-2011)	Construction sites within the 25.27 km^2 Baitan Lake planning area	Construction sites within the "footprint" of the permanent and temporary engineering land take areas
		Emission Standard for Community Noise (GB 22337-2008)	Residential and commercial areas within the 25.27 km^2 Baitan Lake planning area	Not applicable
	Wastewater	*Integrated Wastewater Discharge Standard* (GB 8978-1996), Class I standard (for discharging into Category III water bodies)	Not applicable	Construction sites within the "footprint" of the permanent and temporary engineering land take areas
		Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant (GB 18918-2002), Class 1(B) standard	Domestic wastewater within the 25.27 km^2 Baitan Lake planning area	Not applicable

Source: Planning EIR and Project EIR

E. Assessment Period

86. The duration of impacts assessed in this EIA covers the construction phase and the first three years in the operational phase of the project. Based on the program depicted in the FSR, construction is scheduled for commencement in the 4th quarter of 2015 and completion by the end of 2019. The project implementation schedule is presented in the EMP, **Figure EMP-3**.

III. DESCRIPTION OF THE PROJECT

A. Project Rationale

87. This project is located in the Huangzhou District in Huanggang Municipality. Huanggang Municipality administers over one district (Huangzhou), two county level cities (Wuxue and Macheng), seven counties (Hong'an, Luotian, Yingtian, Xishui, Qichun, Huangmei and Tuanfeng), the county level Longganhu Farm and 134 villages. The total administrative territory is 17,446 km^2, accounting for 9.4% of the size of Hubei Province. With a population of over 7.4 million, it is the second largest municipality in the province after Wuhan. Its urban center is located in Huangzhou District with a population of approximately 0.35 million in a built-up area of approximately 35 km^2.

88. As described earlier, Huanggang's economic development is benefiting from national policies and support such as "The Rise of Central China Plan" and the socio-economic development pilot district of the Dabie Mountain Revolution Old District, as well as provincial policies such as the "Wuhan 1+8 City Cluster" (see **Figure II.1**). Its close proximity to Wuhan, the completion of the Wuhan inter-city railway, and the integration of the Wuhan New Port and the Huanggang Lin Port Economic Zone will expand the Wuhan circle to include Huanggang in forming a future metropolis.

89. Despite its size in terms of population and administrative area and the above policy support, Huanggang lags behind in economic development compared to other cities in the province. It has become a bottleneck in the economic growth of Hubei Province. Its GDP increase in 2010 over 2009 was ranked 14th in the province. Its per capita GDP of CNY 13,421 in 2010 was less than half of the provincial average (CNY 27,614). Its 2010 urban per capita disposable income of CNY 12,832 was below the provincial average of CNY 16,058, and ranked 13th among cities in the province. Its 2010 rural per capita net income of CNY 4,634 was also below the provincial average of CNY 5,832, and ranked 14th among cities in the province.

90. Huangzhou District, being the urban center of Huanggang, has been described in the *Huanggang Urban Master Plan (2011-2030)* as being ineffective in driving the growth of other cities and counties in Huanggang. The main constraint is space limitation for growth in the existing aging urban center. One of the key actions in the *Huanggang Urban Master Plan (2011-2030)* is to develop the 63 km^2 New Eastern District (NED) allowing expansion of the existing urban center to the east. The NED will become the new urban center with administrative, residential, commerce and trade, logistics, recreational and aesthetics functions.

91. The NED development will start within the 25.27 km^2 area around Baitan Lake and Chiye Lake. The urban lake environment at present is not conducive to improving the quality of living around these lakes due to poor lake water quality and low aesthetics and scenic value. These lakes have been receiving untreated domestic wastewater from nearby villages, non-point source pollutants from nearby

farmland, and pollutants from fish culture in and around these lakes. According to the planning EIR[12], approximately 556 t/d of domestic wastewater is generated from the villages within the 25.27 km^2 Baitan Lake planning area. Water quality data for Baitan Lake and Chiye Lake provided by the Huanggang Project Management Office (HPMO) showed worse than Category V water quality in Baitan Lake and Category V water quality in Chiye Lake due to high levels of chemical oxygen demand (COD) and permanganate index, compared to the planning target of Category IV water quality for these two lakes. Data from water quality monitoring conducted in March 2013 for this project by the Huanggang Environmental Monitoring Station (HEMS) showed worse than Category V water quality for Baitan Lake due to high levels of total nitrogen (TN), and Category V water quality in Chiye Lake also due to high TN levels.

92. The surface area of Baitan Lake used to be approximately 1,053 ha. Throughout recent decades, much of the lake area has been bund up to form fish ponds for aquaculture, or reclaimed for land development. The present lake surface area has shrunk to 362 ha, reducing the lake's functions for irrigation, storm water storage and drainage, pollutant assimilation and scenic aesthetics. Discharges described above have also caused siltation problems in the lake and nearby rivers, with deposition depth averaging 1.8 m and up to 2.3 m at some locations in Baitan Lake[13]. This further reduces the storm water holding capacity of Baitan Lake.

93. Siltation in the lakes not only reduces lake volume but also brought in polluted sediment. Baseline sediment quality monitoring for this project conducted by HEMS in March 2013 showed that the sediment in Baitan and Chiye Lakes was not contaminated with heavy metals but had high levels of nutrients (nitrogen and phosphorus). Data showed that the total phosphorus (TP) and total nitrogen (TN) levels in Baitan Lake sediment ranged from 1272~1,410 mg/kg (dry weight) and 5,280~5,955 mg/kg respectively; and TP and TN levels in Chiye Lake sediment ranged from 928~1,093 mg/kg and 4,027~4,114 mg/kg respectively. These levels are considerably higher than those at some rivers and river mouths flowing into Chao Lake in Anhui Province (average TP = 814 mg/kg, average TN = 1,172 mg/kg) where ADB intervention included sediment dredging to remove sediment nutrient that has been contributing to the eutrophication of Chao Lake[14].

94. With the NED development, the drainage system in the Baitan Lake area needs to be improved to reduce waterlogging[15] risk in the NED. Presently Baitan Lake has one inflow point and one outflow point. Water comes into Baitan Lake from the Xingfu Reservoir (which is for irrigation and not for

[12] Hubei Environmental Science Research Institute. 2012. Plan environmental impact report for the Huanggang New Eastern District Baitan Lake area. Review version, July 2012.

[13] Hubei Water and Hydropower Planning and Survey Design Institute. 2012. Huanggang New Eastern District Pan-Baitan Lake Area water system rehabilitation plan.

[14] ADB. 2012. Anhui Chao Lake Environmental Rehabilitation Project. Manila.

[15] "Waterlogging" is a special term used in the PRC. It refers to flooding in built-up areas where storm water runoff in excess of the urban drainage system capacity converges in low-lying areas, causing disruption to traffic, damage to property and threatening safety and lives of residents.

potable use) supplemented by water from Tuojia Lake and Chiye Lake. Jinshui River (presently known as Lannigou) is the only outflow from Baitan Lake into Santai River (which flows to the Ba River and then the Yangtze River). Jinshui River has no embankment and its bank level is basically the same level as the farmland on adjacent sides with little flood control capacity. The river bank is mainly natural steep slope of clayey soil with poor strength and suffering serious soil erosion. During the flood season, high water in the section of Yangtze River off NED is long lasting combined with slow drawdown. The probability of waterlogging from precipitation occurring concurrently with high water in the Yangtze River is high, therefore posing considerable risk to waterlogging incidents in the planning area unless the drainage system is improved. **Figure III.1** shows the water flow pattern for Baitan Lake.

95. This project addresses the above issues through engineering and non-engineering components (**Table III.1**). The environment of Baitan and Chiye Lakes will be improved by removing polluted sediment from the lake bottom, constructing engineered wetlands to improve pollutant assimilation, and constructing a Baitan Lake ring road for non-motorized traffic to enhance aesthetics and scenic enjoyment by future NED residents. River channels will be widened or new channels constructed to improve river-lake connection, thus improving water flow and drainage capacity, and reducing the risk of waterlogging. Solid waste will be collected from the lake surface and from the maintenance of wetland plants and transferred to sanitary landfill for disposal, reducing pollution and enhancing the scenic value of these lakes (see also para. 195). Non-engineering measures will include training and capacity building on water quality, urban lake and solid waste management, as well as public awareness campaign. These measures will improve HMG's ability in managing the urban river and lake systems in Huanggang. **Figure III.2** shows the locations of the project components.

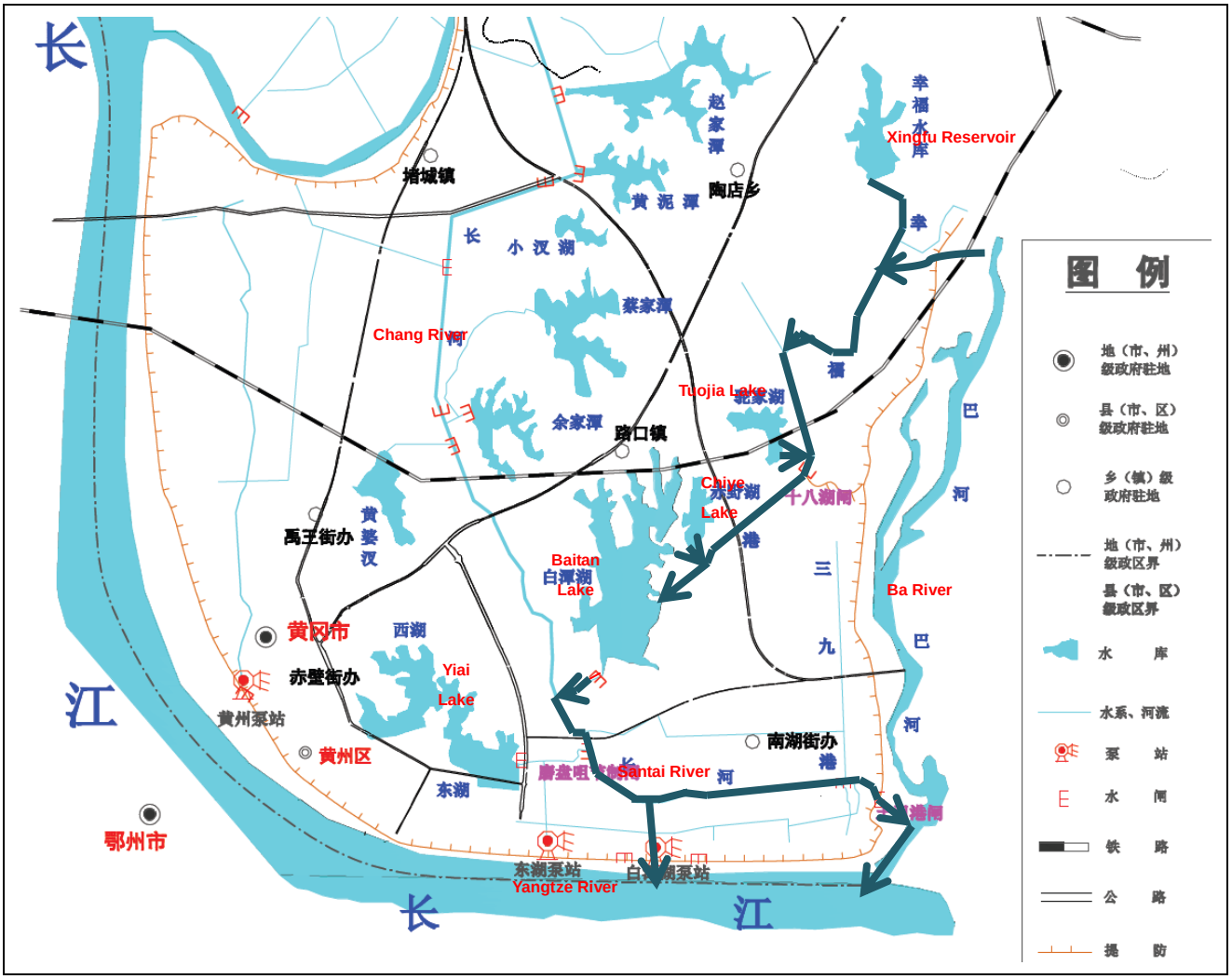


Figure III.1: Existing Baitan Lake water flow pattern

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Table III.1: Summary of project components and scope

Component	Sub-component	Scope
1 Urban lake and river enhancement	1-1 Lake enhancement	• Construct a 13.3 km lake ring road for non-motorized traffic (including 9 small bridges) • Construct 14 km of ecological embankment with 89.02 ha of vegetated buffer strips and 2.8 km of embankment strengthening <u>Baitan Lake</u>: • Dredge lake sediment: 404,405 m^3 • Construct 3 sub-surface flow wetland: total 3.316 ha plus 1.346 ha detention basins • 1.458 ha plus 0.459 ha detention basin • 0.929 ha plus 0.543 ha detention basin • 0.929 ha plus 0.344 ha detention basin • Plant aquatic vegetation: 112 ha • Stock fish species: 24 t • Stock benthic species: 128 t <u>Chiye Lake</u>: • Dredge lake sediment: 135,000 m3 • Construct one sub-surface flow wetland: 0.519 ha plus 0.179 ha detention basin • Construct one surface flow wetland: 80.2 ha • Plant aquatic vegetation: 14.28 ha • Stock fish species: 3.15 t • Stock benthic species: 16.8 t • Purchase equipment for waste collection (one 20 t/d and three 2 t/d boats) and water quality monitoring and maintenance
	1-2 River enhancement	• Enhance 7 rivers: Linglong Bay, Jinshui River, Dongtai River, Qingshui River, Canglang River, Dongchang River and Chushui River totaling 10.78 km to re-establish hydraulic circulation between rivers and lakes

Component	Sub-component	Scope
		• Construct 24.3 km of ecological embankments and 2.56 km of embankment strengthening • Dredge river sediment: 201,002 m^3 • Excavate river bank soil: 343,461 m^3 • Plant aquatic vegetation in the above rivers: 17.7 ha • Plant vegetated buffer strips along river banks: 47.7 ha • Construct 2 sluice gates: one each at Linglong Bay and Jinshui River near their confluences with Santai River (see para. 127 and 319 for function and operational mode) • Construct 3 bridge walkways: 1 across Jinshui River and 2 across Chushui River
2 Solid waste management		• Construct a solid waste collection pier at Baitan Lake • Construct a 30 t/d solid waste transfer station next to the pier • Purchase of two 8 t garbage trucks • Provide 260 waste separation garbage bins
3 Capacity development and institutional strengthening		• Provide project management support for smooth and timely implementation of the project in line with ADB procedures and guidelines. • Provide institutional strengthening support to improve sectoral and operational performance; strategic solid waste management planning; water quality monitoring and model updating; operators' operating capacity strengthening. • Public awareness campaigns on lake ecosystems, environmental protection, public health, and solid waste sorting and recycling • Provide technical support for external resettlement and environment monitoring.

Source: FSR

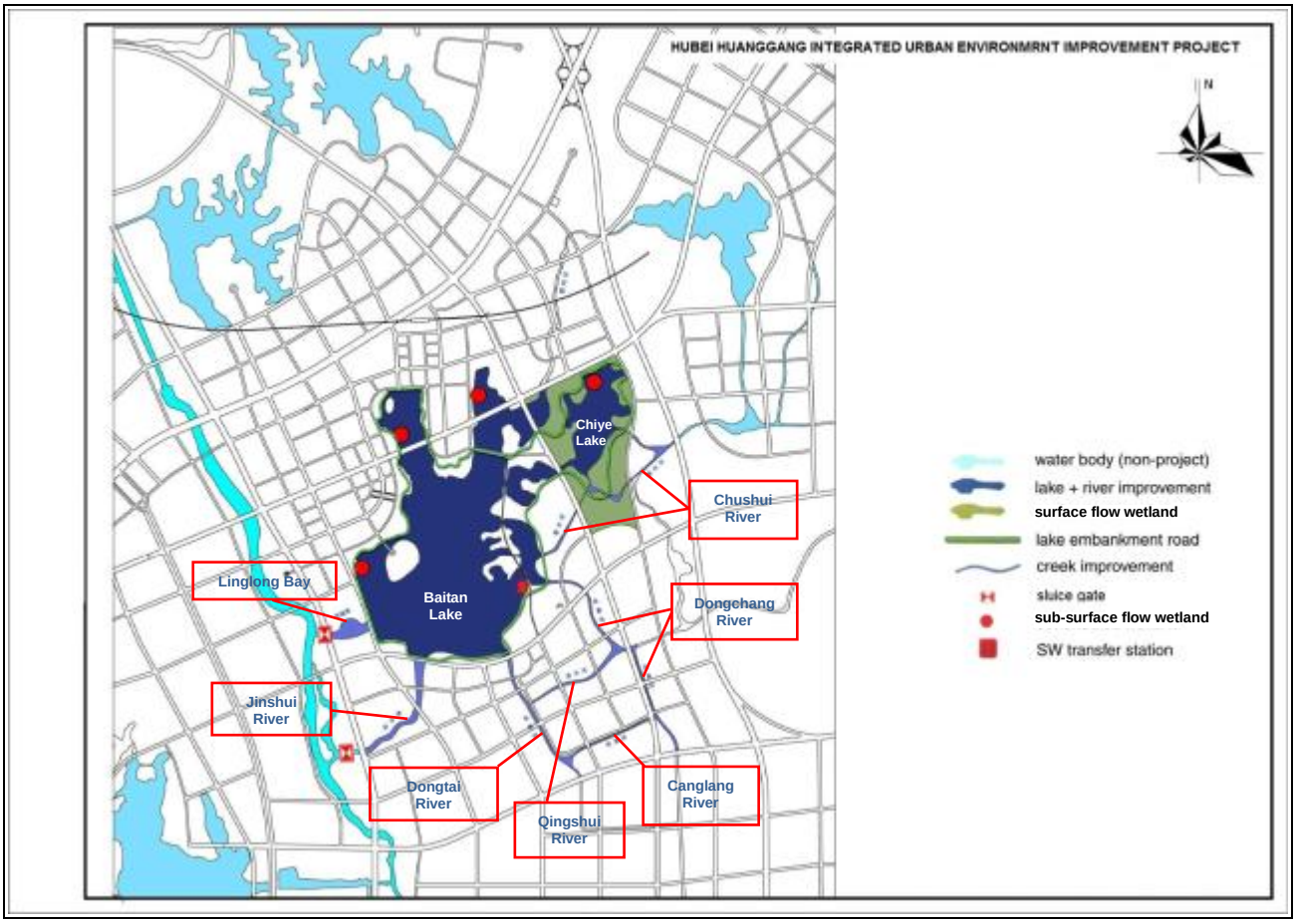


Figure III.2: Location of project components

B. Component 1: Urban Lake and River Enhancement

96. This component consists of two sub-components: lake enhancement and river enhancement.

1. Subcomponent 1-1: Lake Enhancement

97. This sub-component includes engineering measures of constructing a lake ring road for non-motorized traffic (NMT) including ecological embankment along the lakeward side of the ring road, dredging sediments in Baitan Lake and Chiye Lake, constructing sub-surface flow wetlands in Baitan Lake and Chiye Lake, constructing a surface flow wetland in Chiye Lake and the confluence of Chushui River into Chiye Lake, planting of aquatic vegetation, and stocking of fish and mollusks.

98. **Lake ring road for non-motorized traffic**. A 13.3 km long ring road will be constructed around Baitan Lake and Chiye Lake, thus providing leisure and recreational space for non-motorized traffic and pedestrians around the lake shore. The road will be 8 m wide, with 1 m on each side for pedestrians

and 6 m in the middle for NMT. Road elevation will be 18.8 m[16] with slopes ranging between 0.3%~1.5%. Road surface will be asphalt cement paving for NMT lane and thick granite paving for pedestrian lanes, with cement stabilized macadam subgrade. Ring road construction will generate 81,000 m^3 earth cut materials and will require 268,403 m^3 earth fill materials.

99. The lake ring road will include 9 bridges for NMT crossing over the rivers. **Table III.2** shows the design parameters for these bridges.

Table III.2: Design parameters for lake ring road non-motorized traffic bridges

No.	Name	Width (m)	Length (m)	Structure
1	Baitan Lake Bridge	8	350	4*(4*16)+5*16m prefabricated hollow slab
2	Chushui River No. 1 Bridge	8	35	3*10m prefabricated hollow slab
3	Chushui River No. 2 Bridge	8	40	10+13+10m prefabricated hollow slab
4	Chushui River No. 3 Bridge	8	30	3*10m prefabricated hollow slab
5	Chushui River No. 4 Bridge	8	45	3*13m prefabricated hollow slab
6	Dongchang River Bridge	8	75	5*13m prefabricated hollow slab
7	Dongtai River Bridge	8	80	Prefabricated plate girder
8	Jinshui River Bridge	8	160	2*(5*16)m prefabricated hollow slab
9	Linglong Bay Bridge	8	96	6+16m prefabricated hollow slab

Source: FSR

100. **Ecological embankment**. Slope protection on the lakeward side of the ring road will consist of mostly slope type embankment, with also vertical and ladder type embankment at some locations such as the waterfront platforms. The slope type embankment will be in form of ecological slopes composed of soil and rooted vegetation to bind the soil for slope protection against soil erosion but at the same time providing ecological and scenic benefits. Vegetation will include chaparral (*Larrea* spp.), black locust (*Robinia pseudoacacia*), black currant (*Ribes nigrum*), Hubei rosewood (*Dalbergia hupeana*), shrubby bushclover (*Lespedeza bicolor*), pond cypress (*Taxodium ascendens*), common rush (*Juncus effusus*), Japanese honeysuckle (*Lonicera japonica*), false indigo bush (*Amorpha fruticosa*), Chinese red pine (*Pinus tabuliformis*), citron daylily (*Hemerocallis citrina*), Himalayan ivy (*Hedera nepalensis*), showy pigeonpea (*Cajanus scarabaeoides*), common reed (*Phragmites australis*), and wild rice *(Zizania aquatica*).

101. **Sediment dredging and treatment**. The purpose of sediment dredging is to remove from Baitan and Chiye Lakes nutrient laden sediment that is one of the sources of eutrophication.

102. The approach to dredging described in the FSR follows the technical guidelines described in Palermo *et al*. (2008)[17]. Site condition was first evaluated by means of geophysical surveys to establish the thickness and distribution of the unconsolidated sediment. This was followed by the characterization of sediment, indicating that although the sediment was not contaminated with heavy metals, the unconsolidated sediment layer did show high levels of nutrients (nitrogen and phosphorus)

[16] All elevations in this report are based on the Yellow Sea datum unless otherwise stated.

[17] Palermo, M. R., P. R. Schroeder, T. J. Estes and N. R. Francingues. 2008. Technical guidelines for environmental dredging of contaminated sediments. US Army Corps of Engineers. ERDC/EL TR-08-29. Xii + 288 pp.

which are potential sources of eutrophication in these lakes. Environmental dredging performance standards of different dredging methods were compared, followed by dredging sediment transport and treatment. Sediment re-suspension during dredging and control measures were described in the project EIR. **Figure III.3** shows the dredging areas.

103. Dredging will be conducted by cutter suction dredger. Dredging depth averages approximately 1.12 m. The quantities to be dredged have been estimated to be approximately 404.405 m^3 in Baitan Lake and 135,000 m^3 in Chiye Lake. The FSR suggested that the best time of the year for dredging works would be from early winter to late spring, when the water level is low, with calm lake water and low biological activities.

104. The dredged sediment from Baitan Lake will be pumped from the dredger via floating pipeline to two sediment treatment sites (see Figure III.5). The maximum pumping distance is approximately 5 km. Each sediment treatment site has an area of 2.28 ha. The treated sediment will be used for landscaping or fill material in the NED after conducting leaching tests to confirm compliance with heavy metal contents. The dredged sediment from Chiye Lake will be pumped to nearby vacated and empty fish ponds for settling and air dried, and will then be used as fill material for constructing the wetlands.

105. Sediment treatment will be by flocculation and dewatering. At the treatment site, the slurry will first go through an intake screen to rid of large objects, then into an equalization pond. The homogenized slurry will be dosed with flocculants (such as polyacryl amide or a proprietary chemical) and solidifying agent (usually a proprietary chemical), allowed to react with these agents for 15 minutes in a mixing pond, then pumped to a mechanical press for dewatering. The dewatered and solidified material is odorless hard plastic-like product with a moisture content of less than 40%. Volume reduction by this process was estimated in the project EIR to be approximately 53%. The dewatered sediment quantities would be 190,070 m^3 from Baitan Lake. **Figure III.4** shows the process flow of dredging and dredged sediment transport and treatment.

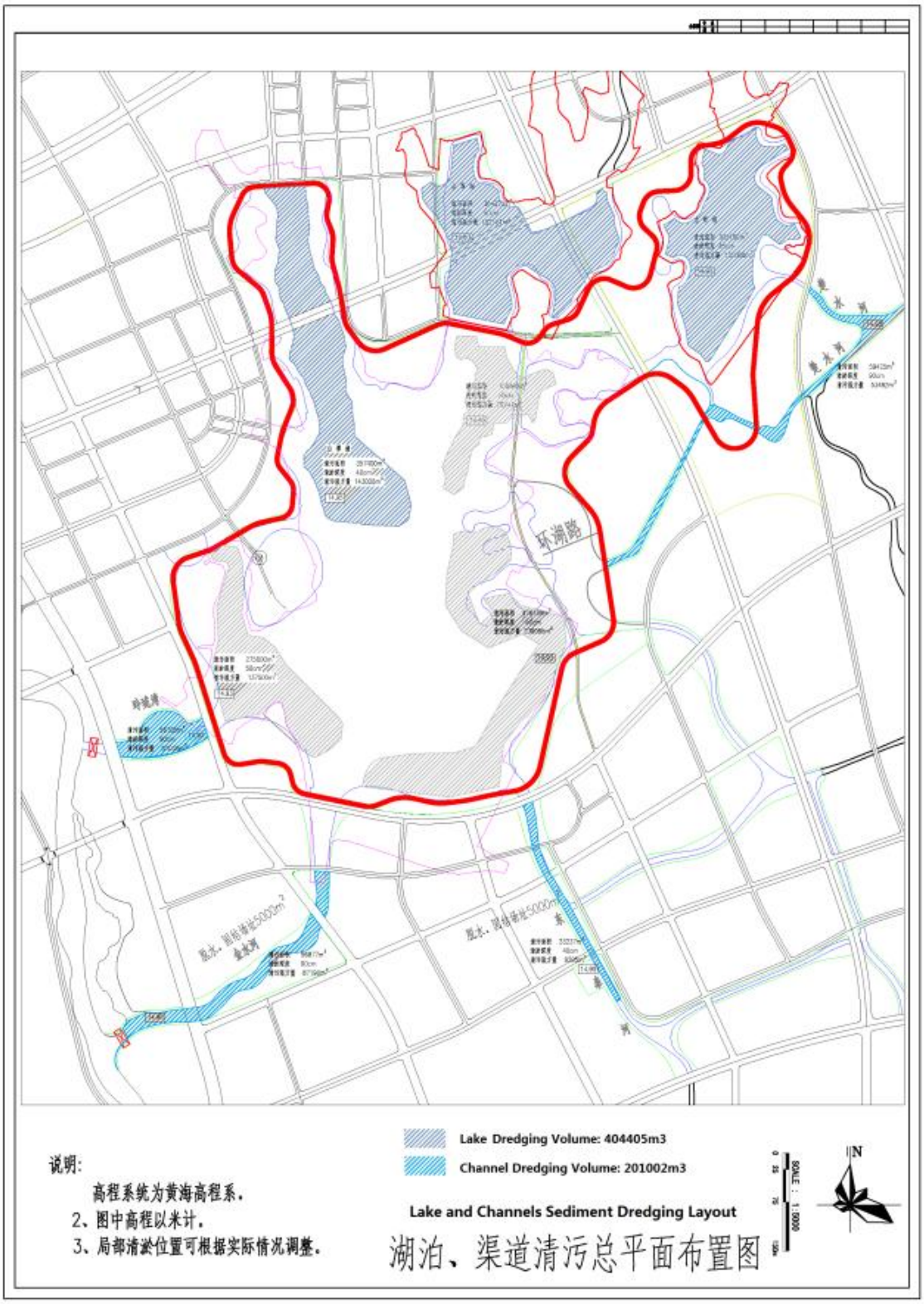

环湖路
Lake Dredging Volume: 404405m3
Channel Dredging Volume: 201002m3
Lake and Channels Sediment Dredging Layout
N
SCALE : 1:8000
说明:
高程系统为黄海高程系.
2、图中高程以米计.
3、局部清淤位置可根据实际情况调整.
湖泊、渠道清污总平面布置图

Figure III.3: Lakes and rivers sediment dredging areas

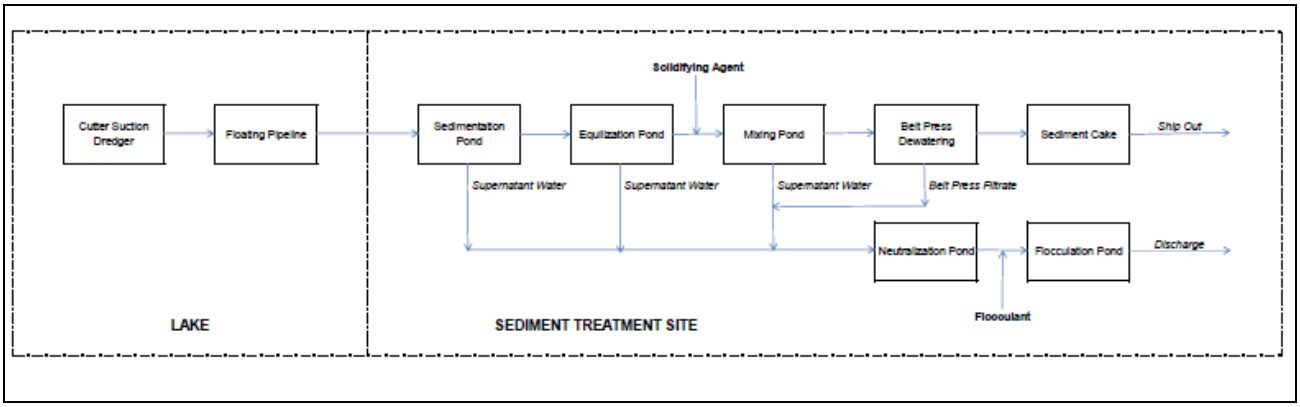


Figure III.4: Sediment dredging and treatment process flow diagram

106. The effluent from the dewatering process as well as the supernatant water from the fish ponds holding the dredged sediment from Chiye Lake will be tested for water quality for compliance with Class I standard of "*Integrated Wastewater Discharge Standard and its Revisions*" (GB 8978-1996) before being discharged back to Baitan Lake and Chiye Lake.

107. The dredging duration will be dictated by the treatment rate of dredged Baitan Lake sediment. According to the FSR, each treatment site would have a 4,000 m^3/d treatment capacity, and the treatment process would require a retention time of approximately 10 days. Assuming that the treatment sites are operating at 100% with no down time, dredging duration would be approximately 4 months for Baitan Lake and two months for Chiye Lake.

108. **Sub-surface flow wetland**. Sub-surface flow wetlands, a form of treatment wetlands, are designed to treat storm water flows to Baitan Lake and Chiye Lake, as well as augmentation water from the upstream river and reservoir. The use of treatment wetlands have been well substantiated as a viable and reproducible treatment process globally, and have been in use in the PRC for the past two decades showing a well-documented trend toward greater application for various types of storm water and wastewater. This represents a progressive and sustainable approach to maintaining the environmental quality of the project. These technologies are sustainable, and often require little additional power for operation or none if placed in the landscape for passive operation.

109.Treatment wetlands need to be adequately sized to achieve the project objectives because they are shallow systems and require large areas compared to conventional water quality treatment methods. Key factors for wetland sizing include the hydraulic loading rate and the pollutant removal rate. In the PRC, the MEP issued *Technical Specification of Constructed Wetlands for Wastewater Treatment Engineering* (HJ 2005-2010) identifies presumptive ranges of water quality performance for specific types of wetlands based on their hydraulic loading rates.

110.Through water quality modeling analysis by the PPTA consultant, three watersheds in Baitan Lake

and one watershed in Chiye Lake were identified in the watershed plan that would contribute considerable pollutant loads to the lakes if untreated. Using the HJ 2005-2010 hydraulic loading rate based sizing criterion for sub-surface flow wetlands of 50 cm/d, the total area of sub-surface flow wetlands was determined to be 3.84 ha (see **Table III.1** on the sizes of the wetlands and detention basins). This equals 1% of the contributing watershed area, which is an acceptable minimum as a range of 1~5% has been commonly observed for effective treatment wetlands. **Table III.3** summarizes the sizing of the four sub-surface flow wetlands planned to treat storm water from their respective watersheds. **Figure III.5** shows the locations of the sub-surface flow wetlands and detention basins (and their sizes), also showing the locations of the dredged sediment treatment sites and the storm water outfalls. **Figure III.6** shows a typical cross-section profile of the sub-surface flow wetland.

Table III.3: Watershed flow volume and sub-surface flow wetland area

Location		Watershed Area	First Flush Volume	Average Event Flow	Wetland Area
		ha	m^3	m^3	ha
Baitan Lake					
	S1	145.15	7257.5	2793.7	1.4515
	S2	92.11	4605.5	1772.9	0.9211
	S4	93.04	4652.0	1790.8	0.9304
Chiye Lake					
	S3	53.70	2685.0	1033.6	0.537
	Total	384.00	19200.0	7390.9	3.84

Notes:
First flush volume assumes 5 mm rainfall
Wetland area based on 50 cm/d hydraulic loading rate

Source: PPTA consultant

111.As shown in **Table III.3**, the average event flow is approximately 38.5% of the first flush volume, corresponding to an average hydraulic loading rate of 19 cm/d. The distribution of storm events historically indicates that between events, flows will decrease to low rates. To maintain the ecological condition of the sub-surface flow wetlands between storm events, lake water will be pumped into the wetlands. Wetland water levels would be managed by adjusting outlet control structures to sustain water within or near the root zone in the wetland media bed. The water pumped into the wetland will be treated in the process, thereby sustaining considerable year-round wetland system pollutant reductions. **Figure III.6** shows the cross section of the sub-surface flow wetland treatment process.

112. The sub-surface flow wetlands will facilitate the subsurface flow of incoming water with the planting of emergent, floating leaf and submerging species, also emphasizing the use of sturdy local species that have relatively high pollutant removal ability. **Table III.4** and **Table III.5** show the incoming and outgoing water quality for the sub-surface flow wetlands in Baitan Lake and Chiye Lake respectively, which formed the basis for their design and plant species selection. **Table III.6** shows the design scheme and the species to be planted for these wetlands.

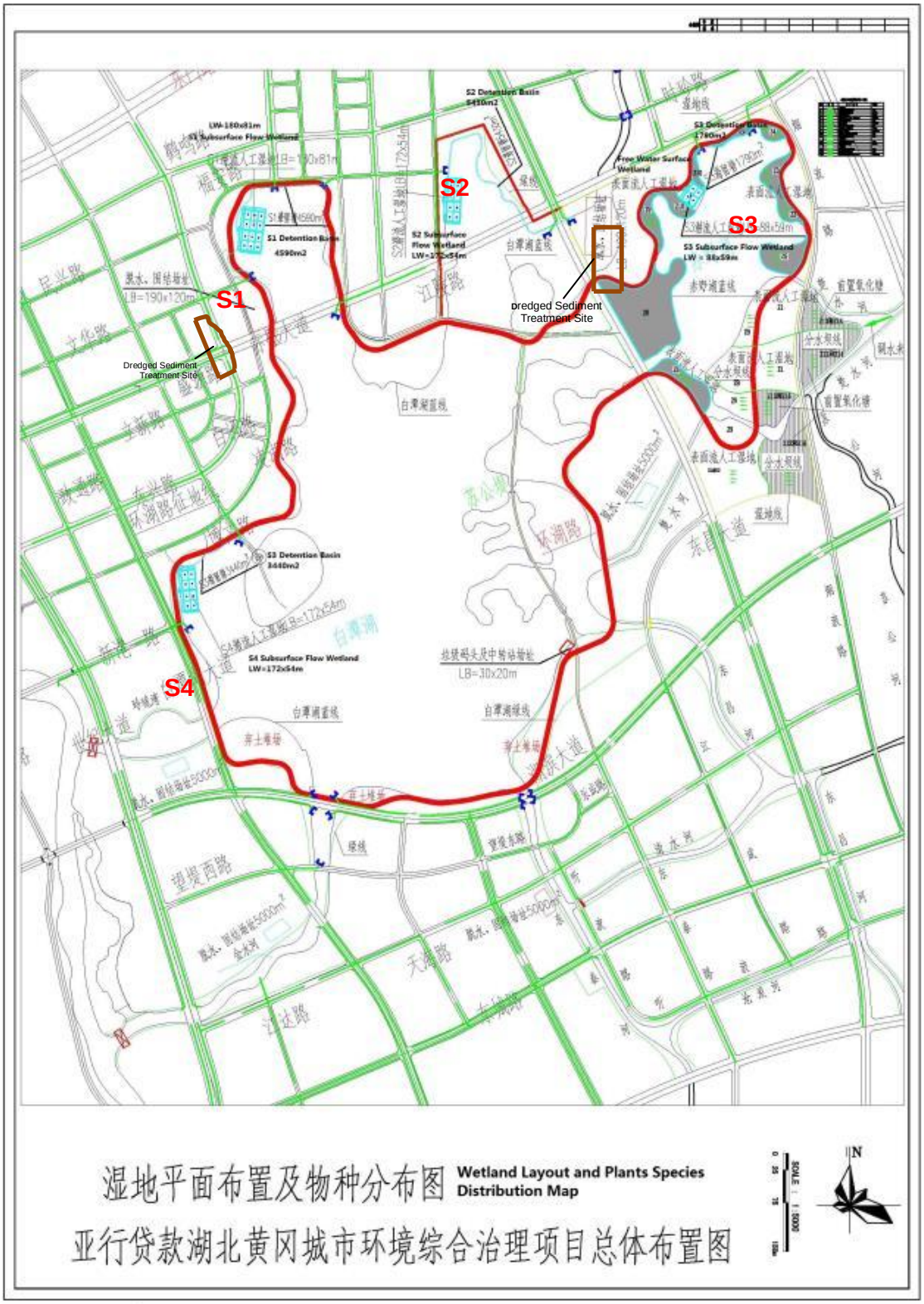


Figure III.5: Locations of sub-surface flow and surface flow wetlands

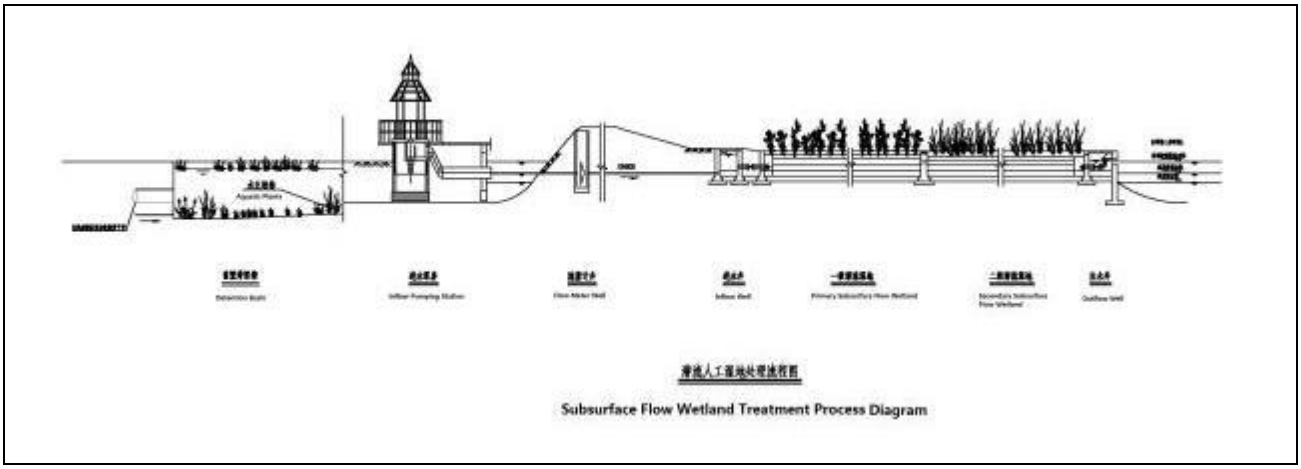


Figure III.6: Typical cross section of the sub-surface flow wetland treatment process

Table III.4: Incoming and outgoing water quality for the sub-surface flow wetlands in Baitan Lake

	Water Quality Parameter Concentrations in mg/L		
	COD	TP	TN
Incoming water quality (first flush)	41~42	0.64	4.14
Outgoing water quality	28	0.47	1.2
Concentration Reduction	32~34%	27%	71%

Source: PPTA consultant

Table III.5: Incoming and outgoing water quality for the sub-surface flow wetland in Chiye Lake

	Water Quality Parameter Concentrations in mg/L		
	COD	TP	TN
Incoming water quality (first flush)	42	0.65	4.06
Outgoing water quality	28	0.48	1.3
Concentration Reduction	34%	26%	68%

Source: PPTA consultant

Table III.6: Sub-surface flow wetland planting

Type of Plant	Planting Approach	Major species used for Planting	
		Scientific Name	Common Name
Emergent aquatic vegetation: includes rooted macrophytes that grow with most of their photosynthetic tissue above the water surface	In depths of +0.3 m to – 0.6 m	*Alisma plantago-aquatica*	Common Water-plantain 泽泻
		Arundo donax	Giant Cane 芦竹
		Canna indica	Indian Shot 美人蕉
		Cyperus alternifolius	Umbrella Plant 风车草
		Iris tectorum	Wall Iris 鸢尾
		Lythrum salicaria	Spiked Loosestrlfe 千屈菜
		Scirpus validus	Softstem Bulrush 水葱
		Phragmites australis	Common Reed 芦苇
		Typha angustifolia	Lesser Bulrush 水烛
Floating-leaved	In depths of -0.3 m to -1.5 m	*Alternanthera philoxeroides*	Alligator Weed 水花生

Type of Plant	Planting Approach	Major species used for Planting	
		Scientific Name	**Common Name**
vegetation: includes rooted macrophytes that grow with most of their photosynthetic tissue on leaves floating on the water surface		*Euryale ferox*	Prickly Water Lily 芡实
Submerged aquatic vegetation: includes rooted or free-floating macrophutes that grow with photosynthetic tissue below the water surface	In depths of -0.3 m to -2.0 m or more	*Ceratophyllum demersum*	Rigid Hornwort 金鱼藻
		Hydrilla verticillata	Hydrilla 黑藻
		Potamogeton crispus	Curly-leaf Pondweed 菹草
		Potamogeton malianus	Curly Pondweed 竹叶眼子菜
		Vallisneria aquatica	Tape Grass 苦草

Source: PPTA consultant

113. To sustain the functionality of the sub-surface flow wetlands by creating an area of sediment settling, a detention basin will be constructed upstream of each wetland. The detention ponds will function as a source of water for the pump station, and will serve to equalize flows to allow relatively uniform pumping to the wetland. Based on literature, the PPTA consultant estimated that the detention pond sizes would be in the order of 20% of the size of the wetlands. At an assumed depth of 1 m, these ponds have a nominal hydraulic detention time of approximately 12 hours during the first flush flows. Average time to pump down the detention pond at average flow rates was estimated to be in the order of 2 to 3 days, consistent with the need to prepare the system to capture the next storm. An additional 40% of pond areas was added to the final area estimate to provide a safety margin for flow variation, settling rate, and sediment accumulation rates above the minimum assumed in the sizing analysis. The pond:wetland ratios are 0.41 for Baitan Lake and 0.34 for Chiye Lake sub-surface flow wetlands.

114. The PPTA consultant estimated that the 4 sub-surface flow wetlands would lead to the annual reduction of 36.2 t COD, 8.1 t TN and 0.5 t TP to Baitan Lake and Chiye Lake, and subsequently the Santai River and Yangtze River. When operated during the non-raining days, these wetlands would further polish lake water continuously by removing approximately 31.9 t COD, 3.6 t TN and 0.08 t TP each year.

115. **Surface flow wetland in Chiye Lake.** Approximately 80.2 ha of surface flow wetland will be constructed in Chiye Lake and at the confluence of Chushui River into Chiye Lake (see **Figures III.2** and **III.5**). This is expected to create substantial wildlife habitat and provide a functional restoration of the former lake littoral zone, now long converted to fish ponds. This effort is also expected to improve and sustain water quality within Chiye Lake, given the potential for treatment of inflow water and exchange between littoral marshes and central open water areas. **Figure III.7** shows a typical cross section of the surface flow wetland.

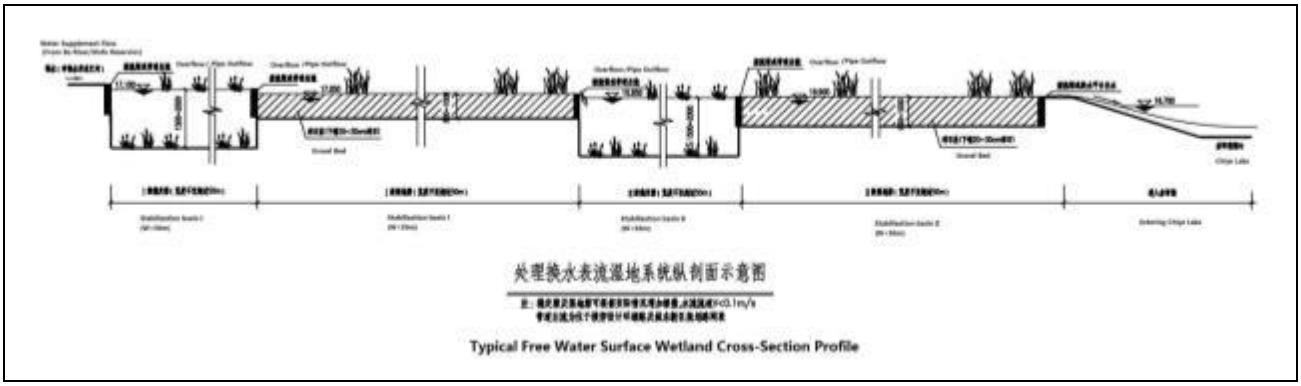


Figure III.7: Typical cross section of the surface flow wetland

116. For a surface flow wetland of 80 ha, the system requires a corresponding hydraulic loading of 80,000 m^3/d. As there is little flow from the Xingfu Channel catchment to the lake if there is no rain, hydrological modeling for the project indicated that the required hydraulic loading of 80,000 m^3/d would need to be provided by transferring 1.1 m^3/s from the Ba River and/or the Xingfu Reservoir through the Xingfu Gate/Hongqi pump station.

117. According to HJ 2005-2010, the 10 m^3/d wetland hydraulic loading rate and a hydraulic retention time of 4 to 8 days would indicate 50 to 60% reductions of COD and TP and 35 to 70% reduction of TN. The PPTA consultant estimated that the surface flow wetland in Chiye Lake would reduce approximately 103 t COD, 37.2 t TN and 0.52 t TP from the upstream catchment

118. The following common local species have been selected for planting in the surface flow wetland: *Typha orientalis* (Bulrush), *Alisma orientale* (Water Plaintain), *Acorus calamus* (Sweet Flag), *Polygonum orientale* (Princess Feather), Lythrum salicaria (Spiked Loosestrife), *Iris tectorum* (Wall Iris), *Phragmites australis* (Common Reed), *Nelumbo nucifera* (Lotus), and *Lonicera japonica* (Japanese Honeysuckle). The FSR estimated that approximately 365 t COD, 20 t TN and 4.3 t TP would be removed by the surface flow wetland each year.

119. Wetland creation (including the sub-surface flow and surface flow wetlands) will require approximately 1.6 million m^3 of fill material according to the SEPP. About 54% (860,000 m^3) will come from re-using treated dredged lake and river sediment, and excavated channel and river bank soil. The remaining 46% (740,000 m^3) will be imported. The SEPP has identified a borrow pit located in a 4.9 ha area with small hilly topography and shrubbery vegetation at Fengjiadawan in Bahe Town of Xishui County (**Figure III.8**).

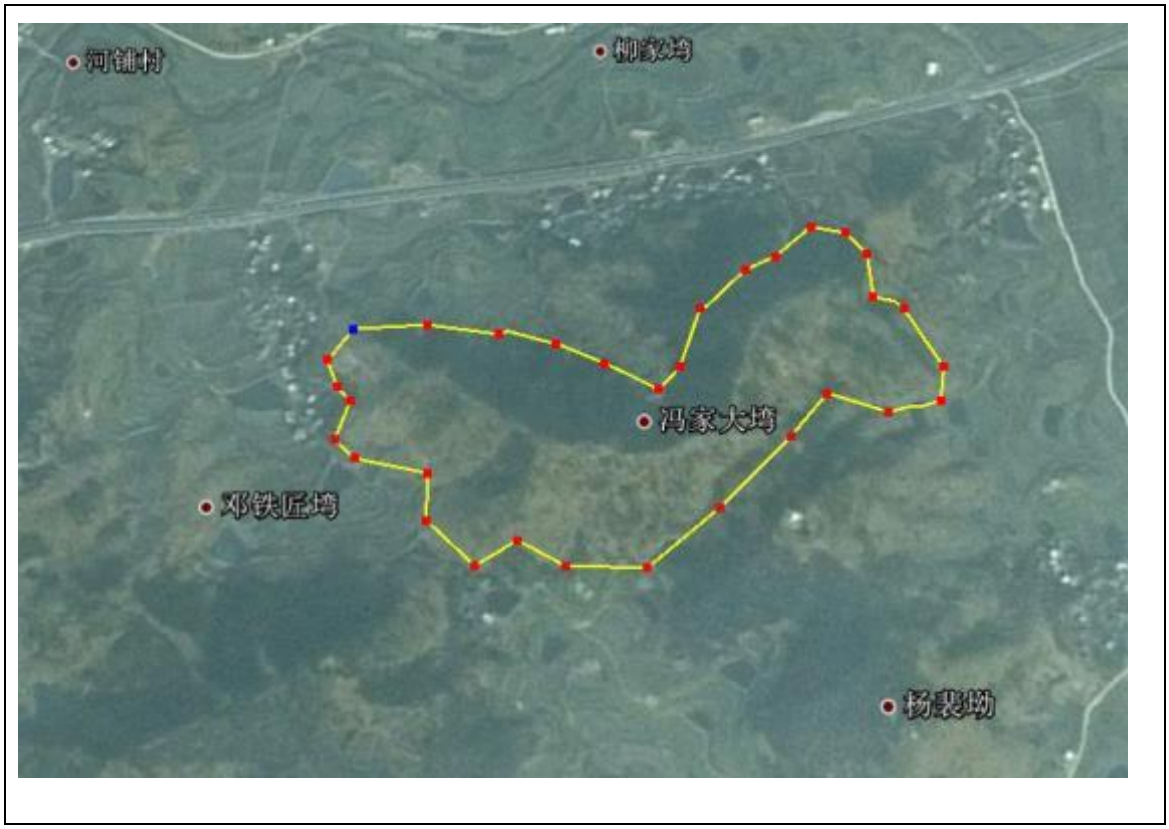


Figure III.8: Location and topography of the borrow area

120. **Planting of aquatic vegetation**. Aquatic vegetation in Baitan Lake and Chiye Lake will also be rehabilitated by planting aquatic species consisting of emergent species, floating leaf species, submergent species, aquatic grass mats mainly along the shoreline, and floating island wetland in deeper stagnant water **Table III.6** shows the sizes of each planting scheme in Baitan Lake and Chiye Lake respectively.

Table III.7: Planting of aquatic species in Baitan Lake and Chiye Lake

Planting Scheme	Baitan Lake	Chiye Lake
Emergent plants	48 ha	6.3 ha
Floating leaved plants	19.2 ha	2.52 ha
Submerging plants	28.8 ha	3.78 ha
Aquatic grass mats	6.4 ha	0.84 ha
Floating island wetland	9.6 ha	0.84 ha
Total area	112 ha	14.28 ha

Source: FSR

121. The floating island wetland is a recent bio-engineering technology for improving water quality. Aquatic species are planted on a floating raft with their roots extending into the water column underneath the raft, thereby able to take up and remove nutrients such as nitrogen and phosphorus from the water. **Figure III.9** shows a picture of a floating island wetland.

Figure III.9: An example of a floating island wetland

Source: Floating Island International (http://www.floatingislandinternational.com/products/leviathan-technology/)

122. **Stocking of fish and benthic species**. Future aquaculture activities in Baitan Lake and Chiye Lake will be managed, with the selection of proper fish species that are beneficial to the ecosystem of the lakes and the prohibition of culturing species that are herbaceous such as the Grass Carp *Ctenopharyngodon idellus* or those that mainly feed on mollusks such as the Black Carp *Mylopharyngodon piceus* within three years after lake rehabilitation. The lakes will be stocked with Silver Carp *Hypophthalmichthys molitrix* that mainly feeds on algae and gastropods, and David's Yellowfin *Xenocypris davidi* that mainly feeds on organic detrital matter. In Baitan Lake, approximately 24 t of fish fry each weighing approximately 50 g will be stocked at a density of 75 kg/ha, 32 t of gastropods such as *Sinotaia aeruginosa* (Pond Snail) and *Parafossarulus sinensis* will be stocked at an average density of 100 kg/ha, and 96 t of bivalves such as S*inanodonta woodiana* (Chinese Pond Mussel) will be stocked at an average density of 300 kg/ha. Applying the same densities for stocking fish fry and mollusk in Baitan Lake, stocking in Chiye Lake would be approximately 3.15 t fish fry, 4.2 t gastropods and 12.6 t bivalves.

2. Subcomponent 1-2: Rehabilitation of Rivers and Connection of River-Lake Network

123. This sub-component includes the rehabilitation of 7 rivers totaling 10.78 km in the Baitan Lake planning area through dredging to remove unconsolidated sediment, excavation of channel soil to widen and deepen these rivers for improving flood retention, embankment construction for bank and soil erosion protection, planting of aquatic species in the rivers and landscaping of the river banks, and construction of 2 sluice gates and 3 bridge walkways (see **Table III.1**).

124. This sub-component will improve the connection of Chiye Lake and Baitan Lake to the Ba River and Xingfu Reservoir that will provide these lakes supplementary water, and to the Santai River that will receive the outflow from these lakes. The connection of the 7 rivers to the lakes will improve the

drainage of storm water runoff and flood protection capacity in the Baitan Lake planning area. Protection against waterlogging will be improved to 1-in-20 year storm events. Design parameters for these rivers are shown in **Table III.8**, indicating that the design flood control water levels will be able to contain 1-in-20 year storm water.

Table III.8: Parameters for river rehabilitation

Name of River	Length (km)	Blue Line Width (m)	Bottom Width (m)	Elevation (Yellow Sea Datum)			1-in-20 Year Storm	
				River Bottom (m)	Normal Water Level (m)	Flood Control Water Level (m)	Maximum Flow Rate (m^3/s)	Water Level (m)
Jinshui River	1.6	50	39.2	15	16.7	18.54	16.4	18.04
Linglong Bay	0.75	68~204	12.2	14	16.7	18.54	16.4	18.04
Chushui River	2.25	19~32	9.2~21.2	15	16.7	18.54	9.6	18.04
Qingshui River	1.16	15~25	14.2	15	16.7	18.54	5.0	18.04
Canglang River	0.99	15	5.2	15	16.7	18.54	5.0	18.04
Dongchang River	3.27	25	14.2	15	16.7	18.54	13.7	18.04
Dongtai River	2.14	20~30	10.2~19.2	15	16.7	18.54	20.3	18.04

Source: FSR

125. Locations of the 7 rivers and the 2 sluice gates are shown in **Figure III.10**. Dredged river sediment will be treated at four treatment sites shown in **Figure III.5**. Chemical testing showed that the sediment was not contaminated with heavy metals but high in nutrient contents. After treatment, most of the dewatered sediment will be used for constructing the wetlands in this project. Excavated spoil from the channel and river banks will also be re-used for wetland construction. **Table III.9** presents the quantities of dredged sediment and excavated spoil generated during the rehabilitation of the 7 rivers, and the amount of earth fill needed. Approximately 350,777 m^3 of imported fill will be needed. This will be taken from the borrow area shown in **Figure III.8**

Table III.9: Earth cut quantities from river rehabilitation

Name of River	Dredged Sediment (m^3)	Excavated Spoil (m^3)	Total Earth Cut (m^3)	Earth Fill Required (m^3)
Linglong Bay	51,035	62,210	113,245	62,210
Jinshui River	87,190	2,240	89,430	81,600
Dongtai River	9,295	23,113	32,408	102,000
Chushui River	53,482	17,714	71,196	112,085
Qingshui River	-----	48,662	48,662	76,392
Canglang River	-----	31,089	31,089	158,433
Dongchang River	-----	158,433	158,433	101,518
Total quantity	***201,002***	***343,461***	***544,463***	***693,238***

Source: FSR

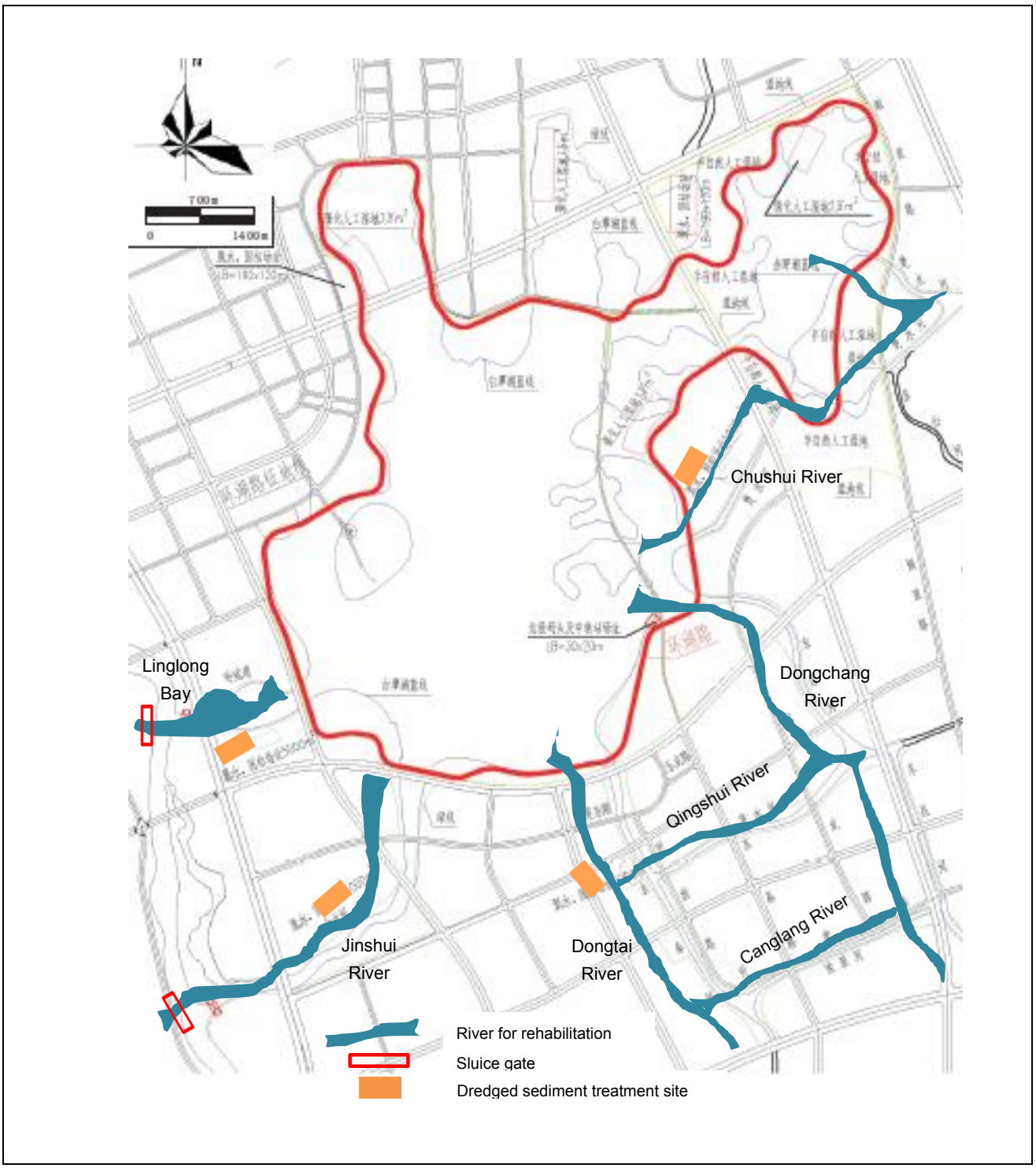


Figure III.10: Sub-component 1-2 project sites

126. **Dredging**. Dredging of sediment will be needed on four of the seven rivers (see **Table III.8**) and will be conducted in the dry. Temporary barriers such as cofferdam or earth bund will be built to block off the section of river to be dredged. Water within the section will be pumped out. Mechanical

dredging which is an excavation operation similar to conventional earth moving by excavator will be deployed to remove the sediment and transport to the sediment treatment sites adjacent to each of the 4 rivers (see **Figure III.8**). Each sediment treatment site is approximately 5,000 m^2 in area, capable of treating 1,000 m^3 of sediment per day using the same technology and treatment process described above for the rehabilitation of Baitan Lake and Chiye Lake.

127. **Sluice gates**. Two sluice gates will be constructed on Linglong Bay and Jinshui River respectively, near their confluences with Santai River. Their function is to prevent the backflow of Santai River water into Baitan Lake when the water level in Santai River is higher than the water level in Baitan Lake, and to control the outflow of water from Baitan Lake when lake water level is higher than the Santai River water level. Their requirements are presented in **Table III.10**.

Table III.10: Requirements for sluice gates at Linglong Bay and Jinshui River

Sluice Gate Location	Planning Control Requirements				
	Channel Width (m)	Channel Bottom Elevation (m)	Maximum Water Level (m)	Regular Water Level (m)	Dry Season Water Level (m)
Linglong Bay	40	14.00	17.90	16.70	16.20
Jinshui River	50	15.00	17.90	16.70	16.20

Source: FSR

128. **Embankment**. Embankment strengthening of approximately 2.56 km along these rivers is required, as defined in **Table III.11 and Figure III.11** will adopt ecological protection slope with different materials (mostly a combination of different materials) taking into account protection strength, anti-erosion and anti-scour performance, vegetation coverage, landscaping and ecological effect, and construction cost. These materials include vegetation slope protection, three-dimensional geomat slope protection, gabion revetment, eco-bag revetment and vegetated concrete revetment. Vegetation slope, three-dimensional geomat slope and eco-bag revetment have comparatively better ecological effect than gabion revetment and vegetated concrete revetment. **Figure III.12** shows the cross-sectional views of the rivers.

Table III.11: Embankment strengthening

River	River Bank Length (m)	Length of Embankment Strength (m)	Ratio (%)	Volume of Strengthening Treatment (m^3)
Linglong	600	120	20	4,200
Jinshui	1,730	350	20	12,250
Dongtai	1,500	450	30	10,500
Qingshui	1,110	222	20	7,770
Changlang	1,000	200	20	7,000
Dongchang	2,500	750	30	26,250
Chushui	2,340	468	20	16,380
Total	10,780	2.560		84,350

Source: FSR

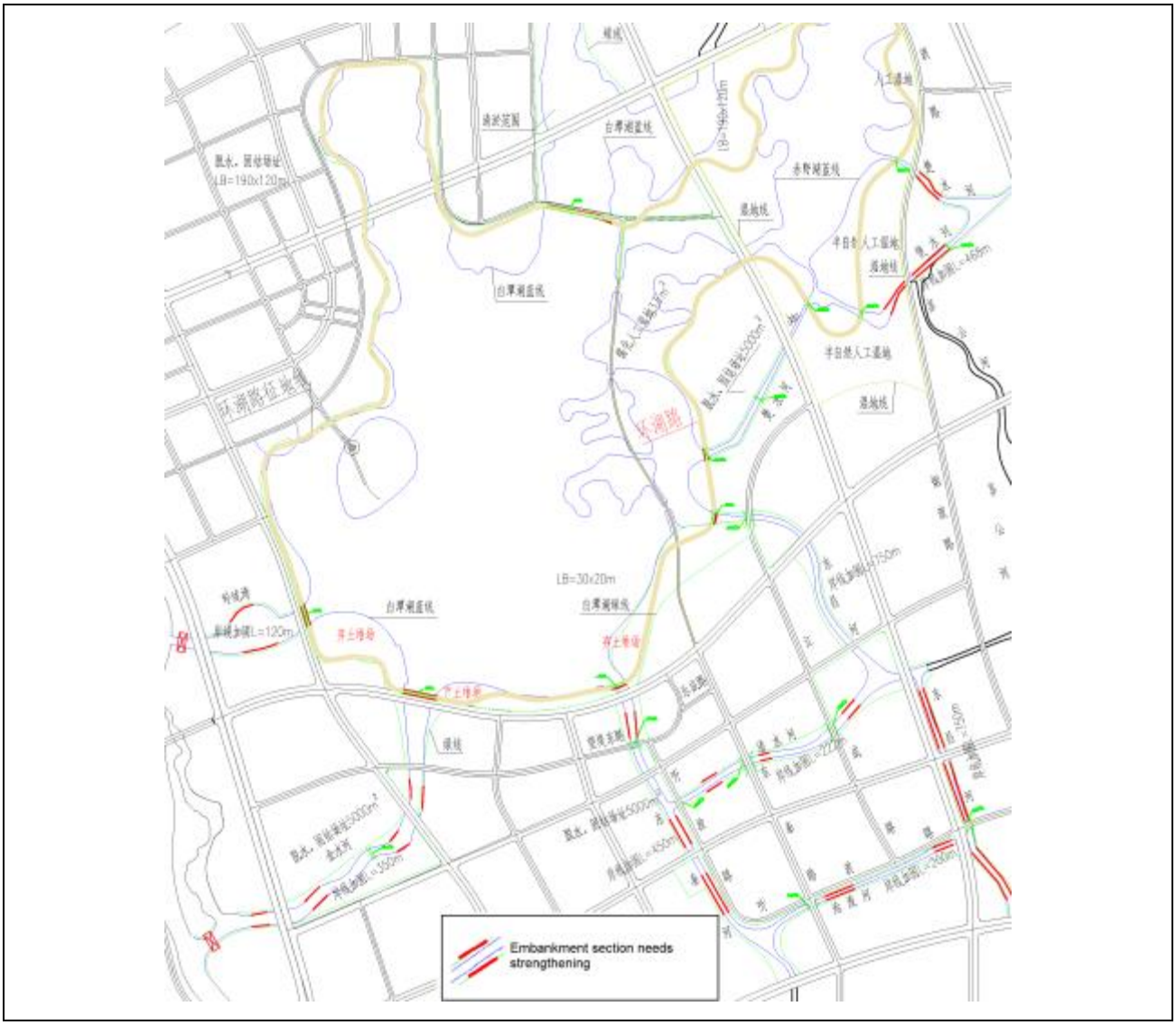
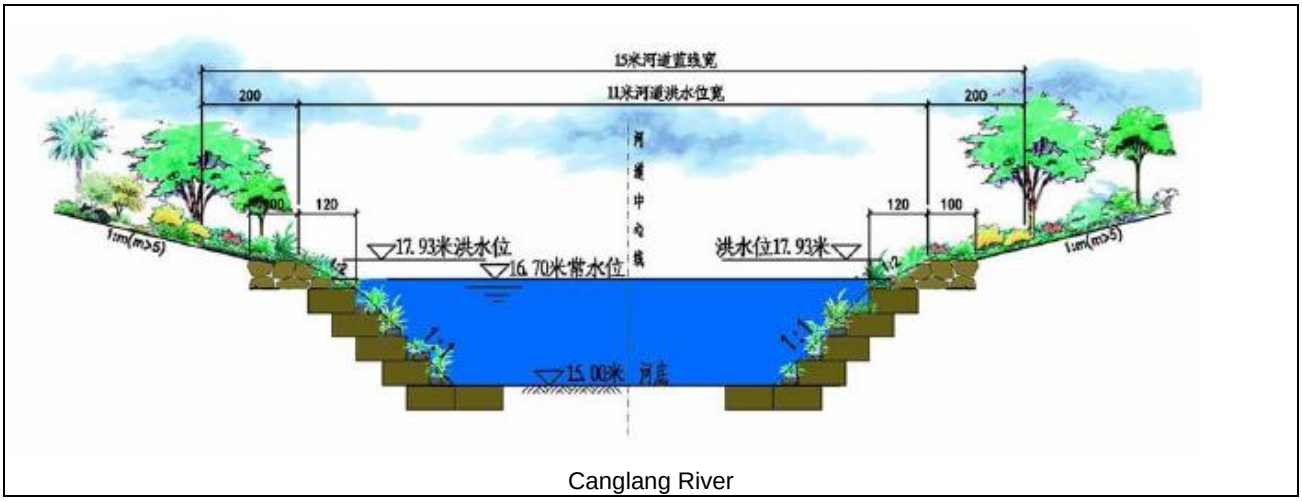
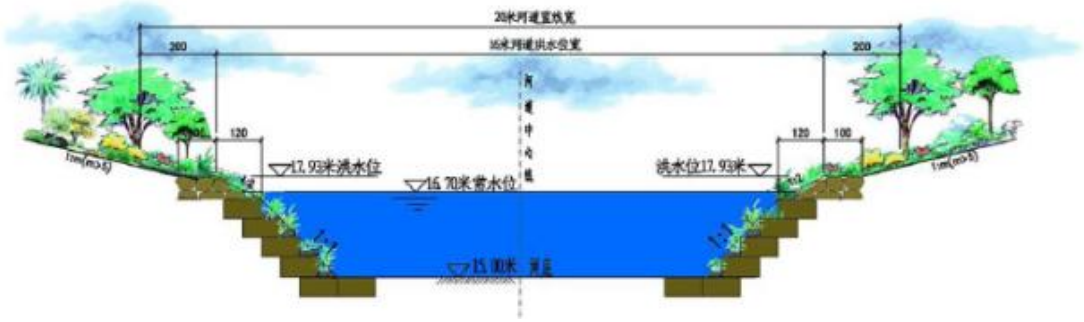


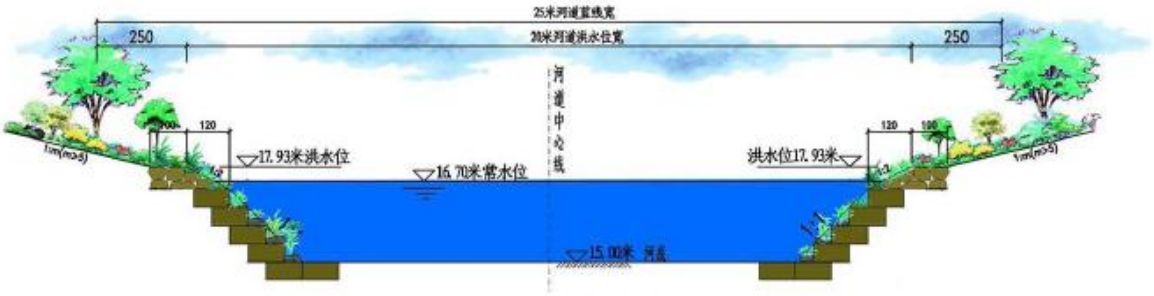
Figure III.11: Embankment strengthening locations



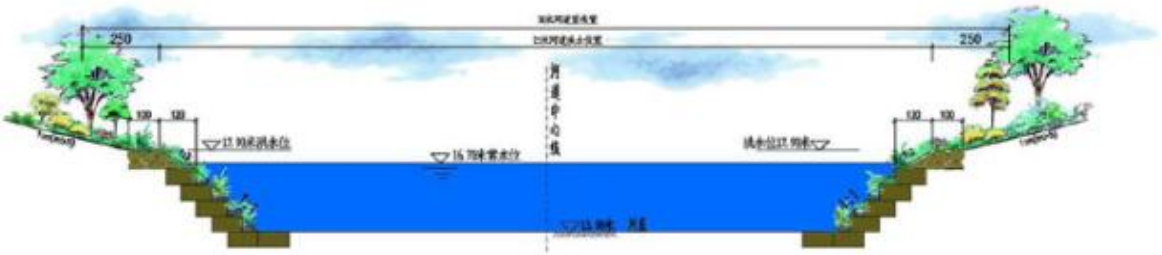
Canglang River



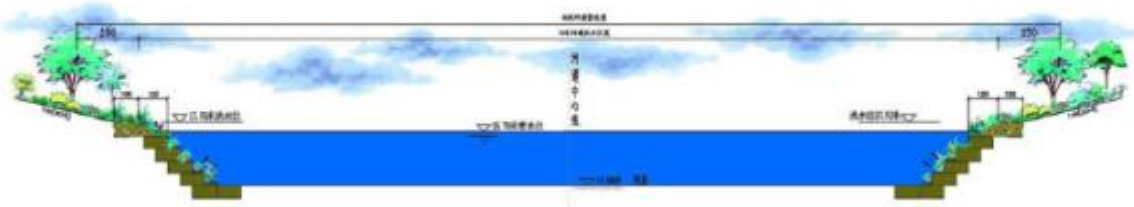
Dongtai River (20 m bottom width)



Qingshui River and Dongchang River



Chushui River and Dongtai River (30 m bottom width)



Linglong Bay

Jinshui River

Figure III.12: Cross-sectional views of project rivers

129. **Planting of aquatic species and river bank landscaping (vegetated buffer strips)**. The planting areas of aquatic species in the 7 rivers will total approximately 17.7 ha, using local wetland species described above. A 10-m wide greenbelt with landscaping will be provided along each side of the river banks. **Table III.12** and **Figure III.13** show the sizes and location of landscaping areas for each river, totally approximately 42.6 ha for the seven rivers.

Table III.12: Landscaping areas for the project rivers

Linglong Bay	Jinshui River	Dongtai River	Dongchang River	Qingshui River	Canglang River	Chushui River	Total
11,279 m^2	119,436 m^2	74,054 m^2	87,064 m^2	78,506 m^2	24,934 m^2	31,005 m^2	426,278 m^2

Source: FSR

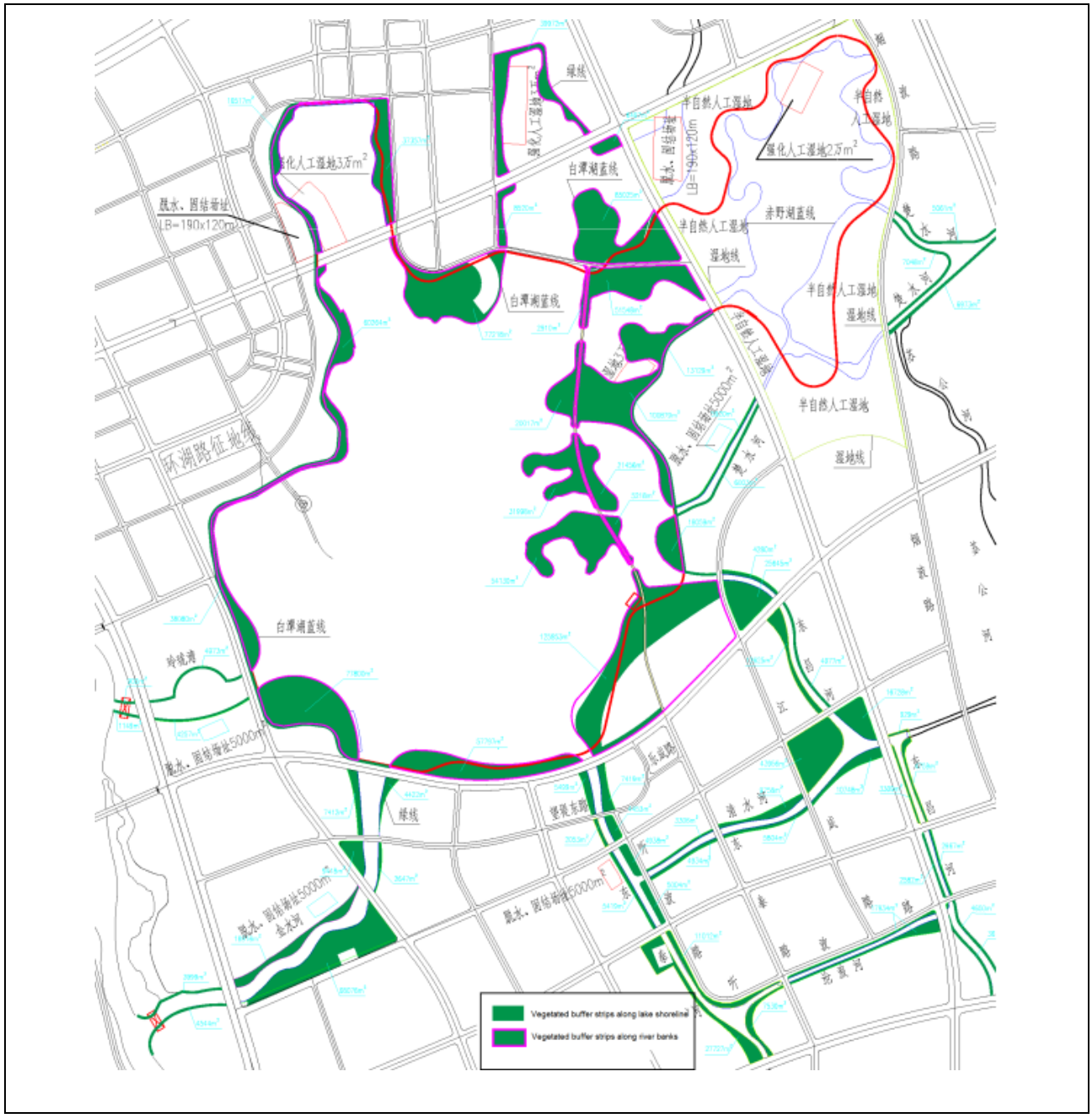


Figure III.13: Vegetated buffer strips along lake shoreline and river banks

C. Component 2: Solid Waste Collection and Transfer

130. To control the pollution of Baitan Lake and Chiye Lake from solid waste and to facilitate the removal of dead or overgrown wetland vegetation from these lakes, a pier and a small waste transfer station will be constructed under this component at the location shown in **Figure III.2**. Waste collection and transfer will be by vessels and trucks to be purchased under this component. These will include one vessel with a 20 t/d collection capacity, three smaller vessels for the rivers with a 2 t/d collection

capacity, and two 8-t garbage trucks.

131. The pier will take up a 400 m^2 area based on an average of 30 t/d waste collection and transfer. The refuse transfer station will take up a 200 m^2 with the capacity of handling 30 t/d solid waste, using vertical compression which takes up less space than horizontal compression. The solid waste will then be transferred by truck to the sanitary landfill at Chayuan Village in Taodian Town 10 km away.

D. Component 3: Capacity Development and Institutional Strengthening

132. This component consists of non-engineering measures to provide project management support to the executing agency, implementing agency and the PMO to ensure that project implementation complies with ADB requirements. This output will provide (i) project implementation support for smooth and timely implementation of the project in line with ADB procedures and guidelines; (ii) consulting services for initial project implementation support; (iii) consulting services for external resettlement, social and environmental monitoring; (iv) solid waste management public awareness campaign; and (v) development of water quality monitoring and forecasting system for Xingfu River, Baitan Lake and Chiye Lake.

133. A five-year water bird survey/monitoring program will be included under project implementation support to compare migratory waterbird species richness and abundance in the project area with the Longgan Lake Nature Reserve and/or the Lijiazhou Egret Nature Reserve. This component will also include the technology transfer of the hydraulic and water quality numerical models developed by the PPTA consultant in this project for the Baitan Lake planning area to the HEPB, to be used as a water quality forecasting tool in managing the water quality of water bodies in the planning area.

134. Since these non-engineering measures do not have adverse environmental implications, they will not be assessed in this report. Nevertheless, the above described items all have environmental focus that will benefit the project and the community in raising their awareness and capacity in environmental management.

E. Institution Arrangement for Construction and Operation

135. The Huanggang Urban Construction Investment Company Limited (HUCIC), a HMG financing and implementing agency established in June 2006 for urban infrastructure investments, will be the implementing agency (IA) for this project. This company will design and construct the works under this project.

136. The following agencies are presently decided to carry out operation and maintenance (O&M) of various sub-components of the project:

(i) Huanggang Landscaping Bureau: O&M of the constructed wetland, artificial wetland and aquatic planting and land side landscaped areas;

(ii) Huanggang Environmental Sanitation Bureau: O&M of solid waste collection and transfer,

including the vessels, vehicles and the transfer station;[18]

(iii) Huanggang Aquatic Products Bureau: will control fish culture within Baitan Lake and Chiye Lake and the stocking of fish and benthic fauna in these lakes;

(iv) Huanggang Water Bureau: O&M of flood control infrastructure such as embankments and the sluice gates.

(v) Huanggang Environmental Protection Bureau: O&M of the hydraulic and water quality numerical model.

F. Associated and/or Linked Facilities

137. SPS (2009) defines associated facilities as "facilities that are not funded as part of a project but whose viability and existence depend exclusively on the project, or whose goods or services are essential for successful operation of the project." In this context, the Hongqi Pump Station could be deemed as an associated facility while the Taodian Town Sanitary Landfill and the Nanhu pump station could be deemed as linked facilities.

138. The Hongqi Pump Station is an associated facility because it is needed to provide 1.1 m^3/s of water to Chiye Lake for maintaining the hydraulic loading to sustain the surface flow wetland. This pump station was for the purpose of irrigating farmland of 16,000 mu in Luokou and Taodian Townships. In 2008, it was upgraded and now houses two pumps. One has a rated discharge of 0.36 m^3/s at the head of 7.5 m and the other has a rated discharge of 0.92 m^3/s at the head of 5.1 m. To provide the 1.1 m^3/s, a new pump is planned to be installed and the expansion work would start in October 2017 for completion in April 2018. Operation of the existing pumps for irrigation water supply will not be affected.

139. The Taodian Town Sanitary Landfill will receive the 30 t/d solid waste collected in this project. This landfill is newly constructed and commenced operation in April 2013, with a 500 t/d design capacity and a 13-year service life. This facility is described in Chapter IV: Baseline Environment, Section D: Socio-economic Environment: Solid Waste. Review of documentation and discussions with relevant agencies confirmed that this facility complied with relevant standards and does not represent significant risks to the success of this project.

140. The Nanhu pump station, as will be described later in Chapter V: Anticipated Environmental Impacts and Mitigation Measures, Section E: Impacts and Mitigation Measures during the Operation Stage, is crucial for flood alleviation in the planning area should the water level in Santai River be higher than that in Baitan Lake. This is a proposed facility to be built in accordance with the *Chang River Basin Water System Plan.* It will have an installed capacity of 30 m^3/s for abstracting storm water from Baitan Lake, Chiye Lake and the Nanhu district during storm events when the water level in Santai

[18] The development plan for the Baitan Lake area already includes solid waste collection and transfer in the Baitan Lake planning area, which will be undertaken by the HMG and implemented by the Huanggang Environmental Sanitation Bureau, the same bureau who will implement solid waste collection and transfer in this project, which forms part of their overall duties for solid waste collection and transfer in the Huanggang Municipality.

River is higher than 17.98 m. This pump station has been listed in the government funded project pipeline and has been scheduled to start in 2015 for 2018 completion.

G. Climate Change Adaptation Considerations

141. As part of the hydraulic modeling exercise, the PPTA consultant has assessed the climate change resilience of project design by modeling a 6% increase in precipitation intensity, in line with recent research findings on climate change in the PRC[19]. **Figure III.13** presents the model simulation results, showing an increase of maximum water level by some 4 cm and the maximum water level could reach 18.02 m, which is approximately 2 cm below the adopted flood protect level of 18.04m. Therefore, the project design is resilient to climate change.

142. During the detailed design stage, the design of the river channels and embankments for flood control will take into consideration adequate safety margin for adaptation to extreme weather events in particular extreme precipitation and flood events.

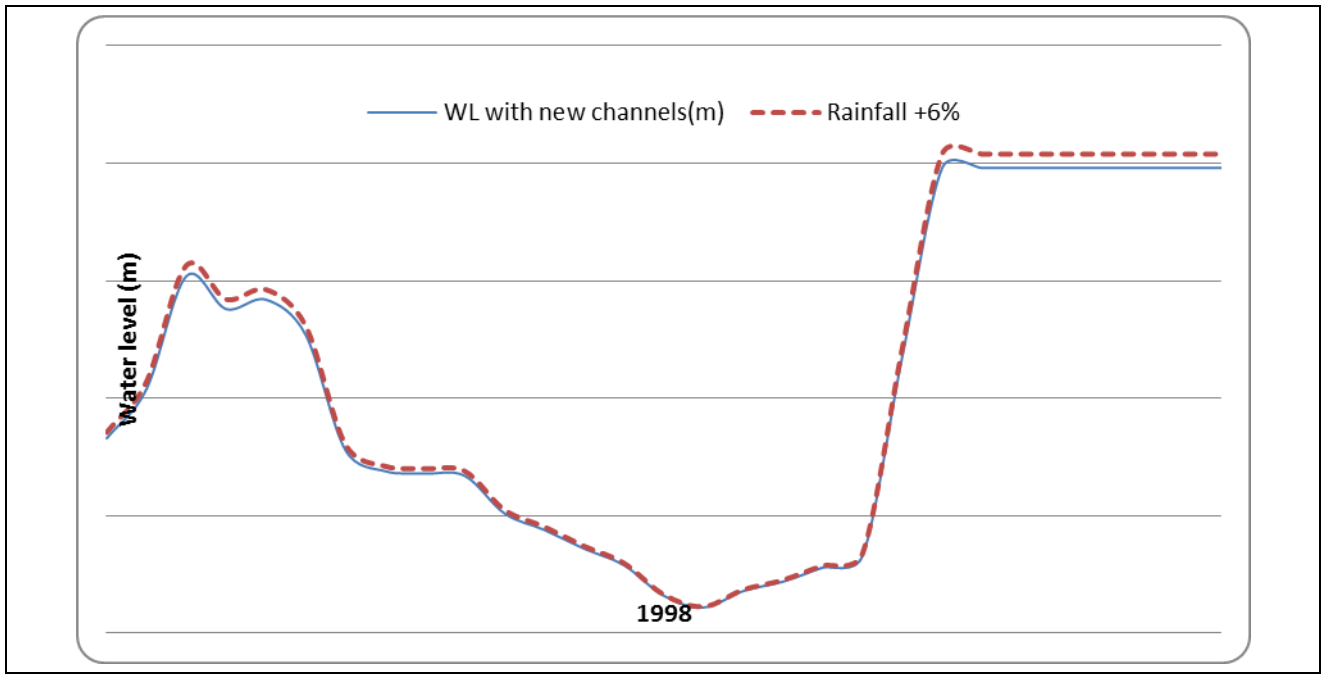


Figure III.13: Comparison of water levels in Baitan Lake under climate change scenario

[19] Research findings from the UL Handley center as part of the Adapation to Climate Change in China (ACCC); http://www.ccadaptation.org.cn/) shows that the temperature and precipitation in Hubei Province could increase by 2% and 6%, respectively, by the end of 2050.

IV. BASELINE ENVIRONMENT

A. Existing Setting of the Baitan Lake Planning Area

143. The existing land use within the 25.26 km^2 of the Baitan Lake planning area is dominated by developed suburban villages. The constructed areas are mainly concentrated at Lukou Town south of Highway G106 and the Nanhu Farm north of Nanhu Road. Besides the land occupied by towns and villages residents, enterprises and administrative offices, the remaining area basically consists of land being used for agricultural production and water bodies, including cultivated land, orchards and fish ponds (see **Figure II.2**).

144. **Table IV.1** shows that 92.7% of the 25.26 km^2 Baitan Lake planning area is occupied by natural water bodies, ponds and ditches, and agricultural and wooded land. The remaining 7.3% is dominated by urban, township and village constructed land. Among the urban constructed land, approximately 1/3 is presently for industrial use consisting of the Nanhu Farm and scattered small to medium size industrial enterprises including the Xinchang Textile Company, the Sanxing Mason Product Company, Huachen Mineral Company, and the Nanhu Farm No. 1 Brick Factory. These establishments will be relocated as the master plan for the Baitan Lake planning area does not have industrial land use.

Table IV.1: Existing land use in the Baitan Lake planning area

No.	Land Use		Area (ha)	% of Urban Constructed Land	% of Total Land
	Code	Type			
1	A	Administration offices	10.32	17.7%	0.4%
		Primary and secondary schools	2.58	4.4%	0.1%
		Social welfare facilities	1.98	3.4%	0.1%
2	B	Commercial & service sector facilities	1.53	2.6%	0.1%
		Hotels	0.22	0.4%	<0.1%
3	M	Industrial	21.75	37.2%	0.9%
4	S	Roads	6.76	11.6%	0.3%
		Transport hubs	0.23	0.4%	<0.1%
5	U	Public facilities	4.32	7.4%	0.2%
6	G	Green belt buffers	8.7	14.9%	0.3%
Urban constructed land sub-total:			*58.39*	*100%*	*2.3%*
7	H	Township constructed land	41.04		1.6%
		Village constructed land	60.18		2.4%
		Roads	24.37		1.0%
8	E	Natural water bodies	450.69		17.8%
		Ponds and ditches	810.34		32.1%
		Agricultural and wooded land	1,081.76		42.8%
Total land use:			2,526.77		100%

Source: Planning EIR

145. The distribution of residents currently living in the Baitan Lake planning area is shown in **Table IV.2**, indicating that there are 2,963 households with a population of approximately 12,000. Table IV.2 also shows the respective future land use.

Table IV.2: Distribution of residents in the Baitan Lake Planning Area

No.	Name	Relative Location	No. of Households	Population	Planned Future Land Use (Year 2020)
1	Tujialaowan 涂家老湾	NW	85	347	Park area and reserved land
2	Zhujiawan 朱家湾	NW	67	296	Primary and secondary schools
3	Wangjiawan 王家湾	NW	422	1,483	Type II residential
4	Zulinwan 竹林湾	NW	56	228	Partly mixed commercial residential; partly neighborhood center and park area
5	Liujiawan 刘家湾	NW	53	195	Park area
6	Shangyaojiawan 上姚家湾	NW	55	198	Telecommunication and other public service facilities
7	Xiayaojiawan 下姚家湾	W	55	185	Administrative offices
8	Wangjiadazui 王家大咀	W	48	178	Hotels
9	Lijiawan 李家湾	W	62	230	Cultural facilities and open area
10	Nanhu Team # 6 南湖六队	S	165	419	Type II residential
11	Nanhu Team # 7 南湖七队	S	199	529	Type II residential
12	Nanhu Team # 2 南湖二队	SE	176	494	Type II residential
13	Nanhu Team #5 南湖五队	SE	177	494	Type II residential
14	Baitan Lake Fish Culture Team 白潭湖养殖成鱼队	E	78	356	Green belt area
15	Baizhangzui 百丈咀	ENE	71	202	Green belt area
16	Baitan Lake District Farm 区白潭湖养殖场	N	29	131	Reserved land
17	Xiashazui 下沙咀	N	56	178	Type II residential
18	Shangshazui 上沙咀	N	26	118	Business and commercial mixed use
19	Xiajiawan 夏家湾	N	51	153	Type II residential
20	Gangjiazui 冈家咀	NNE	36	142	Type II residential
21	Baizhangzui Village 百丈咀村	NNE	701	4,102	Type II residential
22	Xiejiaxiaowan 谢家小湾	NNE	295	1,387	Type II residential
		Total:	2963	12,045	

Source: Planning EIR

146. **Sensitive Receptors**. The project EIR has identified the following 12 existing air quality and noise sensitive receptors for this project (**Table IV.3** and **Figure IV.1**) relative to the project area of influence. Approximately 170 households are located right next to the proposed lake ring road.

Table IV.3: Existing air quality and noise sensitive receptors

No.	Name	In Relation to this Project			No. of Households
		Nearest Project Site	Direction	Nearest Distance	
1	Shangshazui 上沙咀	Lake ring road	NE	52 m	53
2	Xiashazui 下沙咀	Lake ring road	NE	220 m	56
3	Shangyaojiawan 上姚家湾	Baitan Lake dredged sediment treatment site	W	208 m	55
4	Tujiadawan 涂家大湾	Lake ring road, Baitan Lake water area blue line	N	0 m	85
5	Liujiawan 刘家湾	Lake ring road, Baitan Lake water area	NW	150 m	53

No.	Name	In Relation to this Project			No. of Households
		Nearest Project Site	Direction	Nearest Distance	
		blue line			
6	Lijiawan 李家湾	Lake ring road, Baitan Lake water area blue line	W	0 m	62
7	Nanhu Resettlement Community (under construction) 南湖还建小区（在建）	Jinshui River blue line	SE	280 m	---
8	Nanhu Team #5 南湖五队	Canglang River blue line	N	150 m	177
9	Nanhu Farm 南湖农场	Canglang River and Qingshui River blue line	adjacent	0 m	78
10	Baizhangzui Group #6 百丈咀六组	Baitan Lake water area blue line	NE	45 m	32
11	Baizhangzui Group #5 百丈咀五组	Lake ring road	NW	50 m	22
12	Jianchuanwan 建川湾	Lake ring road	NE	0 m	24

Source: Project EIR

147. **Water system**. The water system within the Baitan Lake planning area is dominated by Baitan Lake, which is located approximately 4 km from the urban center in Huangzhou District. It has an elongated shape in a north-to-south direction. The original water surface was approximately 1,053 ha but has shrunk to 352 ha due to formation of fish ponds and land reclamation for development. Approximately 267 ha of surface area have been used for aquaculture. The elevation of the lake bottom is 15.5 m and the normal water level is at 18.5 m, with a water storage capacity of 8.28 million m^3 and an average depth of 2 m.

148. Baitan Lake gets its water mainly from Xingfu Reservoir and Ba River, and to a lesser extent from Tuojia Lake (see **Figure III.1**). It discharges into Santai River which eventually flows to the Yangtze River either directly or through Ba River.

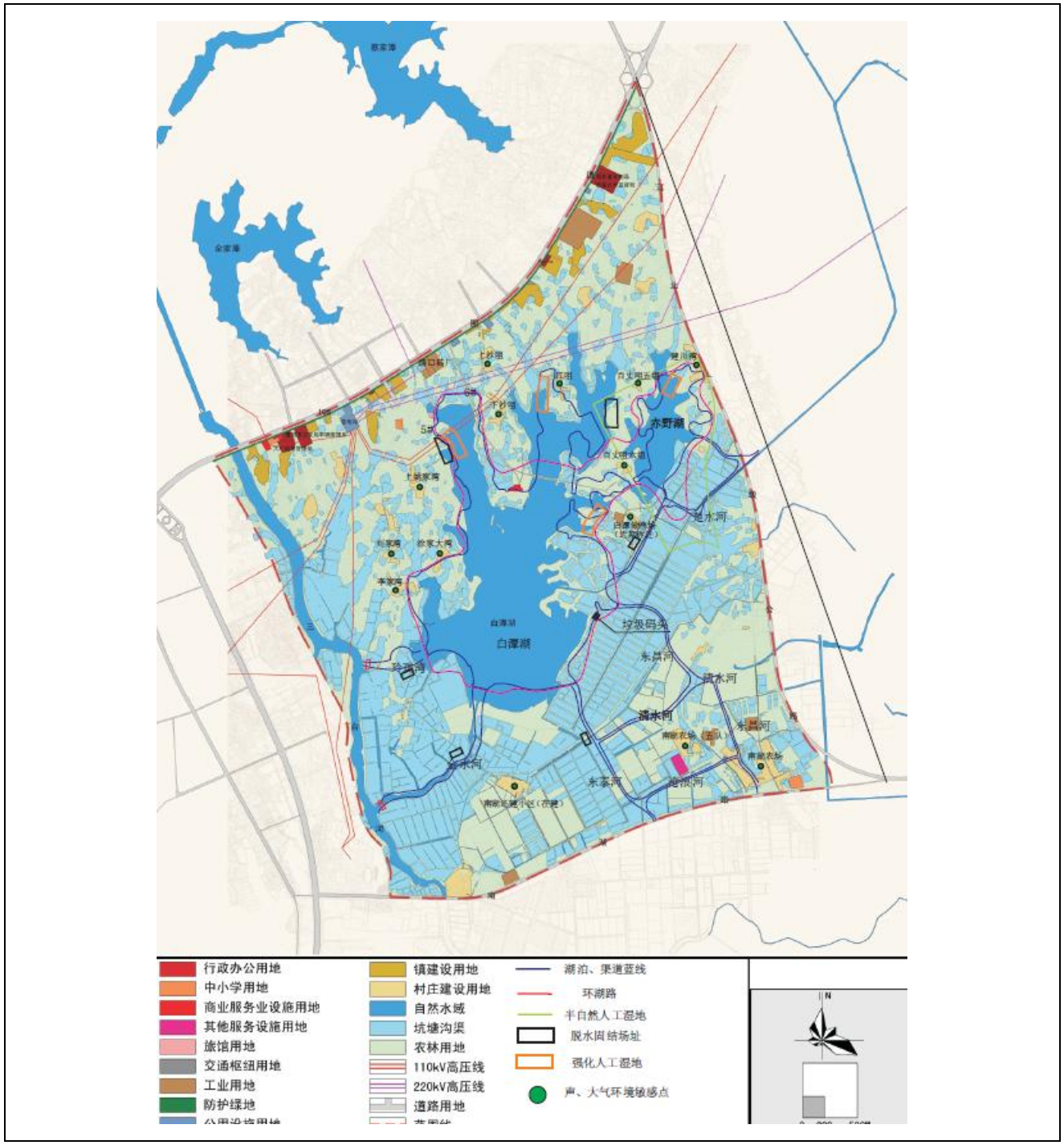


Figure IV.1: Locations of air quality and noise sensitive receptors

149. **Xingfu Reservoir** is located at Xingfu Village in Taodian Town in Huangzhou District and is approximately 11.6 km northeast of Baitan Lake. It has a catchment of 11.5 km^2 and a total water storage volume of 7.0357 million m^3 and an extractable volume of 4.11 million m^3. It was built in 1963 with the main function of supplying irrigation water, and secondary functions of aquaculture and flood water retention. Its present water quality is Category III. It is not being used as a drinking water source.

150. The **Ba River** originates from Dabie Mountain to the north and flows southward into the Yangtze River. Its total length is 148 km and its catchment area is 3,697 km^2. It forms the western boundary of the Huangzhou District and the section through Huangzhou District is 27 km long. Multi-year annual average precipitation in the Ba River catchment has been 1,330 mm, unevenly distributed with the upper reaches receiving more precipitation than its lower reaches. Multi-year annual average runoff has been approximately 507 million m^3. It function is for irrigation and flood control.

151. **Santai River** is the name given to the Huangzhou District section of the Chang River. The section upstream of Santai River is 16.7 km long with a catchment of 195 km^2. The Santai River section is 33.25 km long with a catchment of 289.5 km^2. It joins the Ba River near the latter's confluence with the Yangtze River. Normal water level is 16.7 m, with water levels of 17.9 m in the flood season and 13.63 ~ 13.94 m in the dry season. Its function is for irrigation and flood control.

152. The **Yangtze River** flows from the northwest to southeast forming the western and southern boundaries of Huanggang Municipality. Its section through Huanggang Municipality is 201 km long with a multi-year annual average transit volume of 721.86 billion m^3 through Huanggang Municipality.

153. **Wastewater**. Wastewater generated within the Baitan Lake planning area at present includes both industrial and domestic water. There have been 9 industrial enterprises in the planning area and 4 have been relocated outside the planning area as of March 2012. The five remaining ones are Nanhu Farm, Xinchang Textile Company, Sanxing Mason Product Company, Huachen Mineral Company, and Nanhu Farm No. 1 Brick Factory. All discharge their wastewater into Santai River. Of these only the Xinchang Textile Company has wastewater data showing discharge of 660,000 t/a with pollutant loadings of 58 t/a COD and 1.5 t/a NH_3-N. The master plan for the Baitan Lake planning area has no industrial land use and therefore no industrial wastewater will be generated in the planning area in the future after the remaining 5 industrial enterprises are relocated (expected by 2020 the latest).

154. Domestic wastewater generated by existing residents in the Baitan Lake planning area has been estimated by the planning EIR to be approximately 556 t/a, with pollutant loadings of 71.00 t/a COD, 41.87 t/a BOD_5, 44.64 t/a SS, 5.07 t/a NH_3-N, 4.39 t/a TN, and 0.62 t/a TP. There is no centralized wastewater collection and treatment for wastewater generated by existing residents. Wastewater is either treated by individual septic systems or discharged directly into nearby water bodies.

155. Besides wastewater, Baitan Lake water quality has also been affected by non-point source pollution from agricultural sources and fish farming in and around the lake. The PPTA consultants estimated that as of 2013, the former's pollutant load contribution would be approximately 51.47 t/a COD, 10.84 t/a TN and 0.60 t/a TP; while the latter's contribution would be approximately 99.24 t/a COD, 12.19 t/a TN and 2.80 t/a TP.

156. **Solid waste**. The quantity of municipal solid waste generated by existing residents in the Baitan Lake planning area has been estimated by the planning EIR to be approximately 4 t/d. This small quantity is collected and transported to the Xinqiao Solid Waste Treatment Center for disposal. Industrial solid waste mainly consists of bottom and fly ash from coal burning. All are re-used for

manufacturing building materials and no industrial solid waste is transported for disposal.

B. Physical Environment

157. **Geographical location**. Huanggang Municipality is located in eastern Hubei Province, south of the Dabie Mountain, bordering the northern shore of the middle reaches of the Yangtze River. It is approximately 170 km wide from east to west, and 200 km long from north to south. It borders Anhui Province to the east, the cities of Wuhan and Xiaogan to the west, and Henan Province to the north.

158. The Huangzhou District is located in southwestern Huanggang Municipality (see **Figure II.2**), on the northern shore of the mid-section of the Yangtze River, at longitude 114°50'~115°05' E and latitude 30°5'~30°29' N. It is surrounded by the Yangtze River to the west and south, the Ba River to the East, and mountains to the north. It has an administrative area of 353 km^2, expanding 21.5 km from east to west, and 26 km from north to south.

159. The New Eastern District (NED), within which the 25.26 km^2 Baitan Lake planning area constitutes the development area, is located in the eastern Huangzhou District, and is east of the existing urban center in Huangzhou District (see **Figures II.2**, **II.3** and **II.4**).

160. **Geology and topography**. The topography of Huanggang Municipality shows gentle sloping in terraces from highlands in the north to lowlands in the south. There are high mountains in the north-eastern part of the Municipality, hilly ridges in the central part, and plains and lakes in the southern part. The Dabie Mountain range (highest altitude 1,729 m) in the north-east forms the watersheds for the Yangtze River and Huai River systems. Approximately 34.5% (5,964.6 ha) of the Municipality is mountainous. The hilly ridges in the central area are mostly below 300 m in elevation. In the south are elongated lake plains (altitude 10~20 m) with crisscrossing rivers and lakes as well as scattering water ponds and branching streams. Elevation in the Baitan Lake planning area ranges from 9.3 m to 33.8 m, with an arithmetic mean of 19.8 m.

161. Soil types in the Huanggang Municipality include yellow-brown soil, red soil, alluvial soil and rice paddy soil. Yellow-brown soil is the dominant soil type covering an area of approximately 600,000 ha, which accounts for approximately 55% of the total land area. Yellow-brown soil is mainly found in the mountainous areas of Macheng, Luotian and Yingshan, providing essential forest soil. Red soil covers an area of approximately 173,000 ha, which accounts for 16% of the total land area. Red soil has a low pH of 4.5~6.0 and is mostly found in the hilly central regions and transitional areas. Alluvial soil covers an area of approximately 40,000 ha, which accounts for 3.7% of the total land area and is mainly distributed along the alluvial plains of the Yangtze River and its tributaries in the area, providing fertile soil for dry cultivated land. Rice paddy soil covers an area of approximately 262,000 ha, which accounts for 24% of the total land area and is mainly distributed in the hilly and lake plains providing essential agricultural soil.

162. **Seismicity**. Huanggang Municipality's tectonic structure is located in the border area of the Yangtze plate's Dongbai-Dabie uplift and the lower Yangtze fault zone. Major fractures in the area

belong to the interfaces of tectonic units, new tectonic units and its secondary structure, with complex structure and signs of multi-phase activity. Strong earthquake activity in the area is closely related to the faults. Presently the area is in an earthquake activity quiet period and there has been no comparatively strong earthquake activity in recent years.

163. According to the *China Seismic Ground Motion Parameters Zoning Map* (GB 18306-2001), the seismic intensity in the region of the project area is Grade VI. The PRC classifies seismic intensity into 12 classes under the *China Seismic Intensity Table* (GB/T 17742-2008), from Class I to Class XII based on the severity of "shaking" of the earth surface and the extent of potential impact. Class VI is intermediate in severity with most people unable to stand still and furniture falling.

164. **Climate**. Huanggang Municipality has sub-tropical continental seasonal monsoon climate with distinct seasons. **Table IV.4** summarizes Huanggang's climate characteristics. Rainy days (≥0.1 mm) occur mostly during the spring and summer seasons and especially from mid-June to mid-July that could account up to 30% of the total annual precipitation. Persistent high temperature and scarce precipitation would generally occur after mid-July due to the influence of the Pacific subtropical high pressure, resulting in summer and autumn droughts.

Table IV.4: Huanggang's climate characteristics

Annual average temperature	15.7~17.1 ^{o}C
Highest temperature (usually in July)	38.1 ^{o}C
Lowest temperature (usually in January)	-5.3 ^{o}C
Annual average relative humidity	77%
Annual average sunshine	1959.4 hours
Annual frost free period	237~278 days
Annual average precipitation	1223~1493 mm
Total annual precipitation	22.237 billion m^3
Highest one-day precipitation	224.7 mm
Precipitation days (≥ 0.1 mm)	115~147 days
Dominant wind direction and frequency	North, 19%
Secondary wind direction and frequency	South-east, 14%
Average wind speed	1.0 (Dec) - 1.5 (Aug) m/s

Source: Planning EIR and Project EIR

165. **Ambient air quality**. The PRC ranks air quality into 3 classes according to its *Ambient Air Quality Standard* (GB 3095-1996), with Class I being the best air quality and Class III the worst air quality. Typically, ambient air quality baseline monitoring for environmental impact assessment in the PRC consists of measuring the daily average concentration levels of total suspended particulates (TSP) and/or PM_{10}, sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) on seven consecutive days.

166. The planning EIR conducted baseline ambient air quality monitoring for 7 days in July – August 2012 at selected locations within the Baitan Lake planning area based on wind direction (upwind, downwind, cross wind) and future land use (**Table IV.5**). The project EIR commissioned the Huanggang Environmental Monitoring Station (HEMS) to conduct baseline ambient air quality monitoring for 7 days in March 2013 at selected existing sensitive receptor locations (**Figure IV.2** and **Table IV.6**). **Figure IV.2** also shows the monitoring locations for noise, surface water quality, and sediment.

Table IV.5: Baseline air quality data collected in July-August 2012

No.	Location	Concentration Range in mg/m³					
		SO_2		NO_2		TSP	PM_{10}
		24-hr Average	1-hr Average	24-hr Average	1-hr Average	24-hr Average	24-hr Average
1	Upwind of the predominant wind direction, ESE of the center of the planning area	0.046~0.086	0.049~0.082	0.035~0.077	0.049~0.091	0.045~0.123	0.008~0.024
2	Perpendicular (90º) to the predominant wind direction, NNE of the center of the planning area	0.053~0.082	0.047~0.082	0.052~0.076	0.049~0.093	0.065~0.111	0.006~0.023
3	Downwind of the predominant wind direction, WNW of the center of the planning area	0.030~0.102	0.043~0.102	0.036~0.077	0.049~0.093	0.060~0.122	0.006~0.021
4	Perpendicular (280o) to the predominant wind direction, SWS of the center of the planning area	0.053~0.100	0.049~0.101	0.032~0.077	0.026~0.089	0.032~0.122	0.007~0.026
5	Downwind of the predominant wind direction, WNW of the center of the planning area	0.043~0.086	0.035~0.099	0.050~0.075	0.044~0.099	0.048~0.120	0.008~0.018
6	Future commercial center, N of the center of the planning area	0.038~0.098	0.031~0.099	0.033~0.076	0.031~0.082	0.050~0.110	0.006~0.021
7	Future southern sub-district, S of the center of the planning area	0.032~0.087	0.029~0.099	0.039~**0.087**	0.039~0.093	0.050~0.126	0.006~0.019
Class II standards							
	GB 3095-1996	*0.150*	*0.500*	*0.120*	*0.240*	*0.300*	*0.150*
	GB 3095-2012	*0.150*	*0.500*	*0.080*	*0.200*	*0.300*	*0.150*
WBG EHS standards							
	Interim targets	*0.050~0.125*	*n/a*	*n/a*	*n/a*	*n/a*	*0.075~0.150*
	AQG	*0.020*	*n/a*	*n/a*	*0.200*	*n/a*	*0.050*

Source: Planning EIR *Note: n/a = not available*

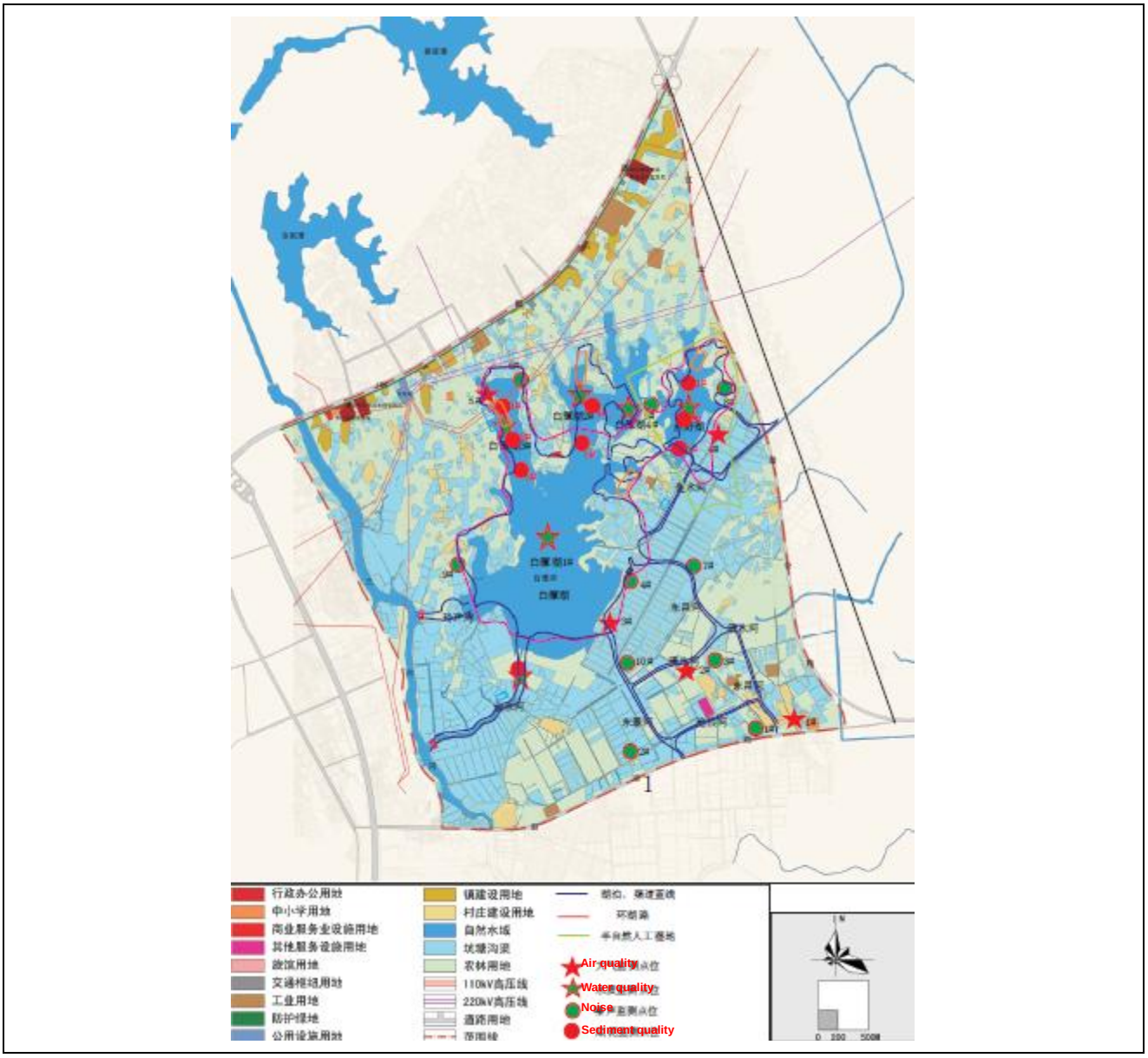


Figure IV.2: Baseline monitoring locations for the project EIR

Table IV.6: Baseline air quality monitoring data collected in March 2013

Monitoring Location	Monitoring Date	Daily Average Concentration (mg/m^3)				Hourly Average Concentration (mg/m^3)	
		SO_2	NO_2	PM_{10}	CO	NH_3	H_2S
# 1	2013.03.07	0.031	0.051	0.05	1.13	---	---
	2013.03.08	0.024	0.032	0.08	1.29	---	---
	2013.03.09	0.034	0.060	0.06	1.64	---	---
	2013.03.10	0.036	0.051	0.03	1.34	---	---
	2013.03.11	0.041	0.042	0.07	1.23	---	---
	2013.03.12	0.033	0.016	0.09	1.29	---	---
	2013.03.13	0.035	0.037	0.08	1.24	---	---
#2	2013.03.07	0.024	0.042	0.05	1.37	< 0.007	< 0.001
	2013.03.08	0.012	0.033	0.06	1.69	< 0.007	< 0.001
	2013.03.09	0.045	0.044	0.10	1.89	< 0.007	< 0.001
	2013.03.10	0.023	0.050	0.03	1.47	< 0.007	< 0.001
	2013.03.11	0.014	0.031	0.04	1.28	< 0.007	< 0.001
	2013.03.12	0.034	0.031	0.06	1.37	< 0.007	< 0.001
	2013.03.13	0.015	0.044	0.07	1.69	< 0.007	< 0.001
#3	2013.03.07	0.025	0.037	0.10	1.58	---	---
	2013.03.08	0.023	0.046	0.06	1.19	---	---
	2013.03.09	0.024	0.029	0.08	1.67	---	---
	2013.03.10	0.025	0.019	0.10	1.87	---	---
	2013.03.11	0.025	0.043	0.08	1.29	---	---
	2013.03.12	0.024	0.033	0.09	1.16	---	---
	2013.03.13	0.023	0.035	0.07	1.37	---	---
#4	2013.03.07	0.024	0.048	0.12	1.99	< 0.007	< 0.001
	2013.03.08	0.025	0.037	0.10	1.37	< 0.007	< 0.001
	2013.03.09	0.023	0.048	0.07	1.28	< 0.007	< 0.001
	2013.03.10	0.022	0.022	0.09	1.67	< 0.007	< 0.001
	2013.03.11	0.034	0.042	0.10	1.28	< 0.007	< 0.001
	2013.03.12	0.033	0.033	0.10	1.67	< 0.007	< 0.001
	2013.03.13	0.035	0.028	0.09	1.57	< 0.007	< 0.001
#5	2013.03.07	0.031	0.043	0.10	1.77	---	---
	2013.03.08	0.022	0.023	0.05	1.28	---	---
	2013.03.09	0.024	0.045	0.10	1.34	---	---
	2013.03.10	0.033	0.038	0.09	1.98	---	---
	2013.03.11	0.031	0.031	0.09	1.47	---	---
	2013.03.12	0.022	0.026	0.07	1.38	---	---
	2013.03.13	0.025	0.039	0.09	1.29	---	---
Class II standards							
	GB 3095-1996	*0.15*	*0.12*	*0.15*	*4.0*	*n/a*	*n/a*
	GB 3095-2012	*0.15*	*0.08*	*0.15*	*4.0*	*n/a*	*n/a*
	GB 14554-93	*n/a*	*n/a*	*n/a*	*n/a*	*1.5*	*0.06*
WBG EHS standards							
	Interim targets	*0.05~0.125*	*n/a*	*0.075~0.150*	*n/a*	*n/a*	*n/a*
	AQG	*0.02*	*n/a*	*0.05*	*n/a*	*n/a*	*n/a*

Source: HEMS Note: n/a = not available

167. Data in **Tables IV.5** and **IV.6** indicate that the concentration levels of the parameters measured

on the monitoring days at the monitoring locations complied with applicable PRC and WBG EHS standards, except for 24-hr average NO_2 at location #7 in the southern part of the Baitan Lake planning area in July-August 2012 (**Table IV.5**). Although the highest 24-hr average NO_2 level at location #7 complied with GB 3095-1996 Class II standard which is applicable at present, it would have exceeded the GB 3095-2012 Class II standard which will become effective on 1 January 2016 with more stringent 24-hr average NO_2.

168. **Acoustic environment**. Noise standards in the PRC are prescribed in *Environmental Quality Standard for Noise* (GB 3096-2008). GB 3096-2008 categorizes 5 functional areas based on their tolerance to noise pollution: from Category 0 to Category 4. Category 0 is for areas with health recovery facilities that are the least tolerant to noisy environment and therefore has the most stringent day and night time noise standards. Category 1 is for areas predominated by residential areas, hospitals and clinics, educational institutions and research centers. Category 2 is for areas with mixed residential and commercial and industrial functions. Category 3 is for areas with industrial production and storage and logistics functions. Category 4 is for areas adjacent to traffic noise sources such as major roads and highways, and is sub-divided into 4a and 4b with the former applicable to road and marine traffic noise and the latter applicable to rail noise.

169. Typically, baseline noise monitoring for environmental impact assessment in the PRC consists of noise level measurements at sensitive receptors once in the day time and once in the night time each day for two consecutive days.

170. **Table IV.7** shows baseline noise monitoring data collected in July-August 2012 for the planning EIR. Monitoring locations were established in form of a grid system set up for the planning area. Data show that on the days of monitoring, day time noise at the monitoring locations complied with both GB and EHS standards, and night time noise complied with GB standard but a few locations in functional area category 2 exceeded the more stringent EHS standard during night time.

Table IV.7: Baseline noise monitoring data collected in the Baitan Lake planning area in 2012

Functional Area Category 2 Noise Levels (in dB)			Functional Area Category 4a Noise Levels (in dB)		
Location	**Day Time**	**Night Time**	**Location**	**Day Time**	**Night Time**
1	46.85	44.55	21 (15 m from road red line)	59.60	53.80
2	50.35	43.40			
3	49.50	46.20			
4	51.45	46.35			
5	51.45	44.65	22 (30 m from road red line)	56.00	51.45
6	52.25	44.55			
7	50.15	43.10			
8	51.25	45.30			
9	49.40	45.20			
10	52.35	45.30			
11	52.30	45.80			
12	49.95	45.30			
13	49.15	45.00			
14	50.00	45.00			
15	49.85	45.35			
16	49.85	43.35			

Functional Area Category 2 Noise Levels (in dB)			Functional Area Category 4a Noise Levels (in dB)		
Location	**Day Time**	**Night Time**	**Location**	**Day Time**	**Night Time**
17	50.60	44.30			
18	49.65	44.45			
19	51.70	44.45			
20	51.50	44.80			
GB 3096-2008 standards	*60*	*50*		*70*	*55*
WBG EHS standards	*55*	*45*		*70*	*70*
Note: Exceed WBG EHS standard					

Source: Planning EIR

171. **Table IV.8** shows baseline monitoring data conducted by HEMS in March 2013 for the project EIR at selected existing sensitive receptor locations and near roads. Data show that on the monitoring days, Nanhu Road traffic noise exceeded both GB and EHS day time standards on day 1. All sensitive receptors showed compliance with GB standards during day time and night time. The Nanhu Farm Team #5 location exceeded the more stringent EHS day time and night time noise standards.

Table IV.8: Baseline noise monitoring data collected in March 2013

No.	Monitoring Location	Day Time Noise (dB)		Night Time Noise (dB)	
		Day 1	**Day 2**	**Day 1**	**Day 2**
1	Nanhu Road 南湖路	72.7	69.8	53.7	54.4
2	Zhazhou Street 榨周街	54.3	53.1	46.7	45.6
GB 3096-2008 Functional Area Category 4a standards		70		55	
WBG EHS standards		70		70	
3	Nanhu Team #6 南湖六队	52.7	54.9	43.1	44.6
4	Nanhu Team #6 (resettled) 南湖六队（安迁）	50.0	52.9	41.2	43.6
5	Aqua Product Bureau 水产局	48.5	50.7	40.3	43.1
6	Wangjiawan Rural Committee 王家湾村委会	48.3	51.7	39.9	44.4
7	Fish Farm 鱼场	50.0	51.9	40.6	41.6
8	Nanhu Farm Team #5 南湖农场五队	58.2	59.1	45.1	45.5
9	Wangjiawan 王家湾	51.1	51.9	42.6	42.9
10	Fish Pond 鱼池	50.0	50.8	43.4	43.8
GB 3096-2008 Functional Area Category II standards		*60*		*50*	
WBG EHS standards		*55*		*45*	
Notes: Exceed both GB 3096-2008 and WBG EHS standards; Exceed WBG EHS standards					

Source: HEMS

172. **Surface water quality**. The PRC's *Environmental Quality Standard for Surface Water* (GB 3838-2002) defines five water quality Categories for different environmental functions. Category I being the best water quality and Category V being the worst water quality. Only Category I to Category III water quality could be used for potable purpose. If Category IV water were to be used for drinking purpose, proper treatment before use is required.

173. **Table IV.9** shows surface water quality monitoring data collected in Baitan Lake, Santai River

and receiving water bodies of the Nanhu Wastewater Treatment Plant (WWTP) in July-August 2012 for the planning EIR. All showed compliance with their planning target of Category III water quality standards for the monitored parameters and on the monitoring days.

174. **Table IV.10** shows surface water quality monitoring data collect in March 2013 by HEMS for the project EIR. Water quality near term planning targets are Category III for Santai River, Xingfu Reservoir and Ba River, and Category IV for Baitan Lake, Chiye Lake and Jinshui River. For lakes and reservoirs, more stringent TP standards also apply as shown in **Table IV.10**. The following observations are made based on data collected for the parameters monitored and on the monitoring days.

(i) Ba River and Jinshui River complied with their respective planning targets of Category III and Category IV water quality;

(ii) Chiye Lake showed Category V water quality due to exceedance of TN Category IV standard, and did not meet its near term Category IV water quality planning target;

(iii) Santai River showed Category IV-V water quality due to high levels of permanganate index, COD, BOD_5 and TN, and did not meet its Category III water quality planning target;

(iv) Xingfu Reservoir showed Category IV-V water quality due to high levels of permanganate index, COD, BOD5 and TP, and did not meet its Category III water quality planning target;

(v) Baitan Lake showed worse than Category V water quality due to high levels of TN. It also showed high levels of permanganate index, COD, BOD_5, NH_3-N and TP that exceeded its near term Category IV water quality planning target.

Table IV.9: Baseline surface water quality monitoring data collected in 2012

Water Body	No.	Monitoring Location	Concentrations of Monitored Parameters												
			pH	COD	BOD_5	TPH	Permanganate Index	DO	$SO_4^{=}$	F^-	Volatile Phenol	NH_3-N	TP	TN	Fecal Coliform
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	no./L
Baitan Lake	1	Chiye Lake entering Baitan Lake	8.1	8.0	3.60	0.03	2.25	6.45	0.026	<0.05	<0.002	0.26	0.040	0.07	3000
	2	Baitan Lake center	8.2	9.0	3.55	0.02	2.35	7.35	0.034	<0.05	<0.002	0.24	0.035	0.08	3000
	3	Baitan Lake sluice gate	8.3	9.0	3.45	0.02	2.35	7.00	0.035	<0.05	<0.002	0.27	0.030	0.08	3000
	4	Jinshui River 200 m upstream of confluence with Santai River	8.2	9.0	3.50	0.02	2.40	6.60	0.036	<0.05	<0.002	0.18	0.090	0.07	3000
Santai River	5	Santai River 500 m upstream of New Eastern District	8.2	9.0	3.40	0.02	2.15	6.85	0.044	<0.05	<0.002	0.22	0.135	0.09	3000
	6	Santai River 500 m downstream of New Eastern District	8.2	9.0	3.50	0.03	2.40	6.40	0.040	<0.05	<0.002	0.21	0.135	0.07	3000
	7	Santai River 2000 m downstream of New Eastern District	8.3	9.0	3.45	0.02	2.50	6.45	0.030	<0.05	<0.002	0.22	0.115	0.08	3000
Receiving Water Body	8	500 m upstream of WWTP outfall	8.1	8.0	3.45	0.02	2.45	6.45	0.030	<0.05	<0.002	0.23	0.110	0.08	3000
	9	500 m downstream of WWTP outfall	8.2	7.0	3.45	0.02	2.30	6.35	0.030	<0.05	<0.002	0.22	0.120	0.09	3000
	10	2000 m downstream of WWTP outfall	8.3	6.5	3.35	0.02	2.30	6.25	0.029	<0.05	<0.002	0.21	0.110	0.08	3000
		GB 3838-2002 Category III standards	*6~9*	*≤20*	*≤4*	*≤0.05*	*≤6*	*≥5*	*≤0.2*	*≤1.0*	*≤0.005*	*≤1.0*	*≤0.2 (≤0.05)*	*≤1.0*	*10000*

Source: Planning EIR

Table IV.10: Baseline surface water quality monitoring data collected in March 2013

Monitoring Location	Monitoring Date	Concentrations of Monitored Parameters																								
		Water Temperature	pH	DO	Permanganate Index	COD	BOD_5	NH_3-N	TP	TN	Cu	Zn	F^-	Se	As	Hg	Cd	Cr	Pb	Cl^-	Volatile Phenol	TPH	Anionic Surfactant	$SO_4^{=}$	Fecal Coliform	Chlorophyll a
		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	no./L	mg/m³
Baitan Lake #1	2013.03.07	9.7	7.9	5.7	8.2	25	4.8	1.19	0.08	2.44	<0.001	<0.05	0.23	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.45
	2013.03.08	9.6	7.8	5.9	9.6	29	5.8	1.21	0.08	2.09	<0.001	<0.05	0.23	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.44
	2013.03.09	9.8	7.9	6.1	7.9	28	5.5	1.22	0.08	2.11	<0.001	<0.05	0.23	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.49
Baitan Lake #2	2013.03.07	9.8	7.7	6.3	8.9	27	4.9	1.31	0.08	2.51	<0.001	<0.05	0.24	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.46
	2013.03.08	9.4	7.5	5.9	9.1	27	5.0	1.56	0.08	2.49	<0.001	<0.05	0.24	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.40
	2013.03.09	9.6	7.9	6.2	9.1	30	5.2	1.44	0.07	2.50	<0.001	<0.05	0.24	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.42
Baitan Lake #3	2013.03.07	9.7	7.8	6.1	8.8	29	5.3	1.39	0.06	2.55	<0.001	<0.05	0.23	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.44
	2013.03.08	9.8	7.7	6.5	9.2	27	4.9	1.41	0.08	2.59	<0.001	<0.05	0.23	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.43
	2013.03.09	9.1	7.5	6.3	9.0	28	5.1	1.35	0.07	2.49	<0.001	<0.05	0.23	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.40
Baitan Lake #4	2013.03.07	9.5	7.8	6.3	8.9	31	5.4	1.32	0.08	2.49	<0.001	<0.05	0.24	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.43
	2013.03.08	9.3	7.8	6.4	9.6	26	5.6	1.29	0.07	2.50	<0.001	<0.05	0.24	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.45
	2013.03.09	9.7	7.6	6.0	8.4	27	4.9	1.26	0.06	2.53	<0.001	<0.05	0.24	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	1.49
Chiye Lake	2013.03.07	9.6	7.4	6.5	7.1	22	5.1	1.18	0.07	1.93	<0.001	<0.05	0.27	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	0.82
	2013.03.08	9.7	7.5	6.8	7.9	25	4.4	1.20	0.06	1.92	<0.001	<0.05	0.27	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	0.74
	2013.03.09	9.7	7.4	6.9	7.6	24	4.1	1.19	0.06	1.92	<0.001	<0.05	0.27	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	0.92
Jinshui River	2013.03.07	10.2	7.6	7.5	6.2	22	4.4	0.20	0.07	0.89	<0.001	<0.05	0.24	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
	2013.03.08	10.0	7.7	6.9	6.2	25	4.6	0.16	0.09	0.90	<0.001	<0.05	0.24	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
	2013.03.09	9.7	7.6	6.8	6.9	21	4.2	0.19	0.08	0.79	<0.001	<0.05	0.24	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
Santai River	2013.03.07	9.9	7.8	7.3	6.7	26	5.3	0.68	0.12	1.34	<0.001	<0.05	0.30	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
	2013.03.08	9.7	7.9	7.4	6.8	27	4.8	0.79	0.15	1.54	<0.001	<0.05	0.23	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
	2013.03.09	10.2	7.8	7.2	6.3	29	5.5	0.88	0.18	1.78	<0.001	<0.05	0.23	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
Xingfu Reservoir	2013.03.07	10.7	7.7	7.5	8.7	33	5.8	0.22	0.07	0.91	<0.001	<0.05	0.27	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
	2013.03.08	10.8	7.9	7.1	7.9	25	4.8	0.16	0.06	0.87	<0.001	<0.05	0.27	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
	2013.03.09	10.2	7.6	6.9	8.0	29	5.4	0.19	0.07	0.83	<0.001	<0.05	0.27	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
Ba River	2013.03.07	12.2	7.6	7.6	2.5	10	2.2	0.21	0.08	0.92	<0.001	<0.05	0.27	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
	2013.03.08	11.5	7.7	7.3	2.2	9	1.8	0.18	0.08	0.89	<0.001	<0.05	0.27	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---
	2013.03.09	11.0	7.6	7.0	2.1	8	1.4	0.19	0.09	0.87	<0.001	<0.05	0.27	<0.0003	<0.007	<0.0001	<0.001	<0.004	<0.01	<0.002	<0.002	<0.01	<0.05	<0.005	2000	---

Monitoring Location	Monitoring Date	Concentrations of Monitored Parameters																								
		Water Temperature	pH	DO	Permanganate Index	COD	BOD_5	NH_3-N	TP	TN	Cu	Zn	F^-	Se	As	Hg	Cd	Cr	Pb	Cl^-	Volatile Phenol	TPH	Anionic Surfactant	$SO_4^=$	Fecal Coliform	Chlorophyll *a*
		°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	no./L	mg/m³
GB 3838-2002 standards																										
	Category III	*≤-2~≤+1 weekly*	*6~9*	*≥5*	*≤6*	*≤20*	*≤4*	*≤1.0*	*≤0.2 (≤0.05)*	*≤1.0*	*≤1.0*	*≤1.0*	*≤1.0*	*≤0.01*	*≤0.05*	*≤0.0001*	*≤0.005*	*≤0.05*	*≤0.05*	*≤0.2*	*≤0.005*	*≤0.05*	*≤0.2*	*≤0.2*	*10000*	*n/a*
	Category IV			*≥3*	*≤10*	*≤30*	*≤6*	*≤1.5*	*≤0.3 (≤0.1)*	*≤1.5*	*≤1.0*	*≤2.0*	*≤1.5*	*≤0.02*	*≤0.1*	*≤0.001*	*≤0.005*	*≤0.05*	*≤0.05*	*≤0.2*	*≤0.01*	*≤0.5*	*≤0.3*	*≤0.5*	*20000*	*n/a*
	Category V			*≥2*	*≤15*	*≤40*	*≤10*	*≤2.0*	*≤0.4 (≤0.2)*	*≤2.0*	*≤1.0*	*≤2.0*	*≤1.5*	*≤0.02*	*≤0.1*	*≤0.001*	*≤0.01*	*≤0.1*	*≤0.1*	*≤0.2*	*≤0.1*	*≤1.0*	*≤0.3*	*≤1.0*	*40000*	

Notes:

Category III standards apply to Santai River, Xingfu Reservoir and Ba River.

Category IV standards apply to the others. TP standards in parentheses apply to lakes and reservoirs

Exceed Category III standard Exceed Category IV standard Exceed Category V standard

Source: HEMS

175. .**Ground water quality**. Ground water quality in the PRC is divided into five categories according to *Quality Standard for Ground Water* (GB/T 14848-93), with Category I having the best ground water quality and Category V the worst. Ground water quality that meets Category I to Category III standards can be used for potable purpose. Ground water in the Baitan Lake planning area has been assigned to meet the planning target of Category II standards.

176. The planning EIR selected three ground water wells that were being extracted for domestic use by local residents for monitoring the ground water quality in the northern, southern and western parts of the Baitan Lake planning area (**Table IV.11**). Data show that ground water quality complied with Category II standards based on the parameters measured on the monitoring days despite having relatively high pH, total hardness and total dissolved solids.

Table IV.11: Baseline ground water quality monitoring data collected in 2012

Parameters Monitored	Unit	Locations of Domestic Ground Water Wells			*GB/T 14848-93 Category II Standards*
		Wangjiazui (N)	Nanhu Team #6 (S)	Nanhu Team #2 (W)	
pH		8.5	8.4	8.4	*6.5~8.5*
NH_3-N	mg/L	0.013	0.016	0.016	*≤ 0.02*
NO_3^-	mg/L	<0.02	<0.02	<0.02	*≤ 5.0*
NO_2^-	mg/L	<0.002	<0.002	<0.002	*≤ 0.01*
Volatile phenol	mg/L	<0.001	<0.001	<0.001	*≤ 0.001*
CN	mg/L	<0.005	<0.005	<0.005	*≤ 0.01*
As	mg/L	<0.007	<0.007	<0.007	*≤ 0.01*
Hg	mg/L	<0.0004	<0.0004	<0.0004	*≤ 0.0005*
Cr^{6+}	mg/L	<0.004	<0.004	<0.004	*≤ 0.01*
Total hardness (as $CaCO_3$)	mg/L	280	300	300	*300*
F^-	mg/L	<0.05	<0.05	<0.05	*≤ 1.0*
Pb	mg/L	<0.01	<0.01	<0.01	*≤ 0.01*
Cd	mg/L	<0.001	<0.001	<0.001	*≤ 0.001*
Fe	mg/L	0.15	0.12	0.12	*≤ 0.2*
Total dissolved solids	mg/L	476	352	468	*≤ 500*
Permanganate index	mg/L	1.7	1.6	1.8	*≤ 2.0*
$SO4^=$	mg/L	52.4	64.2	54.4	*≤ 150*
Cl^-	mg/L	38.4	42.6	34.4	*≤ 150*
Total coliform bacteria	no./L	0	0	0	*≤ 3.0*

Source: Planning EIR

177. **Soil and sediment quality**. Soil quality in the PRC is divided into three classes according to *Environmental Quality Standard for Soils* (GB 15618-1995). Class 1 represents the best and Class 3 the worst. Soil quality in the Baitan Lake planning area has been assigned to meet Class 2 standards, for the protection of agricultural products and human health.

178. The PRC does not have standard for sediments in waterways such as streams, rivers, lakes, reservoirs and the sea. It is common practice in the PRC to use *Environmental Quality Standard for Soils* (GB 15618-1995) to assess sediment quality since most sediment would be disposed on land and mostly likely for future agricultural or planting uses. Some EIRs in the PRC have also used *Control Standards for Pollutants in Sludges from Agricultural Use* (GB 4284-84) for assessing sediment quality. The rationale being that the physical nature of river sediment is similar to sludge. GB 15618-1995

standards are more stringent than GB 4284-84. Since the dredged sediment in this project will not be disposed on land (thus have the potential to affect soil quality) but will be treated and re-used as fill materials for wetland planting, dredged sediment quality was assessed against GB 4284-84 standards.

179. The planning EIR selected two locations, in the northern and southern parts of the planning area respectively, for monitoring the baseline soil quality (**Table IV.12**). Data show that soil quality complied with Class I standards based on the parameters measured on the monitoring days.

Table IV.12: Baseline soil quality monitoring data collected in 2012

Monitoring Location	Concentrations in mg/kg						
	Cr	Cu	Pb	Zn	Hg	As	Cd
Xiejiawan in the north	63.3	17.9	21.9	52.6	0.034	0.047	0.18
Nanhu Team #6 in the south	62.4	18.3	22.3	54.2	0.037	0.052	0.13
GB 15618-1995 Class I standards	*90*	*35*	*35*	*100*	*0.15*	*15*	*0.20*

Source: Planning EIR

180. Baseline monitoring of sediment quality in Baitan Lake, Chiye Lake and Jinshui River was conducted in 2013 by HEMS for the project EIR (**Table IV.13**). Monitoring locations are shown in **Figure IV.3**. Data show that sediment at the monitoring locations in Baitan Lake, Chiye Lake and Jinshui River complied with GB 4284-84 based on parameters measured on the monitoring days and is suitable for agricultural use. Although the sediment did not show contamination by heavy metals and organics, it did show high levels of nutrients in terms of phosphorus and nitrogen compared to rivers such as those in the Chao Lake basin in Anhui Province where TN and TP levels in river sediments were found to be as high as 2,800 mg/kg[20]. The project EIR, based on the concentrations of chlorophyll *a*, TP, TN and permanganate index in the water column, determined that both Baitan Lake and Chiye Lake were in a slightly eutrophic state, partly contributed by the release of nutrients from the lake sediment into the water column.

C. Biological Resources, Ecology and Biodiversity

181. **Existing land use**. **Table IV.14** shows that permanent and temporary land take in this project would total 179.92 ha. Ninety percent of the existing land uses within the land take areas are ponds and ditches (61.8%), dry farmland (19.8%) and shrub land (8.9%)[21]. Construction of wetland and river-lake connection network would account for approximately 85% of the permanent land take. **Table IV.14** also shows that these land uses to be taken up by this project make up only a minute portion of same land use types in the Huanggang Municipality.

182. **Vegetation**. Vegetation surveys were carried out during May to August 2013. Survey quadrants were set up at selected locations in the assessment area (= planning area) and the dominant

[20] Government of Anhui Province. 2012. Environmental Impact Assessment. People's Republic of China: Anhui Chao Lake Environmental Rehabilitation Project. Report prepared for the Asian Development Bank.

[21] Land use classifications are based on PRC's *Current Land Use Classification* (GB/T 21010-2007)

vegetation types and associated flora were recorded (**Table IV.15**). Based on these surveys and information from literature, floral species that have been recorded in the Baitan Lake planning area and their protection status are listed in **Table IV.16**.

183. The national protection status, which is divided into Class I and Class II, is based on the *List of Wild Flora under Nationally Emphasized Protection – First Batch* and its revision. The International Union for Conservation of Nature (IUCN) red list classifies protection status into 6 categories (other than Extinct) in descending order of protection importance: Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC). Those that are EW, CR, EN and VU are deemed to warrant protection.

184. The following observations were made based on data presented in **Tables IV.15** and **IV.16**:

(i) 487 plant species have been recorded in the Baitan Lake planning area and 42 vegetation types have been found during the vegetation survey to occur in the assessment area;

(ii) The 42 vegetation types consisted of trees, shrubs, vines and aquatic plants occurring in and around water bodies, ponds and ditches, as well as on agricultural land, vacant land and in constructed areas adjacent to village households;

(iii) Of the 487 species, 145 species (30%) were cultivated species;

(iv) Of the 487 species, 7 are on the national protection list with 3 species under Class I protection and 4 species under Class II protection. Only 71 of these 487 species have been assessed by IUCN. Of these 71 species, 2 are Endangered (EN), 2 are Near Threatened (NT) and the remaining 67 species are of Least Concern (LC).

Table IV.13: Baseline sediment quality monitoring data collected in 2013

Monitoring Location	Moisture Content	pH	Concentration in mg/kg dry weight												
			As	Hg	Cr	Cu	Ni	Pb	Zn	Cd	B	TPH	Benzo(a) Pyrene	TP	TN
Baitan Lake #1	63.8%	6.9	10.7	0.08	104	49	46	39	125	0.32	2.4	128	ND	1380	5280
Baitan Lake #2	64.3%	6.9	10.5	0.07	103	48	46	36	124	0.29	2.2	132	ND	1410	5368
Baitan Lake #3	61.9%	6.9	10.9	0.08	103	50	46	38	124	0.29	2.2	116	ND	1301	5955
Baitan Lake #4	60.1%	6.8	11.0	0.09	99	49	47	31	113	0.27	1.8	316	ND	1305	5472
Baitan Lake #5	60.2%	6.8	11.2	0.09	97	47	45	35	114	0.26	2.0	300	ND	1272	5414
Chiye Lake #1	60.1%	7.0	15.3	0.07	93	52	38	36	130	0.34	2.2	64	0.003	1055	4047
Chiye Lake #2	61.2%	6.9	14.6	0.06	94	53	38	36	114	0.30	2.0	48	0.004	928	4114
Chiye Lake #3	62.4%	6.9	14.7	0.07	93	53	38	36	114	0.30	2.2	76	0.004	1093	4027
Jinshui River	39.4%	6.8	10.8	0.09	100	48	47	33	117	0.28	1.8	288	ND	950	3452
GB 4284-84 standards	---	*≤6.5*	*75*	*15*	*1000*	*500*	*200*	*1000*	*1000*	*20*	*150*	*3000*	*3*	---	---

Source: HEMS

Table IV.14: Existing land use of engineering land take areas

Project Area			Land Use Type [based on *Current Land Use Classification* (GB 21010-2007)] and Area (ha)								Total Land Take (ha)	
			Cultivated Land		Water Area			Vegetated Area		Residential Land		
			011 Paddy Field	013 Dry Farm Land	111 River Surface	114 Ditch/Pond Surface	112 Lake Surface	022 Orchard	032 Shrub Land	072 Rural Homestead	Permanent	Temporary
Urban lakes & rivers	Lake rehabilitation	Dredging works	1.00	1.00	---	---	---	4.18	0.38	---	---	6.56
		Wetland construction	3.60	17.95	---	53.57	---	1.10	2.60	2.19	81.01	---
	Lake NMT ring road	Road	---	2.05	---	11.36	---	---	8.70	0.70	22.81	---
		Bridge	---	---	0.73	---	---	---	---		0.73	---
	River-lake network connection		---	11.40	3.53	46.30	---	---	---	---	61.23	---
Solid waste collection and transfer	Transfer station		---	0.40	---	---	---	---	0.20	---	0.60	---
	Pier		---	---	---	---	0.04	---	0.02	---	0.06	---
Construction staging areas			---	0.60	---	---	---	---	0.50	---	---	1.10
Haul roads			---	0.76	---	---	---	---	0.16	---	---	0.92
Borrow pits			---	1.50	---	---	---	---	3.40	---	---	4.90
Total:			4.60	35.66	4.26	111.23	0.04	5.28	15.96	2.89	166.44	13.48
% of total (permanent & temporary) land take:			2.6%	19.8%	2.4%	61.8%	<0.01%	2.9%	8.9%%	1.6%	92.5%	7.5%
Huanggang Municipality total based on 2005 data:			383,870		246,400			75,940	713,390	99,034		
Land take from this project as a % of Huanggang Municipality total:			0.01%		0.05%			0.007%	0.002%	0.003%		

Sources: SEPP and Planning EIR

Table IV.15: Vegetation surveys conducted in May to August 2013

Location		Coordinates		Survey Quadrant Size	Dominant Vegetation Type and Associated Flora	Remarks
		Latitude N	Longitude E			
Nanhu Farm Team #4 Village	Adjacent to roadside fish pond	30° 28' 1.2"	114° 58' 57"	10m x 10m	Black Locust *Robinia pseudoacacia.* Associated flora included *Artemisia argyi, Morus alba, Broussonetia papyrifera, Sapium sebiferum, Achyranthes bidentata, Conyza canadensis* and *Paederia scandens.*	Even distribution on flat terrain adjacent to roads and ditches over an area of approximately 400 m^2 at 85% coverage and approximately 12 m in height.
				5m x 5m	Chinese Tallow *Sapium sebiferum* shrubbery. Associated flora included *Artemisia argyi, Imperata cylindrical, Conyza canadensis, Xanthium sibiricum, Aeschynomene indica, Lonicera japonica* and *Paederia scandens.*	Irregular distribution alongside fish pond ditches over an area of approximately 200 m^2 at 70% coverage and approximately 3-4 m in height.
	No. 128	30° 28' 9.2"	114° 58' 1.4"	5m x 5m	Indigo Bush *Amorpha fruticosa* shrubbery. Associated flora included *Broussonetia papyrifera, Morus alba, Alternanthera philoxeroides, Achyranthes bidentata, Artemisia argyi, Persicaria perfoliata, Ipomoea purpurea* and *Glycine soja.*	Even distribution along sides of roads and ponds over an area of approximately 100 m^2 at 70% coverage and approximately 2 m in height.
				5: 1m x 1m	Lamb's Quarters *Chenopodium album.* Associated flora included *Xanthium sibiricum, Amaranthus spinosus, Setaria viridis* and *Ipomoea purpurea.*	Continuous but irregular distribution along roadside and ditches, and in open field and wasteland over an area of approximately 100 m^2 at 70% coverage and approximately 0.3-1.6 m in height.
				5: 1m x 1m	Bermuda Grass *Cynodon dactylon.* Associated flora include *Cyperus rotundus, Xanthium sibiricum, Alternanthera philoxeroides, Echinochloa crusgalli, Acalypha australis* and *Eragrostis ferruginea.*	Ground cover in wet areas alongside roads, farmland, and ditches over an area of approximately 100 m^2 at 90% coverage.
	Adjacent to Yejiazuiwan Village	30° 28' 16"	114° 58' 2.8"	10m x 10m	Dawn Redwood *Metasequoia glyptostroboides.* Associated flora included *Broussonetia papyrifera, Carpesium abrotanoides, Mirabilis jalapa, Phytolacca acinosa, Polygonum hydropiper, Artemisia argyi* and *Dysphania ambrosioides.*	Even distribution adjacent to village houses over an area of approximately 200 m2 at 75% coverage and approximately 15 m in height.
				2m x 2m	Golden Bamboo *Phyllostachys sulphurea.* Associated flora included *Agrimonia pilosa* and *Vitis vinifera.*	Continuous and even distribution along roadside near the village at 95% coverage and approximately 4-8 m in height.
Nanhu Farm Team #5 Village	Adjacent roadside and fish pond	30° 26' 53.1"	114° 57' 39.1"	5m x 5m	Paper Mulberry *Broussonetia papyrifera* shrubbery. Associated flora included *Sapium sebiferum, Alternanthera philoxeroides, Melia azedarach, Morus alba, Alternanthera philoxeroides, Persicaria orientalis, Setaria viridis, Justicia procumbens, Bidens pilosa, Persicaria perfoliata, and seedlings of Broussonetia papyrifera , Sapium sebiferum, Robinia pseudoacacia and Cinnamomum camphora.*	Widely distributed irregularly on both sides of roads and pond ditches over an area of approximately 300 m^2 at 85% coverage and approximately 3-4 m in height.
				5: 1m x 1m	Wild Soybean *Glycine soja.* Associated flora included *Abutilon theophrasti, Artemisia argyi, Setaria viridis, Conyza canadensis* and *Cyperus rotundus.*	Even distribution along edges of woodland, roads and ditches over an area of approximately 50 m^2 at 95% coverage and approximately 0.3-1 m in height.
				5: 1m x 1m	Green Foxtail *Setaria viridis.* Associated flora included *Euphorbia hypericifolia, Kummerowia striata, Kalimeris indica, Persicaria orientalis, Sesbania cannabina*	Continuous distribution along roadside and ditches and in open field at 80% coverage and approximately 0.3-0.7 m in height.

Location		Coordinates		Survey Quadrant Size	Dominant Vegetation Type and Associated Flora	Remarks
		Latitude N	Longitude E			
					and *Conyza canadensis*	
	In village	30° 27' 3.4"	114° 57' 35.1"	2m x 2m	Water Bamboo *Phyllostachys heteroclada.* Associated flora included *Artemisia annua, Alternanthera philoxeroides* and a few seedlings of *Broussonetia papyrifera.*	Continuous and even distribution along roadside near the village at 95% coverage and approximately 4-8 m in height.
Lukou Township	In ponds next to Wangjiawan Community	30° 27' 18.9"	114° 55' 53.4"	5: 1m x 1m	Lotus *Nelumbo nucifera.* Associated flora included *Lemna minor, Typha angustifolia, Alternanthera philoxeroides* and *Paspalum distichum.*	Distributed in pond water body over an area of approximately 250 m^2 at 90% coverage and approximately 1 m in height.
	Adjacent to Baizhangzui Village	30° 29' 6.8"	114° 56' 46.5"	5: 1m x 1m	Common Duckweed *Lemna minor.* Associated flora included *Alternanthera philoxeroides* and *Typha orientalis.*	In ponds and ditches at approximately 95% coverage.
	Wangjiawan Community	30° 27' 58.9"	114° 55' 51.4"	10m x10m	Paper Mulberry *Broussonetia papyrifera.* Associated flora included *Pseudosasa amabilis, Trichosanthes* ***kirilowii,*** *Setaria viridis* and *Cynodon dactylon*	Village roadside with undulating terrain, even distribution over an area of 900 m2 at 90% coverage and approximately 10 m in height.
	Near Xinhuayuan Community	30° 28' 17.8"	114° 55' 14.5"	5m x 5m	Five-leaved Chaste Tree *Vitex negundo* shrubbery. Associated flora included *Cynodon dactylon, Rosa multiflora, Artemisia argyi, Setaria viridis, Conyza canadensis and Amaranthus ascendens.*	Irregular distribution on road side hill slope open field over an area of approximately 200 m^2 at 70% coverage and approximately 1.5-2 m in height.
				5: 1m x 1m	Cogon Grass *Imperata cylindrica.* Associated flora included *Erigeron annuus, Geranium carolinianum, Setaria viridis* and *Xanthium sibiricum*	Irregular distribution on roadside, farmland ridges and open field over an area of approximately 200 m^2 at 90% coverage and approximately 0.2-0.6 m in height.
	Linglong Bay near shore area opposite Shuishang Fishing Village	30° 28' 56.9"	114° 56' 16.5"	5: 1m x 1m	Canadian Fleabane *Conyza Canadensis.* Associated flora included *Xanthium sibiricum, Imperata cylindrical, Setaria viridis* and *Acalypha australis*	Irregular distribution along edges of roadside ponds and open field with approximately 95% coverage and approximately 2 m in height.
				5: 1m x 1m	Water Chestnut *Trapa natans.* Associated flora included *Potamogeton crispus.*	In ponds and lake over an area of approximately 500 m^2 at 80% coverage.
	Linglong Bay in front of Shuishang Fishing Village	30° 28' 58"	114° 56' 11.1"	5: 1m x 1m	Curled Pondweed *Potamogeton crispus.* Associated flora included *Ceratophyllum demersum, Hydrilla verticillata* and *Vallisneria natans.*	In lake at 100% coverage
Aquatic Products Bureau	Huangzhou District Aquatic Products Bureau	30° 28' 15.11"	114° 56' 26.1"	10m x 20 m	Chinese Fir *Cunninghamia lanceolata.* Associated flora included *Dryopteris championii, Commelina communis, Cyclosorus acuminatus, Setaria viridis,* and seedlings of *Melia azedarach* and *Euonymus japonicus*	Irregular distribution on hillside slope over an area of approximately 300 m^2 at 85% coverage and approximately 16 m in height.
Baitan Lake Aquaculture Department	Baitan Lake side by the Baitan Lake Aquaculture Department	30° 28' 28.5"	114° 56' 31"	5m x 20m	London Plane Tree *Platanus acerifolia.* Associated flora included *Ligustrum quihoui, Euonymus japonicus, Broussonetia papyrifera, Rosa cymosa, Achyranthes bidentata, Phytolacca acinosa* and *Artemisia annua*	Even distribution in rows along roadside and behind houses over an area of approximately 600 m^2 at 85% coverage and approximately 18 m in height.
				5: 1m x 1m	Annual Fleabane *Erigeron annuus.* Associated flora included *Setaria viridis, Artemisia argyi, Amaranthus spinosus* and *Cynodon dactylon*	Irregular distribution along roadside and in vacated farmland over an area of approximately 200 m^2 at 80% coverage and approximately 1.3 m in height.
				5m x 20m	Amur Silver-grass *Miscanthus sacchariflorus.* Associated flora included *Typha angustifolia, Echinochloa crusgalli, Aeschynomene indica, Cyperus iria* and *Alternanthera philoxeroides.*	Continuous and even distribution in lakeside open field over an area of approximately 1600 m^2 at 80% coverage and approximately 3-4 m in height.
	Open area and fish	30° 28' 18.9"	114° 57' 17.5"	5: 1m x 1m	Chinese Mugwort *Artemisia argyi.* Associated flora included *Erigeron annuus,*	Irregular distribution along roadside, ditches, woodland edges and in open

Location		Coordinates		Survey Quadrant Size	Dominant Vegetation Type and Associated Flora	Remarks
		Latitude N	Longitude E			
	ponds next to Baitan Lake Aquaculture Community				*Torilis scabra, Amaranthus ascendens, Elymus kamoji* and *Setaria viridis*	field over an area of approximately 80 m^2 at 95% coverage and approximately 1.5 m in height.
				5: 1m x 1m	Marshpepper Knotweed *Polygonum hydropiper.* Associated flora included *Bolboschoenus yagara, Aeschynomene indica, Alternanthera philoxeroides* and *Lemna minor.*	Even distribution in wet areas alongside ditches, roads and ponds over an area of approximately 60 m^2 at 100% coverage and approximately 0.6 m in height.
				5: 1m x 1m	River Bulrush *Bolboschoenus yagara.* Associated flora included *Polygonum hydropiper, Aeschynomene indica, Alternanthera philoxeroides* and *Lemna minor.*	Even distribution alongside ponds and ditches over an area of approximately 2800 m^2 at 95% coverage and approximately 1.5 m in height.
Baitan Lake	Baitan Lake near Wanmu fish pond	30° 28' 12.3"	114° 57' 16.6"	5: 1m x 1m	Alligator Weed *Alternanthera philoxeroides.* Associated flora included *Cynodon dactylon, Bidens tripartite, Echinochloa crusgalli* and *Paspalum distichum.*	Rather continuous distribution alongside roads and woodland edges, and wet areas alongside ponds and ditches over an area of approximately 15 m^2 at 80-100% coverage and approximately 0.5 m in height.
	Baitan Lake south side of Jinghu Resort	30° 28' 50.8"	114° 56' 6.8"	20m x 20m	Canadian Poplar *Populus ×canadensis.* Associated flora included *Broussonetia papyrifera, Melia azedarach, Imperata cylindrica, Sapium sebiferum, Pittosporum tobira, Rosa cymosa, Imperata cylindrical, Erigeron annuus, Bidens pilosa, Conyza canadensis, Setaria viridis, Duchesnea indica, Daucus carota, Artemisia argyi, Justicia procumbens* and *Kummerowia striata*	Continuous and even distribution adjacent to roads, ditches, ponds and on farmland and nurseries over an area of approximately 2000 m^2 at 75% coverage and approximately 18 m in height.
	Baitan Lake north side of Jinghu Resort	30° 28' 53.9"	114° 56' 1.2"	10m x 10m	Golden Rain Tree *Koelreuteria paniculata.* Associated flora included *Conyza Canadensis, Sapium sebiferum, Rosa cymosa, Ophiopogon japonicas, Justicia procumbens, Sedum sarmentosum, Oxalis corniculata* and *Lonicera japonica.*	Even distribution on flat terrain adjacent to roadside and on foot hill over an area of approximately 400 m^2 at 65% coverage and approximately 9 m in height.
	Baitan Lake north side of Jinghu Resort	30° 28' 54.6"	114° 55' 57.2"	20m x 20m	Camphor Tree *Cinnamomum camphora.* Associated flora included *Imperata cylindrical, Lygodium japonicum, Cayratia japonica, Lonicera japonica,* and a few seedlings of *Sapium sebiferum* and *Ligustrum quihoui.*	Continuous and even distribution on undulating terrain near village and the resort over an area of approximately 600 m^2 at 95% coverage and approximately 7-8 m in height.
				10m x 20m	Southern Magnolia *Magnolia grandiflora.* Associated flora included *Polygonum aviculare, Cinnamomum camphora., Glycine soja, Lonicera japonica,* and a few seedlings of *Commelina communis* and *Sapium sebiferum.*	Continuous and even distribution on undulating terrain near village and the resort over an area of approximately 1200 m^2 at 95% coverage and approximately 7-8 m in height.
Jinshui River	Jinshui River mouth by the new bridge	30° 26' 50.7"	114° 55' 58.5"	5m x 20m	Chinese Wingnut *Pterocarya stenoptera.* Associated flora included *Broussonetia papyrifera, Morus alba, Sapium sebiferum, Salix babylonica, Sonchus oleraceus, Justicia procumbens, Cayratia japonica* and *Trichosanthes kirilowii*	Even distribution in rows on flat terrain along roadside and behind houses over an area of approximately 300 m^2 at 75% coverage and approximately 17 m in height.
				5: 1m x 1m	Barnyard Grass *Echinochloa crusgalli.* Associated flora included *Alternanthera philoxeroides, Bidens tripartite, Polypogon fugax, Sesamum indicum* and *Polygonum hydropiper.*	Continuous but irregular distribution in wet areas alongside ponds and ditches at 85% coverage and approximately 0.3 m in height.
	At Jiushui River mouth gate	30° 27' 5.7"	114° 56' 11"	5: 1m x 1m	Mosquito Fern *Azolla pinnata.* Associated flora included *Lemna minor* and *Salvinia natans.*	In ponds, ditches and paddy fields at approximately 95% coverage
Santai River Sub-station	Southwest corner of Santai River Sub-station	30° 28' 41.5"	114° 55' 2.2"	10m x 20m	Woodland Elaeocarpus *Elaeocarpus sylvestris.* Associated flora included *Yucca flaccida, Phytolacca acinosa, Bidens pilosa, Bidens tripartite* and *Persicaria perfoliata*	Continuous and even distribution on undulating terrain near the Sub-station over an area of approximately 200 m^2 at 90% coverage and approximately 5-6 m in height.
Chiye Lake area	Intersection of Chiye	30° 28' 46.1"	114° 57'	5m x 10m	China Berry *Melia azedarach.* Associated flora included *Broussonetia papyrifera*	Irregular distribution adjacent to roads and ponds over an area of 80 m^2 at

Location		Coordinates		Survey Quadrant Size	Dominant Vegetation Type and Associated Flora	Remarks
		Latitude N	Longitude E			
	Lake road and Jiangbei Road		54.28''		and *Setaria viridis*	60% coverage and approximately 11 m in height.
				5m x 5m	Black Locust *Robinia pseudoacacia* shrubbery. Associated flora included *Broussonetia papyrifera, Populus ×canadensis,* and a few seedlings of these species and *Morus alba.*	Even distribution along sides of roads and ponds over an area of approximately 200 m^2 at 70% coverage and approximately 3-4 m in height.
	Chiye Lake lakeside	30° 28' 26"	114° 57' 24.7"	5: 1m x 1m	Manchurian Wild Rice *Zizania latifolia.* Associated flora included *Typha angustifolia, Miscanthus sacchariflorus, Azolla pinnata* and *Lemna minor.*	Continuous but irregular distribution in ponds, water pools and around paddy fields with also planted species over an area of approximately 80 m^2 at 80% coverage and approximately 2.5 m in height.
				5: 1m x 1m	Asiatic Tearthumb *Persicaria perfoliata.* Associated flora included *Broussonetia papyrifera, Melia azedarach, Setaria viridis, Polygonum hydropiper, Erigeron annuus, Artemisia argyi* and *Cyperus rotundus.*	Continuous distribution on roadside wet areas and wasteland over an area of approximately 60 m^2 at 90% coverage.
	Lakeside near Chiye Lake pump station	30° 28' 44.7"	114° 57' 38.5"	5: 1m x 1m	Lesser Bulrush *Typha angustifolia.* Associated flora included *Alternanthera philoxeroides, Persicaria perfoliata* and *Epilobium hirsutum.*	Continuous but irregular distribution in ponds, water pools and around paddy fields over an area of approximately 50 m^2 at 80% coverage and approximately 2.5 m in height.
				5: 1m x 1m	Yellow Floating Heart *Nymphoides peltatum.* Associated flora included *Nelumbo nucifera, Trapa natans, Potamogeton crispus, Zizania latifolia* and *Spirogyra* spp.	Patchy distribution along edges of ponds, ditches and lake over an area of approximately 1000 m^2 at 80% coverage.
				5: 1m x 1m	Prickly Water Lily *Euryale ferox.* Associated flora included *Nelumbo nucifera, Eichhornia crassipes, Lemna minor* and *Potamogeton crispus.*	In lake over an area of approximately 6000 m^2 at 80% coverage

Source: Project EIR

Table IV.16: List of vascular plants recorded in the Baitan Lake planning area

Scientific Name			Common Name	Protection Status	
				PRC	IUCN
PTERIDOPHYTA			Ferns 蕨类植物		
	Adiantaceae	*Adiantum capillus-veneris*	Maidenhair Fern 铁线蕨	---	LC
	Azollaceae	*Azolla pinnata*	Mosquito Fern 满江红	---	LC
	Davalliaceae	*Nephrolepis auriculata*	Sword Fern 肾蕨	---	---
	Dryopteridaceae	*Cyrtomium fortunei*	Holly Fern 贯众	---	---
		Dryopteris championii	Champion's Wood Fern 阔鳞鳞毛蕨	---	---
	Equisetaceae	*Equisetum arvense*	Common Horsetail 问荆	---	---
		Equisetum ramosissimum	Branched Horsetail 节节草	---	---
	Lygodiaceae	*Lygodium japonicum*	Japanese Climbing Fern 海金沙	---	---
	Marsileaceae	*Marsilea quadrifolia*	Water Shamrock 苹（田字苹）	---	LC
	Pteridaceae	*Pteridium aquilinum*	Common Bracken 狼萁	---	---
		Pteris multifida	Spider Fern 井栏凤尾蕨	---	---
		Pteris vittata	Chinese Brake 蜈蚣草	---	LC
	Salviniaceae	*Salvinia natans*	Floating Fern 槐叶苹	---	LC
	Selaginellaceae	*Selaginella moellendorffii*	Spikemoss 江南卷柏	---	---
	Thelypteridaceae	*Cyclosorus acuminatus*	Swamp Ferm 渐尖毛蕨	---	---
GYMNOSPERMAE			Fruitless Seed Plants 裸子植物		
	Cupressaceae	*Chamaecyparis obtusa*	Hinoke Cypress 日本扁柏	---	NT
		Juniperus chinensis	Chinese Juniper 圆柏	---	---
		Juniperus chinensis var kaizuka	Dragon Juniper 龙柏`	---	---
		Juniperus formosana	Formosan Juniper 刺柏	---	LC
		Platycladus orientalis	Chinese Arborvitae 侧柏	---	NT
	Cycadaceae	*Cycas revoluta*	King Sago Palm 苏铁	N(I)	LC
	Ginkgoceae	*Ginkgo biloba*	Maidenhair Tree 银杏	N(I)	EN
	Pinaceae	*Cedrus deodara*	Deodar Cedar 雪松	---	LC
		Pinus elliottii	Slash Pine 湿地松	---	LC
		Pinus massoniana	Masson's Pine 马尾松	---	LC
	Taxodiaceae	*Cunninghamia lanceolata*	Chinese Fir 杉木	---	LC
		Metasequoia glyptostroboides	Dawn Redwood 水杉	N(I)	EN
		Taxodium ascendens	Pond Cypress 池杉	---	---
ANGIOSPERMAE - Dicotyledon			Flowering Plants 被子植物-双子叶		
	Aagnoliaceae	*Magnolia denudate*	Yulan Magnolia 玉兰	---	---
		Magnolia grandiflora	Southern Magnolia 洋玉兰	---	---
		Magnolia liliflora	Lily Magnolia 紫玉兰	---	---
		Michelia figo	Banana Shrub 含笑花	---	---
	Acanthaceae	*Justicia procumbens*	Water Willow 爵床	---	---
		Strobilanthes cusia	Chinese Rain Bell 板蓝	---	---
	Aceraceae	*Acer palmatum*	Japanese Maple 鸡爪槭	---	---
	Alangiaceae	*Alangium chinense*	Chinese Alangium 八角枫	---	---
	Amaranthaceae	*Achyranthes bidentata*	Ox Knee 牛膝	---	---
		Alternanthera philoxeroides	Alligator Weed 空心莲子草、水花生	---	---
		Amaranthus ascendens	Wild Blite 凹头苋	---	---
		Amaranthus spinosus	Spiny Amaranth 刺苋	---	---
		Amaranthus tricolor	Chinese Spinach 苋	---	---
		Amaranthus viridis	Green Amaranth 皱果苋	---	---
		Celosia argentea	Plumed Cockscomb 青箱	---	---
		Celosia cristata	Cockscomb 鸡冠花	---	---
		Gomphrena globosa	Globe Amaranth 千日红	---	---

Scientific Name			Common Name	Protection Status	
				PRC	IUCN
	Anacardiaceae	*Rhus chinensis*	Chinese Sumac 盐肤木	---	---
	Apiaceae	*Apium graveolens*	Celery 旱芹	---	LC
		Centella asiatica	Centella 积雪草	---	LC
		Coriandrum sativum	Cilantro 芫荽	---	---
		Cyclospermum leptophyllum	Fir-leaved Celery 细叶旱芹	---	---
		Daucus carota	Wild Carrot 野胡萝卜	---	---
		Hydrocotyle sibthorpioides	Lawn Pennywort 天胡荽	---	LC
		Oenanthe javanica	Water Dropwort 水芹	---	LC
		Torilis scabra	Rough Hedgeparsley 窃衣	---	---
	Apocynaceae	*Nerium orleander*	Orleander 夹竹桃	---	---
		Trachelospermum jasminoides	Star Jasmine 络石	---	---
	Aquifoliaceae	*Ilex cornuta*	Horned Holly 枸骨	---	---
	Araliaceae	*Eleutherococcus nodiflorus*	细柱五加	---	---
		Hedera nepalensis	Nepal Ivy 尼泊尔常春藤	---	---
	Asclepiadaceae	*Cynanchum auriculatum*	Heart-leaf Swallow-wort 牛皮消	---	---
	Asteraceae	*Artemisia annua*	Sweet Wormwood 黄花蒿	---	---
		Artemisia argyi	Chinese Mugwort 艾蒿	---	---
		Artemisia carvifolia	青蒿	---	---
		Artemisia lancea	Dwarf Mugwort 矮蒿	---	---
		Artemisia scoparia	Redstem Wormwood 猪毛蒿	---	---
		Aster subulatus	Wild Aster 钻叶紫菀	---	---
		Bidens bipinnata	Spanish Needles 婆婆针	---	---
		Bidens pilosa	Cobbler's Pegs 鬼针草	---	---
		Bidens tripartita	Three-lobe Beggarticks 狼把草	---	---
		Carduus crispus	Welted Thistle 丝毛飞廉	---	---
		Carpesium abrotanoides	Pig's Head 天名精	---	---
		Centipeda minima	Spreading Sneeze Weed 石胡荽	---	LC
		Chrysanthemum coronarium	Garland Daisy 茼蒿、艾菜	---	---
		Cirsium japonicum	Japanese Thistle 蓟、大蓟	---	---
		Cirsium setosum	Small Thistle 刺儿菜、小蓟	---	---
		Conyza bonariensis	Flax-leaf Fleabane 香丝草	---	---
		Conyza canadensis	Canadian Fleabane 小蓬草	---	---
		Crassocephalum crepidioides	Oldbag Weed 野茼蒿	---	---
		Dendranthema indicum	Wild Chrysanthemum 野菊	---	---
		Dendranthema morifolium	Garden Mum 菊花	---	---
		Eclipta prostrata	False Daisy 鳢肠	---	---
		Erigeron annuus	Annual Fleabane 一年蓬	---	---
		Eupatorium japonicum	White Thoroughwort 白头婆	---	---
		Gnaphalium affine	Jersey Cudweed 鼠麴草	---	---
		Helianthus annuus	Sunflower 向日葵	---	---
		Helianthus tuberosus	Jerusalem Artichoke 菊芋	---	---
		Hemisteptia lyrata	泥胡菜	---	LC
		Ixeridium sonchifolium	Sow Thistle 抱茎小苦荬	---	---
		Ixeris japonica	剪刀股	---	---
		Kalimeris indica	Indian Aster 马兰	---	---
		Lactuca sativa	Lettuce 莴苣	---	---
		Lapsanastrum apogonoides	Japanese Nipplewort 稻槎菜	---	---
		Paraixeris denticulata	Healing Buddha Weed 黄瓜菜	---	---
		Senecio scandens	German Ivy 千里光	---	---
		Siegesbeckia orientalis	St. Paul's Wort 豨莶	---	---

Scientific Name			Common Name	Protection Status	
				PRC	IUCN
		Sonchus oleraceus	Common Sowthistle 苦苣菜	---	---
		Taraxacum mongolicum	Dandelion 蒲公英	---	---
		Xanthium sibiricum	Siberian Cocklebur 苍耳	---	---
		Youngia japonica	Japanese Hawkweed 黄鹌菜	---	---
		Zinnia elegans	Common Zinnia 百日菊	---	---
	Balsaminaceae	*Impatiens balsamina*	Garden Balsam 凤仙花	---	---
	Berberidaceae	*Berberis thunbergii*	Japanese Barberry 光叶小檗	---	---
		Nandina domestica	Heavenly Bamboo 南天竹	---	---
	Boraginaceae	*Bothriospermum tenellum*	Leave Between Flower 柔弱斑种草	---	---
		Trigonotis peduncularis	Cucumber Herb 附地菜	---	---
	Brassicaceae	*Capsella bursa-pastoris*	Shepherds Purse 荠菜	---	---
		Cardamine lyrata	Chinese Ivy 水田碎米荠	---	---
		Rorippa cantoniensis	Small-seed Yellowcress 广州蔊菜	---	---
		Rorippa globosa	Globe Yellowcress 球果蔊菜、风花菜	---	---
	Buxaceae	*Buxus harlandii*	Harland's Box 雀舌黄杨	---	---
		Buxus microphylla	Littleleaf Box 黄杨	---	---
	Cactaceae	*Opuntia stricta* var. *dillenii*	Erect Pricklypear 仙人掌	---	---
	Calycanthaceae	*Chimonanthus praecox*	Wintersweet 腊梅	---	---
	Campanulaceae	*Lobelia chinensis*	Chinese Creeping Lobelia 半边莲	---	---
	Cannabinaceae	*Humulus japonicus*	Japanese Hop 葎草	---	---
	Caprifoliaceae	*Lonicera japonica*	Japanese Honeysuckle 忍冬、金银花	---	---
		Sambucus chinensis	Chinese Elder 接骨草	---	---
		Viburnum odoratissimum	Sweet Viburnum 珊瑚树	---	---
	Caryophyllaceae	*Arenaria serpyllifolia*	Thyme-leaf Sandwort 蚤缀、无心菜	---	---
		Cerastium caespitosum	Mouse-ear Chickweed 簇生泉卷耳	---	---
		Stellaria media	Common Chickweed 繁缕	---	---
	Celastraceae	*Euonymus alatus*	Winged Spindle 卫矛	---	---
		Euonymus bungeanus	Winterberry 白杜	---	---
		Euonymus japonicus	Japanese Spindle 冬青卫矛	---	---
	Ceratophyllaceae	*Ceratophyllum demersum*	Rigid Hornwort 金鱼藻	---	LC
	Chenopodiaceae	*Chenopodium album*	Lamb's Quarters 藜	---	---
		Chenopodium ficifolium	Fig-leaved Goosefoot 小藜	---	---
		Chenopodium glaucum	Oak-leaved Goosefoot 灰绿藜	---	---
		Dysphania ambrosioides	Epazote 土荆介	---	---
		Spinacia oleracea	Spinach 菠菜	---	---
	Clusiaceae	*Hypericum japonicum*	Matted St. Hohn's Wort 地耳草	---	---
	Convolvulaceae	*Calystegia hederacea*	Japanese False Bindweed 打碗花	---	---
		Calystegia sepium	Hedge Bindweed 欧旋花	---	---
		Ipomoea aquatica	Water Spinach 蕹菜	---	LC
		Ipomoea batatas	Sweet Potato 番薯	---	---
		Ipomoea hederacea	Ivy-leaf Morning Glory 牵牛花	---	---
		Ipomoea purpurea	Common Morning Glory 圆叶牵牛	---	---
	Crassulaceae	*Kalanchoe pinnata*	Air Plant 落地生根	---	---
		Sedum lineare	Carpet Sedum 佛甲草	---	---
		Sedum sarmentosum	Gold Moss Sedum 垂盆草	---	---
	Cruciferae	*Brassica juncea*	Big-stem Mustard 芥菜	---	---
		Brassica rapa	Field Mustard 芸苔	---	---
		Brassica rapa L. var. *glabra*	Chinese Cabbage 白菜	---	---
		Brassica rapa L. var. *purpuraria*	Purple-stem Mustard 紫菜苔	---	---
		Capsella bursa-pastoris	Shepherd's Purse 荠菜	---	---

Scientific Name			Common Name	Protection Status	
				PRC	IUCN
		Cardamine hirsuta	Bittercress 碎米**荠**	---	---
		Cardamine lyrata	Chinese Ivy 水田碎米**荠**	---	---
		Lepidium apetalum	Peppercress 独行菜	---	---
		Raphanus sativus	Radish **萝卜**	---	---
		Rorippa cantoniensis	Chinese Yellowcress 广州**蔊**菜	---	---
		Rorippa globosa	Globe Yellowcress 球果**蔊**菜	---	---
		Rorippa indica	Variableleaf Yellowcress **蔊**菜	---	---
	Cucurbitaceae	*Benincasa hispida*	Winter Melon **冬瓜**	---	---
		Citrullus lanatus	Watermelon **西瓜**	---	---
		Cucumis melo var. conomon	Oriental Pickling Melon **菜瓜**	---	---
		Cucumis sativus	Cucumber **黄瓜**	---	---
		Cucurbita moschata	Crookneck Squash **南瓜**	---	---
		Lagenaria siceraria	Bottle Gourd **葫芦**	---	---
		Luffa cylindrica	Sponge Gourd **丝瓜**	---	---
		Trichosanthes kirilowii	Snake Gourd 栝楼	---	---
	Ebenaceae	*Diospyros kaki*	Persimmon **柿**	---	---
	Elaeocarpaceae	*Elaeocarpus sylvestris*	Woodland Elaeocarpus **山杜英**	---	---
	Ericaceae	*Rhododendron simsii*	Indian Azalea 杜**鹃**	---	---
	Euphorbiaceae	*Acalypha australis*	Asian Copperleaf **铁苋菜**	---	---
		Alchornea davidii	**山麻干**	---	---
		Bischofia javanica	Bishopwood 秋**枫**	---	---
		Euphorbia esula	Leafy Spurge 乳**浆**大戟	---	---
		Euphorbia helioscopia	Sun Spurge **泽漆**	---	---
		Euphorbia humifusa	Creeping Spurge **地锦草**	---	---
		Euphorbia hypericifolia	Graceful Spurge **通奶草**	---	---
		Euphorbia pekinensis	Peking Spurge 京大戟	---	---
		Glochidion puberum	Abacus Plant **算盘子**	---	---
		Mallotus apelta	White-back-leaf Mallotus **白背叶**	---	---
		Mallotus tenuifolius	**野桐**	---	---
		Ricinus communis	Castor Oil Plant 蓖麻	---	---
		Sapium sebiferum	Chinese Tallow **乌**桕	---	---
		Vernicia fordii	Tung Oil Tree 油桐	---	---
	Fabaceae	*Amorpha fruticosa*	Indigo Bush 紫穗槐	---	---
		Caesalpinia decapetala	Mysore Thorn 云**实**	---	---
		Cercis chinensis	Chinese Redbud 紫**荆**	---	LC
		Gleditsia sinensis	Honey Locust **皂荚**	---	---
		Senna tora	Sickle Senna 决明	---	---
		Sesbania cannabina	Sesbania Pea 田菁	---	LC
	Fagaceae	*Castanea mollissima*	Chinese Chestnut 板栗	---	---
	Fumariaceae	*Corydalis edulis*	**紫堇**	---	---
	Gentianaceae	*Nymphoides peltatum*	Yellow Floating Heart 荇菜	---	---
	Geraniaceae	*Geranium carolinianum*	Carolina Geranium **野老鹳草**	---	---
	Hamamelidaceae	*Liquidambar formosana*	Formosan Gum Tree **枫**香树	---	---
	Hasmamelidaceae	*Loropetalum chinense*	Chinese Fringe Flower **檵木**	---	---
	Hypericaceae	*Hypericum japonicum*	Matted St. John's Wort **地耳草**	---	---
		Hypericum perforatum	St. John's Wort **贯叶连翘**	---	---
	Juglandaceae	*Platycarya strobilacea*	化香**树**	---	---
		Pterocarya hupehensis	Hubei Wingnut 湖北**枫杨**	---	---
		Pterocarya stenoptera	Chinese Wingnut **枫杨**	---	---
	Lamiaceae	*Agastache rugosa*	Korean Mint **藿**香	---	---

Scientific Name			Common Name	Protection Status	
				PRC	IUCN
		Ajuga multiflora	Bugle 多花筋骨草	---	---
		Clinopodium chinense	Wild Basil 风轮菜	---	---
		Clinopodium gracile	Slender Wild Basil 细风轮菜	---	---
		Glechoma longituba	活血丹	---	---
		Keiskea elsholtzioides	香薷状香简草	---	---
		Lagopsis supina	夏至草	---	---
		Lamium amplexicaule	Henbit Deadnettle 宝盖草	---	---
		Leonurus japonicus	Honeyweed 益母草	---	---
		Mentha canadensis	Wild Mint 薄荷	---	---
		Mosla chinensis	石香薷	---	---
		Mosla dianthera	Miniature Beefsteak Plant 小鱼仙草	---	---
		Perilla frutescens	Beefsteak Plant 紫苏	---	---
		Phlomis umbrosa	糙苏	---	---
		Prunella vulgaris	Common Self-heal 夏枯草	---	---
		Salvia plebeia	Small Flowered Sage 荔枝草	---	---
		Salvia splendens	Scarlet Sage 一串红	---	---
		Sesamum indicum	Sesame 芝麻	---	---
		Stachys japonica	水苏	---	---
	Lardizabalaceae	*Akebia quinata*	Chocolate Vine 木通	---	---
	Lauraceae	*Cinnamomum camphora*	Camphor Tree 樟树	N(II)	---
	Lythraceae	*Lagerstroemia indica*	Crape Myrtle 紫薇	---	---
		Rotala indica	Indian Toothcup 节节菜	---	LC
		Rotala rotundifolia	Roundleaf Toothcup 圆叶节节菜	---	LC
	Malvaceae	*Abutilon theophrasti*	Velvetleaf 苘麻	---	---
		Althaea rosea	Hollyhock 蜀葵	---	---
		Gossypium hirsutum	Upland Cotton 陆地棉	---	---
		Hibiscus mutabilis	Dixie Rosemellow 木芙蓉	---	---
		Hibiscus rosa-sinensis	Chinese Hibiscus 朱槿	---	---
		Hibiscus syriacus	Rose of Sharon 木槿	---	---
	Meliaceae	*Melia azedarach*	Chinaberry 楝树	---	---
		Toona sinensis	Chinese Mahogany 香椿	---	---
	Menispermaceae	*Cocculus trilobus*	Snail Seed 木防己	---	---
		Stephania japonica	Snake Vine 千金藤	---	---
	Moraceae	*Broussonetia papyrifera*	Paper Mulberry 构树	---	---
		Cudrania tricuspidata	Silkworm Thorn 拓树	---	---
		Morus alba	White Mulberry 桑树	---	---
	Nyctaginaceae	*Mirabilis jalapa*	Common Four O'Clock 紫茉莉	---	---
	Nymphaceae	*Euryale ferox*	Prickly Water Lily 芡实	---	LC
		Nelumbo nucifera	Lotus 莲	N(II)	---
	Oleaceae	*Ligustrum lucidum*	Glossy Privet 女贞	---	---
		Ligustrum quihoui	Waxyleaf Privet 小叶女贞	---	---
		Ligustrum vicaryi	Golden Privet 金叶女贞	---	---
		Osmanthus fragrans	Sweet Olive 桂花	---	---
	Onagraceae	*Epilobium hirsutum*	Great Willowherb 柳叶菜	---	LC
	Oxalidaceae	*Oxalis corniculata*	Creeping Wood Sorrel 酢浆草	---	---
		Oxalis pes-caprae	African Wood Sorrell 黄花酢浆草	---	---
	Papilionaceae	*Aeschynomene indica*	Sensitive Vetch 合萌、田皂角	---	LC
		Amorpha fruticosa	False Indigo Bush 紫穗槐	---	---
		Arachis hypogaea	Peanut 落花生	---	---
		Astragalus sinicus	Chinese Milk Vetch 紫云英	---	---

Scientific Name			Common Name	Protection Status	
				PRC	IUCN
		Dalbergia hupeana	Hubei Rosewood **黄檀**	---	---
		Dolichos lablab	Hyacinth Bean 扁豆	---	---
		Glycine max	Soybean 大豆	---	---
		Glycine soja	Wild Soybean 野大豆	N(II)	---
		Indigofera pseudotinctoria	Dwarf Chinese Indigo **马**棘	---	---
		Kummerowia striata	Japanese Clover **鸡眼草**	---	---
		Lespedeza cuneata	Perennial Lespedeza 截叶**铁扫帚**	---	LC
		Medicago polymorpha	Toothed Bur Clover 南苜蓿	---	---
		Pachyrhizus erosus	Yam Bean 豆薯	---	---
		Phaseolus vulgaris	String Bean 四季豆	---	---
		Pisum sativum	Garden Pea 豌豆	---	---
		Robinia pseudoacacia	Black Locust **刺槐**	---	LC
		Styphnolobium japonicum	Chinese Scholar Tree 槐**树**	---	---
		Trifolium repens	White Clover **白车轴草**	---	---
		Vicia cracca	Tufted Vetch 广布野豌豆	---	---
		Vicia faba	Broad Bean 蚕豆	---	---
		Vicia sativa	Common Vetch 救荒野豌豆	---	---
		Vigna radiata	Mung Bean **绿**豆	---	---
		Vigna umbellata	Rice Bean 赤小豆	---	---
		Vigna unguiculata	Cowpea 豇豆	---	---
	Phytoaccaceae	*Phytolacca acinosa*	Indian Pokeweed **商陆**	---	---
	Pittosporaceae	*Pittosporum tobira*	Japanese Cheesewood **海桐**	---	---
	Plantaginaceae	*Plantago major*	Common Plantain **车**前	---	---
		Plantago virginica	Virginia Plantain 北美**车**前	---	---
	Platanaceae	*Platanus acerifolia*	London Plane Tree 法国梧桐、**悬铃**木	---	---
	Polygonaceae	*Fallopia multiflora*	Tuba Fleece Flower 何首**乌**	---	---
		Persicaria orientalis	Kiss Me over the Garden Gate **红**蓼	---	---
		Persicaria perfoliata	Asiatic Tearthumb 杠板**归**	---	---
		Polygonum amphibium	Amphibious Bistort 两栖蓼	---	LC
		Polygonum aviculare	Common Knotgrass 扁蓄	---	---
		Polygonum caespitosum	Bristled Knotweed 丛枝蓼	---	---
		Polygonum cuspidatum	Japanese Knotweed 虎杖	---	---
		Polygonum fagopyrum	Buckweed **荞**麦	---	---
		Polygonum hydropiper	Marshpepper Knotweed 水蓼	---	LC
		Polygonum jucundum	愉悦蓼	---	---
		Polygonum pubescens	Drooping Knotweed 伏毛蓼	---	LC
		Polygonum viscosum	香蓼	---	---
		Rumex acetosa	Garden Sorrel 酸模	---	---
		Rumex crispus	Curly Dock **皱**叶酸模	---	---
		Rumex dentatus	Toothed Dock **齿果酸模**	---	---
		Rumex japonicus	Japanese Dock **羊蹄**	---	---
	Portulacaceae	*Portulaca oleracea*	Common Purslane **马齿苋**	---	---
	Primulaceae	*Lysimachia candida*	Garden Yellow Loosestrife **泽**珍珠菜	---	---
		Lysimachia clethroides	Gooseneck Loosestrife 矮桃	---	---
		Lysimachia congestiflora	Dense-flowered Loosestrife **临时**救	---	---
	Punicaceae	*Punica granatum*	Pomegranate **石榴**	---	LC
	Ranunculaceae	*Batrachium bungei*	Water Crowfoot 水毛茛	---	---
		Clematis chinensis	Clematis Root **威灵仙**	---	---
		Ranunculus chinensis	Chinese Buttercup **茴茴蒜**	---	---
		Ranunculus japonicus	Japanese Buttercup **毛茛**	---	---

Scientific Name			Common Name	Protection Status	
				PRC	IUCN
		Ranunculus sceleratus	Cursed Buttercup 石龙芮	---	---
		Ranunculus ternatus	Cat Claw Buttercup 猫爪草	---	---
	Rhamnaceae	*Ziziphus jujube*	Chinese Date 枣	---	---
	Rosaceae	*Agrimonia pilosa*	Cocklebur 龙芽草	---	---
		Ampelopsis japonica	Japanese Peppervine 白蔹	---	---
		Cerasus pseudocerasus	Cambridge Cherry 樱桃	---	---
		Crataegus cuneata	Chinese Hawthorn 野山楂	---	---
		Duchesnea indica	Indian Strawberry 蛇莓	---	---
		Eriobotrya japonica	Loquat 枇杷	---	---
		Malus pumila	Paradise Apple 苹果	---	---
		Photinia beauverdiana	中華石楠	---	---
		Potentilla chinensis	Chinese Cinquefoil 委陵菜	---	---
		Potentilla discolor	Silverweed 翻白草	---	---
		Potentilla freyniana	三叶委陵菜	---	---
		Potentilla kleiniana	蛇含委陵菜	---	---
		Prunus armeniaca	Apricot 杏	---	---
		Prunus cerasifera	Cherry Plum 樱桃李	---	---
		Prunus mume	Chinese Plum 梅	---	---
		Prunus persica	Peach 桃	---	---
		Prunus salicina	Japanese Plum 李	---	---
		Pyracantha fortuneana	Chinese Firethorn 火棘	---	---
		Pyrus pyrifolia	Sand Pear 沙梨	---	---
		Rosa chinensis	China Rose 月季花	---	---
		Rosa cymosa	Elderflower Rose 小果蔷薇	---	---
		Rosa laevigata	Cherokee Rose 金樱子	---	---
		Rosa multiflora	Multiflora Rose 野蔷薇	---	---
		Rubus coreanus	Korean Black Raspberry 插田泡	---	---
		Rubus corchorifolius	Blackberry 山莓	---	---
		Rubus leucanthus	白花悬钩子	---	---
		Rubus parvifolius	Japanese Raspberry 矛莓	---	---
		Rubus tephrodes	灰白毛莓	---	---
		Sanguisorba officinalis	Great Burnet 地榆	---	---
	Rubiaceae	*Adina pilulifera*	Adina 水团花	---	---
		Galium aparine	Goosegrass 猪殃殃	---	---
		Gardenia jasminoides	Cape Jasmine 栀子	---	---
		Paederia scandens	Skunk Vine 鸡矢藤	---	---
		Rubia cordifolia	Common Madder 茜草	---	---
		Serissa serissoides	Tree of a Thousand Stars 白马骨	---	---
	Rutaceae	*Citrus reticulata*	Tangerine 柑橘	---	---
		Citrus sinensis	Sweet Orange 甜橙	---	---
		Poncirus trifoliata	Bitter Orange 枳	---	---
		Zanthoxylum armatum	Bamboo-leaf Prickly Ash 竹叶花椒	---	---
		Zanthoxylum simulans	Szechuan Pepper 野花椒	---	---
	Salicaceae	*Populus ×canadensis*	Canadian Poplar 加杨	---	---
		Salix babylonica	Weeping Willow 垂柳	---	---
		Salix chaenomeloides	Giant Pussy Willow 河柳、腺柳	---	---
		Salix matsudana	Corkscrew Willow 旱柳	---	---
	Sapindaceae	*Koelreuteria paniculata*	Golden Rain Tree 栾树	---	---
	Saururaceae	*Houttuynia cordata*	Chameleon Plant 蕺菜（鱼腥草）	---	---
	Saxifragaceae	*Hydrangea macrophylla*	Big-leaf Hydrangea 八仙绣球	---	---

Scientific Name			Common Name	Protection Status	
				PRC	IUCN
		Saxifraga stolonifera	Strawberry Begonia 虎耳草	---	---
	Scrophulariaceae	*Limnophila sessiliflora*	Asian Marshweed 石龙尾	---	LC
		Lindernia procumbens	Lindernie couchée 陌上菜	---	LC
		Mazus japonicus	Japanese Mazus 白花通泉草	---	---
		Mazus stachydifolius	Betonyleaf Mazus 弹刀子菜	---	---
		Paulownia tomentosa	Empress Tree 毛泡桐	---	---
		Veronica peregrina	Purslane Speedwell 蚊母草	---	---
		Veronica persica	Persian Speedwell 波斯婆婆纳	---	---
		Veronica polita	Grey Field Speedwell 婆婆纳	---	---
	Simarubaceae	*Ailanthus altissima*	Tree of Heaven 臭椿	---	---
	Solanaceae	*Capsicum annuum*	Ornamental Pepper 辣椒	---	---
		Capsicum frutescens	Hot Pepper 辣椒	---	---
		Lycium chinense	Wolfberry 枸杞	---	---
		Lycopersicon esculentum	Tomato 番茄	---	---
		Nicotiana tabacum	Tobacco 烟草	---	---
		Physalis alkekengi	Chinese Lantern 酸浆	---	---
		Physalis angulata	Cutleaf Groundcherry 毛苦蘵	---	---
		Solanum lyratum	Lyreleaf Nightshade 白英	---	---
		Solanum melongena	Eggplant 茄	---	---
		Solanum nigrum	Black Nightshade 龙葵	---	---
		Solanum pseudocapsicum	Madeira Winter-cherry 珊瑚樱	---	---
		Solanum tuberosum	Potato 阳芋	---	---
	Sterculiaceae	*Firmiana simplex*	Chinese Parasol Tree 梧桐	---	---
	Theaceae	*Camellia japonica*	Camellia 山茶	---	---
	Tiliaceae	*Corchoropsis crenata*	光果田麻	---	---
	Trapaceae	*Trapa incisa*	Wild Water Chestnut 细果野菱	N(II)	LC
		Trapa natans	Water Chestnut 菱角	---	LC
	Ulmaceae	*Celtis sinensis*	Chinese Hackberry 朴树	---	---
		Ulmus parvifolia	Chinese Elm 榔榆	---	---
		Ulmus pumila	Siberian Elm 白榆	---	---
	Urticaceae	*Boehmeria nivea*	False Nettle 苎麻	---	---
	Valerianaceae	*Patrinia villosa*	Patrinia 白花败酱	---	---
	Verbenaceae	*Clerodendrum bungei*	Rose Glorybower 臭牡丹	---	---
		Verbena officinalis	Common Vervain 马鞭草	---	---
		Vitex negundo	Five-leaved Chaste Tree 黄荆	---	---
	Violaceae	*Viola arcuata*	Hidden Violet 如意草（堇菜）	---	---
		Viola philippica	Chinese Violet 紫花地丁	---	---
	Vitaceae	*Cayratia japonica*	Bushkiller 乌蔹莓	---	---
		Parthenocissus tricuspidata	Boston Ivy 地锦	---	---
		Vitis piasezkii	变叶葡萄	---	---
		Vitis vinifera	Wild Grape 葡萄	---	LC
ANGIOSPERMAE - Monocotyledon			Flowering Plants 被子植物-单子叶		
	Alismataceae	*Alisma orientale*	Common Water-plantain 东方泽泻	---	---
		Sagittaria pygmaea	Pygmy Arrowhead 矮慈姑	---	LC
		Sagittaria trifolia	Three-leaf Arrowhead 慈姑	---	LC
	Araceae	*Acorus calamus*	Sweet Flag 菖蒲	---	LC
		Acorus tatarinowii	Calamus of the Orient 石菖蒲	---	---
		Colocasia esculenta	Wild Taro 芋	---	LC
		Pistia stratiotes	Tropical Duck-weed 大薸	---	LC
	Arecaceae	*Trachycarpus fortunei*	Chusan Palm 棕榈	---	---

Scientific Name			Common Name	Protection Status	
				PRC	IUCN
	Cannaceae	*Canna indica*	Indian Shot 美人蕉	---	---
	Commeliaceae	*Commelina communis*	Asiatic Dayflower 鸭跖草	---	---
	Cyperaceae	*Bolboschoenus yagara*	River Bulrush 荆三棱	---	---
		Carex argyi	阿齐薹草	---	---
		Carex dimorpholepis	Sedge 垂穗薹草	---	---
		Carex tristachya	三穗薹草	---	---
		Carex unisexualis	单性薹草	---	---
		Cyperus difformis	Smallflower Umbrella Sedge 异型莎草	---	LC
		Cyperus iria	Rice Flatsedge 碎米莎草	---	LC
		Cyperus rotundus	Nut-grass 香附子	---	LC
		Eleocharis dulcis	Chinese Water Chestnut 荸荠	---	---
		Eleocharis yokoscensis	牛毛毡	---	---
		Fimbristylis dichotoma	Forked Fimbry 两歧飘拂草	---	LC
		Fimbristylis diphylloides	拟二叶飘拂草	---	---
		Fimbristylis miliacea	Grasslike Fimbry 水虱草	---	---
		Kyllinga brevifolia	Shortleaf Spikesedge 短叶水蜈蚣	---	LC
		Schoenoplectus juncoides	Hard Stem Bulrush 萤蔺	---	---
		Schoenoplectus tabernaemontani	Softstem Bulrush 水葱	---	---
		Schoenoplectus triqueter	Triangular Club-rush 三棱水葱	---	---
	Dioscoreaceae	*Dioscorea polystachya*	Chinese Yam 薯蓣	---	---
	Hydrocharitaceae	*Hydrilla verticillata*	Indian Stargrass 黑藻	---	LC
		Hydrocharis dubia	Frogbit 水鳖	---	LC
		Ottelia alismoides	Duck Lettuce 龙舌草、水车前	---	LC
		Vallisneria natans	Tape Grass 苦草	---	LC
	Iridaceae	*Iris tectorum*	Roof Iris 鸢尾	---	---
	Juncaceae	*Juncus effusus*	Soft Rush 灯心草	---	LC
		Juncus setchuensis	野灯心草	---	---
	Lemnaceae	*Lemna minor*	Common Duckweed 浮萍	---	LC
		Lemna trisulca	Star Duckweed 品藻	---	LC
		Spirodela polyrhiza	Greater Duckweed 紫萍	---	LC
	Liliaceae	*Allium cepa*	Onion 洋葱	---	---
		Allium fistulosum	Green Onion 葱	---	---
		Allium macrostemon	Macrostem Onion 薤白	---	---
		Allium sativum	Garlic 蒜	---	---
		Allium tuberosum	Garlic Chives 韭	---	---
		Chlorophytum comosum	Spider Plant 吊兰	---	---
		Ophiopogon bodinieri	沿阶草	---	---
		Ophiopogon japonicus	Mondo Grass 麦冬	---	---
		Yucca flaccida	Adam' s Needle 丝兰	---	---
	Poaceae	*Alopecurus aequalis*	Shortawn Foxtail 看麦娘	---	---
		Alopecurus japonicus	Japanese Foxtail 日本看麦娘	---	---
		Arthraxon hispidus	Small Carpgrass 荩草	---	---
		Arundo donax	Giant Reed 芦竹	---	LC
		Avena fatua	Common Wild Oat 野燕麦	---	---
		Beckmannia syzigachne	American Sloughgrass 菵草	---	---
		Bromus japonicus	Japanese Chess 雀麦	---	---
		Coix lacryma-jobi	Job's Tears 薏苡	---	---
		Cynodon dactylon	Bermuda Grass 狗牙根	---	---
		Digitaria ciliaris	Southern Crabgrass 纤毛马唐	---	---
		Digitaria ischaemum	Smooth Crabgrass 止血马唐	---	---

Scientific Name			Common Name	Protection Status	
				PRC	IUCN
		Digitaria sanguinalis	Hairy Crabgrass 马唐	---	---
		Echinochloa crusgalli	Barnyard Grass 稗	---	LC
		Eleusine indica	Indian Goosegrass 牛筋草	---	LC
		Elymus kamoji	鹅观草、柯孟披碱草	---	---
		Eragrostis cilianensis	Stinkgrass 大画眉草	---	---
		Eragrostis ferruginea	知风草	---	---
		Eragrostis pilosa	Indian Love Grass 画眉草	---	---
		Festuca parvigluma	小颖羊茅	---	---
		Imperata cylindrica	Cogon Grass 白茅	---	---
		Leersia hexandra	Southern Cut Grass 李氏禾	---	---
		Leptochloa panicea	Mucronate Sprangletop 虮子草	---	LC
		Miscanthus floridulus	Giant Silver Grass 五节芒	---	---
		Miscanthus sacchariflorus	Amur Silver-grass 荻	---	---
		Miscanthus sinensis	Maiden Grass 芒	---	---
		Oryza sativa	Rice 稻	---	---
		Panicum miliaceum	Proso Millet 稷	---	---
		Paspalum distichum	Knotgrass 双穗雀稗	---	---
		Paspalum thunbergii	Japanese Paspalum 雀稗	---	---
		Pennisetum alopecuroides	Fountain Grass 狼尾草	---	---
		Phragmites australis	Common Reed 芦苇	---	LC
		Phyllostachys heteroclada	Water Bamboo 水竹	---	---
		Phyllostachys sulphurea	Golden Bamboo 刚竹	---	---
		Poa acroleuca	白顶早熟禾	---	---
		Poa annua	Annual Meadow Grass 早熟禾	---	---
		Polypogon fugax	Asia Minor Bluegrass 棒头草	---	---
		Pseudosasa amabilis	Tonkin Cane 茶秆竹	---	---
		Setaria viridis	Green Foxtail 狗尾草	---	---
		Sorghum bicolor	Sorghum 高粱	---	---
		Themeda triandra	Red Oat Grass 黄背草	---	---
		Triticum aestivum	Common Wheat 小麦	---	---
		Zea mays	Corn 玉蜀黍	---	---
		Zizania latifolia	Manchurian Wild Rice 菰	---	---
	Pontederiaceae	*Eichhornia crassipes*	Common Water Hyacinth 凤眼莲	---	---
		Monochoria korsakowii	Oval Leaf Pondweed 雨久花	---	LC
		Monochoria vaginalis	Pickerel Weed 鸭舌草	---	LC
	Potamogetonaceae	*Potamogeton crispus*	Curled Pondweed 菹草	---	LC
		Potamogeton distinctus	Round-leaf Pondweed 眼子菜	---	LC
		Potamogeton wrightii	Bamboo-leaved Pondweed 竹叶眼子菜	---	LC
	Smilaceae	*Heterosmilax japonica*	肖菝葜	---	---
		Smilax china	China Root 菝葜	---	---
	Typaceae	*Typha angustifolia*	Lesser Bulrush 水烛	---	LC
		Typha orientalis	Bullrush 香蒲	---	LC
	Zingiberaceae	*Zingiber officinale*	Ginger 姜	---	---

Notes:

Protection Status: N(I): national class I protected species; N(II) = national class II protected species; IUCN: International Union for Conservation of Nature, LC = least concern; NT = near threatened, EN = endangered.

Cultivated species

Scientific Name	Common Name	Protection Status	
		PRC	IUCN

Source: Project EIR

(v) The three species that are under Class I national protection status include the King Sage Palm (*Cycas revoluta*), the Maidenhair Tree (*Ginkgo biloba*) and the Dawn Redwood (*Metasequoia glyptostroboides*). Both the Maidenhair Tree and the Dawn Redwood are also listed as Endangered on the IUCN red list. The King Sago Palm is listed by IUCN as of Least Concern. All three species are cultivated species in the area.

(vi) The four species that are under Class II national protection status include the Camphor Tree (*Cinnamomum camphora*), the Lotus (*Nelumbo nucifera*), the Wild Soybean (*Glycine soja*) and the Wild Water Chestnut (*Trapa incisa*). The Wild Water Chestnut has been assessed by IUCN as of Least Concern, while the other three species have not been assessed by IUCN. Both the Camphor Tree and the Lotus are cultivated species in the assessment area.

(vii) The vegetation surveys (see **Table IV.15**) have identified that the Camphor Tree, the Lotus and the Wild Soybean are among the dominant vegetation types in the assessment area, indicative of their wide distribution either by cultivation (Camphor Tree and Lotus) or by adaptation to the area (Wild Soybean and Wild Water Chestnut). The Camphor Tree was the dominant vegetation type with continuous and even distribution on undulating terrain near village and the Jinghu Resort by Baitan Lake. The Lotus was the dominant vegetation type in ponds next to Wangjiawan Community in Lukou Township. The Wild Soybean was the dominant vegetation type along edges of woodland, roads and ditches near the Nanhu Farm Team #5 village.

185. **Phytoplankton**. Phytoplankton consists of microscopic planktonic plants that are the primary producers in the aquatic environment, forming the basis of the aquatic food chain. The species composition and numerical abundance of phytoplankton were monitored at 17 locations as shown in **Figure IV.3**. The following observations could be made based on monitoring results shown in **Table IV.17**.

(i) The phytoplankton community consisted of 48 taxa dominated by green algae (Chlorophyta) with 23 taxa (48%) followed by blue-green algae (Cyanophyta) and diatoms (Bacillariophyta) each with 9 taxa (19%). Seven taxa were present at all the monitoring locations. These were the green algae *Scenedesmus* sp., *Selenastrum* sp. and *Tetraedron* sp.; the cryptomonid (Cryptophyta) *Cryptomonas* sp.; and the diatoms *Cyclotella* sp., *Melosira* sp. and *Synedra* sp.

(ii) In terms of numerical abundance, blue green algae had the highest cell counts per unit volume (mL), accounting for almost 38% of total phytoplankton abundance, followed by green algae with approximately 31%. These two groups together accounted for two-third of phytoplankton abundance.

(iii) On spatial distribution, the centers of Baitan Lake (monitoring locations 15 and 16) and

Chiye Lake (monitoring location 10) showed the highest phytoplankton abundance compared to other monitoring locations. Despite having highest phytoplankton abundance, phytoplankton community in Baitan Lake center was dominated by blue-green and green algae and was among the monitoring locations with fewest number of phytoplankton species. Low biodiversity with blue-green algae dominance is an indication of eutrophication.

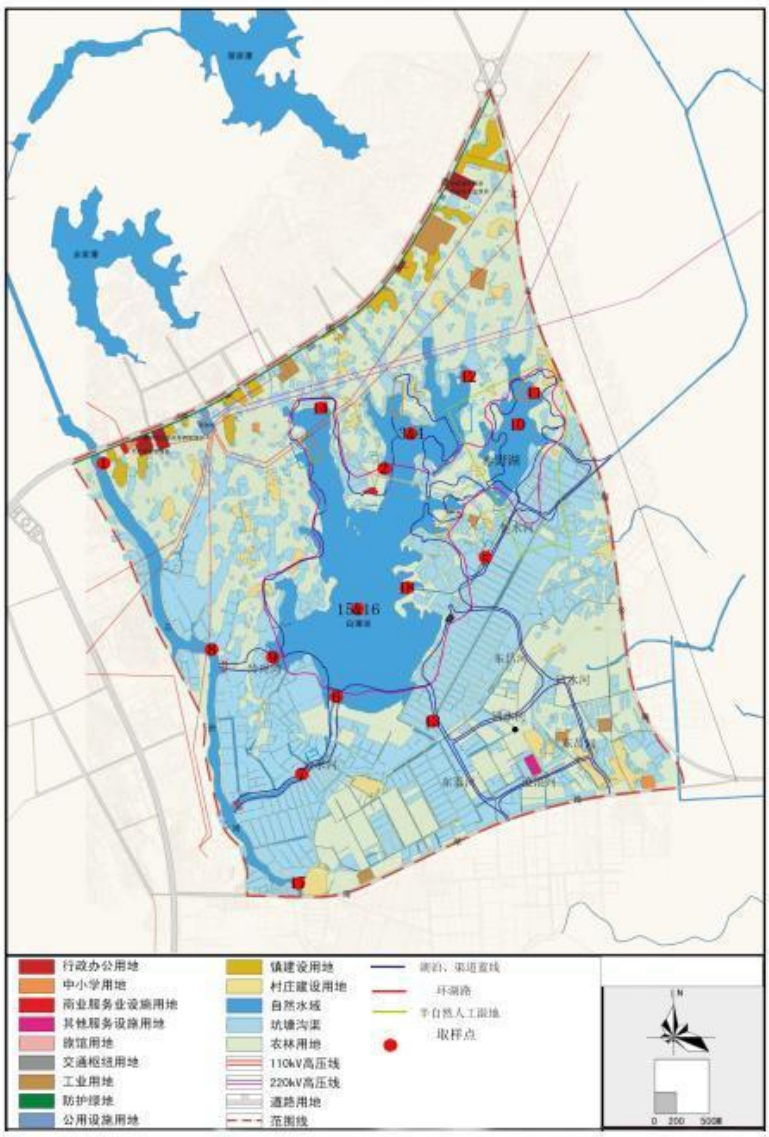


Figure IV.3: Phytoplankton monitoring locations

Table IV.17: Baseline monitoring data on the distribution and abundance of phytoplankton

Scientific Name	Numerical Abundance (in number of cells/mL) at Monitoring Locations																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Average
Cyanophyta																		***37.7%***
Subtotal	*1849*	*24516*	*24479*	*16737*	*2222*	*6801*	*6801*	*3728*	*3129*	*40053*	*245*	*17205*	*2437*	*5547*	*183870*	*181352*	*2336*	*30783*
Anabaena sp.	---	4731	3154	824	---	---	---	---	215	1344	29	1219	---	774	---	---	323	742
Dactylococcopsis sp.	150	1470	1254	1720	430	1882	1882	---	32	---	22	1183	358	1419	---	---	52	697
Limnothrix sp.	194	---	---	---	---	---	---	---	---	---	---	---	538	---	---	---	---	43
Lynglya sp.	344	215	---	---	---	---	---	---	---	---	108	---	---	---	---	---	---	39
Merismopedia sp.	774	11469	12652	5448	1792	4462	4462	3728	2602	24946	---	5986	1541	---	182709	180270	1703	26150
Oscillatoria sp.	172	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	10
Planktothrix anagnostidis	215	5950	7061	8745	---	457	457	---	280	12312	86	8817	---	1935	---	---	258	2740
Raphidiopsis sp.	---	681	358	---	---	---	---	---	---	806	---	---	---	---	---	---	---	109
Spirulina sp.	---	---	---	---	---	---	---	---	---	645	---	---	---	1419	1161	1082	---	253
Euglenophyta																		***0.4%***
Subtotal	*65*	*108*	*36*	*108*	---	*323*	*323*	*215*	*194*	*699*	---	---	*394*	*387*	*1032*	*1024*	*77*	*293*
Euglena sp.	65	108	36	108	---	323	323	215	194	699	---	---	394	387	645	645	77	248
Phacus sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	387	379	---	45
Pyrrophyta																		***0.1%***
Subtotal	---	---	*72*	*108*	*72*	*54*	*54*	---	*32*	*108*	---	*36*	*36*	*387*	*387*	*400*	---	*103*
Ceratocorys sp.	---	---	---	---	---	27	27	---	---	---	---	---	---	129	---	---	---	11
Peridinium sp.	---	---	72	108	72	27	27	---	32	108	---	36	36	258	387	400	---	92
Chlorophyta																		***30.7%***
Subtotal	*10129*	*26164*	*21432*	*29104*	*10324*	*4545*	*4545*	*14302*	*7636*	*43654*	*983*	*24443*	*27383*	*46322*	*72903*	*71538*	*11303*	*25101*
Actinastrum sp.	---	---	---	143	---	---	---	394	161	1989	---	108	---	---	---	---	142	173
Ankistrodesmus sp.	989	1326	1398	1613	215	323	323	1326	1183	3871	---	1290	1362	1290	16129	15929	400	2880
Chlamydomonas sp.	151	466	430	538	358	161	161	287	161	1398	7	645	---	774	3613	3701	542	788
Chlorococcales	1699	2688	1075	1577	2796	565	565	3405	742	5107	72	1864	---	---	2710	2710	955	1678
Chlorogonium sp.	---	108	251	323	---	---	---	36	22	---	---	36	72	---	---	---	---	50
Closterium sp.	---	---	---	---	---	27	27	---	---	---	---	---	---	---	---	---	---	3
Coccomyxa sp.	129	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8
Coelastrum sp.	172	2760	1720	2652	502	---	---	430	215	860	93	2222	753	4774	774	752	774	1144
Crucigenia sp.	430	430	860	860	287	108	108	---	215	1183	86	573	1434	---	---	---	1535	477
Dictyosphaerium sp.	---	1147	358	1147	---	---	---	---	---	3011	---	1290	538	2065	---	---	181	573
Elakatothrix sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	258	---	---	---	15
Franceia sp.	---	---	---	---	---	---	---	---	11	---	---	---	---	129	---	---	---	8
Golenkinia sp.	---	36	72	72	---	---	---	---	---	---	---	36	---	---	129	130	---	28
Kirchneriella sp.	---	---	---	---	---	81	81	---	---	1290	57	---	1039	---	2065	2057	400	416
Lagerheimia sp.	129	215	358	358	108	108	108	36	43	430	7	430	143	258	129	129	---	176
Oocystis sp.	129	143	143	143	---	---	---	538	108	1021	22	143	215	258	1032	1029	710	331
Pediastrum sp.	43	609	394	430	---	---	---	---	108	645	---	1039	251	2065	---	---	---	328
Scenedesmus sp.	4559	13118	11003	15305	4875	2581	2581	4875	3795	18871	337	11254	17455	28645	36774	35779	3664	12675
Schroederia sp.	86	179	251	430	---	---	---	108	108	860	165	108	---	1806	387	362	65	289
Selenastrum sp.	731	502	717	932	502	242	242	1505	505	1559	22	1219	2258	516	4258	4123	710	1208
Staurastrum sp.	---	---	72	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4
Tetraedron sp.	237	860	932	717	179	134	134	358	65	699	115	1039	358	903	1806	1812	335	628
Tetrastrum sp.	645	1577	1398	1864	502	215	215	1004	194	860	---	1147	1505	2581	3097	3025	890	1219
Chrysophyta																		***0.1%***
Subtotal	*22*	*215*	*466*	*431*	---	---	---	*108*	*65*	*430*	*21*	*36*	---	---	---	---	*13*	*106*
Chrysomonadales	22	36	215	108	---	---	---	36	22	---	7	---	---	---	---	---	---	26
Mallomonas sp.	---	179	251	323	---	---	---	72	43	430	14	36	---	---	---	---	13	80

Scientific Name	Numerical Abundance (in number of cells/mL) at Monitoring Locations																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Average
Cryptophyta																		***13.0%***
Subtotal	*2366*	*6702*	*8315*	*9211*	*3728*	*1881*	*1881*	*6416*	*1527*	*50752*	*860*	*4982*	*11900*	*4516*	*31226*	*31345*	*3509*	*10654*
Cryptomonas sp.	2366	6702	8315	9211	3728	1881	1881	6416	1527	50752	860	4982	11900	4516	31226	31345	3509	10654
Bacillariophyta																		***18.0%***
Subtotal	*3872*	*13297*	*12473*	*14373*	*4193*	*6506*	*6506*	*7635*	*4086*	*9087*	*430*	*15304*	*14121*	*48387*	*43226*	*43411*	*2465*	*14669*
Achnanthes sp.	---	---	---	---	---	---	---	---	32	---	14	---	---	---	---	---	---	3
Cyclotella sp.	2688	10788	10932	11685	2007	3172	3172	6452	1602	3925	93	13011	3978	44129	34968	35212	2116	11172
Cymatopleura sp.	---	---	---	---	---	---	---	---	11	---	---	---	---	---	---	---	---	1
Gomphonema sp.	43	---	---	---	36	---	---	72	54	---	43	---	36	258	---	---	---	32
Gyrosigma sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	26	2
Melosira sp.	839	1756	1254	2222	896	2285	2285	932	1387	753	36	1111	8387	1548	6064	5999	52	2224
Navicula sp.	108	36	---	---	645	81	81	36	290	54	79	358	215	---	---	---	39	119
Pinnularia sp.	---	---	---	---	---	---	---	---	---	---	7	---	---	129	---	---	---	8
Synedra sp.	194	717	287	466	609	968	968	143	710	4355	158	824	1505	2323	2194	2200	232	1109
Total abundance	**18303**	**71002**	**67273**	**70072**	**20539**	**20110**	**20110**	**32404**	**16669**	**144783**	**2539**	**62006**	**56271**	**105546**	**332644**	**329070**	**19703**	**81708**
Total number of species	**28**	**30**	**30**	**29**	**19**	**22**	**22**	**23**	**32**	**29**	**25**	**28**	**26**	**27**	**22**	**22**	**26**	**48**

Monitoring Locations:

#1: Santai River under the Santai River Bridge
#2: Northern Baitan Lake nearshore
#3: Northern Baitan Lake center 0.5 m below water surface
#4: Northern Baitan Lake center 0.5 m above water bottom
#5: Baitan Lake and Chushui River confluence
#6: Baitan Lake outflow location
#7: Jinshui River
#8: Santai River near Xingang No. 2 Road
#9: Baitan Lake at Linglong Bay nearshore
#10: Chiye Lake center
#11: Cheyi Lake by the pump station
#12: Baitan Lake nearshore by Baizhang Village No. 5 Group
#13: Wanmu Aquaculture Base drainage ditch
#14: Baitan Lake near Shuizhang Fishing Village
#15: Baitan Lake center 0.5 m below water surface
#16: Baitan Lake center 0.5 m above water bottom
#17: Santai River underneath the Nanhu Road Bridge

Source: Project EIR

186. **Benthic Fauna**. Benthic fauna are animals that live on the sediment surface (epi-fauna) or burrowed in the sediment (in-fauna). Baseline monitoring results shown in **Table IV.18** indicate that the benthic community consisted of annelids (ringed worms) such as freshwater worms and leeches, arthropods (jointed-foot invertebrates) such as crustaceans (shrimps and crabs) and insects (mainly their larval forms), and mollusks such as gastropods (snails) and bivalves (clams and mussels).

187. Two species of freshwater mussel, *Lamprotula rochechouartii* and *Lamprotula tortuosa*, have been assessed by IUCN as Vulnerable.

Table IV.18: List of benthic fauna in Baitan Lake and nearby Santai River and Jinshui River

Scientific Name	Common Name	Relative Dominance	Protection Status	
			PRC	IUCN
ANNELIDA	环节动物门(Ringed Worms)			
Oligochaeta	寡毛纲			
Tubificida	颤蚓目			
Aulodrilus pluriseta	多毛管水蚓	+++	---	---
Chaetogaster diastrophus	盘缠毛腹虫	++	---	---
Limnodrilus hoffmeisteri	霍甫水丝蚓	+	---	---
Monopylephorus limtosus	淡水单孔蚓	+	---	---
Paranais communis	普通拟仙女虫	+++	---	---
Paranais mobilis	活动拟仙女虫	+	---	---
Paranais paradalis	豹行拟仙女虫	+	---	---
Rhyacodrilus sinicus	中华河蚓	+	---	---
Salvinia natans	苏氏尾鳃蚓	++	---	---
Slavina appendiculata	多突瘸皮虫	+	---	---
Stylaria fossularis	尖头杆吻虫	+	---	---
Citellata	蛭纲			
Arhynchobdellida	无吻蛭目			
Hirudo nipponia	Korean Blood Sucking Leech 日本医蛭	+++	---	---
ARTHROPODA	节肢动物门(Jointed-foot Invertebrates)			
Crustacea	甲壳纲			
Decapoda	十足目(Crabs, Shrimps & Lobsters)			
Caridina longirostris	Long Nose Shrimp 长额米虾	+++	---	LC
Eriocheir sinensis	Chinese Mitten Crab 中华绒螯蟹	+	---	---
Macrobrachium nipponense	Oriental River Shrimp 日本沼虾	+++	---	LC
Procambarus clarkii	Red Swamp Crayfish 克氏原螯虾	+++	---	LC
Insecta	昆虫纲			
Coleoptera	鞘翅目(Beetles)			
Dytiscus sp.	Great Diving Beetle 龙虱	+	---	---
Hydrophilus sp.	Water Scavenger Beetle 牙甲	+	---	---
Oulema oryzae	RiceLeaf Beetle 水稻负泥虫	+	---	---
Oxycetonia bealiae	Flower Scarab Beetle 斑青花金龟	+++	---	---
Paederus sp.	Rove Beetle 隐翅虫	++	---	---
Diptera	双翅目(Mosquitoes, Gnats & Midges)			
Aedes albopictus	Tiger Mosquito 白纹伊蚊	++	---	---
Anopheles maculatus	多斑按蚊	+++	---	---
Chironomaptera sp.	幽蚊	++	---	---
Chironomus dorsalis	背摇蚊	+	---	---
Chironomus plumosus	Buzzer Midge 羽摇蚊	+	---	---
Clinotanypus sp.	菱跗摇蚊	+++	---	---

Scientific Name	Common Name	Relative Dominance	Protection Status	
			PRC	IUCN
Cricotopus sp.	环足摇蚊	+++	---	---
Culex tritaeniorhynehus	三带喙库蚊	+++	---	---
Culicoides sp.	库蠓	+++	---	---
Glyptotendipes sp.	雕翅摇蚊	+	---	---
Orthocladius sp.	直突摇蚊	++	---	---
Procladius choreus	花翅前突摇蚊	+++	---	---
Tanypus chinensis	中国长足摇蚊	+++	---	---
Ephemeroptera	蜉蝣目(Mayflies)			
Baetis sp.	四节蜉	+	---	---
Caenis sp.	细蜉	+	---	---
Hemiptera	半翅目(True Bugs)			
Aquarlus elongatus	Water Skater 水黾	++	---	---
Enithares sinica	华仰蝽	+	---	---
Hydrometra sp.	尺蝽	+	---	---
Kirkaldyia deyrollei	田蝽	+	---	---
Lethocerus indicus	Giant Water Bug 桂花蝉	+	---	---
Lethocerus rustica	负子蝽	+	---	---
Micronecta quadriseta	小划蝽	+	---	---
Nepa chinensis	卵圆蝎蝽	+	---	---
Notomecta chinensis	黑纹仰蝽	+	---	---
Ramatra unicdor	华堂蝎蝽	+	---	---
Sympetrum croceolum	半黄赤蜻	++	---	---
Odonata	蜻蜓目(Dragonflies and Demselflies)			
Anotogaster kuchenbeiseri	双斑圆臀大蜓	+	---	---
Caenagrion sp.	虫忽	+	---	---
Ceriagrion fullax	长尾黄蜓	+	---	---
Crocothemis servilia	Oriental Scarlet 红蜻	+++	---	LC
Indictinogomphus rapax	黑印叶箭蜓	+	---	---
Ischnura senegalensis	Common Bluetail 隆蜓	+	---	LC
Palpopleura sexmaculata	Blue-tailed Yellow Skimmer 六斑曲缘蜻	++	---	LC
Pantala flavescens	Globe Skimmer 黄蜻	+++	---	LC
Sigara substriata	横纹划蝽	+	---	---
MOLLUSCA	软体动物门			
Gastropoda	腹足纲(Snails & Slugs)			
Bellamya purificata	梨形环棱螺	++	---	---
Bithynia fuchsiana	赤豆螺	++	---	LC
Cipangopaludina cahayensis	中华圆田螺	+	---	---
Oncomelania hupensis	湖北钉螺	+	---	LC
Parafossarulus sinensis	中华沼螺	+++	---	---
Radix auricularia	耳萝卜螺	++	---	LC
Radix ovata	卵萝卜螺	++	---	---
Semisulcospira cancellata	方格短沟蜷	+++	---	---
Sinotaia aeruginosa	Pond Snail 铜锈环棱螺	+++	---	LC
Valvata piscinalis	鱼盘螺	++	---	LC
Bivalvia	瓣鳃纲(Clams, Oysters, Mussels, Scallops)			
Acuticosta chinensis	中国尖嵴蚌	+	---	LC
Arconaia lanceolata	扭蚌	+	---	LC
Corbicula fluminea	Golden Freshwater Clam 河蚬	++	---	LC
Cristaria plicata	褶纹冠蚌	+	---	---
Cuneopsis celtiformis	圆头楔蚌	+	---	LC

Scientific Name	Common Name	Relative Dominance	Protection Status	
			PRC	IUCN
Cuneopsis heudei	圆头楔蚌	+	---	LC
Hyriopsis cumingii	Triangle Sail Mussel 三角蚌帆	+++	---	LC
Lamprotula leai	背瘤丽蚌	+	---	LC
Lamprotula rochechouartii	猪耳丽蚌	+	---	VU
Lamprotula tortuosa	失衡丽蚌	+	---	VU
Limnoperna lacustris	湖沼股蛤	+++	---	---
Sinanodonta woodiana	Chinese Pond Mussel 背角无齿蚌	+++	---	LC
Solenaia oleivora	橄榄蛏蚌	+	---	---
Sphaerium lacustre	湖球蚬	+	---	---
Unio douglasiae	圆顶珠蚌	+	---	---

Notes:
IUCN: International Union for Conservation of Nature, LC = least concern; VU = Vulnerable

Source: Project EIR

188. **Fish**. **Table IV.19** lists 49 fish species that have been recorded in Baitan Lake, dominated by carps and minnows (Cypriniformes) with 33 species making up two-third of the species composition. **Table IV.19** shows that there are 9 species that are distributed in the Yangtze River water system moving into the lakes along the Yangtze River basin. They were not among the dominant species in Baitan Lake.

Table IV.19: Fish recorded in Baitan Lake

Scientific Name	Common Name	Dominance	Belongs to Yangtze River Fish Community	Protection Status	
				PRC	IUCN
Beloniformes	颌针鱼目				
Hyporhamphus intermedius	Asian Pencil Halfbeak 间下鱵	+	√	---	---
Oryzias latipes	Japanese Rice Fish 青鳉	+	√	---	LC
Clupeiformes	鲱形目				
Coilia brachygnathus	Yangtze Grenadier Anchovy 短颌鲚	+		---	---
Cypriniformes	鲤形目				
Acheilognathus macropterus	Deep Body Bitterling 大鳍鱊	++		---	---
Aristichthys nobilis	Bighead Carp 鳙	+++		---	---
Carassius auratus	Goldfish 鲫	+++		---	LC
Chanodichthys dabryi	Humpback 青梢红鲌	+		---	LC
Chanodichthys erythropterus	Redfin Culter 红鳍鲌	++		---	LC
Chanodichthys mongolicus	Mongolian Redfin 蒙古鲌	+		---	LC
Cobitis macrostigma	大斑花鳅	++		---	---
Cobitis sinensis	Siberian Spiny Loach 中华花鳅	++		---	LC
Coreius heterodon	Bronze Gudgeon 铜鱼	+		---	---
Ctenopharyngodon idellus	Grass Carp 草鱼	++		---	---
Culter oxycephaloides	拟尖头鲌	+		---	---
Cyprinus carpio	Wild Common Carp 鲤	+++		---	VU
Elopichthys bambusa	Yellowcheek 鱤	+		---	---
Hemiculter bleekeri	Minnow 贝氏□	+		---	---
Hemiculter leucisculus	Sharpbelly□子	+++		---	LC
Hypophthalmichthys molitrix	Silver Carp 鲢	+++		---	NT
Megalobrama amblycephala	Wuchang Bream 团头鲂	+		---	LC
Megalobrama terminalis	Black Amur Bream 三角鲂	+		---	---

Scientific Name	Common Name	Dominance	Belongs to Yangtze River Fish Community	Protection Status	
				PRC	IUCN
Misgurnus anguillicaudatus	Pond Loach 泥鳅	+++		---	LC
Mylopharyngodon piceus	Black Carp 青鱼	+		---	---
Myxocyprinus asiaticus	Chinese Sucker 胭脂鱼	+	√	N(II)	---
Ochetobius elongatus	鳜鱼	+		P	LC
Opsariichthys uncirostris	Three-lips 真马口鱼	+	√	---	---
Parabramis pekinensis	White Bream 鳊	+++		---	---
Paracanthobrama guichenoti	似刺鳊鮈	+	√	---	---
Plagiognathops microlepis	Smallscale Yellowfin 细鳞斜颌鲴	+		---	LC
Pseudorasbora parva	Topmouth Gudgeon 麦穗鱼	++		---	LC
Rhodeus ocellatus	Rosy Bitterling 高体鳑鲏	++		---	---
Sarcocheilichthys sinensis	Chinese Lake Gudgeon 华鳈	+	√	---	LC
Saurogobio dabryi	Chinese Lizard Gudgeon 蛇鮈			P	---
Squaliobarbus curriculus	Barbel Chub 赤眼鳟	+		---	---
Xenocypris argentea	Yellow Tail 银鲴	+		---	LC
Xenocypris davidi	David's Yellowfin 黄尾鲴	+		---	---
Cyprinodontiformes	鳉形目				
Oryzias latipes	Japanese Rice Fish 青鳉			---	LC
Perciformes	鲈形目				
Macrognathus aculeatus	Lesser Spiny Eel 刺鳅	+		---	---
Macropodus opercularis	Paradise Fish 圆尾斗鱼	+		---	LC
Odontobutis obscura	Dark Sleeper Goby 暗色沙塘鳢	+	√	---	---
Ophiocephalus argus	Snakehead 乌鳢	+		---	---
Rhinogobius giurinus	Barcheek Goby 子陵吻鰕虎鱼	+		---	LC
Siniperca chuatsi	Chinese Perch 鳜、桂花鱼	+		---	---
Siniperca kneri	大眼鳜	+		---	---
Siluriformes	鲶形目				
Pseudobagrus vachellii	Darkbarbel Catfish 瓦氏黄颡鱼	+	√	---	---
Silurus asotus	Amur Catfish 鲶	++		---	LC
Tachysurus fulvidraco	Yellow Catfish 黄颡鱼	++		---	LC
Tachysurus nitidus	Shining Catfish 光泽黄颡鱼	+	√	---	---
Symbranchiformes	合鳃目				
Monopterus albus	Rice Swampeel 黄鳝	++		---	LC

Notes:

YRS: belongs to the Yangtze River fish community and could move with river water into nearby lakes;

Protection Status: N(II) = national class II protected wild animal; P = provincially protected wild animal; IUCN: International Union for Conservation of Nature, LC = least concern; NT = near threatened, VU = vulnerable

Source: Project EIR

189. The cyprinid Chinese Sucker Fish (*Myxocyprinus asiaticus*), endemic to the PRC, is under Class II national protection. This species has not been assessed by IUCN as to its protection status. Two cyprinids, *Ochetobius elongatus and Sarcocheilichthys sinensis*, are on the Hubei Provincial protection list. IUCN has assessed *Ochetobius elongatus* as of Least Concern and has not assessed the protection status of *Sarcocheilichthys sinensis*. Another cyprinid, the Wild Common Carp *Cyprinus carpio*, has been assessed by IUCN as Vulnerable. This species is not on the national or provincial protection list.

190. **Amphibians**. Eight amphibian species consisting of toads and frogs have been recorded in

the Baitan Lake planning area (**Table IV.20**). None of these is on IUCN's protection list although the Black-spotted Pond Frog (*Pelophylax nigromaculatus*) was assessed to be near threatened (NT).

191. The East Asian Bullfrog (*Hoplobatrachus chinensis*) is on the Class II national protection list. This species has been assessed by IUCN to be of Least Concern (LC). The remaining amphibian species except the Japanese Tree Frog are on the provincial protection list.

192. All the amphibian species except the East Asian Bullfrog which is under national Class II protection are also on PRC's *Nationally Protected Wild Animal with Beneficial, Economic and Scientific Research Value* (NBES) list, protected for their values as stated rather than their rare or endangered status.

Table IV.20: Amphibians recorded in the Baitan Lake planning area

Scientific Name	Common Name	Relative Dominance	Fauna Type			Protection Status	
			Os	Ps	Cs	PRC	IUCN
Bufonidae	蟾蜍科 (true toads)						
Bufo gargarizans	Zhoushan Toad 中华蟾蜍	++			√	NBES, P	LC
Hylidae	雨蛙科 (tree frogs)						
Hyla japonica	Japanese Tree Frog 日本雨蛙	+	√			NBES	LC
Microhylidae	姬蛙科 (narrow-mouthed frogs)						
Microhyla ornata	Ornamented Pygmy Frog 饰纹姬蛙	++	√			NBES, P	LC
Ranidae	蛙科 (true frogs)						
Fejervarya multistriata	Rice Frog 泽蛙	++	√			NBES, P	---
Hoplobatrachus chinensis	East Asian Bullfrog 虎纹蛙	++	√			N(II)	LC
Pelophylax nigromaculatus	Black-spotted Pond Frog 黑斑蛙	+++			√	NBES, P	NT
Pelophylax plancyi	Eastern Golden Frog 金线蛙	++	√			NBES, P	LC
Rana japonica	Japanese Brown Frog 日本林蛙	+	√				LC

Notes:
Fauna Type: Os = oriental species; Ps = palaearctic species; Cs = cosmopolitan species;
Protection Status: N(II) = national Class II protected wild animal; NBES = nationally protected wild animal with beneficial, economic and scientific research value; P = provincially protected wild animal; IUCN: International Union for Conservation of Nature, LC = least concern; NT = near threatened.

Source: Project EIR

193. **Reptiles**. Twenty reptile species dominated by snakes (13 species) have been recorded in the Baitan Lake planning area (**Table IV.21**). All are on the NBES list and 6 are also on the provincial protection list.

Table IV.21: Reptiles recorded in the Baitan Lake planning area

Scientific Name	Common Name	Relative Dominance	Fauna Type			Protection Status	
			Os	Ps	Cs	PRC	IUCN
Testudines	龟鳖目 (turtles)						
Chinemys reevesii	Reeves' Turtle, Chinese Pond Turtle 乌龟	++			√	NBES	EN
Mauremys mutica	Yellow Pond Turtle 黄喉拟水龟	++	√			NBES, P	EN
Pelodiscus sinensis	Chinese Soft-shell Turtle 鳖	+++				NBES	VU
Serpentes	蛇目蛇目 (snakes)						
Amphiesma craspedogaster	Kuatun Keelback 锈链腹链蛇	++	√			NBES	---
Dinodon rufozonatum	Red-banded Snake 赤练蛇	+++			√	NBES	---

Scientific Name		Common Name	Relative Dominance	Fauna Type			Protection Status	
				Os	Ps	Cs	PRC	IUCN
	Elaphe bimaculata	Chinese Leopard Snake 双斑锦蛇	++	√			NBES, P	LC
	Elaphe carinata	King Ratsnake 王锦蛇	+++	√			NBES, P	---
	Elaphe rufodorsata	Red-back Ratsnake 红点锦蛇	+++			√	NBES	LC
	Elaphe taeniura	Beauty Ratsnake 黑眉锦蛇	+++			√	NBES, P	---
	Gloydius brevicaudus	Short-tailed Mamushi 短尾蝮	++	√			NBES	---
	Ptyas korros	Chinese Ratsnake 灰鼠蛇	++	√			NBES	---
	Ptyas mucosus	Oriental Ratsnake 滑鼠蛇	++	√			NBES, P	---
	Rhabdophis nuchalis	Groove-necked Keelback 颈槽蛇	++	√			NBES	LC
	Rhabdophis tigrina	Tiger Keelback 虎斑颈槽蛇	++			√	NBES	---
	Sinonatrix annularis	Ringed Water Snake 水赤链游蛇	++			√	NBES	---
	Zaocys dhumnades	Black-striped Snake 乌梢蛇	++	√			NBES, P	---
Squamata		有鳞目 (scaled reptiles)						
	Gekko japonicus	Japanese Gecko 多疣壁虎	+++			√	NBES	---
	Scincella modesta	Slender Forest Skink 宁波滑蜥	++	√			NBES	---
	Sphenomorphus indicus	Indian Forest Skink 铜蜓蜥	++	√			NBES	---
	Takydromus septentrionalis	Northern Grass Lizard 北草蜥	++			√	NBES	---

Fauna Type: Os = oriental species; Ps = palaearctic species; Cs = cosmopolitan species;
Protection Status: NBES = nationally protected wild animal with beneficial, economic and scientific research value; P = provincially protected wild animal; IUCN: International Union for Conservation of Nature, LC = least concern; VU = vulnerable, EN = endangered.

Source: Project EIR

194. All three turtle species are under IUCN protection status. The Chinese Pond Turtle (*Chinemys reevesii*) and the Yellow Pond Turtle (*Mauremys mutica*) have been assessed by IUCN as Endangered (EN), and the Chinese Soft-shell Turtle (*Pelodiscus sinensis*) as Vulnerable (VU). *Pelodiscus sinensis* is among the dominant reptiles in the Baitan Lake area

195. All three turtle species are nationally protected for their beneficial, economic and scientific research values. None is protected for their rare or threatened status on the national level.

196. **Terrestrial Mammals**. Fourteen terrestrial mammal species consisting of carnivores, hedgehogs, hares and rabbits, and rodents have been recorded in the Baitan Lake planning area (**Table IV.22**). The Hog Badger (*Arctonyx collaris*) and the Siberian Weasel (*Mustela sibirica*) are on the provincial protection list. These two, plus the Manchurian Hedgehog (*Erinaceus amurensis*) and the Tolai Hare (*Lepus tolai*) are also on the NBES list for their beneficial, economic and scientific research values.

197. None of the species are on the IUCN protection list, although the Hog Badger (*Arctonyx collaris*) and the Schreiber's Bent-winged Bat (*Miniopterus schreibersii*) have been assessed as Near Threatened (NT) due to declining population.

Table IV.22: Terrestrial mammals recorded in the Baitan Lake planning area

Scientific Name		Common Name	Relative Dominance	Fauna Type			Protection Status	
				Os	Ps	Cs	PRC	IUCN
Carnivora		食肉目 (meat eating)						
	Arctonyx collaris	Hog Badger 猪獾	+	√			NBES, P	NT
	Mustela sibirica	Siberian Weasel 黄鼬	+		√		NBES, P	LC
Chiroptera		翼手目 (bats)						

Scientific Name	Common Name	Relative Dominance	Fauna Type			Protection Status	
			Os	Ps	Cs	PRC	IUCN
Miniopterus schreibersii	Schreiber's Bent-winged Bat 普通长翼蝠	+++	√				NT
Pipistrellus abramus	Japanese Pipistrelle 东亚伏翼	+++			√		LC
Rhinolophus affinis	Intermediate Horseshoe Bat 中菊头蝠	+	√				LC
Rhinolophus ferrumequinum	Greater Horseshoe Bat 马铁菊头蝠	+++			√		LC
Rhinolophus shortridgei	Shortridge's Horseshoe Bat 短翼菊头蝠	+++	√				LC
Erinaceomorpha	猬目 (hedgehogs)						
Erinaceus amurensis	Manchurian Hedgehog 东北刺猬	+		√		NBES	LC
Lagomorpha	兔形目 (hares and rabbits)						
Lepus tolai	Tolai Hare 草兔	++			√	NBES	LC
Rodentia	啮齿目 (rodents)						
Apodemus agrarius	Striped Field Mouse 黑线姬鼠	++		√			LC
Cricetulus barabensis	Striped Dwarf Hamster 黑线仓鼠	++		√			LC
Mus musculus	House Mouse 小家鼠	+++		√			LC
Rattus norvegicus	Brown Rat 褐家鼠	+++		√			LC
Rattus tanezumi	Asian House Rat 黄胸鼠	++	√				LC

Notes:
Fauna Type: Os = oriental species; Ps = palaearctic species; Cs = cosmopolitan species;
Protection Status: NBES = nationally protected wild animal with beneficial, economic and scientific research value; P = provincially protected wild animal; IUCN: International Union for Conservation of Nature, LC = least concern; NT = near threatened.

Source: Project EIR

198. **Birds.** Bird surveys were conducted in the Baitan Lake planning area in the late spring – early summer of 2013. **Table IV.23** lists the bird species recorded during the surveys as well as those that have been recorded in literature to occur in the Baitan Lake area.

Table IV.23: Birds recorded in the Baitan Lake planning area

Scientific Name	Common Name	Relative Dominance	Seasonal Type				Faunal Type			Protection Status	
			R	W	S	P	Os	Ps	Cs	PRC	IUCN
Podicipediformes	Grebes䴙䴘目										
Podiceps cristatus	Great-crested Grebe 凤头䴙䴘	+		√				√		P	---
Tachybaptus ruficollis	Little Grebe 小䴙䴘	+++	√						√	---	LC
Pelecaniformes	鹈形目										
Phalacrocorax carbo	Great Cormorant 普通鸬鹚	+	√						√	P	LC
Ciconiiformes	鹳形目										
Ardea cinerea	Grey Heron 苍鹭	++	√						√	P	LC
Ardea purpurea	Purple Heron 草鹭	+		√					√	---	LC
Ardeola bacchus	Chinese Pond Heron 池鹭	++			√		√			---	LC
Botaurus stellaris	Eurasian Bittern 大麻鳽	+		√				√		---	LC
Bubulcus ibis	Cattle Egret 牛背鹭	++			√		√			P	LC
Egretta alba	Eastern Great Egret 大白鹭	++	√						√	P	---
Egretta garzetta	Little Egret 小白鹭	+++			√		√			P	LC
Egretta intermedia	Intermediate Egret 中白鹭	++		√			√			P	---
Ixobrychus cinnamomeus	Cinnamon Bittern 栗苇鳽	+			√		√			---	LC
Nyticorax nyticorax	Night Heron 夜鹭	++			√				√	---	LC
Anseriformes	雁形目										
Anas crecca	Common Teal 绿翅鸭	++		√				√		---	LC
Anas penelope	Eurasian Wigeon 赤颈鸭	+++		√				√		---	LC
Anas platyrhynchos	Mallard 绿头鸭	++		√				√		P	LC
Anas poecilorhyncha	Spot-billed Duck 斑嘴鸭	++		√			√			---	LC

Scientific Name	Common Name	Relative Dominance	Seasonal Type				Faunal Type			Protection Status	
			R	W	S	P	Os	Ps	Cs	PRC	IUCN
Anser albifrons	Great White-fronted Goose 白额雁	++		√				√		N(II)	LC
Anser anser	Greylag Goose 灰雁	+++		√				√		P	LC
Anser cygnoides	Swan Goose 鸿雁	++		√				√		P	VU
Anser fabalis	Bean Goose 豆雁	++		√				√		P	LC
Aythya ferina	Common Pochard 红头潜鸭	++		√				√		---	LC
Aythya fuligula	Tufted Duck 凤头潜鸭	++		√				√		---	LC
Mergus merganser	Goosander 普通秋沙鸭	+		√				√		P	LC
Mergus serrator	Red-breasted Merganser 红胸秋沙鸭	++		√				√		---	LC
Tadorna ferruginea	Ruddy Shelduck 赤麻鸭	+++		√				√		P	LC
Galliformes	鸡形目										
Phasianus colchicus	Common Pheasant 环颈雉	+	√						√	P	LC
Falconiformes	隼形目										
Accipiter buteo	Common Buzzard 普通鵟	+		√				√		N(II)	LC
Accipiter gentilis	Northern Goshawk 苍鹰	+	√					√		N(II)	LC
Accipiter nisus	Eurasian Sparrowhawk 雀鹰	+		√				√		N(II)	LC
Accipiter soloensis	Chinese Goshawk 赤腹鹰	+		√			√			N(II)	LC
Circus cyaneus	Northern Harrier 白尾鹞	+		√				√		N(II)	LC
Falco columbarius	Merlin 灰背隼	+		√				√		N(II)	LC
Falco peregrinus	Peregrine Falcon 游隼	+		√				√		N(II)	LC
Falco tinnunculus	Common Kestrel 红隼	+	√					√		N(II)	LC
Falco vespertinus	Red-footed Falcon 红脚隼	+		√				√		N(II)	NT
Gruiformes	鹤形目										
Amaurornis akool	Brown Crake 红脚苦恶鸟	+			√		√			---	LC
Amaurornis pheonicurus	White-breasted Waterhen 白胸苦恶鸟	+++			√		√			---	LC
Fulica atra	Common Coot 白骨顶鸡	+	√						√	P	LC
Gallicrex cinerea	Watercock 董鸡	+			√		√			---	LC
Grus grus	Common Crane 灰鹤	++		√				√		N(II)	LC
Grus monacha	Hooded Crane 白头鹤	+++		√				√		N(I)	VU
Rallus aquaticus	Water Rail 普通秧鸡	++			√			√		---	LC
Charadriiformes	鸻形目										
Actitis hypoleucos	Common Sandpiper 矶鹬	+		√				√		---	LC
Charadrius alexandrinus	Kentish Plover 环颈鸻	+		√				√		---	LC
Charadrius dubius	Little Ringed Plover 金眶鸻	++		√				√		---	LC
Gallinago gallinago	Common Snipe 扇尾沙锥	++		√				√		---	LC
Gallinago megala	Swinhoe's Snipe 大沙锥	++		√				√		---	LC
Gallinago stenura	Pintail Snipe 针尾沙锥	++		√				√		---	LC
Glareola maldivarum	Oriental Pratincole 普通燕鸻	++			√		√			---	LC
Hydrophasianus chirurgus	Pheasant-tailed Jacana 水雉	+			√		√			P	LC
Pluvialis squatarola	Grey Plover 灰斑鸻	++				√		√		---	LC
Recurvirostra avosetta	Pied Avocet 反嘴鹬	+		√				√		---	LC
Tringa glareola	Wood Sandpiper 林鹬	+		√				√		---	LC
Tringa nebularia	Common Greenshank 青脚鹬	++		√				√		---	LC
Tringa ochropus	Green Sandpiper 白腰草鹬	+++		√				√		---	LC
Tringa totanus	Common Redshank 红脚鹬	++		√				√		---	LC
Vanellus cinereus	Grey-headed Lapwing 灰头麦鸡	++	√				√			---	LC
Vanellus vanellus	Northern Lapwing 凤头麦鸡	+++		√				√		P	LC
Lariformes	鸥形目										
Larus argentatus	Herring Gull 银鸥	++		√				√		P	LC
Larus canus	Mew Gull 普通海鸥	+		√				√		---	LC
Larus ridibundus	Black-headed Gull 红嘴鸥	+++		√				√		P	LC

Scientific Name	Common Name	Relative Dominance	Seasonal Type				Faunal Type			Protection Status	
			R	W	S	P	Os	Ps	Cs	PRC	IUCN
Sterna hirundo	Common Tern 普通燕鸥	++			√			√		---	LC
Columbiformes	鸽形目										
Sterna chinensis	Spot-necked Dove 珠颈斑鸠	+++	√				√			P	LC
Streptopelia orientalis	Oriental Turtle Dove 山斑鸠	++	√						√	---	LC
Streptopelia tranquebarica	Red Collared-dove 火斑鸠	++	√				√			---	LC
Cuculiformes	鹃形目										
Cuculus canorus	Common Cuckoo 大杜鹃	+			√				√	P	LC
Cuculus micropterus	Short-winged Cuckoo 四声杜鹃	+++			√				√	P	LC
Strigiformes	鸮形目										
Asio flammeus	Short-eared Owl 短耳鸮	++		√				√		N(II)	LC
Glaucidium cuculoides	Asian Barred Owlet 斑头鸺鹠	++	√				√			N(II)	LC
Otus scops	Common Scops-owl 红角鸮	++	√					√		N(II)	LC
Tyto longimembris	Eastern Grass-owl 草鸮	++	√				√			N(II)	LC
Coraciiformes	佛法僧目										
Alcedo atthis	Common Kingfisher 普通翠鸟	+++	√						√	---	LC
Upupiformes	戴胜目										
Upupa epops	Eurasian Hoopoe 戴胜	++			√				√	P	LC
Piciformes	形目										
Dendrocopos hyperythrus	Rufous-bellied Woodpecker 棕腹啄木鸟	++	√						√	P	LC
Dendrocopos major	Greater Pied Woodpecker 大斑啄木鸟	++	√					√		---	LC
Passeriformes	雀形目										
Acridotheres cristaltellus	Crested Myna 普通八哥	+++	√				√			P	LC
Acrocephalus arundinaceus	Great Reed-warbler 大苇莺	++		√			√				LC
Aegithalos concinnus	Black-throated Tit 红头长尾山雀	++	√				√				LC
Alauda arvensis	Eurasian Skylark 云雀	++		√				√		---	LC
Alauda gulgula	Oriental Skylark 小云雀	++	√				√			---	LC
Anthus richardi	Paddy-field Pipit 田鹨	+++		√				√		---	LC
Anthus spinoletta	Water Pipit 水鹨	++		√				√		---	LC
Carduelis sinica	Grey-capped Greenfinch 金翅雀	++	√					√		---	LC
Cettia fortipes	Brownish-flanked Bush-warbler 强脚树莺	++			√		√				LC
Cisticola juncidis	Zitting Cisticola 棕扇苇莺	++			√		√			---	LC
Copsychus saularis	Oriental Magpie-robin 鹊鸲	++	√				√			---	LC
Corvus corone	Carrion Crow 小嘴乌鸦	++	√					√		P	LC
Corvus macrorhynchos	Large-billed Crow 大嘴乌鸦	++	√						√	P	LC
Cyanopica cyana	Grey Tree Magpie 灰喜鹊	+++	√					√		P	LC
Dicrurus marcocercus	Black Drongo 黑卷尾	+++			√		√			P	LC
Emberiza aureola	Yellow-breasted Bunting 黄胸鹀	+++		√		√		√		---	VU
Emberiza chrysophrys	Yellow-browed Bunting 黄眉鹀	+++		√				√		---	LC
Emberiza cioides	Meadow Bunting 三道眉草鹀	++	√					√		---	LC
Emberiza elegans	Yellow-throated Bunting 黄喉鹀	++		√				√		---	LC
Emberiza pallasi	Pallas's Bunting 苇鹀	++		√				√		---	LC
Emberiza pusilla	Little Bunting 小鹀	++		√				√		---	LC
Emberiza rustica	Rustic Bunting 田鹀	++		√				√		---	LC
Emberiza schoeniclus	Reed Bunting 芦鹀	++			√			√		---	LC
Emberiza spodocephala	Black-faced Bunting 灰头鹀	++	√					√		---	LC
Eophona migratoria	Black-tailed Hawfich 黑尾蜡嘴雀	++	√					√		---	LC
Eophona personata	Japanese Grosbeak 黑头蜡嘴雀	+++		√				√		---	LC
Fringilla montifringilla	Brambling 燕雀	++		√				√		---	LC
Hirundo daurica	Red-rumped Swallow 金腰燕	++			√			√		P	LC
Hirundo rustica	Barn Swallow 家燕	+++			√			√		P	LC

Scientific Name	Common Name	Relative Dominance	Seasonal Type				Faunal Type			Protection Status	
			R	W	S	P	Os	Ps	Cs	PRC	IUCN
Lanius cristatus	Brown Shrike 红尾伯劳	+	√					√		P	LC
Lanius schach	Rufous-backed Shrike 棕背伯劳	+++	√				√			P	LC
Lonchura striata	White-rumped Munia 白腰文鸟	++	√				√			---	LC
Motacilla alba	White Wagtail 白鹡鸰	+++	√						√	---	LC
Motacilla cinerea	Grey Wagtail 灰鹡鸰	++		√				√		---	LC
Motacilla flava	Yellow Wagtail 黄鹡鸰	++				√		√		---	LC
Oriolus chinensis	Black-naped Oriole 黑枕黄鹂	++			√		√			P	LC
Parus davidi	Rusty-breasted Tit 红腹山雀	++	√					√		---	LC
Parus major	Great Tit 大山雀	+++	√						√	P	LC
Parus venustulus	Yellow-bellied Tit 黄腹山雀	++	√				√			---	LC
Passer montanus	Eurasian Tree Sparrow 麻雀	+++	√						√	---	LC
Phoenicurus auroreus	Daurian Redstart 北红尾鸲	++	√					√		---	LC
Phylloscopus affinis	Tickell's Leaf-warbler 黄腹柳莺	++		√				√			LC
Phylloscopus fuscatus	Dusky Warbler 褐柳莺	++		√				√			LC
Pica pica	Black-billed Magpie 喜鹊	+++	√					√		P	LC
Pycnonotus sinensis	Chinese Bulbul 白头鹎	+++	√				√			---	LC
Sturnus cineraceus	Ashy Starling 灰椋鸟	++	√					√		---	LC
Terpsiphone paradisi	Asian Paradise-flycatcher 寿带鸟	+			√		√			P	LC
Turdus merula	Eurasian Blackbird 乌鸫	+++	√				√			P	LC
Turdus naumanni	Dusky Thrush 红尾鸫	+++	√					√			LC
Zosterops japonicus	Japanese White-eye 暗绿绣眼鸟	+	√				√			---	LC

Notes:

recorded during field surveys for this project

Seasonal Type: R = resident; W = winter migrant; S = summer migrant; P = passing migrant;

Fauna Type: Os = oriental species; Ps = palaearctic species; Cs = cosmopolitan species;

Protection Status: N(I): national class I protected wild animal; N(II) = national class II protected wild animal; P = provincially protected wild animal; IUCN: International Union for Conservation of Nature, LC = least concern; NT = near threatened, VU = vulnerable.

All bird species listed here are on the NBES (nationally protected wild animal with beneficial, economic and scientific research value) list except those that are already on the national protection list plus *Cettia fortipes, Cisticola juncidis, Corvus corone, Corvus macrorhynchos, Emberiza spodocephala, Lonchura striata, Phasianus chirurgus* and *Turdus merula*

Source: Project EIR

199. The following observations are made based on data in **Table IV.23**:

(i) Birds recorded during the surveys for this project and in literature for the Baitan Lake planning area totaled 126 species, of which 64 species (51%) were recorded during the bird surveys. These species were dominated by winter migrants (57 species, 45%) and resident species (44 species, 35%). The dominant faunal type was of palaearctic origin (75 species, 60%) followed by oriental origin (33 species, 26%).

(ii) The dominance of winter migrants indicates that the Baitan Lake planning area is a popular wintering ground for birds. Of the wintering migrants, the water birds are most important because they feed in and around Baitan Lake. Wintering water birds include the Anseriformes (ducks, geese, swans), Podicipediformes (grebes), Charadriiformes (the waders), Ciconiiformes (storks, herons, egrets, ibises, spoonbills, etc.) and Lariformes (gulls and terns). Winter migrants usually arrive in late October to early November and stay in the area until the following March. Due to the bird surveys being undertaken outside the winter migration period, only 5 of the 57 winter migrant species recorded in the area were observed

during the surveys. Despite this, literature has provided a comprehensive record of potential wintering migrants in the planning area. The planning EIR indicated that most of the migrant water birds would winter at Longgang Lake, which is a provincial nature reserve, in the southern tip of Huanggang Municipality rather than Baitan Lake.

(iii) There are 16 species on PRC's national protection list and 38 species on the provincial protection list. One species, the Hooded Crane (*Grus monacha*) is under Class I national protection. The other 15 species under Class II national protection consisted of 9 species of Falconiformes (falcons, eagles and hawks), 4 species of Strigiformes (owls), the Common Crane (*Grus grus*) and the Great White-fronted Goose (*Anser albifrons*). None of these species has been assigned protection status in the IUCN Red List except the Hooded Crane, which has been assessed by IUCN as Vulnerable (VU). None of these species was recorded during the bird surveys for this project.

(iv) Of the 126 species recorded, 123 species have been assessed by IUCN as to their protection status. Of these, 119 species are of Least Concern (LC), one species Near Threatened (NT), and three species Vulnerable (VU). Besides the Hooded Crane described above, the Swan Goose (*Anser cygnoides*) and the Yellow-breasted Bunting (*Emberiza aureola*) have been assessed by IUCN as Vulnerable (VU). Both are not on PRC's national protection list but the Swan Goose is on the provincial protection list. All three species are winter migrants. Only the Yellow-breasted Bunting was recorded during the bird survey for this project.

200. **Protected areas**. Huangzhou District has one provincially protected natural reserve, the Lijiazhou Egretry Nature Reserve; one provincially protected forest, the Huangzhou Binjiang Forest Park; and one AAA scenic sight, the Dongpo Red Cliff Scenic Area. **Figure IV.3** shows that the egretry is approximately 16 km to the northwest of the project area, while the other two are approximately 6 km to the southwest of the project area.

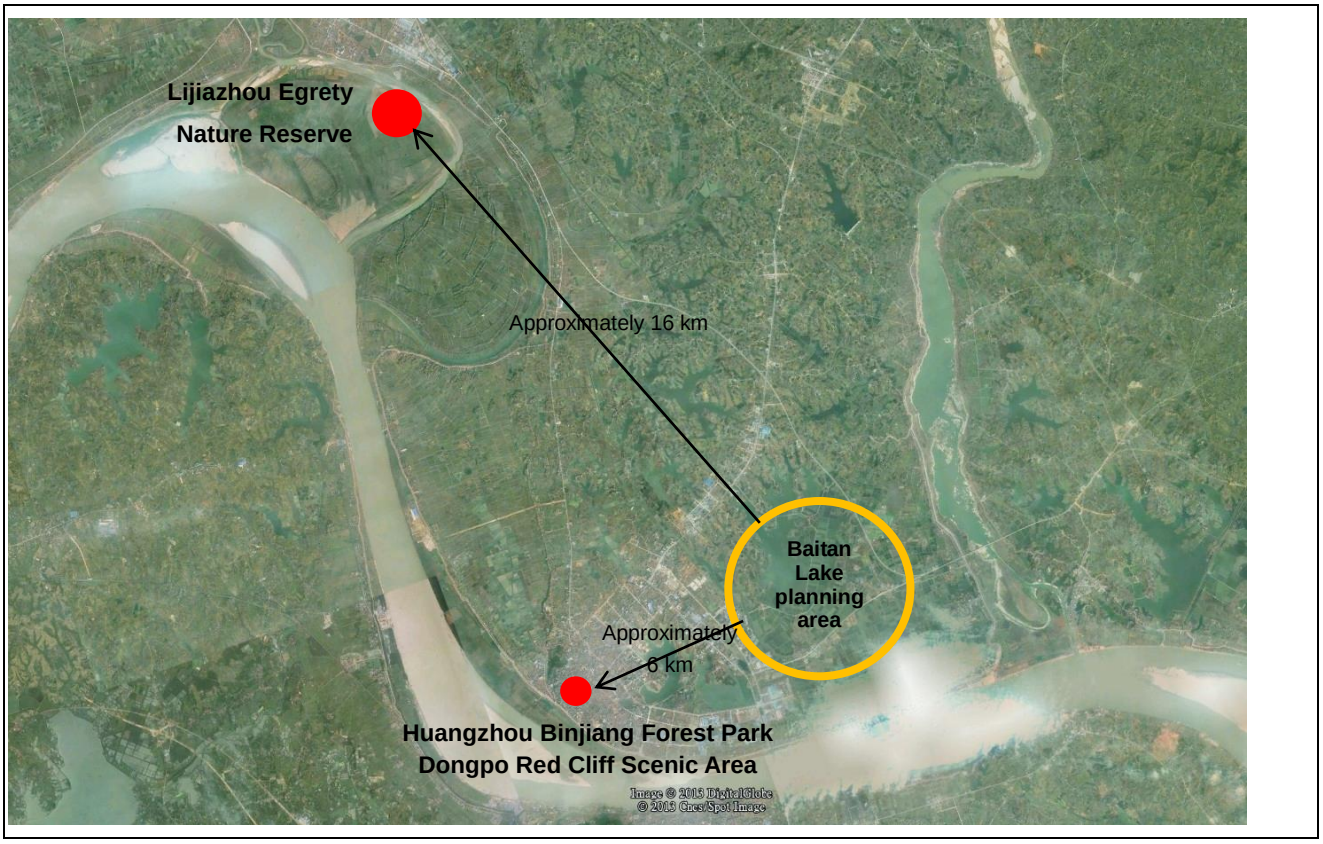


Figure IV.3: Locations of protected areas near the Baitan Lake planning area

201. Longgan Lake Nature Reserve, a major wintering ground for water birds in Huanggang Municipality, is located approximately 120 km to the southeast of the project area (**Figure IV.4**).

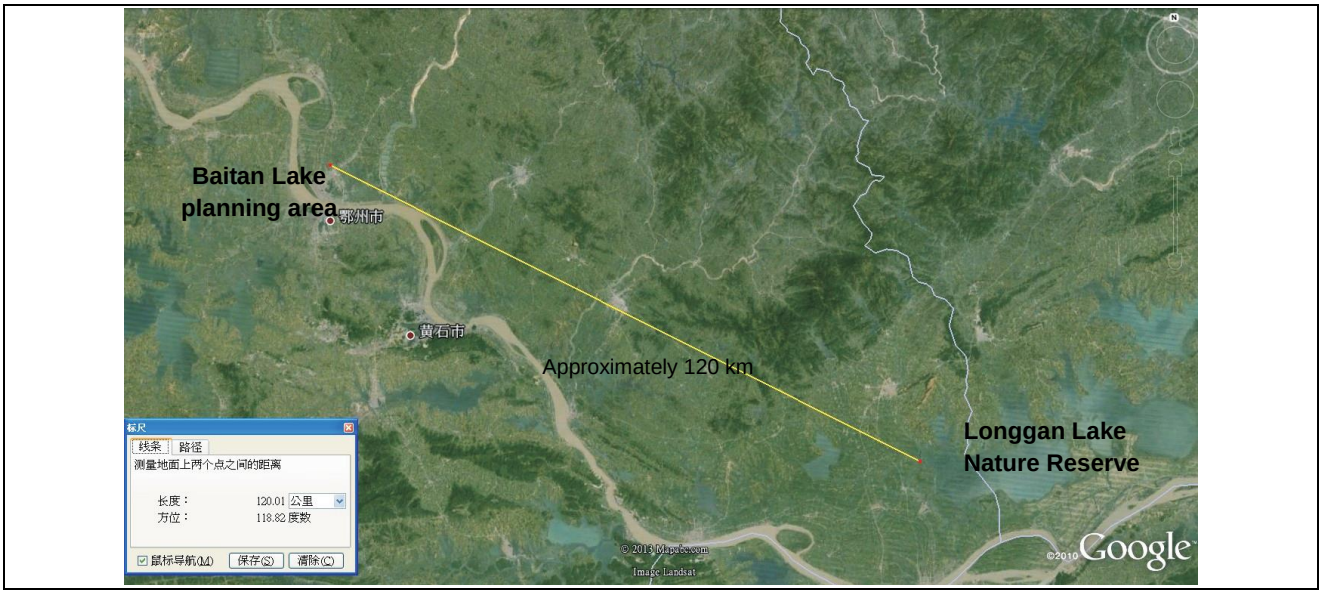


Figure IV.4: Location of Longgan Lake Nature Reserve relative to the NED

D. Socio-economic Environment

202. **Socio-economic conditions**. Huanggang is one of twelve Prefecture-level Cities (PLC) in Hubei Province, located in PRC's central region along the Yangtze River. Hubei is the 10th largest provincial economy in PRC; it ranks 9th in size of population with 57.6 million registered residents (2011). **Table IV.25** summarizes the socio-economic conditions of Huanggang PCL in 2010. Huanggang PLC urban area (UA) is the second most populated city in the province after Wuhan. Huanggang PLC covers an area of 17,453 km^2 and had a total registered population of 7.44 million in 2010. It is comprised of the Huanggang urban area (Huangzhou District), two county-level cities (CLCs), and seven counties, five of which are national-level poverty counties and one of which is a provincial-level poverty county (**Figure IV.5**). The total population of Huanggang UA (Huangzhou District) was 366,769 in 2010 of which 267,860 were 'urban' (73%). Huangzhou District covers an area of 353 km^2 and is comprised of four Street Committees, four townships, and a relatively new Railway Chemical Park in the northern portion of the city. Urban built-up area is currently 63 km^2. The old urban area (OUA) fronts along the Yangtze River and covers 36 km^2; much of the OUA has poor quality housing and is served by an old combined sewer system that often overflows during heavy episodic rains. There are only 32 km^2 of construction land available in the UA.

203. **GDP.** Huanggang PLC has traditionally been a rural economy, and has lagged behind other PLCs in Hubei. Its gross domestic product (GDP) was ranked 4th in the province, but with the primary industries ranked 1st in the province with approximately 20% contributed by revenue from aquaculture. Tourism income contributed to approximately 15% of tertiary industries. Per capita GDP in 2010 was 14,355 RMB, 51% of the provincial average. Both per capita urban disposable income and rural net income were ranked relatively low in the province. Its expenditure was more than two times the financial revenue, with only 3.9% spent on environmental protection.

Table IV.25: Socio-economic conditions of Huanggang PLC in 2010

Item	Statistics	Remarks
Year-end total population	7.4241 million	
No. of permanent residents	6.162 million	Ranked 2nd after Wuhan
No. of rural permanent residents	3,962,166	64.3%
No. of females	2,983,400	48.4%
Gross domestic product (GDP)	86.23 billion CNY	Ranked 4th after Wuhan, Yichang & Shuangyang
Primary industries	24.696 billion CNY	Ranked 1st in the province
Secondary industries	32.816 billion CNY	Ranked 8th in the province
Tertiary industries	28.718 billion CNY	Ranked 4th in the province
GDP increase over 2009	14.1%	Ranked 14th in the province
Per capita GDP	14,355 CNY	Compared to Hubei Province of 27,614 CNY
Per capita urban disposable income	12,832 CNY	Ranked 13th in the province
Per capita rural net income	4,634 CNY	Ranked 14th in the province
Urban employee average annual salary	22,207 CNY	Ranked 13th in the province
Year-end registered unemployment rate	4.01%	
Total financial revenue	9.968 billion CNY	
Financial expenditure	22.308 billion CNY	More than twice the financial revenue
Budgeted revenue	3.898 billion CNY	

Item	Statistics	Remarks
Budgeted expenditure	18.31 billion CNY	More than 4 times the budgeted revenue
Environmental protection expenditure	859 million CNY	3.9% of total expenditure
Area of cultivated land	3.3752 million ha	Ranked 3rd in the province
Urban constructed area	442.3 km^2	
Aquatic product output volume	407,300 t	
Fisheries gross output value	4.901 billion CNY	20% contribution to primary industry
Total mileage of roads	23,400 km	
Number of tourists	8.19 million	
Tourism revenue (realized)	4.4 billion CNY	15% contribution to tertiary industry
No. of days with good or excellent air quality	356	
Net COD reduction	168 t	
Drinking water sources meeting standard	100%	

Source: Huanggang Municipality Statistical Yearbook 2011

204. **Economic structure.** Huanggang PLC's primary sector's share increased from 25.8% (2000) to 28.6% (2010). The decline in industry's share of GDP is largely due to the widespread restructuring and closure of polluting, locally-owned SOEs during the last decade, particularly in Huanggang's counties and county-level cities. Within the secondary sector there have been significant shifts in the structure and performance of the UA's industries from 2000 to 2010. In 2000, there were 25 enterprises with a GVIO over Y 5 million employing 3,875 workers; in 2010, there were 108 companies employing 10,250 workers (**Figure IV.5**). While textile and clothing remains the UA's dominant industry, the number of firms in this sector quadrupled and the number of employees doubled from 2000 to 2010. The traditional, lower value-added industries of textile and clothing, building materials, machinery, and food and beverages continue to dominate the UA economy in terms of output value (63% in 2010, down from 66% in 2000), number of enterprises (66% in 2010, down from 72%) and number of employees (72%, down from 79%). However, two new manufacturing industries have emerged: metal processing, largely of finished steel from Wuhan, employing 18% of the manufacturing workforce; and electronics and telecommunication, employing 7.5% of the manufacturing workforce. While employing only 1,500 workers, these two new industries do show that the UA's industrial economy is capable of shifting away from lower value-added sectors.

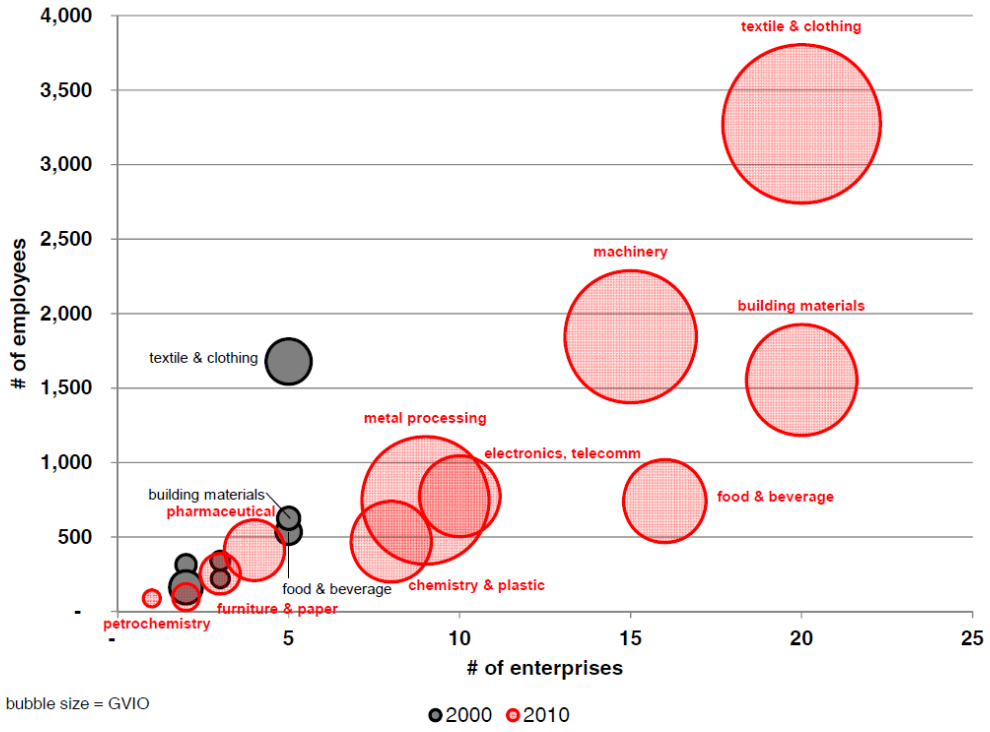


Figure IV.5: Industrial structure, Huanggang PLC Urban Area (Huangzhou District)

Source: Huanggang Statistical Yearbooks, 2001, 2011.

Note: figures refer to enterprises with GVIO over RMB 5 million

205. **Industrial parks.** There are currently five main industrial parks in the Huanggang UA; three are owned and managed by HMG and two by Huangzhou District Government (**Figure IV.6**). Aside from the Railway Chemistry Park which focuses on petrochemicals, there is no apparent industrial specialization in the four other parks (**Table IV.26**). Despite some of these parks having been approved in 1990s and in 2002, occupancy rates are still quite low.

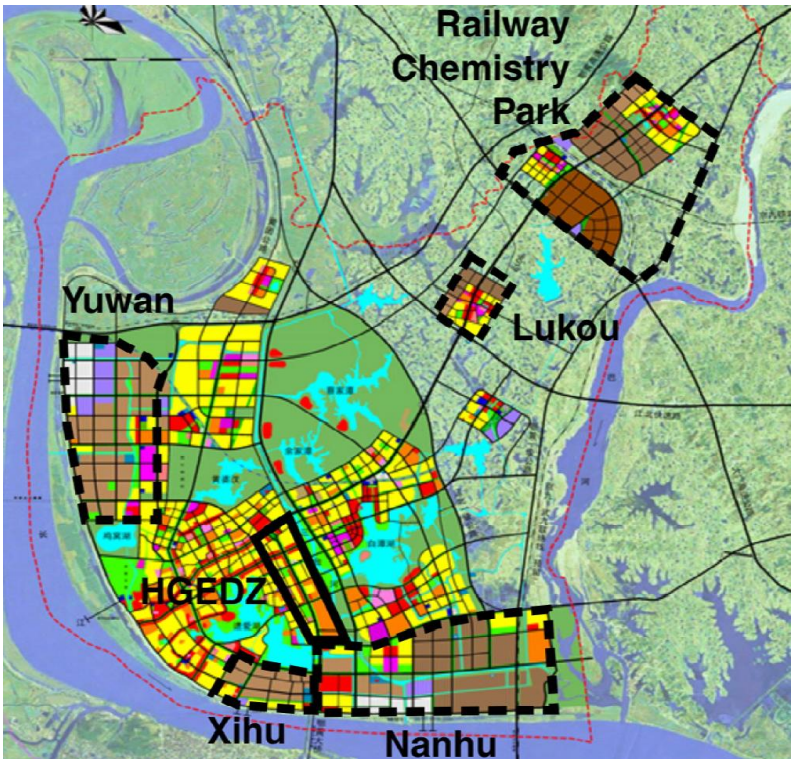


Figure IV.6: Existing industrial parks in Huanggang PLC urban area

Table IV.26: Existing industrial parks in Huanggang PLC urban area

Name		approval date	approved by	jurisdiction	total planned (ha)	Phase 1									
						Phase 1 end year	planned area (ha)	Occupied to date (ha)	% total planned area occupied	% Phase 1 area occupied	current average land price (RMB/ha)	types of industries	firms (2013)	Employees (2013)	average # employees per firm	average land area (ha) per firm
I	Xihu Industrial Park (1990)	1990	Hubei Prov. Govt	Hangguang Economic Development Zone(Committee)/HMG	2000	2010	1224	568	28.4	46.4	900,000	- machinery - electronics - food/bev - pharmaceuticals	23	4558	198	25
II	Nanhu Industrial Park (2010)	2010-Feb-9	Hubei DRC	Hangguang Economic Development Zone(Committee) /HMG	2118	2010	2118	450	21.2	21.2	900,000	- food/bev - machinery - electronics - logistics - warehousing - commercial	14	3000	214	32
III	Railway Chemical Park (1997)	1997	Hubei DRC/ Hubei Pro Govt	Huanggang Railway Station Development Zone Committee/HMG	2032	2010	400	117	5.8	29.3	900,000	- medical chemicals - petrochemicals	34	5300	156	3
IV-A	Yuwang Industrial Park (2002)	2002	Hubei DRC	Huangzhou District Government	1917	2010	800	700	36.5	87.5	900,000	- solar energy - logistics	28	2400	86	25
IV-B	Lukou Industrial Park (2002)	2002	Hubei DRC	Huangzhou District Goverment	1350	2010	424	125	9.3	29.5	900,000	-logistics -textiles -machinery -electronics	12	1600	133	10

Source: Huanggang PMO

206. **Water Resources and Supply**. The total water resources in Huanggang Municipality in 2009 were 8.42 billion m^3, which converts to a runoff depth of 356.2 mm. Water resources per capita averaged 1,156 m^3. Water usage per capita for the whole Municipality averaged 366 m^3, with a daily usage per urban capita averaging 160 L and a daily usage per rural capita averaging 50 L. Irrigation water usage per mu averaged 537 m^3.

207. Water supplied to the whole Municipality in 2009 totaled 2.70 billion m^3, with 2.47 billion m^3 (91.6%) from surface water sources and 229 million m^3 (8.4%) from ground water sources. Of this amount, 1.83 billion m^3 (67.8%) were supplied for irrigation use, 516 million m^3 (19%) for industrial use, 221 million m^3 (8.2%) for domestic use and 135 million m^3 (5%) for forestry-fisheries-livestock use. Water consumed totaled 1.40 billion m^3, with agriculture accounted for 76.7%, industries 10.1% and domestic 13.2%.

208. Huanggang Municipality has 18 water treatment plants (WTP) in operation with 593,500 m^3/d total supply capacity (**Table IV.27**). Huanggang No. 2 WTP and No. 3 WTP supply drinking water to the Huangzhou District, of which Huanggang No. 3 WTP supplies water to the Baitan Lake planning area, with the Huangzhou District section of the Yangtze River as its water source. The planning EIR estimate that the future potable water use in the Baitan Lake planning area will be 59,000~66,000 m^3/d, based on a future population of 180,000~200,000. A new NED WTP with 100,000 m^3/d supply capacity has been planned for supplying potable water to the future population in the Baitan Lake planning area.

Table IV.27: Existing water treatment plants in Huanggang Municipality

Location	Name of WTP	Intake Water Location	Supply Capacity (m^3/d)
Urban Huanggang	No. 2 WTP	Huangzhou District section of the Yangtze River	100,000
	No. 3 WTP	Huangzhou District section of the Yangtze River	100,000
Macheng City	Dongmen WTP	Macheng urban section of the Jushui River	50,000
	No. 2 WTP	Fuqiaohe Reservoir	100,000
Wuyue City	No. 1 WTP	Wuyue City section of the Yangtze River	40,000
	No. 2 WTP	Wuyue City section of the Yangtze River	40,000
	Sanli WTP	Wuyue City section of the Yangtze River	20,000
Tianfeng County	No. 1 WTP	Tianfeng County section of the Yangtze River	10,000
	No. 2 WTP	Tianfeng County section of the Yangtze River	
Hong'an County	WTP	Jinshahe Reservoir	30,000
Luotian County	No. 3 WTP	Yishui River (tributary of the Bashui river system)	40,000
Yingshan County	WTP	Dong River (tributary of Bailian River)	6,000
Xishui County	No. 1 WTP	Xishui County urban section of the Xishui River	5,000
	No. 2 WTP	Xishui County urban section (ground water)	
Qichun County	Yaoyingyan WTP	Yaoyingyan Reservoir	2,500
	No. 1 WTP		
	No. 2 WTP	Qixhui West River station section	20,000
Huangmei County	WTP	Longping Reservoir	15,000
Longgan Lake	WTP	Huangmei County of the Yangtze River	15,000
		Total	593,500

Source: PMO

209. **Wastewater**. During the 11th five-year period (2006-2010), 13 wastewater treatment plants (WWTP) were built, with a combined 492,000 m^3/d treatment capacity and 71.97% treatment rate of urban domestic wastewater. In 2010, the quantity of domestic wastewater from Huanggang Municipality totaled 96.1227 million tons, accounting for 72.18% of the total amount of wastewater in 2010. The quantity of COD discharged was 305.80 million tons, representing 78.54% of the total amount of COD discharged in 2010. The quantity of NH_3-N discharged in 2010 was 2,982.4 t.

210. In 2010, industries in the Huanggang Municipality discharged 37.04 million tons of industrial wastewater. Of the amount discharged, 35.97 million tons complied with discharge standards, representing a compliance rate of 97%. Industrial wastewater treatment capacity in 2010 from 157 sets of treatment equipment was 145,000 m^3/d.

211. The Nanhu WWTP is nearest to the Baitan Lake planning area with 100,000 m^3/d design treatment capacity and an existing 50,000 m^3/d treatment capacity using the anerobic-aerobic-oxic (A^2/O) treatment process. It commenced operation in 2009 and from 2009 to April 2012, the quantity of wastewater treated per day ranged from 33,000 m^3 to 42,000 m^3. Wastewater is treated to meet Class 1B standard under *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant* (GB 18918-2002) and its revision, then is discharged to Santai River. Construction for its Phase 2 to increase the total treatment capacity to 100,000 m^3/d has commenced, including expanding the collection pipeline network to collect wastewater from the surrounding areas of Mingzhu Road, Nanhu Industrial Park, New Eastern District (NED) and the Zhongwan Road sub-district north of Dongmen Road. The long term plan is to further expand its treatment capacity to 200,000 m^3/d.

212. Despite the nearby Nanhu WWTP, domestic wastewater generated by the existing residents in the Baitan Lake planning area, estimated by the planning EIR to be approximately 556 m^3/d, is not collected and treated at the WWTP due to lack of collection pipeline. Domestic wastewater from the existing residents is discharged to nearby water body or land untreated. With the implementation of the Master Plan (2030), domestic wastewater will be collected and treated in the Nanhu WWTP.

213. **Solid waste**. There are two landfills in the Huangzhou District for disposal of municipal solid waste (MSW): the Xinqiao Solid Waste Treatment Center and the Taodian Town Sanitary Landfill. MSW generated in the urban area of Huangzhou District, estimated to be 320 t/d, has been disposed of at the Xinqiao Solid Waste Treatment Center. However, it had reached its capacity and was closed in April 2013. The planning EIR estimated the quantity of MSW being generated by existing residents in the Baitan Lake planning area to be approximately 4 t/d.

214. The Taodian Town Sanitary Landfill is newly constructed and has commenced operation since April 2013. It has a 500 t/d design capacity and a 13-year service life. It is located at Chayuan Village in Taodian Township, Lukou Town, approximately 10 km from the Baitan Lake planning area. The bottom of the landfill is lined with HPPE membrane to prevent the leachate from impacting ground water quality. It has both leachate and landfill gas collection systems. The collected leachate will be treated on site to meet Class I standard under *Standard for Pollution Control on the Landfill Site for Domestic Waste* (GB 16889-1997) before discharging into the Ba River. The small quantity of landfill gas collected will be flared.

215. **Transport infrastructure.** A north-south expressway passes through the northern part of Huanggang UA and connects Huanggang with Wuhan (**Figure IV.7**). Most of the expressways in the long-term road network plan for Huanggang PLC have been completed. Current travel-time to central Wuhan is 90 minutes by the northern expressway. A bridge across the Yangtze connects the UA with Ezhou UA. A second bridge will be completed in the northeast part of Huanggang UA in December 2013, shortening the drive-time to central Wuhan to 50 minutes. The bridge will be the world's largest span railway-highway bridge, a double-deck structure with the upper deck used for automobile traffic and the lower deck for a new two-way high speed railway (HSR) connecting Huanggang to Wuhan. The high-speed railway (HSR) is scheduled to be completed by the end of 2013 and will have three stops in the Huanggang UA (**Figure IV.8**). Travel time from the Lukou Station (in NED) to central Wuhan is expected to be under 30 minutes.

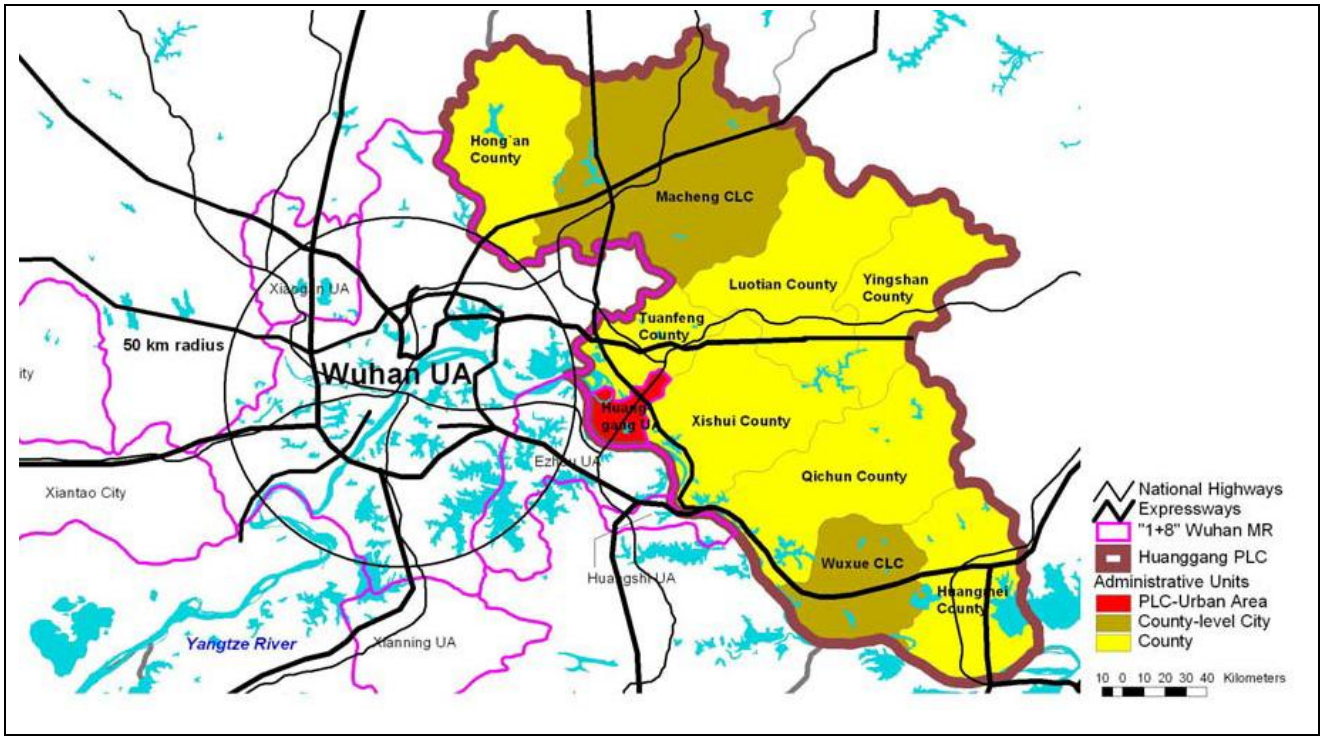


Figure IV.7: Huanggang PLC administrative units and major highways[22]

[22] Leman, Rufei, Yanxia. 2013. Huanggang Development Strategy Review: Final Report. Manila.

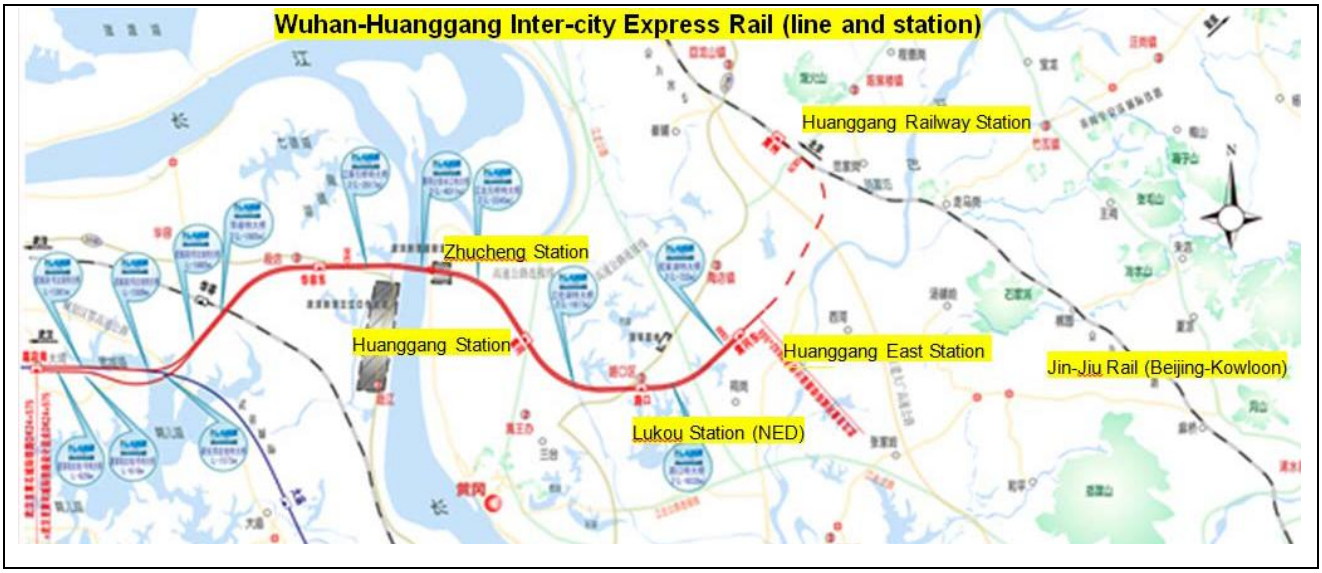


Figure IV.8: High-speed railway network in Huanggang PLC[23]

216. **Physical cultural resources**. The project EIR has reviewed the status of cultural heritage within the project area of influence and concluded that no physical cultural resource existed within the project area of influence. This was also confirmed by the Huanggang Cultural Bureau during public consultation. Should buried artifacts of archaeological significance be uncovered during the construction stage within the project areas, construction will be stopped and immediately reported to the Huanggang Cultural Bureau in accordance with the PRC's *Cultural Relics Protection Law* (2002).

E. Climate Change Projections

217. Climate change is defined as any change in global temperatures and precipitation over time due to natural variability or to human activity. Global warming is the increase in Earth's average surface temperature due to rising levels of greenhouse gases (GHGs) (e.g. carbon dioxide, methane) and is a sub-set of global climate change. Natural factors causing climate change include oceanic processes, solar radiation received by Earth, plate tectonics, and volcanic eruptions. Examples of human activity affecting the climate are burning fossil fuels, which emits GHGs into the atmosphere, and construction of impervious surfaces using materials such as asphalt and concrete which tend to increase the ambient temperature (heat island effect) as well as increase the volume of storm water runoff. Climate change analysis suggests that the severity of existing weather patterns will intensify, with wet areas getting wetter, and dry and arid areas becoming more so. Much climate change research addresses flood risk. Climate change may invalidate traditional assumptions that historical flood records may predict future conditions.

[23] Ibid.

218. Based on analyses by the Wuhan Regional Weather Center[24], Hubei would experience temperature and precipitation increases in the 21st century. Annual mean temperature would increase by 0.8 °C in early 21st century, 2.4 °C in mid-21st century and 3.1 °C in late 21st century. Precipitation would show decreasing trend in early 21st century, changing to increasing trend in mid-21st century, and reaching a 6% increase by the end of the 21st century. Recent research by UK Hadley Centre[25] as part of the Adaptation to Climate Change in China (http://www.ccadaptation.org.cn/) showed that the temperature and precipitation in Hubei province could increase by 2% and 6% by the end of 2050. It is likely that the province would experience more frequent and more intense extreme weather events, such as torrential rain, heat waves and extreme cold with heavy snow storms, which will impact on infrastructure and various adaptation measures need to be considered. An example is the nearby city of Wuhan, which experienced one of the worst snow storms in January 2008, resulting in the collapse of power towers and power lines due to heavy snow deposits on these structures. The 2008 incident has prompted the Wuhan Municipal Government to consider revising the design codes for these structures to withstand heavy snow deposits. The Hubei Provincial Government established a Leading Group on Climate Change in 2007 and issued an action plan to combat climate change in the province in 2009. However, the focus of the actions was on mitigation (mainly energy conservation and emission reduction) rather than adaptation. For this project, the PPTA consultant has examined climate change implications on the water level of Baitan Lake.

[24] ADB. 2011. Guide to increasing the climate change resilence of urban water infrastructure. TA 4971-PRC: KPS.

[25] The UK Hadley Centre participated in the UK DFID funded project Adaptation in Climate Change in China (http://www.ccadaptation.org.cn/)

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Positive Impacts and Environmental Benefits

219. This project will improve the environmental quality in the Baitan Lake planning area and the living conditions of present and future residents in the New Eastern District (NED). NED development is a key thrust in the *Huanggang Urban Master Plan (2011-2030)* to provide infrastructure and public services that cannot now be provided in the old urban center due to space constraint, and is part of an overall plan to improve the effectiveness of Huangzhou District as the key urban center to drive socio-economic developments in Huanggang Municipality. This project therefore brings environmental, social and economic benefits to Huanggang Municipality and its residents.

220. **Beneficiaries**. The existing population of 12,000 and the projected population of approximately 100,000 by 2020 in the Baitan Lake planning area will directly benefit from this project. By 2020, the projected population of approximately 500,000 in Huanzhou District will indirectly benefit from this project.

221. **Pollutant Reduction and improved water quality by dredging and wetland creation**. Baseline sediment quality monitoring results showed that the unconsolidated sediments in Baitan Lake, Chiye Lake and Jinshui River are laden with high levels of total nitrogen and total phosphorus. Through dredging, this project will remove approximately 740,000 m^3 of nutrient laden sediment from these water bodies, together with approximately 486 t total phosphorus and 1,920 t total nitrogen (**Table V.1**). This will increase the normal lake storage by 9%, leading to reduction in pollution loadings releasing from sediment deposits by 20% (estimated to be TN 21.6 t/year and TP 2.6 t/year, approximately).

Table V.1: Removal of sediment nutrients through dredging

Sediment Source	Dredged Quantity (m3)	Removal Quantity (t)	
		Total Phosphorus	Total Nitrogen
Baitan Lake	404,405	266	1,097
Chiye Lake	135,000	70	276
River channels	201,002	150	547
Total	740,407	486	1,920

Source: PPTA consultant

222. The 4 subsurface flow wetlands with a total area of 38,000 m^2, in conjunction with 4 detention ponds with a total area of 15,250 m^2 in Baitan and Chiye lakes, will treat an annual average volume of 7,390m^3 of stormwater runoff (which equals to about 38% of the first flush flow volume). This is expected to lead to the annual reduction of 36.2t COD, 8.1 t TN and 0.5 t TP to the lakes, and subsequently the Santai River and the Yangtze River. When operated during the non-raining days, these wetlands will further attract pollutants from polluted in-lake water (estimated to be COD, 31.9 t/year, TN 3.6 t/year and TP 0.08 t/year, approximately), improving the lake water quality continuously (**Table V.2**).

223. The construction of 80.20ha of surface flow wetlands at the surrounding area of Chiye lake, supported by transferring 1.1 m^3/s of water from Ba River through Xingfu gate/Hongqi Pumping station, will reduce the pollution loads from the upstream catchment. The estimated annual pollutant reductions are COD 102.83 t, TN 37.19 t and TP 0.52 t.

224. The cumulative impact of the engineering measures will improve the water quality of the two lakes from worse than Class V to Class IV for organic pollutants by 2020; nutrient levels will also be significantly reduced. Overall, the Project will provide healthy conditions and a pleasant environment for the residents in the Baitan Lake Basin.

Table V.2: Removal of water quality pollutants each year by wetlands

Wetland Location	Wetland Size (ha)	Pollutant Removal (t/y)		
		Chemical Oxygen Demand	Total Phosphorus	Total Nitrogen
Sub-surface flow wetlands	3.80	68.1	0.58	11.7
Free-surface flow wetlands	80.20	102.8	0.52	37.2
Total	84.00	170.9	1.10	48.9

Source: PPTA Consultant report

225. **Improved protection against floods and water logging**. River rehabilitation will improve flood control against 1-in-20 year storm events, thus alleviating water-logging risk in the Baitan Lake planning area and protecting its residents against economic loss. The hydraulic model established for the project was used to assess flood and water-logging in the project area. The model was run based on the daily rainfall data in July 1998. The simulation results show that the maximum water level with project interventions will be 17.98 m, which is some 37 cm below the recorded water level for the same period in 1998. As compared with the existing system ("without project option"), the potential benefit in flood protection is the reduction of some 37 cm in the lake water level.

226. **Improved water flow by connecting the river-lake network**. By connecting the river-lake network and providing supplementary water at 1.1 m^3/s, the water flow within the system will be improved and the water level in Baitan Lake will be controlled at a level that is conducive to maintaining its scenic function and value.

227. **Improved ecological, scenic and aesthetic values of the Baitan Lake planning area**. The creation of a surface flow wetland in Chiye Lake, the construction of a ring road for NMT around Baitan Lake, and landscaping of the surrounding areas and river banks will provide open space for the enjoyment of the residents in the area, thus enhancing the scenic and aesthetic value of the Baitan Lake planning area. The surface flow wetland in Chiye Lake will also provide approximately 80 ha of wetland habitat for wildlife, thus enhancing the ecological value of the area.

228. The provision of the pier, solid waste collection and transfer vessels and vehicles, and a solid waste transfer station will improve the collection, transfer and disposal of solid waste floating in the lakes and rivers as well as vegetation from wetland maintenance will also reduce lake pollution and improve the scenic and aesthetic value of the Baitan Lake planning area.

B. Screening of Environmental Impacts Related to Project Implementation and Operation

229. The potential environmental impacts of the project were screened at PPTA inception stage to (i) identify the relative significance of potential impacts from the activities of the proposed project components; (ii) establish the scope of the assessment which assists in focusing on major, critical, and specific impacts; and (iii) enable flexibility in regard to consideration of new issues, such as those that reflect the requirements by ADB's SPS (2009).

230. **Potential impacts during construction**. The screening process showed that during the construction phase, potential impacts mainly relate to earthwork, sediment dredging, and construction of embankments, bridges, ring road and the pier. The project may have soil erosion, air quality, noise, water quality, ecology, solid waste and occupational health and safety impacts. Potential air quality impact could occur due to fugitive dust generated on the construction site from stockpiles of uncovered earth materials and vehicles travelling on unpaved haul roads, as well as fumes from asphalt cement during road paving. The use of powered mechanical equipment during construction activities will generate noise. Construction activities will generate process wastewater and construction workers will produce wastewater. Dredging will stir up and re-suspend the sediment, affecting water quality as well as aquatic biota. Earthwork and construction activities will remove vegetation and ecological habitats, causing disruption and disturbance to nearby biota. Construction works will produce construction and demolition (C&D) wastes including excavated earth materials and dredged sediment. Workers will face occupational health and safety issues working on construction sites.

231. **Potential impacts during operation**. The project will mainly generate positive environmental impacts during operation (see benefits described above). River-lake connection will change the flow regime of the water system and therefore will have water quality implications, which could be positive or negative. Other potential impacts during operation include the generation of vegetation waste from maintenance of the wetlands and landscaped areas, the operation of the waste transfer station (with potential community health and safety implications), and induced and cumulative impacts described below.

232. **Potential induced and cumulative impacts**. The river-lake connection scheme will obtain water from Xingfu Reservoir and outflow into the Santai River and Ba River. This will have minor induced impacts to the water quantity in Xingfu Reservoir and the water quality in Santai River and Ba River.

233. This project requires the resettlement of fishermen and the re-provision of fish ponds in an area near to and downstream of the Xingfu Reservoir. Such action will have impacts on local livelihoods[26] as well as minor induced environmental impacts to the area of fish pond re-provision.

234. Besides direct resettlement impacts from this project, other existing households within the NED would have to be resettled to make way for other projects induced by developments in the Baitan

[26] Impacts on local livelihoods, and the government's income restoration program are discussed in the Resettlement Due Diligence Report on Acquisition of State-owned Land of Baitan Lake Fish Farm in Huanggang (available from list of RRP linked documents)

Lake planning area (NED Phase 1). These associated resettlement impacts are discussed in Section V.G, para. 328.

235. The development of the Baitan Lake planning area will eventually house approximately 200,000 population, who will generate wastewater and solid waste that will have an induced impact on the environment. Besides this project, the Baitan Lake planning area is under rapid infrastructure development including the construction of roads, bridges, water supply and wastewater collection pipelines, power and communication cables, and residential and commercial buildings. These construction works are ongoing and likely to overlap with the construction activities in this project, generating cumulative impact to nearby residents and the environment.

C. Measures during Detailed Design and Pre-construction Stages

236. **Measures during detailed design**. The following environmental measures will permanently become part of the infrastructure and will be listed in the EMP as design approach for detailed design of facilities by the local design institute:

- Technical design of the NMT ring road and bridges must ensure public health and safety and ensure barrier-free design for disabled people; fences shall be installed at 15 sections of the road running close to the lakeshore (3,430m); control facilities shall be installed to block vehicles from using roads without permission;
- Technical design of the NMT ring road shall be based on the flood water level, and shall allow groundwater and surface water to flow (requiring installation of 27 culverts);
- Technical design of the flood control function of the river channels must take into consideration extreme storm events due to climate change;
- Technical design of embankments must be adequate and stable enough to withstand the strong force of heavy storm water flow but at the same time maximize the adoption of eco-friendly embankment designs;
- Technical design of the solid waste transfer station must be adequate to treat odor, equipment noise and wastewater to levels that comply with GB 14554-93 (Emission Standards for Odor Pollutants), GB 12348-2008 (Emission Standard for Industrial Enterprises Noise at Boundary), and GB 8978-1996 (Integrated Wastewater Discharge Standard).
- Technical design of the sub-surface flow and surface flow wetlands must use local species with local provenance and under no circumstance shall exotic or invading species be used.
- Technical design of the sub-surface flow and surface flow wetlands must comply with Technical Specification of Constructed Wetlands for Wastewater Treatment Engineering (HJ 2005-2010).

237. **Measures during pre-construction**. A number of environmental management measures will be implemented in the pre-construction phase to ensure project's environment management readiness.

These include:

- Institutional strengthening, including (a) appointment of one qualified environment specialist within the HPMO; (b) appointment of one environment specialist within HUCIC; (c) hiring of a loan implementation environment consultant (LIEC) within loan administration consultant services by the HPMO; (d) contracting by HPMO of a licensed environment monitoring entity to conduct external environment monitoring and verify environment performance; and (e) contracting of ornithologist(s) by HUCIC to conduct regular bird surveys.
- Updating EMP: Mitigation measures defined in this EMP will be updated based on final technical design. This will be the responsibility of the HPMO, using the local design institute and/or the LIEC;
- Land-take confirmation: The Resettlement Plan will be updated with final inventory. This will be the responsibility of the IA, using the local design institute;
- Environmental protection training: The loan administration consultant services (mainly but not exclusively through the LIEC) will provide training on implementation and supervision of environmental mitigation measures to contractors, the HPMO and HUCIC;
- Contract documents: Issues can potentially arise if the bidding documents are prepared without access to or use of this project EIA and particularly the EMP. As such, no bid documents will be prepared without the authors having incorporated a Chinese copy of the EMP, which shall be included in the safeguard clauses of the Technical Specifications in the contracts. This will be the responsibility of the HPMO with the support of the tender agent.

D. Impacts and Mitigation Measures during the Construction Stage

1. Physical Impacts and Mitigation – Air Quality

238. Air pollution is known to cause a variety of health risks to both the workers and the public in general. Emissions from crushers and quarry sites can cause health impacts ranging from coughing, influenza, respiratory ailments, to irritation in eyes and reduction in visibility. Children are at particular risk for such negative impacts which, however, are most of the time temporary and localized. Main air pollutants during the construction stage in this project include (i) fugitive emission of dust during earth works, (ii) fumes from asphalt mixing during road paving and exhaust from movements of construction vehicles and machinery, and (iii) odor during dredging, transport and disposal of lake and river sediment.

239. **Dust and gaseous air pollution**. The project EIR predicted that the impact distance of fugitive dust, also called total suspended particulates (TSP) from construction works would be within 150 m downwind of the source. TSP levels would comply with GB 3095-1996 Class II standard at 150 m and beyond downwind of the source. **Table IV.3** shows that of the 12 existing sensitive receptors within the Baitan Lake planning area, 7 were located within 150 m of project sites, particularly ring road

construction (including No. 1, 4, 5, 6, 10, 11 and 12). These receptors would be impacted by fugitive dust during ring road construction.

240. Asphalt paving will produce fumes containing small quantities of toxic and hazardous chemicals such as volatile organic compounds (VOC) and poly-aromatic hydrocarbons (PAH). The project EIR predicted that fumes and exhaust generated during asphalt cement paving and by construction vehicles and machinery would impact an area within 18 m downwind of the source. Four sensitive receptors, Tujiadawan, Lijiawan, Nanhu Farm and Jianchuanwan were located next to the ring road alignment (see **Table IV.3**) and would therefore be affected by fumes and exhaust during ring road construction.

241. **Odor (dredging)**. Odors emitted during sediment dredging, transportation and treatment could impact the surrounding environment. Odor intensity is classified based on odor threshold values. Odor intensity is classified into six levels in the PRC. The limitation criteria are generally equivalent to class 2.5-3.5 of odor intensity.

242. Lake sediment will be dredged by a cutter suction dredger, where the unconsolidated sediment will be loosened by the cutter head and sucked up immediately by the dredger followed by transport via a floating pipeline to the treatment site. The dredged sediment therefore has a short exposure time to the ambient water environment rather than in the air. Two locations (see **Figure IV.1**) near the shoreline of Baitan Lake have been identified for siting two treatment centers. The first site take up an area of 27,800 m^2 (190mX120m) while the second 5,000 m^2. No resident is expected in the radius of 2 km during 2015-16 when the dredging is scheduled to take place. Dredging will be scheduled in the winter from November to April. With a design processing rate of 4000 m^3/day, it is expected that the sediment dredging and treatment for Baitan lake will last 4 months while that for Chiye lake take 2 months. The dewatered product after treatment is odorless based on inspections in other projects in Huanggang PLC with similar treatment technology. Dredging and treatment of lake sediment should not cause any odor impact to the existing sensitive receptors in the Baitan Lake planning area.

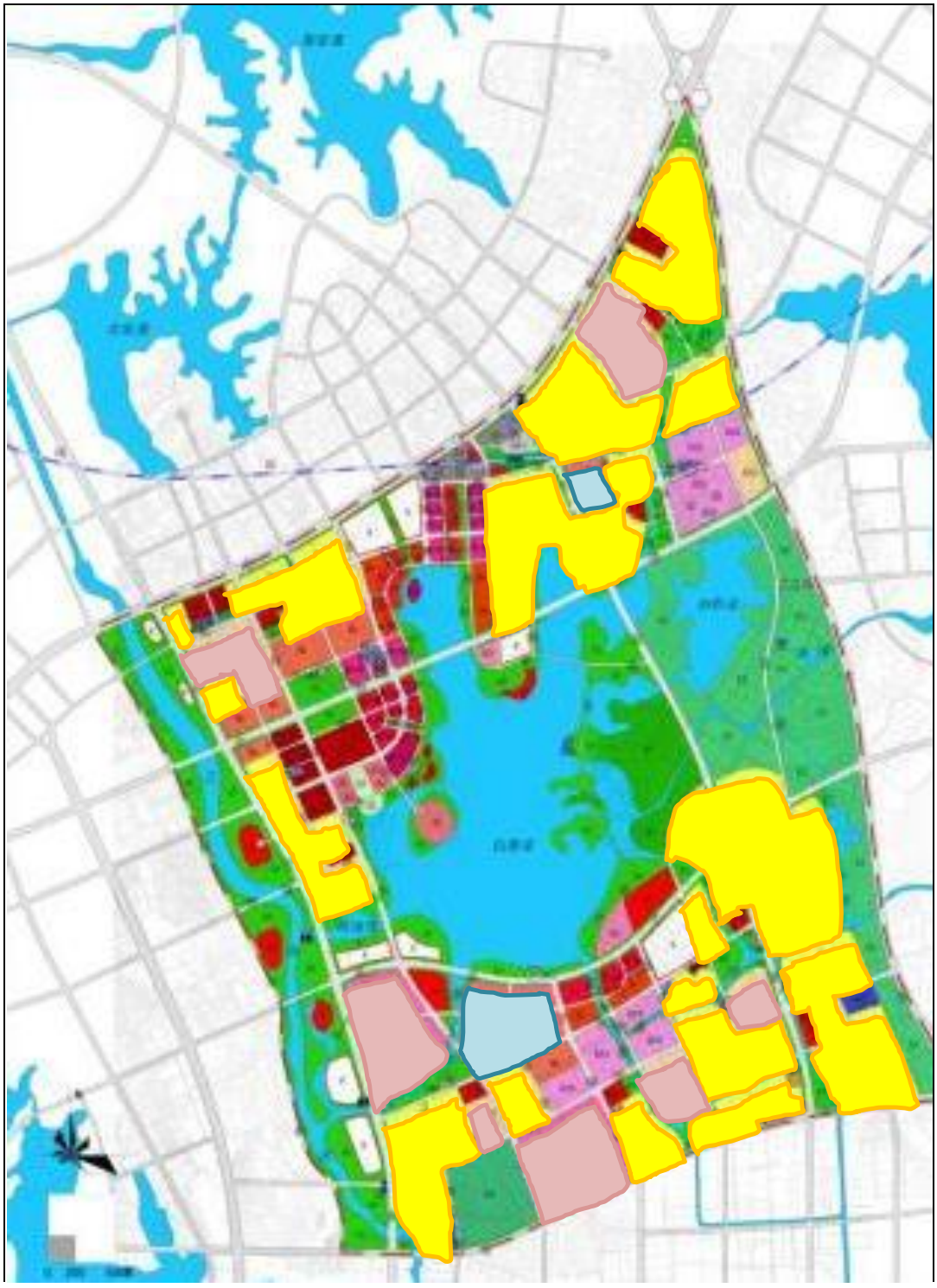
243. River dredging will be done in the dry, where the excavation of river sediment could potentially produce odor. Only four of the seven rivers will be dredged: Linglong Bay, Jinshui River, Dongtai River and Chushui River (see **Table III.9**). None of the 12 existing sensitive receptors listed in **Table IV.3** were located within 200 m of these rivers (see **Figure IV.1**). Odor impact on existing sensitive receptors from river dredging is not expected.

244. **Mitigation of dust and gaseous air pollutant impacts**. The Contractor shall include all necessary measures to reduce air pollution and dust development that would impact public health, by implementing the following air quality control measures. Some of these measures are generic measures that are applicable to all construction sites and construction activities. Yet these are effective measures and are also described in WBG's EHS guidelines. **Figure V.1** shows the locations of future potential sensitive receptors of residential, hospital and school areas based on the Baitan Lake Area Control Plan.

- Provide dust masks to operating personnel;

- Spray water regularly on hauling and access roads to borrow pits (at least once a day) to suppress dust; and erect hoarding around dusty activities;
- Minimize the storage time of construction and demolition wastes on site by regularly removing them off site;
- Equip asphalt, hot mix and batching plants with fabric filters and/or wet scrubbers to reduce the level of dust emissions. Additionally, site asphalt mixing stations at least 300 meters downwind of the nearest residential household;
- Mount protective canvasses on all trucks which transport material that could generate dust;
- Build access and hauling roads at sufficient distances from residential areas, particular, from local schools and hospitals;
- Assign haulage routes and schedules to avoid transport occurring in the central areas, traffic intensive areas or residential areas. For the areas with high-demand on environmental quality, transport should be arranged at night.
- Keep construction vehicles and machinery in good working order, regularly service and turn off engines when not in use;
- Vehicles with an open load-carrying case, which transport potentially dust-producing materials, shall have proper fitting sides and tail boards. Dust-prone materials shall not be loaded to a level higher than the side and tail boards, and shall always be covered with a strong tarpaulin;
- Install wheel washing equipment or conduct wheel washing manually at each exit of the works area to prevent trucks from carrying muddy or dusty substance onto public roads;
- In periods of high wind, dust-generating operations shall not be permitted within 200 m of residential areas. Special precautions need to be applied in the vicinity of sensitive areas such as schools, kindergartens and hospitals;
- Equip material stockpiles and concrete mixing equipment with dust shrouds. For the earthwork management for backfill, measures will include surface press and periodical spraying and covering. The extra earth or dreg should be cleared from the project site in time to avoid long term stockpiling. The height of stockpiles should be less than 0.7m;
- To avoid odor impacts caused by channel cleaning, transport the removed trash quickly to the local landfill. Transport of dredged sediments will be undertaken in closed tank wagons to prevent scattering along the way and impacting the urban area;
- Unauthorized burning of construction and demolition waste material and refuse shall be subject to penalties for the Contractor, and withholding of payment.

245. These measures are defined in the EMP. Contractors will be required to ensure compliance with relevant PRC emission standards. Air quality monitoring will be carried out by contractors (internal) and a licensed environmental monitoring entity (external) during the construction period.



Residential School Hospital

Figure V.1: Potential future sensitive receptors in the Baitan Lake Area Control Plan

2. Physical Impacts and Mitigation - Noise

246. Noise is emitted by powered mechanical equipment (PME) used during construction. Applicable noise standards at construction site boundary are 70 dB(A) for day time and 55 dB(A) for night time according to GB 12523-2011. The WBG does not have standards for construction noise per se, but applies the same noise standards listed in **Table II.4** to the receptors during construction activities (55 dB(A) for day time and 45 dB(A) for night time). Based on the types of PME used and their sound power levels, the project EIR predicted that the impact distance would be within 50 m during day time and up to 280 m in night time. All 12 existing sensitive receptors were within 280 m (see **Table IV.3**) of the project sites particularly the ring road, and 6 were at or within 50 m from the project sites. Night time construction therefore will not be carried out within 300 m of any existing or future sensitive receptor, and mitigation is needed to reduce day time construction noise impact.

247. **Mitigation of construction noise impact**. Contractors will be required to implement the following mitigation measures for construction activities to meet PRC construction site and WBG recommended noise limits and to protect sensitive receptors. Some measures are generic and are applicable to all construction sites and activities. Yet they are effective measures and are also in line with WBG's EHS guidelines.

- During daytime construction, the contractor will ensure that: (i) noise levels from equipment and machinery conform to the PRC standard for Noise Limits for Construction Sites (GB12523-2011) and the WBG EHS Standards, and properly maintain machinery to minimize noise; (ii) equipment with high noise and high vibration are not used near village or township areas and only low noise machinery or the equipment with sound insulation is employed; (iii) sites for concrete-mixing plants and similar activities will be located at least 300 m away from the nearest sensitive receptor; and (iii) temporary anti-noise barriers or hoardings will be installed around the equipment to shield residences when there are residences within 50 m of the noise source;
- No night time (between 2200 and 0600 hours) construction within 300 m of existing and future sensitive receptors;
- Regularly monitor noise at sensitive areas (refer to the monitoring plan). If noise standards are exceeded by more than 3 dB, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation;
- Provide the construction workers with suitable hearing protection (ear muffs) according to the worker health protection law of the PRC;
- Control the speed of bulldozer, excavator, crusher and other transport vehicles travelling on site, adopt noise reduction measures on equipment, step up equipment repair and maintenance to

keep them in good working condition;

- Limit the speed of vehicles travelling on site (less than 8 km/hr), forbid the use of horns unless absolutely necessary, minimize the use of whistles;
- Maintain continual communication with the villages and communities in the Baitan Lake planning area.

3. Physical Impacts and Mitigation – Surface Water Quality

248. **Pollution of surface water**. Uncontrolled wastewater and muddy runoff from construction sites and work camps could potentially pollute nearby water bodies such as Baitan Lake and Chiye Lake and clog up drains. The construction of the ring road, the bridges and the sluice gates may disrupt water flow and spillage of pollution. Construction of the bridge foundation could disturb river sediment and increase suspended solid (SS) concentration in the rivers. Dredging in Baitan Lake will also disturb the bottom sediment and increase suspended solid (SS) concentration in the water column. The discharge of dewatering effluent from the dredged sediment treatment sites could potentially affect the water quality of the receiving water bodies (Baitan Lake, Chiye Lake and the four rivers).

249. The project EIR predicted that during dredging, elevated suspended solids levels together with released nitrogen and phosphorus from the sediment will mostly be confined to within 30 m down current of the dredger, and that SS and other pollutants would reach ambient levels within a distance of 50 m down current of the dredger.

250. The project EIR estimated that dewatered effluent would be discharged at rates of approximately 0.029 m^3/s at the lake dredged sediment treatment sites and 0.003 m^3/s at the river dredged sediment treatment sites. Based on monitoring data from the Wuhan East Lake project using similar dredged sediment treatment and dewatering technology, the project EIR estimated that the suspended solids (SS) concentration in the dewatering effluent would be less than 20 mg/L, which would comply with Class I standard of GB 8978-1996 and could be discharged to nearby water bodies. By removing the suspended solids, chemical species such as nitrogen and phosphorus “adsorbed” on the solids particles would also be removed. The effluent should only contain, if any, minute amounts of nitrogen and phosphorus.

251. **Mitigation measures to prevent water pollution**. The contractors will implement the following measures to prevent water pollution:

- Portable toilets and small package wastewater treatment plants will be provided on construction sites for the workers and canteens; If there are nearby public sewers, interim storage tanks and pipelines will be installed to convey wastewater to those sewers;
- Sedimentation tanks will be installed on construction sites to treat process water (e.g. concrete batching for bridge construction) and muddy runoff with high concentrations of suspended solids. If necessary, flocculants such as polyacryl amide (PAM) will be used to facilitate

sedimentation;

- Construction of sluice gates and ring road bridge foundations will avoid the rainy season from May to October to minimize potential water quality impact. Mitigation measures such as placement of sandbags or berms around foundation works areas to contain muddy water runoff will be adopted. Slurry from pile drilling in the river bed will be pumped to shore and properly disposed of. This will reduce the disturbance of sediments and the impact on water quality. Pier construction in Baitan Lake will be planned and laid out to ensure adequate opening for water flow;
- Construction machinery will be repaired and washed at special repairing shops. No onsite machine repair and washing shall be allowed;
- Storage facilities for fuels, oil, and other hazardous materials will be within secured areas on impermeable surfaces, and provided with bunds and cleanup kits;
- The contractors' fuel suppliers must be properly licensed, follow proper protocol for transferring fuel, and must be in compliance with Transportation, Loading and Unloading of Dangerous or Harmful Goods (JT 3145-88);
- Material stockpiles will be protected against wind and runoff waters which might transport them to surface waters;
- Any spills are to be cleaned up according to PRC norms and codes within 24 hours of the occurrence, with contaminated soils and water treated according to PRC norms and codes. Records must be handed over without delay to the HPMO and HEPB;
- Mitigation of water quality impact during dredging will be based on water quality monitoring results. The water quality monitoring approach for dredging works will include, at each dredging location, one control station up current of the dredger and one impact station down current of the dredger. When the monitoring result shows that the suspended solids (SS) level at the down current impact station is 130% higher than that at the up current control station, it is indicative of bottom sediment being stirred up by the dredger, re-suspended in the water column, and transported down current. The contractor shall reduce the dredging rate and/or adopt alternative dredging method until the down current SS level is less than 130% above the upstream SS level.
- Similar monitoring approach will be adopted for mitigating water quality impact during ring road bridge and sluice gate construction, where up current and down current monitoring stations will be set up and SS levels monitored. When the SS levels at the down current impact station is 130% higher than the SS levels at the up current control station, the contractor shall adopt alternative construction methods or additional mitigation measures until the down current SS level is less than 130% above the upstream SS level.

4. Physical Impacts and Mitigation – Solid Waste, Earth Work, Soil Erosion

252. **Solid waste and waste management**. Solid waste generated during construction will include construction and demolition (C&D) waste dominated by excavated spoil during earth works for the ring road, river channel deepening and widening, and embankment construction (see below), dredged sediment from Baitan Lake, Chiye Lake and four rivers (see below), and refuse generated by construction workers on construction sites. If not properly disposed, such wastes will create community health and sanitation problems.

253. To minimize adverse impacts from the refuse generated by the workers, refuse will be stored in closed containers and regularly transported off-site for disposal at landfills (see also Occupational Health and Safety Section). Since the C&D waste is common solid waste without toxic or harmful content, it can be used for filling and foundations of other construction works specified by the municipal and planning departments. Unused waste will be delivered to the local construction waste landfill site. Generally, C&D waste including disposal is not anticipated to have adverse impacts on the environment.

254. **Earthwork. Table V.3** shows the earth cut and fill balance in this project. Approximately 740,407 m^3 of sediment will be dredged from the two lakes and four rivers. The 135,000 m^3 of dredged sediment from Chiye Lake will be temporarily stored in nearby drained fish ponds then re-used as fill materials for wetland construction in Chiye Lake. The remaining 605,407 m^3 of dredged sediment will be treated at the treatment sites shown in **Figures III.5** and **III.10**. The dewatered mud cakes would total approximately 284,543 m^3, indicating a volume reduction of approximately 53%. Based on baseline sediment quality monitoring data, it is unlikely that the mud cakes would contain heavy metal contaminants. This will be confirmed using leaching test and if no heavy metal contaminant is found and the mud cakes comply with CJ/T 291-2008 (*The Disposal of Sludge from Municipal Wastewater Treatment Plant – Sludge Quality for Land Improvement*) and/or CJ/T 309-2009 (*The Disposal of Sludge from Municipal Wastewater Treatment Plant –Control Standards for Agricultural Use*), they would be used for landscaping and/or site formation in NED development.

255. The project would generate approximately 1.23 million m^3 earth cut materials. All except 33,729 m^3 from lake embankment works would be re-used as fill materials, requiring a permanent disposal of 33,729 m^3. In addition to the re-used fill, the project would also require approximately 1.68 million m^3 of imported fill mostly for forming the lake ring road landscape strips. The fill will be obtained from the borrow area shown in **Figure III.8.**

Table V.3: Earth material balance (m^3)

Project Area		Earth Cut	Earth Fill		Dredged Sediment	Disposal	
			Re-used	Imported		Mud Cake	Earth Spoil
Rivers	Linglong	62,210	62,210	---	51,035	23,987	---
	Jinshui	2,240	2,240	79,360	87,190	40,980	---
	Dongtai	23,113	23,113	78,887	9,295	4,369	---
	Qingshui	48,662	48,662	63,423	---	---	---

Project Area		Earth Cut	Earth Fill		Dredged Sediment	Disposal	
			Re-used	Imported		Mud Cake	Earth Spoil
	Canglang	31,089	31,089	45,303	---	---	---
	Dongchang	158,433	158,433	---	---	---	---
	Chushui	17,714	17,714	83,840	53,482	25,137	---
Baitan Lake	Dredging	---	---	---	404,405	190,070	---
	SSF wetlands	33,030	33,030	---	---	---	---
	Detention ponds	13,460	13,460	---	---	---	---
Chiye Lake	Dredging	---	135,000	---	135,000	---	---
	SSF wetlands	5,197	5,197	---	---	---	---
	Detention ponds	1,790	1,790	---	---	---	---
	SF wetland	802,000	802,000	---	---	---	---
Lake embankments		33,729	---	208,785	---	---	33,729
Lake ring road landscape strips		---	---	1,116,100	---	---	---
Total		**1,232,667**	**1,333,938**	**1,675,698**	**740,407**	**284543**	**33,729**

Source: FSR

256. **Borrow pit** and spoil disposal sites have been identified in the SEPP. (see **Figure III.8**) Excavated earthworks will be collected and disposed by Huanggang Administration Office of Construction Waste. The following **mitigation measures** will be implemented to manage generated earthwork:

- Borrow pit and spoil disposal site management and restoration plans will be developed, to be approved by responsible authority; a protocol will be established between the contractors and Huanggang Municipal Administrative Bureau to clarify the spoil quantity and a permit for the clearance of excavated earthwork shall be obtained;
- Pit restoration will follow the completion of works in full compliance with all applicable standards and specifications, and will be required before final acceptance and payment under the terms of contracts.

257. **Soil erosion**. Runoff from construction sites is one of the largest sources of sediment in urban areas under development. Soil erosion removes over 90% of sediment by tonnage in urbanizing areas where most construction activities occur. If uncontrolled, eroded sediment from construction sites creates many problems, including adverse impacts on water quality, navigation and recreational activities. **Table V.4** shows that the estimated soil erosion from this project would total 77,551 t, mostly during wetland creation and river-lake connection works.

Table V.4: Soil erosion during the construction stage

Project Area		Assessment Area (ha) and Duration		Soil Erosion Rate (t/km^2.a)			Background Soil Erosion Quantity (t)		Predicted Total Soil Erosion Quantity (t)		Soil Erosion Quantity from this Project (t)	
		Construction Period (5 yr)	Restoration Period (1 yr)	Background	Construction Period	Restoration Period	Construction Period	Restoration Period	Construction Period	Restoration Period	Construction Period	Restoration Period
Urban lakes & rivers	Dredging works	6.56	6.56	472	8462	787	155	31	2776	52	2621	21
	Wetland	81.01	81.01	214	10497	643	869	174	42518	521	41649	347
	Lake NMT ring road	22.81	1.53	196	8803	1281	223	3	10040	20	9817	17
	Ring road bridges	0.73	0	0	7531	0	0	0	275	0	275	0
	River-lake network connection	61.23	61.23	149	6572	627	456	91	20120	384	19664	293
Solid waste collection & transfer	Transfer station	0.60	0	633	4360	0	19	0	131	0	112	0
	Pier	0.06	0	100	8561	0	0	0	26	0	25	0
Construction staging areas		1.10	1.10	573	4530	818	32	6	249	9	218	3
Haul roads		0.92	0.92	713	8782	1032	33	7	404	9	371	3
Borrow pit		4.90	4.90	453	9011	845	111	22	2208	41	2097	19
						Total:	**1897**	**334**	**78746**	**1036**	**76849**	**702**
							2231		**79782**		**77551**	

Source: SEPP

258. Soil erosion protection measures including engineering, planting and temporary measures depicted in the SEPP are presented in **Table V.5**. These measures have been incorporated into the EMP and will be included as contractual obligations for contractors. The most effective erosion control will be interception drainage to protect disturbed surfaces from surface flows, and sedimentation ponds to remove silt and sand from construction site runoff.

Table V.5: Soil erosion protection measures

Protection Zoning		Protection Measures		
		Engineering	**Planting**	**Temporary**
Urban lakes and rivers rehabilitation zone	Dredging works sub-zone	Drainage ditch Site leveling	Restore vegetation	Hoarding Drainage ditch Sedimentation pond
	Constructed wetland sub-zone	Slope protection Retaining wall Drainage ditch Sedimentation pond	Landscaping	Hoarding Thatch cover Drainage ditch Sedimentation pond
	Lake ring road sub-zone	Top soil stripping Slope protection Retaining wall Drainage ditch Barrier berm	Side slope landscaping	Thatch cover
	Ring road bridges sub-zone	Embankment	----	Mud pond Drainage ditch Sedimentation pond
	River-lake network connection sub-zone	Embankment	Aquatic plants for shoreline protection	----
Solid waste collection and transfer zone	Transfer station sub-zone	----	----	Drainage ditch
	Pier sub-zone	----	----	Hoarding Drainage ditch Sedimentation pond
Construction staging area zone		Top soil stripping Site leveling Drainage ditch Sedimentation pond	Restore vegetation	Hoarding Thatch cover
Haul road zone		Top soil stripping Site leveling	Restore vegetation Grass planting for side slope protection	Drainage ditch
Borrow pit zone		Top soil stripping Site leveling	Restore vegetation	Hoarding Thatch cover Drainage ditch Sedimentation pond

Source: SEPP

259. The allowable soil erosion rate is 500 t per km^2 per year. The SEPP assessed that with the implementation of protection measures, soil erosion rate for this project would average 270 t per km^2 per year. Further, vegetation restoration would be close to 100%. Besides implementing protection measures, the SEPP also requires soil erosion monitoring at 10 locations during project implementation. Soil erosion monitoring has been incorporated into the EMP.

260. For all the above-mentioned soil erosion mitigation measures, a total investment of CNY 268

million has been included in the overall project cost estimate covering all the proposed engineering measures, re-vegetation and soil erosion supervision and monitoring program. The implementation of the SEPP will be part of the contractual obligations for the contractors and supervised by the project owner and construction supervision companies (CSCs) throughout the project implementation.

5. Impacts and Mitigation on Biological Resources, Ecology and Biodiversity

261. This project is located in the Baitan Lake planning area, which is a suburban area with rural setting dominated by fish ponds and farms with scattered villages. **Table IV.1** shows that the 92.7% of the existing land use is made up of agricultural and wooded areas (42.8%), ponds and ditches (32.1%) and natural water bodies (17.8%).

262. The project EIR described 42 vegetation types indicating the diversity of plant communities in the Baitan Lake planning area. These vegetation types consisted of trees, shrubs, vines and aquatic plants occurring in and around water bodies, ponds and ditches, as well as on and adjacent to agricultural land, vacant land and in constructed areas. Of the 487 plant species recorded, 145 species (30%) were cultivated species.

263. Species composition of phytoplankton was dominated by blue-green algae, especially in Baitan Lake and Chiye Lake. This is indicative of eutrophication. The project EIR also assessed that these lakes were in a mild eutrophic state.

264. The fish community in Baitan Lake was dominated by carps and minnows. Of the 49 fish species recorded to occur in Baitan Lake, 9 species (see **Table IV.20**) were known to be associated with the Yangtze River water system, meaning that they could migrate in and out of Baitan Lake.

265. The bird community is dominated by winter migrants, indicating that Baitan Lake is a popular wintering ground for birds, especially water birds. The planning EIR indicates that the major wintering ground for water birds in Huanggang Municipality is the Longgan Lake, located at the southern tip of the Municipality and bordering Jiangxi Province, and is far from the Baitan Lake area.

266. **Protected species**. Among the flora and fauna recorded in the Baitan Lake planning area either in the field surveys for this project or in literature, 84 species (not including those on the NBES list) are under national, provincial, and/or IUCN protection status (**Table V.6**). These species were made up of 7 plants, 2 benthic bivalve mollusks, 4 fishes, 6 amphibians, 8 reptiles, 2 terrestrial mammals and 55 birds. Among these, 11 species are on the IUCN red list with 4 species assessed as Endangered (EN) and 7 species Vulnerable (VU); 25 species are on the national protection list with 4 species in Class I and 21 species in Class II; and 53 species on the provincial protection list. None of these species is native to the Baitan Lake area.

Table V.6: Protected species recorded in the Baitan Lake planning area

Scientific Name		Common Name	Protection Status		
			PRC		IUCN
			National	Provincial	
Vascular plants					
	Cycas revoluta	King Sago Palm 苏铁	I		
	Ginkgo biloba	Maidenhair Tree 银杏	I		EN
	Metasequoia glyptostroboides	Dawn Redwood 水杉	I		EN
	Cinnamomum camphora	Camphor Tree 樟树	II		
	Nelumbo nucifera	Lotus 莲	II		
	Glycine soja	Wild Soybean 野大豆	II		
	Trapa incisa	Wild Water Chestnut 细果野菱	II		
Benthic bivalve mollusks					
	Lamprotula rochechouartii	猪耳丽蚌			VU
	Lamprotula tortuosa	失衡丽蚌			VU
Fish					
	Cyprinus carpio	Wild Common Carp 鲤			VU
	Myxocyprinus asiaticus	Chinese Sucker 胭脂鱼	II		
	Ochetobius elongatus	鳜鱼		P	
	Saurogobio dabryi	Chinese Lizard Gudgeon 蛇鮈		P	
Amphibians					
	Bufo gargarizans	Zhoushan Toad 中华蟾蜍		P	
	Fejervarya multistriata	Rice Frog 泽蛙		P	
	Hoplobatrachus chinensis	East Asian Bullfrog 虎纹蛙	II		
	Microhyla ornata	Ornamented Pygmy Frog 饰纹姬蛙		P	
	Pelophylax nigromaculatus	Black-spotted Pond Frog 黑斑蛙		P	
	Pelophylax plancyi	Eastern Golden Frog 金线蛙		P	
Reptiles					
	Chinemys reevesii	Reeves' Turtle, Chinese Pond Turtle 乌龟			EN
	Mauremys mutica	Yellow Pond Turtle 黄喉拟水龟		P	EN
	Pelodiscus sinensis	Chinese Soft-shell Turtle 鳖			VU
	Elaphe bimaculata	Chinese Leopard Snake 双斑锦蛇		P	
	Elaphe carinata	King Ratsnake 王锦蛇		P	
	Elaphe taeniura	Beauty Ratsnake 黑眉锦蛇		P	
	Ptyas mucosus	Oriental Ratsnake 滑鼠蛇		P	
	Zaocys dhumnades	Black-striped Snake 乌梢蛇		P	
Terrestrial mammals					
	Arctonyx collaris	Hog Badger 猪獾		P	
	Mustela sibirica	Siberian Weasel 黄鼬		P	
Birds					
	Accipiter buteo	Common Buzzard 普通鵟	II		
	Accipiter gentilis	Northern Goshawk 苍鹰	II		
	Accipiter nisus	Eurasian Sparrowhawk 雀鹰	II		
	Accipiter soloensis	Chinese Goshawk 赤腹鹰	II		
	Acridotheres cristaltellus	Crested Myna 普通八哥		P	
	Anas platyrhynchos	Mallard 绿头鸭		P	
	Anser albifrons	Great White-fronted Goose 白额雁	II		
	Anser anser	Greylag Goose 灰雁		P	
	Anser cygnoides	Swan Goose 鸿雁		P	VU
	Anser fabalis	Bean Goose 豆雁		P	
	Ardea cinerea	Grey Heron 苍鹭		P	

Scientific Name		Common Name	Protection Status		
			PRC		IUCN
			National	Provincial	
	Asio flammeus	Short-eared Owl 短耳鸮	II		
	Bubulcus ibis	Cattle Egret 牛背鹭		P	
	Circus cyaneus	Northern Harrier 白尾鹞	II		
	Corvus corone	Carrion Crow 小嘴乌鸦		P	
	Corvus macrorhynchos	Large-billed Crow 大嘴乌鸦		P	
	Cuculus canorus	Common Cuckoo 大杜鹃		P	
	Cuculus micropterus	Short-winged Cuckoo 四声杜鹃		P	
	Cyanopica cyana	Grey Tree Magpie 灰喜鹊		P	
	Dendrocopos hyperythrus	Rufous-bellied Woodpecker 棕腹啄木鸟		P	
	Dicrurus marcocercus	Black Drongo 黑卷尾		P	
	Egretta alba	Eastern Great Egret 大白鹭		P	
	Egretta garzetta	Little Egret 小白鹭		P	
	Egretta intermedia	Intermediate Egret 中白鹭		P	
	Emberiza aureola	Yellow-breasted Bunting 黄胸鹀			VU
	Falco columbarius	Merlin 灰背隼	II		
	Falco peregrinus	Peregrine Falcon 游隼	II		
	Falco tinnunculus	Common Kestrel 红隼	II		
	Falco vespertinus	Red-footed Falcon 红脚隼	II		
	Fulica atra	Common Coot 白骨顶鸡		P	
	Glaucidium cuculoides	Asian Barred Owlet 斑头鸺鹠	II		
	Grus grus	Common Crane 灰鹤	II		
	Grus monacha	Hooded Crane 白头鹤	I		VU
	Hirundo daurica	Red-rumped Swallow 金腰燕		P	
	Hirundo rustica	Barn Swallow 家燕		P	
	Hydrophasianus chirurgus	Pheasant-tailed Jacana 水雉		P	
	Lanius cristatus	Brown Shrike 红尾伯劳		P	
	Lanius schach	Rufous-backed Shrike 棕背伯劳		P	
	Larus argentatus	Herring Gull 银鸥		P	
	Larus ridibundus	Black-headed Gull 红嘴鸥		P	
	Mergus merganser	Goosander 普通秋沙鸭		P	
	Oriolus chinensis	Black-naped Oriole 黑枕黄鹂		P	
	Otus scops	Common Scops-owl 红角鸮	II		
	Parus major	Great Tit 大山雀		P	
	Phalacrocorax carbo	Great Cormorant 普通鸬鹚		P	
	Phasianus colchicus	Common Pheasant 环颈雉		P	
	Pica pica	Black-billed Magpie 喜鹊		P	
	Podiceps cristatus	Great-crested Grebe 凤头□□		P	
	Sterna chinensis	Spot-necked Dove 珠颈斑鸠		P	
	Tadorna ferruginea	Ruddy Shelduck 赤麻鸭		P	
	Terpsiphone paradisi	Asian Paradise-flycatcher 寿带鸟		P	
	Turdus merula	Eurasian Blackbird 乌鸫		P	
	Tyto longimembris	Eastern Grass-owl 草鸮	II		
	Upupa epops	Eurasian Hoopoe 戴胜		P	
	Vanellus vanellus	Northern Lapwing 凤头麦鸡		P	

Notes:

I: national class I protected species; II = national class II protected species; P = provincially protected species; IUCN: International Union for Conservation of Nature, VU = vulnerable.

267. Seven plant species are on the national protection list with 3 species under Class I protection and 4 species under Class II protection. The three species under Class I national protection status included the King Sage Palm (*Cycas revoluta*), the Maidenhair Tree (*Ginkgo biloba*) and the Dawn Redwood (*Metasequoia glyptostroboides*). All three species were cultivated species in the Baitan Lake planning area (see **Table IV.16**). Both the Maidenhair Tree and the Dawn Redwood are also listed as Endangered on the IUCN red list. The four species under Class II national protection status included the Camphor Tree (*Cinnamomum camphora*), the Lotus (*Nelumbo nucifera*), the Wild Soybean (*Glycine soja*) and the Wild Water Chestnut (*Trapa incisa*). Both the Camphor Tree and the Lotus were cultivated species in the assessment area (see **Table IV.16**).

268. The King Sago Palm is an ornamental plant native to southern Japan. According to *Catalogue of Life China 2012 Annual Checklist*[27], its predominant occurrence in the PRC is in Fujian Province.

269. The Maidenhair Tree is a living fossil with no close relative. It is native to the PRC and is widely cultivated and used in traditional medicine and as a source of food. According to *Catalogue of Life China 2012 Annual Checklist*, this species widely occurs in the provinces of Anhui, Fujian, Gansu, Guizhou, Hebei, Henan, Hubei, Jiangsu, Jiangxi, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan, Zhejiang.

Maidenhair Tree

Dawn Redwood

King Sago Palm

Figure V.2: Plant species on the IUCN red list (Endangered) and under Class I national protection status

Source: www.iucnredlist.org

270. The Dawn Redwood is a fast growing deciduous tree. It is the sole living species of the genus *Metasequoia* and is one of three species of conifers known as redwoods. According to IUCN it is endemic to central China: Chongqing (Shizhu), Hubei (Lichuan, Zhonglu), and Hunan (Longshan,

[27] *Catalogue of Life China 2012 Annual Checklist*: http://data.sp2000.cn/2012u_cnode_c/browse_taxa.php

Sangzhi). Other than being native to Chongqing, Hubei and Henan, *Catalogue of Life China 2012 Annual Checklist* describes that its distribution includes cultivation in Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hebei, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Liaoning, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan, Zhejiang. According to the vegetation surveys (see **Table IV.15**), the Dawn Redwood was found to be the dominant vegetation type that distributed evenly (indication of plantation) adjacent to village houses in Yejiazuiwan Village of the Nanhu Farm Team #4.

271. The vegetation surveys (see **Table IV.15**) have identified that the Camphor Tree, the Lotus and the Wild Soybean are among the dominant vegetation types in the assessment area, indicative of their wide distribution either by cultivation (Camphor Tree and Lotus) or by adaptation to the area (Wild Soybean and Wild Water Chestnut).

272. The *Catalogue of Life China 2012 Annual Checklist* describes that the Camphor Tree is widely distributed in southern and southwestern PRC; the Lotus occurs all over the country; the Wild Soybean is widespread in almost all of PRC except Hainan, Qinhai and Xinjiang provinces; and the Wild Water Chestnut is distributed in the provinces of Heilongjiang, Jilin, Liaoning, Hebei, Shaanxi, Henan, Jiangsu, Anhui, Hubei, Hunan, Zhejiang, Fujian, Jiangxi, Sichuan, Yunnan, Guizhou, Sichuan, Yunnan, Guangdong, Hainan.

273. Two benthic bivalve mollusks, the freshwater mussels *Lamprotula rochechouartii* and *Lamprotula tortuosa*, have been assessed by IUCN as Vulnerable. According to IUCN, both live in lakes and associated waterways with deeper, fast or slow, clear water and silt sediments. They are vulnerable and warrant protection because of population decline due to destruction of habitat from pollution and damming for *Lamprotula rochechouartii* and heavy harvesting and pollution for *Lamprotula tortuosa*. IUCN describes that both are native to the PRC and that *Lamprotula rochechouartii* has been recorded in the provinces of Anhui, Zhejiang, Jiangsu, Jiangxi, Hubei and Hunan; and *Lamprotula tortuosa* in Tai Lake and the Grand Canal in Jiangsu, Shuiyang River in Anhui's Ningguo, Poyang Lake, Gan Jiang, Fuhe, Xin Jiang and Boyang River in Jiangxi, Liangzi Lake in Hubei, and Dongting Lake in Hunan.

274. Four fish species are under protection status, the Wild Common Carp (*Cyprinus carpio*), has been assessed by IUCN as Vulnerable, the Chinese Sucker Fish (*Myxocyprinus asiaticus*) is under Class II national protection, two cyprinids, *Ochetobius elongatus and Sarcocheilichthys sinensis*, are on the Hubei Provincial protection list.

275. *Cyprinus carpio* has a cosmopolitan distribution and IUCN’s concern is on the decline in its native populations due to river regulation (in the Black, Caspian and Aral Sea basins) and hybridization with domesticated introduced stocks.

276. *Myxocyprinus asiaticus* is endemic to the PRC. This species is among those distributed in the Yangtze River water system. Its natural spawning grounds are the upstream Yangtze River tributaries Jinsha River (in Yunnan and Sichuan), Min River (in Sichuan) and Jialing River (in Shaanxi and Sichuan). It goes up the Yangtze River to these tributaries around mid-February before the raining season to spawn from March to May in rapid streams. It stays around the spawning grounds until after autumn and returns with the receding flow to deeper waters along the Yangtze River for wintering.

Since the construction of the Three Gorges Dam, those living below the dam can no longer go upstream to spawn at their natural spawning grounds and breeding groups have been reported downstream of the Dam.

277. *Ochetobius elongatus and Sarcocheilichthys sinensis*, are migrating species entering the lakes from July to September to feed and winter, then migrate to rivers in April to June to spawn in flowing water.

278. Six amphibian species are on the PRC protection list, with the East Asian Bullfrog (*Hoplobatrachus chinensis*) on the Class II national protection list and the other 5 species of toads and frogs on the provincial protection list. According to *Catalog of Life China 2012 Annual Checklist*, the East Asian Bullfrog has wide distribution in the PRC in Yunnan, Hainan, Jiangxi, Sichuan, Henan, Guizhou, Macau, Jiangsu, Guangdong, Fujian, Anhui, Hong Kong, Hunan, Zhejiang, Hubei, Shanghai and Guangxi.

279. Eight reptile species of turtles and snakes are under protection status. The three turtle species are on the IUCN red list, with the Chinese Pond Turtle (*Chinemys reevesii*) and the Yellow Pond Turtle (*Mauremys mutica*) Endangered (EN), and the Chinese Soft-shell Turtle (*Pelodiscus sinensis*) Vulnerable (VU). *Mauremys mutica*, together with five species of snakes, are also on the provincial protection list.

	
Chinese Pond Turtle	Yellow Pond Turtle

Figure V.3: Turtles on the IUCN red list, Endangered

280. According to IUCN, *Chinemys reevesii* has become subject to intensive exploitation for food and medicine and to supply the aquaculture industry with breeding animals, as well as being extensively impacted by habitat degradation and loss, and a decline has been observed in the market supply of *Mauremys mutica*. *Catalogue of Life China 2012 Annual Checklist* describes that *Chinemys reevesii* is distributed in Gansu, Yunnan, Shandong, Shaanxi, Jiangxi, Sichuan, Henan, Guizhou, Hebei, Jiangsu, Guangdong, Anhui, Fujian, Hong Kong, Hunan, Zhejiang, Hubei and Guangxi; while

Mauremys mutica is distributed in Yunnan, Hainan, Jiangsu, Guangdong, Anhui, Jiangxi, Fujian, Zhejiang, Guangxi and Hubei.

281. IUCN describes *Pelodiscus sinensis* to be vulnerable because the wild populations continue to be exploited for food and possibly farm founder stock, resulting in a decline in abundance throughout its wide range despite this species is commercially farmed in vast numbers (several millions per year) for the food trade. *Catalogue of Life China 2012 Annual Checklist* describes that this species is distributed in Gansu, Yunnan, Shandong, Beijing, Shaanxi, Jilin, Jiangxi, Guizhou, Tianjin, Hebei, Hunan, Guangxi, Chongqing, Hainan, Liaoning, Sichuan, Henan, Heilongjiang, Shanxi, Jiangsu, Guangdong, Anhui, Zhejiang, Shanghai and Hubei.

282. Two terrestrial mammals, the Hog Badger (*Arctonyx collaris*) and the Siberian Weasel (*Mustela sibirica*), are on the provincial protection list. None of them is on the national or IUCN protection list.

283. Of the 55 bird species under protection status, three are on the IUCN red list as Vulnerable (VU) and all three are winter migrants, 16 are on the national protection list (one Class I and fifteen Class II), and 38 are on the provincial protection list.

284. The Hooded Crane (*Grus monacha*) is on both the IUCN list (VU) and the national protection list (Class I), and according to IUCN, because of declining population and wintering grounds due to wetland loss and degradation. *Catalogue of Life China 2012 Annual Checklist* describes that the Hooded Crane is distributed in Jilin, Tianjin, Shanghai, Heilongjiang, Henan, Fujian, Hebei, Hubei, Inner Mongolia, Hunan, Liaoning, Anhui, Shandong, Yunnan, Guizhou, Jiangxi and Jiangsu.

285. The Swan Goose (*Anser cygnoides*) and the Yellow-breasted Bunting (*Emberiza aureola*) have also been assessed by IUCN as Vulnerable (VU). The Swan Goose is also on the provincial protection list.

286. The Swan Goose is listed as Vulnerable by IUCN because it is suspected to be undergoing a rapid population decline owing to poor breeding success in recent years as a result of drought and considerable pressure from habitat loss, particularly owing to agricultural development, as well as unsustainable levels of hunting. *Catalogue of Life China 2012 Annual Checklist* describes that the Swan Goose is distributed in Jilin, Tianjin, Guangxi, Xinjiang, Heilongjiang, Fujian, Guangdong, Sichuan, Hubei, Nei Mongol, Hunan, Liaoning, Shandong, Ningxia, Shanxi, Macau, Zhejiang, Shanghai, Henan, Qinghai, Hebei, Gansu, Anhui, Yunnan, Hong Kong, Beijing, Jiangxi, Jiangsu and Chongqing.

287. The Yellow-breasted Bunting is listed as Vulnerable by IUCN because overall it has undergone a very rapid population decline owing mainly to trapping on wintering grounds despite its being locally abundant. *Catalogue of Life China 2012 Annual Checklist* describes that the Yellow-breasted Bunting is distributed in Jilin, Tianjin, Xinjiang, Guangxi, Heilongjiang, Fujian, Guangdong, Sichuan, Hubei, Inner Mongolia, Hunan, Liaoning, Shandong, Ningxia, Shaanxi, Shanxi, Macau, Shanghai, Zhejiang, Henan, Qinghai, Hebei, Gansu, Anhui, Yunnan, Hong Kong, Guizhou, Beijing, Hainan, Jiangxi, Jiangsu and Chongqing.

288. **Protected areas.** Ecologically protected areas include the Lijiazhou Egretry Nature Reserve in

Huangzhou District located approximately 16 km to the northwest of the Baitan Lake planning area, and the Longgan Lake Nature Reserve in Huanggang Municipality located approximately 120 km to the southeast of the Baitan Lake planning area. The Huangzhou Binjiang Forest Park and the Dongpo Red Cliff Scenic Area are located approximately 6 km to the southwest of the Baitan Lake planning area. These protected areas would not be affected by this project.

289. **Impact assessment summary**. The above assessment indicates that the habitats in the Baitan Lake planning area have been influenced by human activities, dominated by man-made fish ponds and farmland. Baitan Lake has been decreasing in surface area, from 1,053 ha to 352 ha, due to continual development in the area. Lake water quality has been adversely affected by point and non-point source pollution and aquaculture in the lake. The assessment area, including the project area of influence, is unlikely to sustain any natural habitat that would be deemed large enough to be of ecological significance. The assessment area is also unlikely to have any habitat critical to the survival of ecologically important floral and faunal species. This assessment was confirmed by the Forestry Bureau in the framework of the discussion forum held on 25 October 2012 (see Chapter VII, Section 4). The Baitan Lake area is not the 'type locality' of any of the protected species. The protected species are either cultivated in the area (plants) or are widely distributed in many provinces in the PRC (both plants and animals).

290. **Dredging in Baitan Lake and Chiye Lake** would destroy the benthic fauna in the dredging areas. Benthic communities are dominated by worms, arthropods and insect larvae (see **Table IV.18**) which are ubiquitous species. Two species of freshwater mussels are deemed Vulnerable on the IUCN red list. As described above these two species have wide distribution. Upon completion of dredging, benthic species would recolonize in the dredged areas and dredging impact on benthic fauna is deemed short term and temporary.

291. Dredging would also stir up the bottom sediment thereby raising the turbidity level of the water column affecting light penetration and possibly the photosynthetic activity of phytoplankton. Reduced photosynthesis would reduce primary production and potentially food availability to the herbivores and higher trophic levels preying on the herbivores. The use of cutter suction dredger would in fact minimize such impact. Once the sediment is loosened up by the cutter head, it would immediately be sucked into the dredger then transported by pipeline to the sediment treatment site. As described above on potential surface water quality impact, the impact zone of increased suspended solids levels has been estimated by the project EIR to be within approximately 30 m down current of the dredger and that SS levels should return to ambient condition at approximately 50 m down current of the dredger. The impacted area is therefore small and should not affect the overall primary productivity of these lakes. Planktons would be sucked into the dredger but the impacted area is small and localized and should not have significant and irreversible impact on the population of these ubiquitous planktonic species in the lakes.

292. The protected species especially those under national and/or IUCN protection status are widely distributed in the PRC and that the Baitan Lake planning area is not the 'type locality' of any of the protected species. However, Baitan Lake is a popular wintering ground for water birds and measures will be needed to mitigate disturbance and impacts from construction activities during the

wintering period from November to March.

293. This project will rehabilitate Baitan Lake, Chiye Lake and seven river channels, improving the water quality and creating wetland habitats. The recently promulgated *Hubei Province Lake Protection Regulation* (effective on 1 October 2012) will provide administrative and enforcement measures to prevent and control pollution in Baitan Lake, including aquaculture activities in the lake. In the long term all these improvements and actions will enhance the ecological value of Baitan Lake, benefiting nearby biota especially wintering water birds. The Regulation describes the following responsibilities, which will benefit the project in terms of improved lake management and pollution control:

- ***Environmental protection administrators:*** (i) development of lake water pollution control plan, (ii) management and supervision of water pollution sources, (iii) lake water quality monitoring and information disclosure, (iv) integrated control and supervision of water pollution, (v) approval of construction project environmental impact assessment documents concerning lakes, (vi) organization and guidance for integrated pollution control tasks in townships and villages in the lake catchments, and (vii) other responsibilities required by laws and regulations.
- ***Agricultural and fisheries administrators:*** (i) establishment of no fishing zones and time periods, (ii) protection of the quality of fishery resources, (iii) supervision of fish culture, (iv) control of agricultural non-point source pollution, (v) organize the development and implementation of fisheries development and protection plan, and (vi) other responsibilities required by laws and regulations.
- ***Forestry administrators:*** (i) development and management of wetland nature reserves and wetland parks, (ii) construction of ecological and water source protection woodland around the lakes, (iii) ecological rehabilitation of lake wetlands, (iv) protection of lake biodiversity, and (v) other responsibilities required by laws and regulations.

294. **Mitigation measures to prevent ecological impact**. The contractors will implement the following measures to prevent ecological impact during construction. These conditions as well as bird monitoring during wintering periods will be put into the EMP and the tender documents and construction contracts:

- All construction activities within the Baitan Lake and Chiye Lake blue lines and within 1 km outside the Baitan Lake and Chiye Lake blue lines will be restricted to between 0900 hr and 1600 hr from 1 November to 31 March the following year to prevent disturbance to the dawn and dusk feeding periods and nesting of water birds;
- Cutter suction dredgers will be applied for lake sediment dredging to minimize stirring up of bottom sediments that might affect photosynthetic activity of phytoplankton, reduce primary production and potentially food availability to the herbivores and higher trophic levels preying on the herbivores;
- Construction workers are prohibited from capturing any wildlife in the project area;
- Preserve existing vegetation where no construction activity is planned;

- Protect existing trees and grassland during construction; where a tree has to be removed or an area of grassland disturbed, replant trees and re-vegetate the area after construction;
- Remove trees or shrubs only as the last resort if they impinge directly on the permanent works or necessary temporary works.

6. Socio-economic Impacts and Mitigation – Land Acquisition and Resettlement

295. **Land acquisition**. **Table V.7** shows that this project will take up 166.44 ha of land permanently and 13.48 ha temporarily. Over 80% of the land take are artificial fish ponds (61.8%) and dry farmland (19.8%). All these account for only a minute portion of similar land use types in the Huanggang Municipality. Approximately 85% of the permanent land take will be for creating the wetlands and constructing the river-lake connection. Temporary land take will be for construction staging areas, haul roads and borrow pits. These areas will be restored and re-vegetated after construction completion. According to the Resettlement Plan (RP), approximately 53 ha are collective land while the rest is state owned land.

296. **Resettlement**. **Table V.8** shows that a population of 1,324 from 360 households will be affected by this project. House demolition will involve 4,736.5 m^2 of residential houses and 11,038 m^2 of non-residential houses. Compensation will be in accordance with the RP. Resettlement work of the Project will be implemented over a period of one year (June 2014 to June 2015), and the estimated resettlement budget is 183.8279 million yuan (prices of 2013).

297. The Project will affect Nanhu Farm, Lukou Town and Baitan Lake Fish Farm in Huangzhou District. 8,678.9 mu (578ha) of state-owned land will be occupied, including 162.6 mu of non-irrigated land (1.87 %), 2,486.4 mu of state-owned fishpond (28.65%), 1.7 mu of garden land (0.02%), 141.5 mu of construction land (1.63 %) and 5,886.7 mu of water surface (67.83%), affecting 187 households with 727 persons. 798.6 mu of collective land will be acquired, including 120.3 mu of irrigated land (15.06%), 188.2 mu of non-irrigated land (23.56%), 418.2 mu of fishpond (52.36 %), 39 mu of woodland (4.88 %) and 33 mu of construction land (4.13%), affecting 129 households with 408 persons. 77.5 mu of land will be occupied temporarily, including 57.9 mu of collective land and 19.6 mu of state-owned land, affecting 42 households with 184 persons. Compensation for LA in Baitan Lake Fish Farm has been completed, and a resettlement due diligence report prepared therefor.

298. Residential houses totaling 4,736.5 m^2 will be demolished, affecting 22 households with 79 persons; non-residential properties totaling 4,736.5 m^2 will be demolished, including 8,974 m^2 in frame structure (81.3%), 2,026 m^2 in masonry concrete structure (18.35%) and 38 m^2 in masonry timber structure (0.34%), affecting two entities with 5 persons. The Project will affect 1,732weed trees and 244landscaping trees (see **Table V.9**). The Forestry Bureau has planned to create 30.04 ha of forest at Taodian Village and Chencelou Township in the spring and winter of 2013.

299. **Economic displacement[28].** Since most of the land acquisition will involve fish ponds and most fishpond lessees were formerly workers of state-owned Baitan Lake Fish Farm, and were converted into urban residents after the restructuring and liquidation of the farm in 2007, the NED construction headquarters has developed the following livelihood restoration measures in order to further protect their livelihoods:

- The affected persons who were formerly workers of Baitan Lake Fish Farm are provided with state-owned construction land at 20 m² per capita for developing secondary and tertiary sector operations, to realize nonagricultural employment.
- The affected persons who are willing to continue in the fish culture business may rent fish pond surface in the standard fish farm near Xingfu Village (2,000 mu).
- The affected population is provided with free skills-training, whilst young adult laborers are assisted in re-employment.
- Endowment insurance is provided for the affected population.

[28] Impacts on local livelihoods, and the government's income restoration program, are discussed in the Resettlement Due Diligence Report on Acquisition of State-owned Land of Baitan Lake Fish Farm in Huanggang (available from list of RRP linked documents)

Table V.7: Existing land use of engineering land take areas

Project Area			Land Use Type [based on *Current Land Use Classification* (GB 21010-2007)] and Area (ha)								Total Land Take (ha)	
			Cultivated Land		Water Area			Vegetated Area		Residential Land		
			011 Paddy Field	013 Dry Farm Land	111 River Surface	114 Ditch/Pond Surface	112 Lake Surface	022 Orchard	032 Shrub Land	072 Rural Homestead	Permanent	Temporary
Urban lakes & rivers	Lake rehabilitation	Dredging works	1.00	1.00	---	---	---	4.18	0.38	---	---	6.56
		Wetland	3.60	17.95	---	53.57	---	1.10	2.60	2.19	81.01	---
	Lake NMT ring road	Road	---	2.05	---	11.36	---	---	8.70	0.70	22.81	---
		Bridge	---	---	0.73	---	---	---	---		0.73	---
	River-lake network connection		---	11.40	3.53	46.30	---	---	---	---	61.23	---
Solid waste collection and transfer	Transfer station		---	0.40	---	---	---	---	0.20	---	0.60	---
	Pier		---	---	---	---	0.04	---	0.02	---	0.06	---
Construction staging areas			---	0.60	---	---	---	---	0.50	---	---	1.10
Haul roads			---	0.76	---	---	---	---	0.16	---	---	0.92
Borrow pits			---	1.50	---	---	---	---	3.40	---	---	4.90
Total:			4.60	35.66	4.26	111.23	0.04	5.28	15.96	2.89	166.44	13.48
% of total (permanent & temporary) land take:			2.6%	19.8%	2.4%	61.8%	<0.01%	2.9%	8.9%	1.6%	92.5%	7.5%
Huanggang Municipality total based on 2005 data:			383,870		246,400			75,940	713,390	99,034		
Land take from this project as a % of Huanggang Municipality total:			0.01%		0.05%			0.007%	0.002%	0.003%		

Source: SEPP and Planning EIR

Table V.8. Resettlement plan

Affected Population				House Demolition (m^2)	
Description		No. of Households	Population	Residential	Non-residential
Permanently affected	Land acquisition of collective land	129	408		
	Land occupation of state-owned land	187	727		
	House demolition on collective land	22	79		
	Both land acquisition and house demolition	22	79		
	Entities/stores	2	5		
	Subtotal	318	1140		
Temporary affected	Temporary land occupation	42	184		
Total		**360**	**1324**	**4736.5**	**11038**

Source: RP

Table V.9: Weed trees and landscaping trees affected by the project

Weed trees				Landscaping trees			
Breast height diameter <5cm	Breast height diameter 5-8cm	Breast height diameter 8-10cm	Breast height diameter 10-15cm	Breast height diameter 8-10cm	Breast height diameter 10-15cm	Breast height diameter 15-20cm	Breast height diameter >=20cm
950	364	246	172	82	75	59	28

Source: RP

7. Socio-economic Impacts and Mitigation – Physical Cultural Resources

300. The project EIR has reviewed the status of cultural heritage within the project area of influence and concluded that no physical cultural resource existed within the project area of influence. Should buried artifacts of archaeological significance be uncovered during the construction stage within the project area of influence, construction will be stopped and immediately reported to the Huanggang Cultural Bureau in accordance with the PRC's *Cultural Relics Protection Law (2002)*.

8. Socio-economic Impacts and Mitigation – Health and Safety

301. **Occupational Health and Safety**. Due to its nature the construction industry is considered to be one of the most hazardous industries where a number of potentially hazardous operations are carried out. The civil works contractors will implement adequate precautions to protect the health and safety of construction workers. Contractors will manage occupational health and safety risks by applying the following measures:

- Construction site sanitation: (i) Each contractor shall provide adequate and functional systems for sanitary conditions, toilet facilities, waste management, labor dormitories and cooking facilities. Effectively clean and disinfect the site. During site formation, spray with phenolated water for disinfection. Disinfect toilets and refuse piles and timely remove solid waste; (ii) Exterminate rodents on site at least once every 3 months, and exterminate mosquitoes and flies at least twice each year; (iii) Provide public toilets in accordance with the requirements of labor management and sanitation departments in the living areas on construction site, and appoint designated staff responsible for cleaning and disinfection; (iv) Work camp wastewater shall be discharged into the municipal sewer system or treated on-site with portable system.

- Occupational safety: (i) Provide safety hats and safety shoes to all construction workers; (ii) Provide safety goggles and respiratory masks to workers doing asphalt road paving; (iii) Provide ear plugs to workers working near noisy PME.

- Food safety: (i) Inspect and supervise food hygiene in canteen on site regularly. Canteen workers must have valid health permits. Once food poisoning is discovered, implement effective control measures immediately to prevent it from spreading.

- Disease prevention, health services: According to the Huanggang Disease Control Center, schistosomiasis disease which is a common disease in the waterways in Hubei, Anhui and Jiangxi provinces, does not occur in the Baitan Lake planning area. However, the following disease prevention measures and health services will be undertaken: (i) All contracted labor shall undergo a medical examination which should form the basis of an (obligatory) health/accident insurance and welfare provisions to be included in the work contracts. The contractors shall maintain records of health and welfare conditions for each person contractually engaged; (ii) Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents; (iii) Specify (by the IA and contractors) the person responsible for health and epidemic prevention responsible for the education and propaganda on food hygiene and disease prevention to raise the awareness of workers.

- Social conflict prevention: No major social risks and/or vulnerabilities are anticipated as a result of the project. The project construction workers will be engaged locally. Civil works contracts will stipulate priorities to (i) employ local people for works, (ii) ensure equal opportunities for women and men, (iii) pay equal wages for work of equal value, and to pay women's wages directly to them; and (iv) not employ child or forced labor.

302. **Community Health and Safety**. Temporary traffic diversions, continual generation of noise and dust on hauling routes, and general hindrance to local accesses and services are common impacts associated with construction works within or nearby local settlements.

303. The project may also contribute to road accidents through the use of heavy machinery on existing roads, temporarily blocking pavements for pedestrians etc. Although new roads are being constructed in the Baitan Lake planning area, the existing roads in the area are predominantly rural roads that are narrow and winding and heavy construction traffic and large dump trucks travelling on

these rural roads and through villages with pedestrians and no side walk has been observed during site visits, causing traffic congestion and potential accident. The potential impacts on community health and safety will be mitigated through a number of activities defined in the EMP.

304. The contractors will implement the following measures:

- Traffic management: A traffic control and operation plan will be prepared together with the Huangzhou traffic police prior to any construction. The plan shall include provisions for diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at road crossings with an emphasis on ensuring public safety through clear signs, controls and planning in advance.
- Information disclosure: Residents and businesses will be informed in advance through media of the road improvement activities, given the dates and duration of expected disruption.
- Construction sites: Clear signs will be placed at construction sites in view of the public, warning people of potential dangers such as moving vehicles, hazardous materials, excavations etc. and raising awareness on safety issues. Heavy machinery will not be used after day light and all such equipment will be returned to its overnight storage area/position before night. All sites will be made secure, discouraging access by members of the public through appropriate fencing whenever appropriate.

305. **Utilities provision interruption.** Construction may require relocation of municipal utilities such as power, water, communication cables. Temporary suspension of services (planned or accidental) can affect the economy, industries, businesses and residents' daily life. **Mitigation** of impacts on utilities provision will be through a number of activities defined in the EMP, to be incorporated in the tender documents and construction contracts:

- Contractors will assess construction locations in advance for potential disruption to services and identify risks before starting construction. Any damage or hindrance/disadvantage to local businesses caused by the premature removal or insufficient replacement of public utilities is subject to full compensation, all at the full liability of the contractor who caused the problem.
- If temporary disruption is unavoidable the contractor will, in collaboration with relevant local authorities such as power company, water supply company and communication company, develop a plan to minimize the disruption and communicate the dates and duration in advance to all affected people.
- Construction billboards, which include construction contents, schedule, responsible person and complaint phone number, will be erected at each construction site.

E. Impacts and Mitigation Measures during the Operation Stage

306. During operation, the Hongqi pump station will extract 1.1 m^3/s of water from the Ba River and

Xingfu Reservoir to supplement the water in Chiye Lake and Baitan Lake. This could reduce the availability of Ba River flow to downstream users especially during the dry season. Operation of the sub-surface flow and surface flow wetlands aims at improving the water quality of Baitan Lake, which is a positive impact. To realize this benefit, maintenance of the wetlands is a necessity during the operational stage. Another positive impact is improved flood control against localized water logging. The deployment of sluice gates at Linglong Bay and Jinshui River to maintain the water level in Baitan Lake in winter and to prevent backflow of Santai River water into Baitan Lake during storm events might impinge on the migration of several fish species, Operation of the Hongqi pump station and other associated pump stations would have noise impacts. Operation of the solid waste transfer station would have potential odor and noise impacts.

307. **Downstream Impact of water extraction of 1.1 m^3/s at the Hongqi pump station**. **Table V.10** shows that water extraction of 1.1 m^3/s would account for less than 4% of the Ba River average flow during the dry season, and would further be less percentage wise during the wet season. No significant impact on the river hydrology and downstream water uses is anticipated.

Table V.10: Percentage of water extraction from Ba River dry season flow

Location	Distance from Hongqi pump station	Multi-year average dry season flow rate (m^3/s)	1.1 m^3/s water extraction as a percentage of flow
At Majiatan	21.5 km upstream	28.97	3.8%
At confluence with Yangtze River	11.5 km downstream	35.95	3.1%

Source: PPTA consultant

308. **Noise from associated pumping station**. Noise impacts caused by the operation of the associated Hongqi pump station is mainly from the pump at the level of 70-80dB(A). The pumping station will be constructed in form of semi-buried structures, and accordingly it is projected that the noise levels at the site boundary of pump station will be 40-43dB(A), complying with the targeted Class 2 of “Environmental Quality Standard for Noise” (GB3096-2008). To further control the noise impacts, the pump station is designed with efficient acoustic mitigation measures, such as adequate thick walls, soundproof doors, and double-glazed windows, using low-noise equipment. The external appearance of the pumping station will be designed to harmonize well with the surrounding landscape.

309. **Wetland O&M requirements**. For treatment wetlands to function well, there will be staff assigned to monitor, operate and manage the wetland system. Key operational requirements for sub-surface flow wetlands are monitoring, water level control, vegetation and detrital accumulation management, and periodic renovation to address clogging, should it occur. Key operational requirements for surface flow wetlands are monitoring, water level control, vegetation management, wetland grazing animal management, and periodic removal of localized sediment accumulation to sustain desirable hydraulics. For the combined total of 3.8 ha of sub-surface flow wetlands, the annual operational costs are estimated to be on the order of CNY 32,000/yr. Operational costs for the surface flow wetland are estimated to be CNY 286,000 /yr.

310. The capacity to operate and monitor wetlands will be created through training, production of written operations manuals, continued sharing of water quality performance monitoring data, and a continuous process of quality assurance and control (QA/QC). The latter is important because the wetland quality, operability, and aspect will change with time. After the first five years of operation, it is reasonable to anticipate that the vegetative community should be robust and self-sustaining, and as a result, cover composition will shift. Of greatest importance from a treatment perspective is the need to sustain robust vegetative biomass to sustain and naturally regenerate the wetland sediment and detrital layers where important removal processes of nitrogen, phosphorus and carbon assimilation and cycling are operating.

311. **Hydraulic and water quality modeling**. Numerical modeling was conducted by the PPTA consultant to assess changes in hydraulics and water quality during operation (Attachment 2). The United States Environmental Protection Agency (USEPA) storm water management model (SWMM), which is a dynamic rainfall-runoff simulation model for management, analysis and design of storm water events and control measures, was used to assess flooding and water logging. **Figure V.4** shows the schematic of the SWMM components, **Figure V.5** shows the schematic of the interconnected water system, and **Figure V.6** shows the model domain with 207 sub-catchments in the planning area.

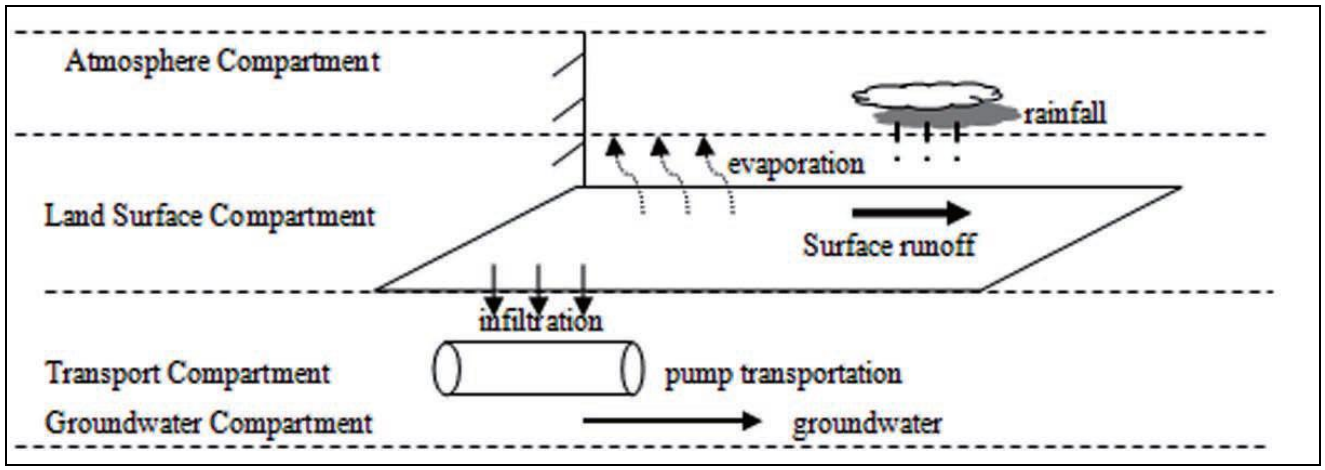


Figure V.4: Schematic of the storm water management model components

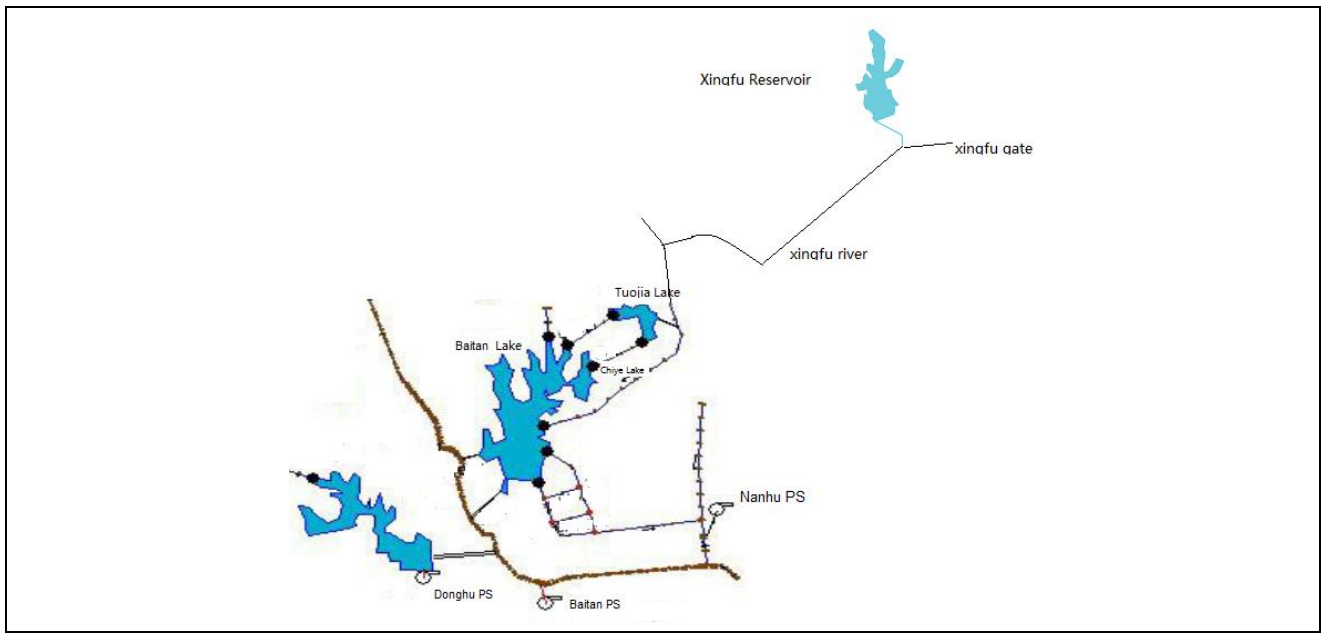


Figure V.5: Schematic of the interconnected water system in the model domain

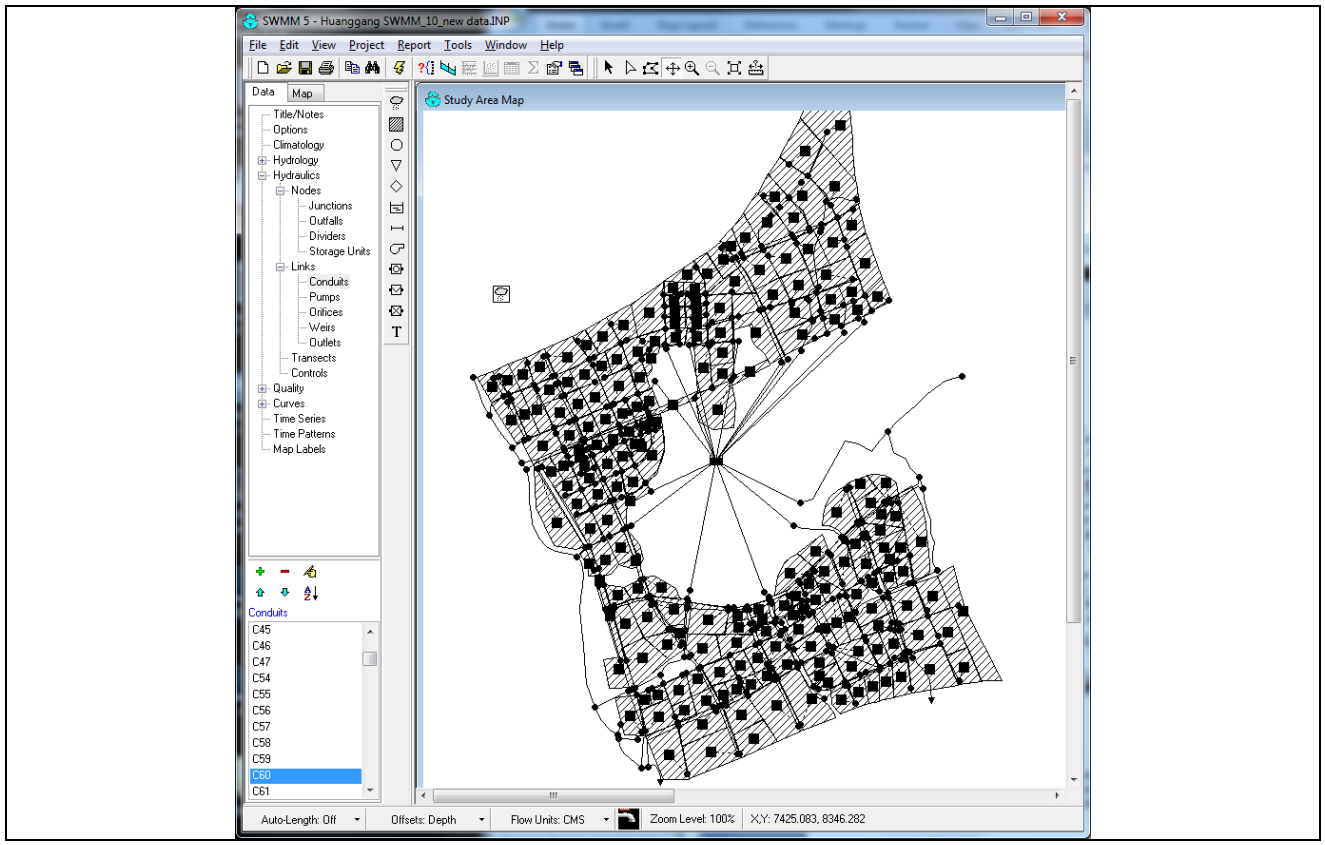


Figure V.6: Model domain and sub-catchment areas

312. A two-dimensional numerical water quality model was developed by the PPTA consultant for assessing changes in water quality due to project intervention including dredging and the construction of sub-surface flow and surface flow wetlands. The model is based on bathymetric data and covers both Baitan Lake and Chiye Lake. **Figure V.7** shows the model domain and computational grids. The model was calibrated against field data collected at 14 locations in the lakes on 12 May 2013, then verified against field data collected on 7, 8, 9 March 2013, showing error ranges of ± 10% for 90% of the samples.

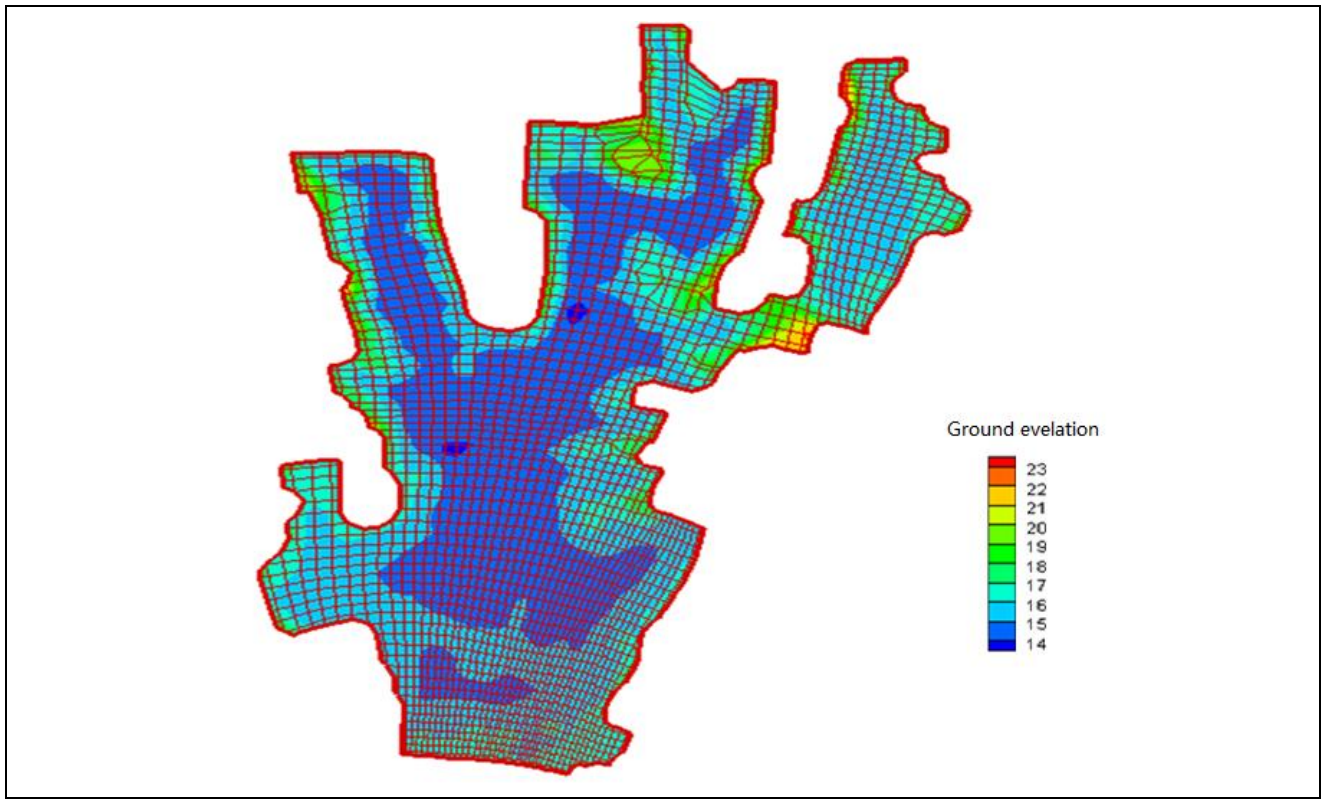


Figure V.7: Water quality model domain and computational grids

1. Impacts from Regulating Water Flow after River-Lake Connection

313. **Water level and flood control**. The SWMM was run based on the daily rainfall data in July 1998, to analyze the water level and flood and water-logging in the project area. The model results show that the maximum water level in the inter-connected water system for the 20 year return flood event would be 17.98 m, which is approximately 6 cm below the proposed control level of 18.04 m, indicating that the hydraulic capacity is adequate.

314. The results show that the maximum water level of 17.98 is some 37 cm below the recorded water level for the same period in 1998 (**Figure V.8**). As compared with the existing system ("without project option"), the potential benefit in flood protection is the reduction of some 37 cm in the system water level.

315. The modeling results also show that water-logging could occur at some locations within the planning area as shown in **Figure V.9**, indicating that the size of the drainage pipes or the connections need further optimization. The need to confirm the size of drainage pipes is flagged as loan assurance.

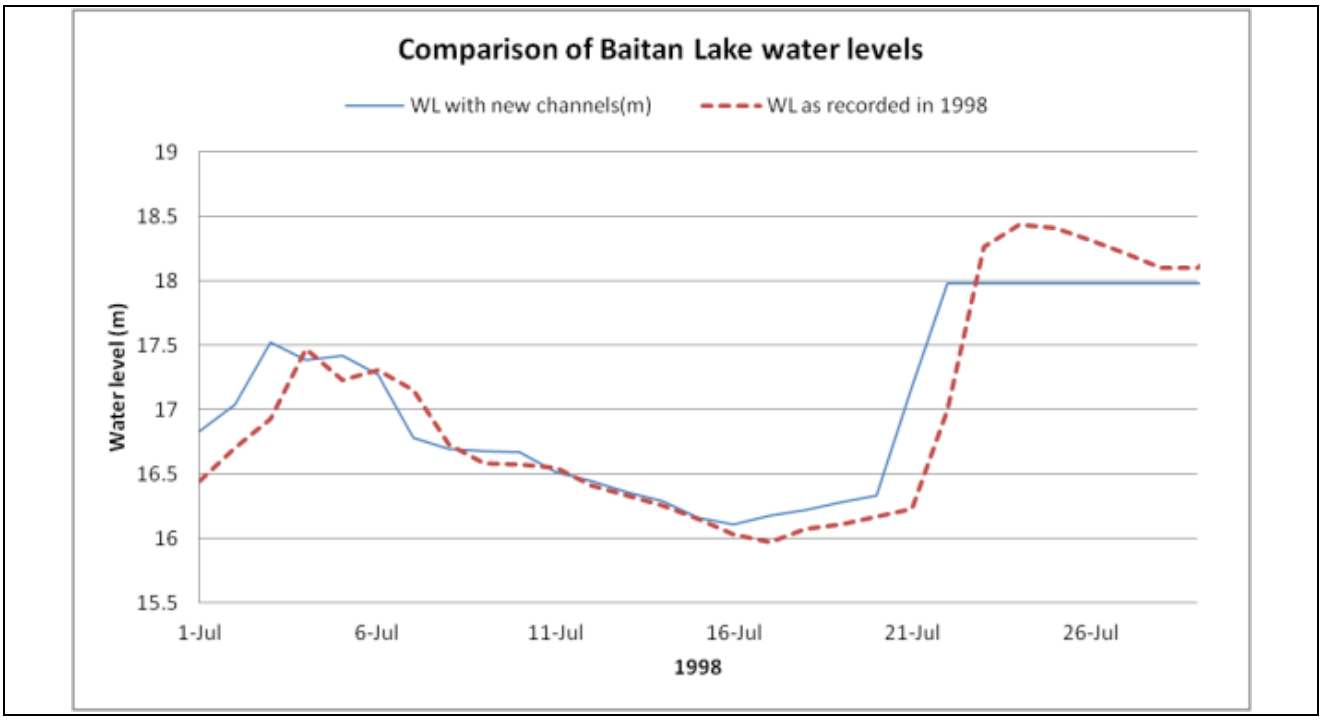


Figure V.8: Simulated lake water levels

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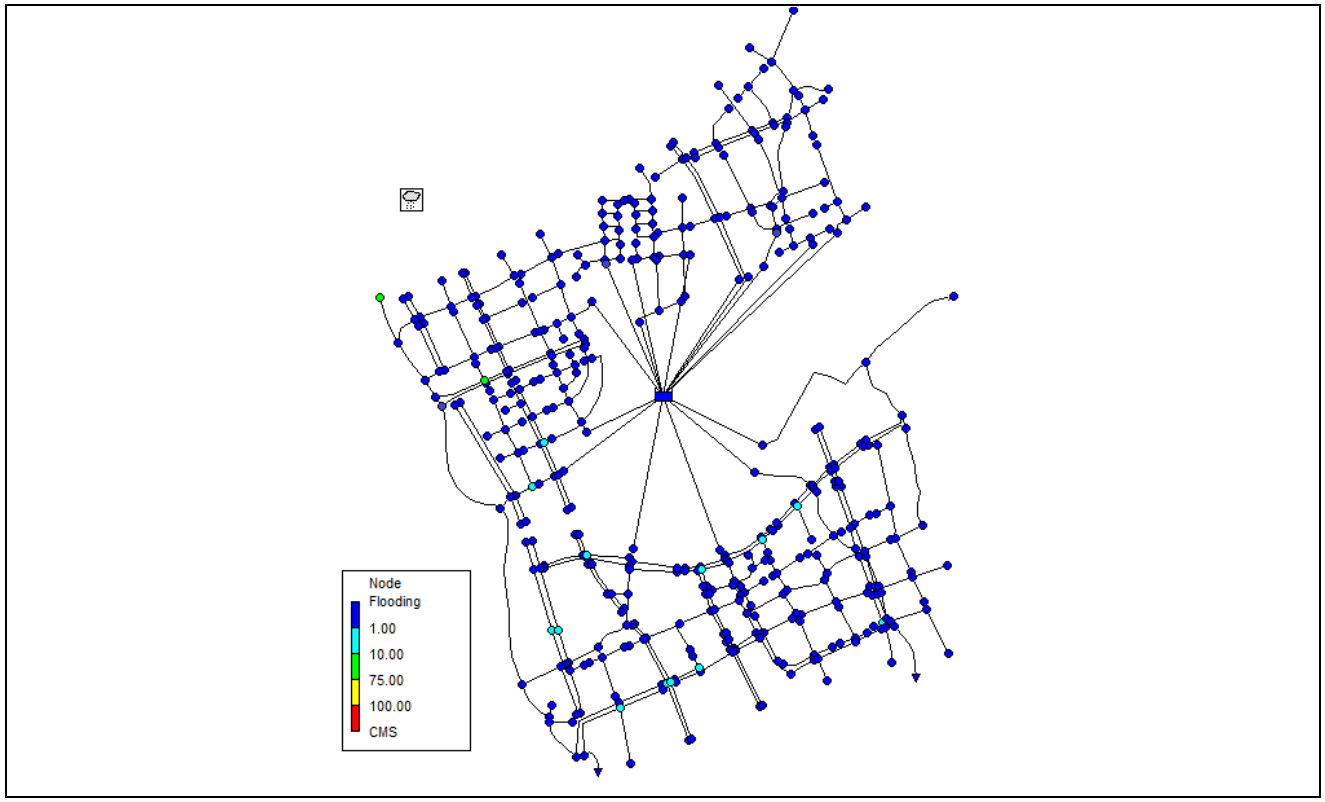


Figure V.9: Locations of potential water logging

316. **Nanhu Pump Station**. According to the *Chang River Basin Water System Plan*, the Nanhu pump station with an installed capacity of 30 m^3/s is required to abstract storm water from Baitan Lake, Chiye Lake and the Nanhu district during storm events when the water level in Santai River is higher than 17.98 m.

317. To test the flooding risk in the planning area of a delayed installation of the Nanhu pump, a hydraulic modeling scenario was run assuming the completion of the pump station is delayed. Simulation results shown in **Figure V.10** indicate that without the Nanhu pump station, the water level in Baitan Lake would reach 18.58 m, which is some 60 cm above the maximum water level when the pumping station is operational, and 54 cm higher than the control water level. The Nanhu pump station is therefore a crucial component for flood control in the planning area. HMG has provided document evidence, showing that this pump station has been listed in the government funded project pipeline and has been scheduled to start in 2015 for 2018 completion.

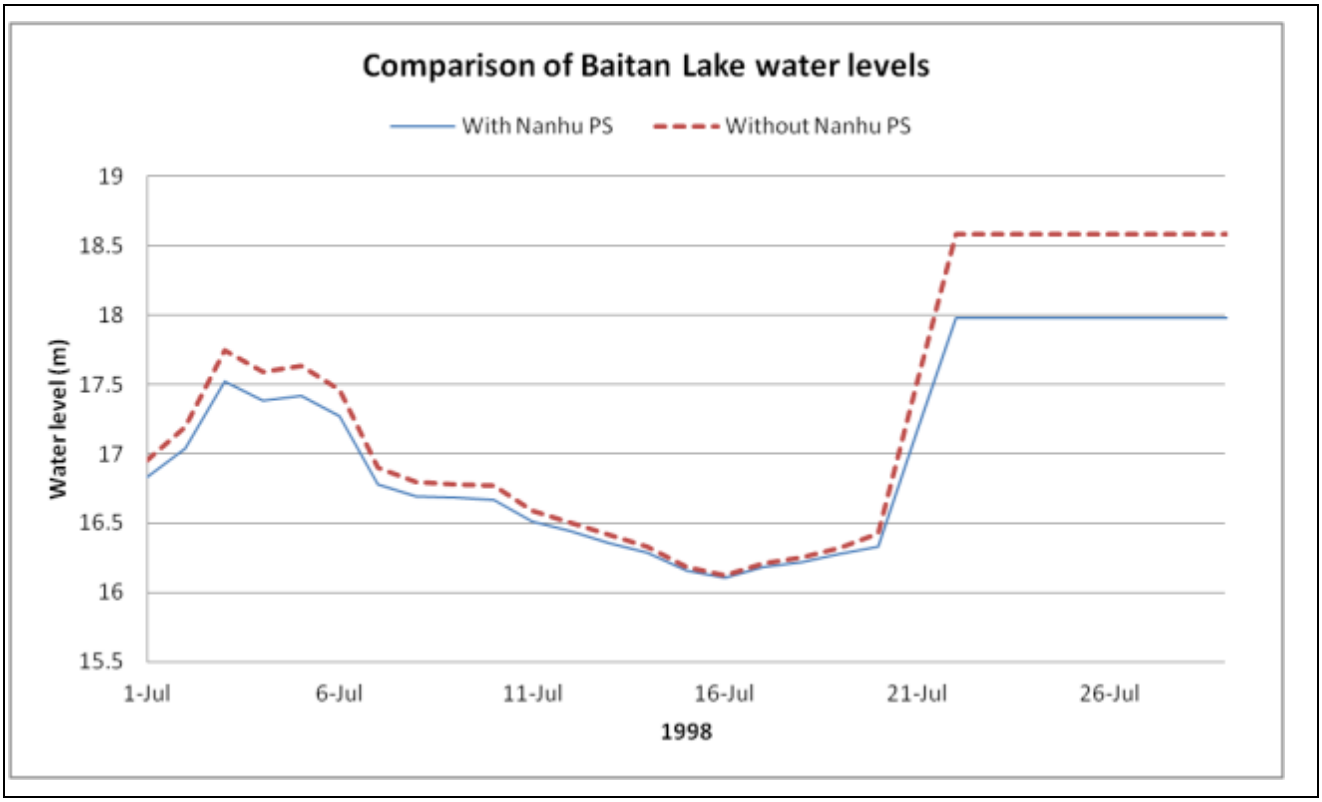


Figure V.10: Comparison of Baitan Lake water levels with and without the Nanhu pump station

318. **Water quality**. The calibrated water quality model was used to assess the project's engineering measures on lake water quality for the pollutants of concern (COD, NH_3-N, TP and TN). The simulations were undertaken for 1 year under a dry hydrologic condition in 1988. Four locations as shown in **Figure V.11** were selected for comparing water quality simulation results. The following future pollutant loading scenarios were estimated and input into the model (**Table V.11**).

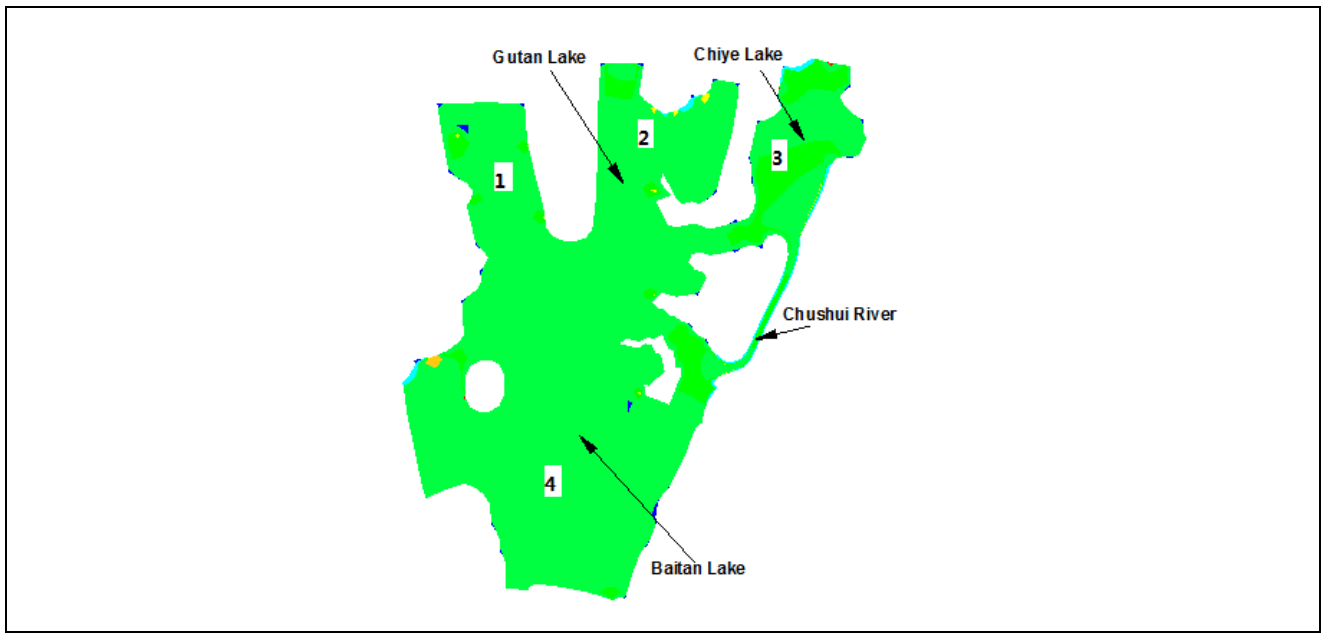


Figure V.11: Representative locations of the water quality simulation results

Table V.11: Summary of pollution loading discharging to Baitan and Chiye Lakes in 2020

Source	COD (t/a)	NH_3-N(t/a)	TN(t/a)	TP(t/a)
Urban Runoff	113.05	5.07	11.45	1.76
Dust deposition	68.56	11.20	14.00	0.88
Xingfu river catchment	321.35	44.50	52.35	1.93
Total (t/a)	502.95	60.77	77.80	4.57

Source: PPTA consultant

319. **Table V.12** compares water quality simulation results of three scenarios at the four representative locations. The three scenarios are (i) the existing 2013 condition, (ii) without the project (do nothing) in 2020, and (iii) with the project in 2020. The results show that in general and in terms of maximum concentrations and percentage time meeting Category IV water quality standards, water quality based on the four parameters would deteriorate in 2020 without the project compared to the existing condition, as illustrated by overall increases in maximum pollutant concentrations and decreases in the percentage time that would meet Category IV water quality standards for the four parameters. Water quality improvements at the four locations are obvious in 2020 with the project, compared to the existing condition and also the do-nothing scenario, with COD and NH_3-N meeting Category IV standards 100% of the time, TP close to 100% of the time, and TN ranging from approximately 84-98% of the time.

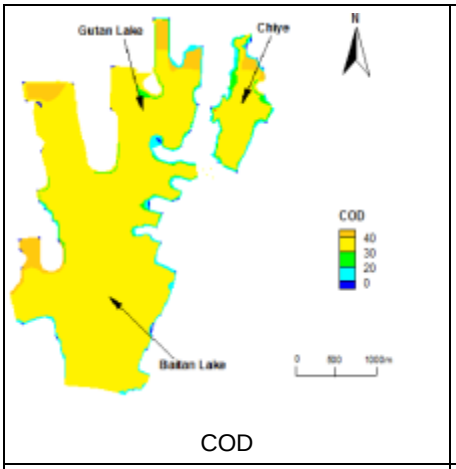
Table V.12: Comparison of water quality simulation results at representative locations under different scenarios

Location	Scenario	Water Quality Simulation Results							
		COD		NH_3-N		TN		TP	
		Maximum Concentration (mg/L)	Percentage Time in Category IV	Maximum Concentration (mg/L)	Percentage Time in Category IV	Maximum Concentration (mg/L)	Percentage Time in Category IV	Maximum Concentration (mg/L)	Percentage Time in Category IV
1	2013 existing	25.7	100%	1.60	40.2%	2.01	0%	0.09	100%
	2020 do nothing	33.3	47.8%	2.43	14.2%	2.64	0%	0.20	4.4%
	2020 with project	20.91	100%	1.00	100%	1.61	94.3%	0.07	100%
2	2013 existing	37.4	6.0%	1.60	47.3%	2.67	0%	0.12	29.8%
	2020 do nothing	41.9	29.8%	1.53	99.5%	2.22	76.8%	0.17	86.6%
	2020 with project	20.8	100%	0.88	100%	1.58	98.1%	0.11	98.9%
3	2013 existing	32.3	51.4%	1.29	100%	1.92	0%	0.07	100%
	2020 do nothing	29.54	100%	1.62	41.3%	2.34	0%	0.11	87.7%
	2020 with project	24.2	100%	1.17	100%	1.86	83.6%	0.07	100%
4	2013 existing	39.9	58.5%	1.89	82.5%	2.74	1.9%	0.10	91.0%
	2020 do nothing	40.8	64.5%	2.15	50.5%	2.89	0%	0.15	60.4%
	2020 with project	28.2	100%	1.38	100%	2.04	92.1%	0.11	99.2%

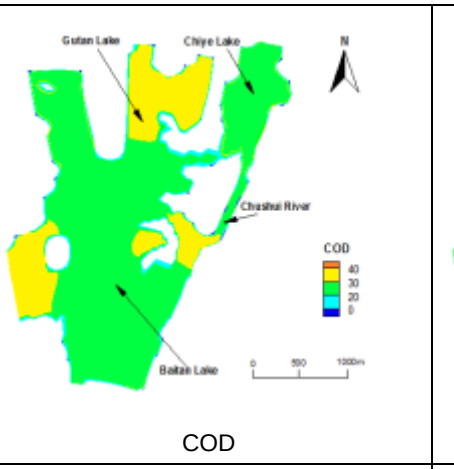
Source: PPTA consultant

320. **Figure V.12** compares the pollutant concentration contours for the same three scenarios at the end of the year. The followings should be noted: (i) Figure V.12 shows annual average concentrations whilst Table V.11 shows maximum concentrations and also percentages of concentrations that would comply with the standards, (ii) the "without project" scenario has taken into account implementation of sewerage infrastructure as planned development in the Baitan Lake area and some water quality improvements especially COD is noted. Comparison shows that without the project, deterioration would mainly occur in the northwestern and western parts of Baitan Lake and mainly due to higher NH_3-N and TP levels due to inflowing stormwater runoff. This provides justification for siting sub-surface flow wetland at these locations for water quality improvement. The concentration contours for the 2020 with project implementation scenario clearly show environmental benefit in terms of water quality improvements compared to the other two scenarios.

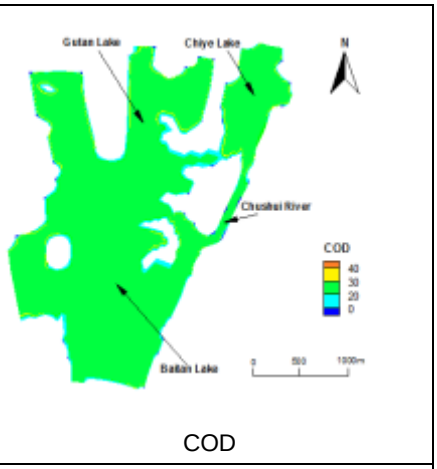
2013 existing condition	2020 without project	2020 with project



COD



COD



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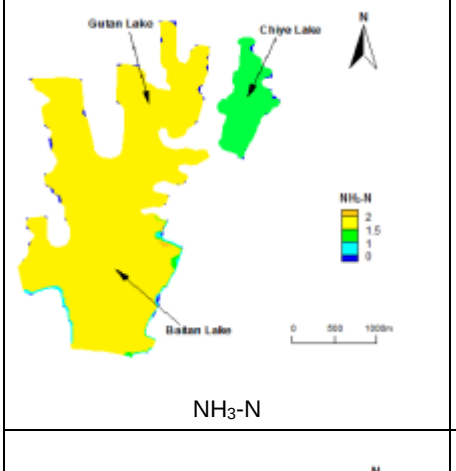
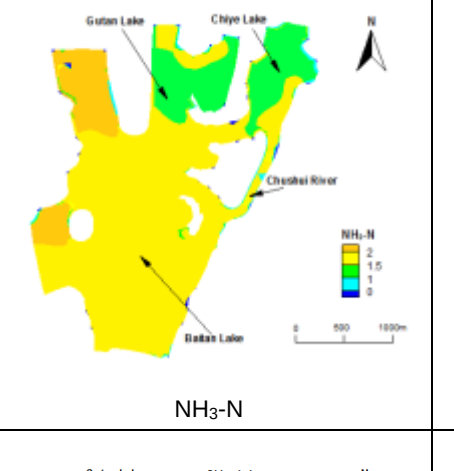


NH_3-N



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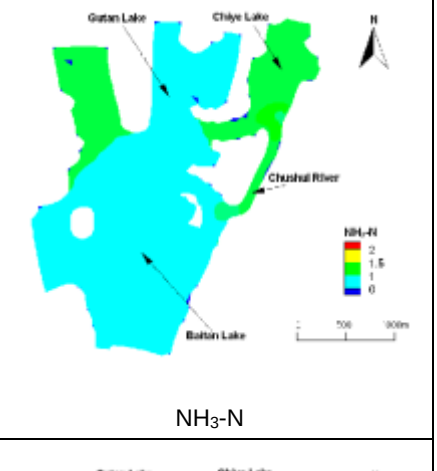

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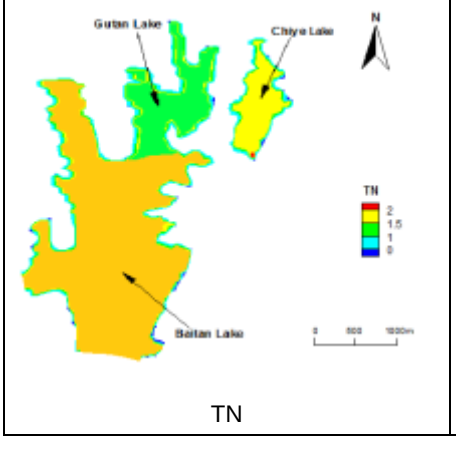

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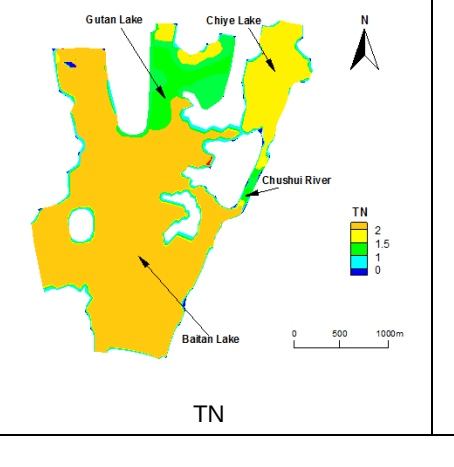

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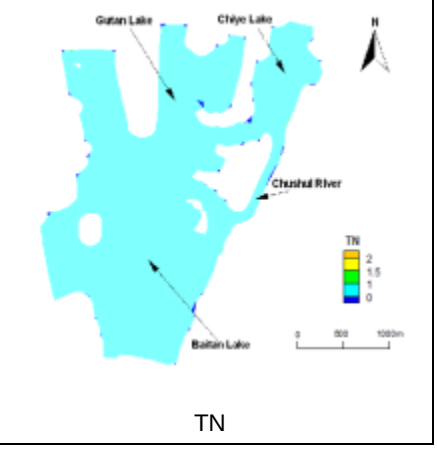

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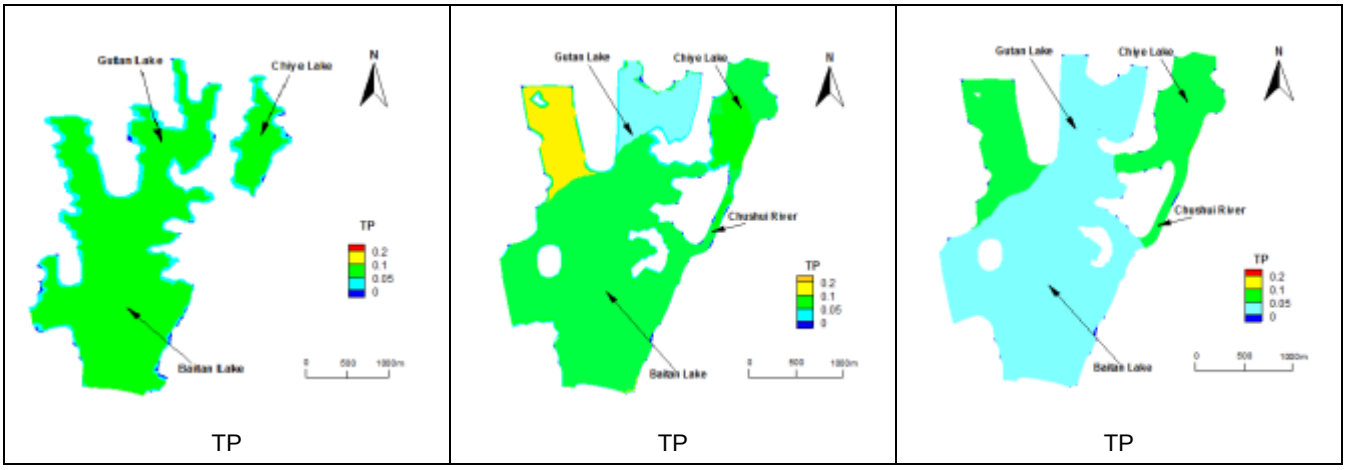

TP TP TP

Figure V.12: Comparison of pollutant concentration contours at the end of the year

321. **Sluice gate operation and fish migration**. This project will install two sluice gates at the confluences of Jinshui River and Linglong Bay with Santai River to prevent the backflow of Santai River water into the Baitan Lake when Santai River water level is higher than that in Baitan Lake. The sluice gates will be operated as follows:

(i) During the dry season and winter, the gates will be closed to maintain the water level at the Baitan lake between 16.7m to 17.1 m;

(ii) During the wet season (between 4 April and 30 April) or before any storm events, the gates should be opened to discharge water from the lake to the Santai river and keep the lake water level at 16.7m;

(iii) During a flood event when the water level in the lake is above 16.7m, the gates should be fully opened if the lake water level is higher than the water level in the river. However, when the river water level rises to the same level as lake or the lake water level reaches to 18.04m, the gates will be closed and the water in the lake will flow southward via Dongtai and Dongchang rivers to the Nanhu pumping station to be pumped out to the Ba River.

322. Nine fish species are associated with the Yangtze River water system and might migrate in and out of Baitan Lake. Fish generally migrate upstream to spawn in shallow areas in April to June and return to deeper waters in the lake in autumn. The two sluice gates will only be deployed in the dry season and winter to maintain the water level at the Baitan Lake and therefore should not affect migratory fish species except the Chinese Sucker Fish (*Myxocyprinus asiaticus*) which usually migrates upstream around mid-February, which may use alternative migratory routes through Dongtai and Dongchang rivers.

2. Impacts from the Operation of the Solid Waste Transfer Station

323. The transfer station will receive approximately 30t of solid waste per day and compacted using a vertical compactor. Operation of the transfer station could have odor and noise impacts. The design of the transfer station will incorporate odor removal equipment and acoustic shielding. Odor and noise impacts during refuse station operation are not expected.

F. Cumulative Impacts

324. Cumulative impacts would mainly be from other projects particularly road projects and buildings being constructed concurrently with the construction stage of this project. The planning EIR estimated the main impact to be construction noise. Construction noise impact areas from the notional noise source at each construction site, based on general construction activities using typical power mechanical equipment, would average 34 m in the day time and 335 m in the night time. Night time (2200 hr – 0600 hr) construction work within 0.5 km of any sensitive receptor would be forbidden. Day time cumulative construction noise could be mitigated to acceptable levels if the noise mitigation measures listed in this EIA and EMP are implemented on construction sites in the Baitan Lake planning area. Similarly, cumulative dust impact from construction sites could be mitigated to acceptable levels if the dust suppression measures listed in this EIA and EMP are implemented on construction sites in the Baitan Lake planning area.

325. Two other projects in the Huangzhou District may also overlap with the construction stage of this project: the Yiai Lake ecological rehabilitation project and the Chang River improvement project. Yiai Lake is located in the old urban center and most of the works would be within and around the lake and far away from this project's area of influence. Cumulative impact with the Yiai Lake ecological rehabilitation project is not anticipated. The Chang River improvement project started in the 4th quarter of 2011 and phase 1 involving approximately 4 km of the Santai River section from the Santai River Bridge to the Huanggang Teachers' College, which is west and southwest of the planning area, should be completed by the end of 2013 and therefore would not overlap with the construction stage of this project. Phase 2 covering approximately 8.2 km from the Huanggang Teachers' College further south (downstream) to Tusi Channel Gate (which is at the Santai River confluence with the Ba River) would occur from 2014 till the end of 2015. The Phase 2 location is far enough away from this project's area of influence and negative cumulative impact is also not expected.

G. Indirect and Induced Impacts

326. **Impacts on future land use**. To accommodate a future population of up to 200,000, the Baitan Lake planning area will undergo changes to the existing land use. **Table V.13** compares existing and future land use, showing that the major increase will be urban constructed land dominated by residential and mixed residential/commercial uses (21%) and green belt buffers and open areas (18.4%). The future land use will not have industrial use and therefore will not generate industrial wastewater and solid waste. The urban constructed land will mostly be taken from fish ponds, ditches and agricultural and wooded areas. This project would not cause a reduction in the total size of the

lakes. Some of the fish ponds will be returned to the lakes, increasing the size of the natural water bodies by approximately 4%.

Table V.13: Comparison of land use change in the Baitan Lake planning area

No.	Land Use		Existing		Future (Year 2020)		Change	
	Code	Type	Area (ha)	% of Total	Area (ha)	% of Total	Area (ha)	% Change
1	R	Residential & mixed residential commercial	0	0%	530.08	21.0%	+530.08	new
2	A	Public management & service facilities	14.88	0.6%	269.74	10.7%	+254.86	1713%
3	B	Commercial service facilities	1.75	0.1%	189.51	7.5%	+187.76	10729%
4	M	Industrial	21.75	0.9%	0	0%	-21.75	-100%
5	S	Roads & transport facilities	6.99	0.3%	332.53	13.2%	+325.54	4657%
6	U	Public facilities	4.32	0.2%	11.76	0.5%	+7.44	172%
7	G	Green belt buffers and open areas	8.7	0.3%	466.05	18.4%	+457.35	5257%
8	K	Reserved land	0	0%	60.29	2.4%	+60.29	new
		Urban constructed land:	*58.39*	*2.3%*	*1859.96*	*73.6%*	*+1,801.57*	*3085%*
9	H	Railroad	0	0%	2.00	0.1%	+2.00	new
		Township constructed land	41.04	1.6%	0	0%	-41.04	-100%
		Village constructed land	60.18	2.4%	0	0%	-60.18	-100%
		Roads	24.37	1.0%	0	0%	-24.37	-100%
10	E	Natural water bodies	450.69	17.8%	469.18	18.6%	+18.49	4%
		Ponds and ditches	810.34	32.1%	0	0%	-810.34	-100%
		Agricultural and wooded land	1,081.76	42.8%	195.63	7.7%	-886.13	-82%
		Total land use:	2,526.77	100%	2526.77	100%		

Source: Planning EIR

327. **Impacts of future development on Baitan Lake.** The future population of 200,000 will generate domestic wastewater and municipal solid waste, thus will result in induced impacts to the environment if the provision of wastewater treatment and solid waste treatment and disposal are not properly planned and implemented. On ADB's request, a planning EIR was conducted to assess and address, amongst others potential impacts from the proposed urban development on the Baitan Lake system. The findings of the planning EIR are summarized below.

328. **Associated resettlement.** Besides direct resettlement impacts from this project, other existing households and population within the NED would have to be resettled to make way for other projects induced by developments in the Baitan Lake planning area (NED Phase 1). According to the planning EIR, of the existing 2,963 households and 12,045 population in the Baitan Lake planning area, development of the planning area will eventually require the resettlement of some 10,000 population (including those affected by this project who will be compensated according to the RP). The HMG's program for local poverty reduction, social risk management and economic development in the NED includes the main key activities:

- 4 resettlement sites are under construction within the NED to host 6,484 households and 20,106 persons who will be affected by the NED land acquisition and resettlement (NED Phase 1 and 2). In addition to the standard resettlement compensation package, vulnerable groups are eligible to obtain additional 20m^2 per capita;
- Construction of economic and low income and public rental housing is planned in 4

designated sites within NED at a total floor area of 250,000 m^2 on over 200 mu of land at an estimated investment cost of CNY400 million. They will host 4,500 households and 15,000 persons, including new employees and migrant workers in Huanggang municipality without private housing which are entitled to public rental housing;

- A technical and vocational education and training (TVET) centre will be built within NED in 800 mu of land with a total floor area of 220,000 m^2 and an estimated investment cost of CNY450 million. This is expected to start operation in September 2014 and provide training services to about 15,000 students. At present, 3 different types of trainings—internship program for would-be graduates; industry-demanded training; outsourced re-training of industry employees—are under implementation in the existing TVET schools. Municipal Education Department initiated a study to (a) identify needs from existing and emerging industries; (b) survey interests from potential labour forces in Huanggang; (c) explore different training modalities such as inviting industry employees as trainer for potential labor for concerned industry; and (d) develop curriculum tailored to the needs of industries in Huanggang.

329. As of December 2013, all 4 resettlement communities were under construction and are expected to be completed in July 2014. 825 households (2,987 persons) have signed land acquisition and resettlement agreements with Huangzhou District Government. It is expected that by the end of 2014, all 10,000 affected residents (in the NED Phase 1 area will have signed land acquisition and resettlement agreements. The relocated HHs will start moving into the resettlement houses before September 2014.

330. The planning EIR estimated that the future population of 200,000 would generate approximately 26,400 m^3/d of **domestic wastewater**. This wastewater will be treated at the Nanhu Wastewater Treatment Plant (WWTP) to GB 18918-2002 Class IB standard and discharged to Santai River. The loadings of COD and NH_3-N in the treated effluent going into Santai River were estimated by the planning EIR to be approximately 578 t/a and 58 t/a respectively.

331. There is no plan to build and operate a WWTP within the Baitan Lake planning area. The Nanhu WWTP is an existing facility adjacent to the NED at the intersection of Huangzhou Avenue and Nanhu No. 1 Road with a planned Phase 3 expansion to increase the treatment capacity to 200,000 m^3/d, to meet the future wastewater treatment need of the Baitan Lake planning area. This facility has been described in Chapter IV Baseline Environment under Section D: Socio-economic Environment.

332. The planning EIR estimated that the future population of 200,000 would generate 73,000 t/a of **municipal solid waste**, which will be transferred to and disposed of at the Taodian Town Sanitary Landfill with a 500 t/d design capacity. This facility has been described in Chapter IV Baseline Environment under Section D: Socio-economic Environment.

333. The planning EIR has raised **six recommendations on protecting Baitan Lake** and speeding up environmental infrastructure during a discussion forum with relevant stakeholders and government agencies (see Chapter VII: Information Disclosure, Consultation and Participation). These recommendations were endorsed by the NED Command Headquarters who is responsible for

administering the NED development.

334. According to the Development Plan of the New Eastern District and the Detailed Control Plan for the Baitan Lake and Its Surrounding Area of 25 km^2, the planned structural measures in the NED include:

- Interception of all wastewater by a sewer-pipe network separated from the drainage-pipe network. The wastewater will be transmitted to the existing Nanhu wastewater-treatment plant which is to be upgraded to a capacity of 200,000t/day. Therefore, when completed, it is expected that no wastewater will be directly discharged into the Baitan and Chiye lakes, nor into the urban rivers;
- Relocation of existing factories and fish farms elsewhere. The future NED will not have any industrial enterprise;
- Interception of all non-point pollution sources from the urban area by urban drainage pipeline.

335. The HMG has provided document evidences and assured that structured measures have been implemented and/or scheduled to deal with the water quality of major water bodies in Huangzhou District, including:

- **Chang (including Santai) River Environment Improvement Project** has been included in the National Construction Plan for the Medium and Small Rivers. The Project is being implemented in two phases. Phase I covers the river segment from Santai River Bridge to Huanggang Teachers College. Phase II covers the segment from Huanggang Teachers College to Tusi Gate. The Phase I project started in 2011, from sections no. 8+166 to 12+237 with a total length of 4071m. The total investment is RMB 28.2 million, including embankment strengthening, sediment dredging, construction of pedestrian platform and revetment. It is scheduled to complete by the end of 2013. The Phase II project has been included in 2015 investment plan. The project scope covers stage no. 0+000 to 8+166 with a total length of 8166m, including embankment strengthening, sediment dredging and revetment. Currently, the survey work has been completed and the design work is ongoing. The total investment is estimated to be RMB 30 million. According to the central government plan, the project is scheduled to complete by the end of 2015.
- **Yiai Lake Ecological restoration project** is aiming to improve the water quality of Yiai lake to reach Class III. The total project investment is CNY 855million and 75% the work has been completed so far. The project activities mainly include a wastewater interceptor system, a wastewater and storm-water collection system and a lake sediment dredging. Although the project has been implemented for three years, the water quality of Yiai hasn't met the planning target. As per the available information to date, the main reasons included: (a) the current Yiai Lake is in a hydraulic closed system as there is no water circulation with other water bodies and therefore the only recharge water source is rainfall; (b)the drainage system is a combination of storm-water outfalls and sewerage which cannot completely cut off the pollution source; (c) as per the Ecological farming requirements, the ideal amount of fish farming is 500,000kg/year,

but the current amount is almost 2,000 t/year, and therefore, is significantly over the lake's self-purification ability; (d) since the dredging construction of the lake sediment was not appropriately implemented, it has stirred up the bottom sediment and increased the suspended-solids levels and released pollutants such as nitrogen and phosphorus. In order to further improve the water quality of Yiai lake, the "Yiai Lake (East Lake part) ecological rehabilitation project" was launched in 2013. The total investment is CNY 1201.75million, with a project period from June 2013 until May 2016. The project's key activities include: (a) to create the connection between the Yiai Lake and Santai River, allowing the water-circulation system to improve the water quality; (b) to control the fish- farming activities in Yiai Lake by relocating them; (c) to complete and improve the wastewater interception system and further control the pollution source.

- **Xinqiao Landfill Closure Project.** The Xinqiao landfill is located 6 km from the city center of Huangzhou district. It covers a total area of 125 mu where the filled waste is stored in an area of 95 mu with an average depth of 10m. It has a total load of 1.1 mn m3 and is untreated. The landfill site, commissioned in 2000, has reached capacity and is being de-commissioned. There are no liners for this site. Untreated leachate is currently stored in two large open ponds at the base of the landfill which are regularly transported to the new landfill by tank for further treatment. The preliminary design of the landfill closure project completed in June 2013 and the currently EIA is being carried out. It is expected that the detailed design would be completed in October and the project start in November 2013. The total capital cost is CNY 3.42 million.

- **Interception of untreated discharges from the eastern district (including 4 educational institutions)** – This is part of the on-going eastern district sewer and rainwater separation project which started in 2011. It is planned that the construction for the sewer pipeline for the area will start in 2014 and complete in 2015 when all untreated wastewater in the area will be intercepted and transmitted to the Nanhu wastewater treatment plant. The total investment is estimated to be CNY 3.42 million.

- **Interception of overflows from combined sewers in the old urban area** – the old urban covers some 26 km^2. Apart from the surrounding are of the Yiai lake where the sewer was separated from urban drainage as part of the Yiai Lake ecological restoration project, the remaining district still has combined sewer and drainage network. Currently, the master planning has been drawn up by Fanghu Group and Zhongnan Municipal Design and Engineering Institute. According to the plan, it is expected that the capacity of the existing combined sewer system will be expanded and discharged capacity doubled by 2015 and by 2020, the sewer will be gradually separated from the combined system.

- **Nanhu Pump Station and its connecting channel** – According to the master plan, this pumping station is located at 1.5 km north of the Changsun Dike on the right bank of the Ba river. The pumping station will house 3 1000kw pumps with a design discharge of 10 m3/s and operating head of 7.54 m. The length of the connecting channel from the pumping station to the Dongchang river is 3.3 km. It is expected that the project will start in October 2015 and complete in May 2018. The total capital cost is estimated to be CNY 69.35 million.

- **Hongqi Pump Station** – This pumping station was initially built for the purpose of irrigating farm land of 16,000 mu in Luokou and Taoding townships. In 2008, it was upgraded and now houses two pumps. One pump (16HBC-30) has a rated discharge of 0.36 m^3/s at the head of 7.5 m and the other (Y355L-12) has a rated discharge 0.92 m^3/s at the head of 5.1m. For the purpose of providing additional 1.0 m^3/s for flushing the Baitan and Chiye lakes, a new pump (650HW-5) is planned to be installed. It is planned the expansion work start in October 2017 and complete in April 2018.

336. **Impacts related to the provision of fish ponds near Xingfu Village**. As described under Land Acquisition and Resettlement above, approximately 2,000 mu of fish ponds near Xingfu Village would be provided for rent to those affected persons who are willing to continue in the fish culture business. These fish ponds are part of the *Xingfu Aquaculture Base project* funded by the national *Modern Agricultural Production Development Fund*, using the low lying plains downstream of the Xingfu Reservoir for establishing an "ecologically healthy aquaculture demonstration base".

337. Due diligence and site visit by the PPTA consultant revealed that no domestic environmental impact assessment had been done for the site selection and creation of these fish ponds. There were small villages scattered around Xingfu Reservoir. The site was not located in legally protected area such as nature reserve, cultivated land, or physical cultural heritage site. The site was also not located in an important wetland area or wildlife habitat. There was no large scale industrial and traffic activities around Xingfu Reservoir and the air quality and noise pollution in the area should be minor. Small quantities of illegally dumped municipal solid waste were observed, indicating poor solid waste management in the area.

338. The functions of Xingfu Reservoir are for irrigation and aquaculture and not for centralized drinking water supply. Its water quality target for such functions was Category III or IV. There was no routine water quality monitoring station set up within the reservoir. Based on interviews with local residents, the water quality of Xingfu Reservoir would mostly be Category IV due to relatively high COD, NH_3-N and TP, and floating vegetation and algae were observed.

339. Of the approximately 2,000 mu fish ponds, approximately 500 mu were made up of ponds that were 5 mu each for growing fish stocks, and the remaining 1,500 mu were made up of ponds that were 15-20 mu each for culturing freshwater fish.

VI. ANALYSIS OF ALTERNATIVES

A. No Project Alternative

340. Project components include (i) rehabilitation of Baitan Lake and Chiye Lake consisting of removing nutrient laden lake sediment by dredging, creating wetlands to improve lake water quality, and constructing a ring road for NMT around Baitan Lake; (ii) rehabilitation of river channels by dredging, excavation and embankment construction to improve flood control and river-lake connections; and (iii) solid waste management to remove solid waste and floating vegetation from the lakes and rivers. With this project, the following improvements and benefits will be realized:

341. Through the dredging of nutrient laden lake and river sediment, the normal lake storage would be increased by 9%. Approximately 486 t total phosphorus (TP) and 1,920 t total nitrogen (TN) will be removed from the water system, reducing the eutrophic potential of these water bodies. This would lead to reduction in pollutant loadings releasing from sediment deposits by approximately 2% (estimated to be 21.6 t/a TN and 2.6 t/a TP).

342. The construction of 4 subsurface flow wetlands with a total area of 38,000 m^2, in conjunction with 4 detention ponds with a total area of 15,250 m^2 in Baitan and Chiye lakes, is expected to reduce the annual loads 36.2t COD, 8.1 t TN and 0.5 t TP to the lakes, and subsequently the Santai River and the Yangtze River. When operated during the non-raining days, these wetlands will further attract pollutants from polluted in-lake water (estimated to be COD 31.9 t/year, TN 3.6 t/year and TP 0.08 t/year, approximately), improving the lake water quality continuously.

343. The construction of 800,000 m^2 of surface flow wetlands at the surrounding area of Chiye lake, supported by transferring 1.1 m^3/s of water from Ba River through Xingfu gate/Hongqi pumping station, will reduce the pollution loads from the upstream catchment. The estimated annual pollutant reductions are COD 102.83 t, TN 37.19 t and TP 0.52 t.

344. The construction of ecological embankments, together with vegetated buffer strips along the lake shorelines and aquatic plants will attract the pollution loads at estimated rates of COD 6.0 t/year, TN 25 t/year and 6.1 t/year.

345. The above interventions will improve lake water quality to meet the short term target of Category IV for its scenic water function. The wetlands would also regulate the surrounding micro-climate and provide habitats to wildlife. Water quality improvements with and without the project have been shown in **Figure V.9**.

346. By rehabilitating the rivers through widening, deepening and embankment construction, the flood control capacity of these rivers will be improved to 1-in-20 year storm events, and soil erosion along river banks will be prevented. This will reduce the water logging risk in the Baitan Lake planning area.

347. An intangible benefit of this project is to provide scenic and aesthetic enjoyment to the future

residents of Baitan Lake planning area, with the lake ring road, the wetlands and the landscaped and open areas around the lake and along the rivers. By connecting the river-lake network and providing supplementary water, the water flow within the system will be improved and the water level in Baitan Lake will be controlled at a level that is conducive to maintaining its scenic function and value.

348. Direct beneficiaries have been estimated to be approximately 12,000 existing residents and 100,000 projected residents of the Baitan Lake planning area by 2020. Indirectly, 500,000 in Huangzhou District would be able to enjoy these benefits. Without this project, the above benefits cannot materialize. Future residents could be exposed to higher water logging risk with potential economic loss. Their quality of life would be lower since the scenic and aesthetic values of Baitan Lake and Chiye Lake would be less.

349. This project would reclaim the fish ponds within the project area affecting the livelihood of fishermen using these ponds for fish culture. Without this project, their livelihood would not be affected. However, the RP provides compensation according to PRC and ADB guidelines and fish ponds will also be provided in the Xingfu Village area should they decide to rent them and continue their fish culture activities.

B. Alternatives Considered

350. Various alternatives have been considered for each of the components in this project. Alternatives eventually selected were due to either being the least cost or the best environmental merit, or both.

351. **Dredging location and volume**. The dredging volume of unconsolidated sediment in Baitan Lake and Chiye Lake was originally 950,000 m^3. Upon review of the nutrient levels and distribution in the Baitan Lake sediment, the dredging location and volume was optimized by the PPTA consultant and reduced from 780,000 m^3 to 404,405 m^3 in Baitan Lake (see **Figure VI.1 and Table VI.1**).

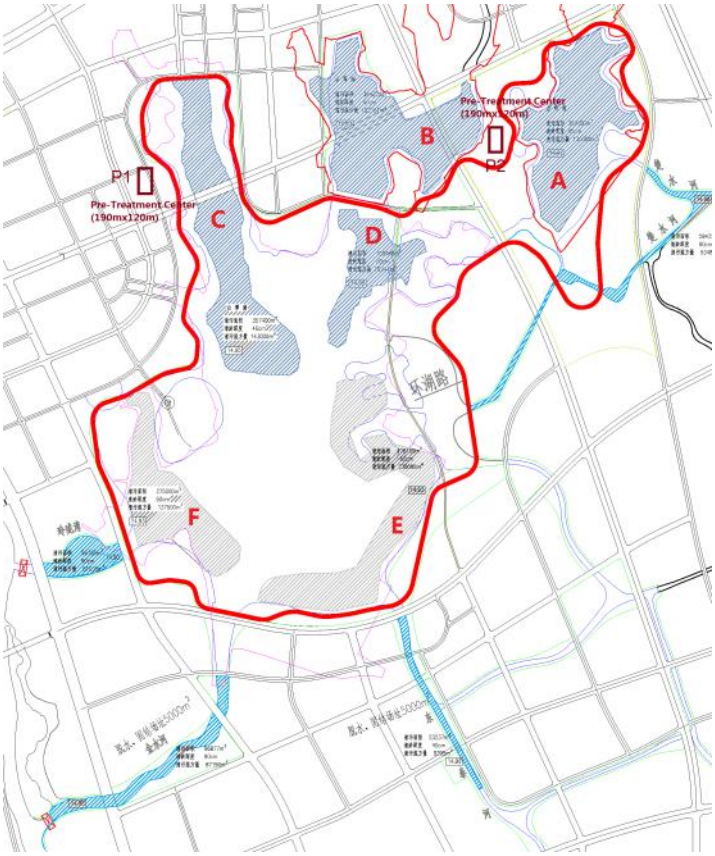

Figure VI.1: Dredging locations considered in alternative analysis

Table VI.1: Dredging locations, areas and volumes

Lake	Locations	Area(m2)	Average Depth of dredging(m)	Dredging quantity (m3)	Comments
Chiye	A	302,160	0.45	135,000	Considered in the revised proposal
Baitan	B	364,322	0.5	182,161	
	C	357,400	0.4	143,000	
	D	158,488	0.5	79,244	
Total		***1,182,370***		***539,405***	
Baitan	E	476,189	0.5	238,095	Considered in the Initial proposal
	F	275,000	0.5	137,500	

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352. **Dredging method**. Four dredging methods were evaluated (**Table VI.2**). Due to the shallow water depth in the dredging zones in Baitan and Chiye lakes (less than 2 m in average water depth)

and the precision required at a dredging depth of 0.4-0.5m of surficial sediment, the cutter suction dredger was determined to be most suitable and adopted for dredging works in Baitan Lake and Chiye Lake with the necessary horizontal and vertical operating efficiencies. This approach is the most accurate in terms of dredging depth and also reduces the amount of re-suspended sediments due to dredging. Dredging of the rivers will be done in the dry by blocking the river flow first then pump out the water followed by traditional earth excavation method.

Table VI.2: Comparison of dredging equipment

Dredging Equipment	Pros and Cons	Suitability for this Project
Cutter suction dredger	Good slurry adaptive characteristic Can be transported by pumping through pipeline eliminating pollution during transport Flexible in production rate and transport distance Mechanical cutting of sediment will stir up sediment causing pollution near the cutter head The cutter suction opening could be blocked if there is substantive quantity of refuse on the lake bed.	Suitable
Trailing suction hopper dredger	The smallest dredging capacity in the PRC is 500 m3 with a draft of > 3m and difficult to deploy in shallow water The trailing suction hopper and the boat are together and therefore difficult to transport the equipment During dredging, diluted slurry will be lost to the water causing pollution Not suitable for dredging short distances and poor control on the accuracy of the dredging radius.	Not suitable
Grab dredger	Most suitable for hard sediment with relatively high dredging rate Less suitable for soft sediment where leakage back to the water would cause pollution Dredging efficiency would be reduced substantially for shallow dredging depths Need other boats to support (e.g. transport of dredged sediment) which might interfere with dredging works	Less suitable
Open suction dredger	Suitable for dredging sediment with high moisture content Need to use high pressure spray to loosen clayey sediment which would cause water pollution This type of dredger is old, out dated and with poor efficiency	Not suitable

Source: FSR

353. **Dredged sediment treatment**. Six sediment treatment methods were evaluated (**Table VI.3**). The natural drying method was selected for treating the dredged sediment from Chiye Lake, which will be re-used for wetland fill material. The integrated solidification and dewatering method was selected

for treating the dredged sediment from Baitan Lake and the rivers, which will be re-used for fill material for other infrastructure projects or for landscaping during NED development.

Table VI.3: Comparison of dredged sediment treatment methods

Treatment Method	Pros and Cons	Suitability for this Project
Natural drying	Simple and low cost Needs bottom liner if the sediment is polluted with heavy metals or organics Slow and takes up large area Affected by weather conditions	Suitable for Chiye Lake sediment which will be used for wetland fill
Vacuum compaction	Make use of the sediment weight assisted by vacuum pipes Simple technology and low cost Slow and takes up large area Suitable for sandy sediment Less suitable for clayey-silt sediment	Not suitable
Geotextile bag	Put dredged sediment into geotextile bags and stack them up to get compression from their weights Suitable for sandy sediment with high moisture content content Sediment with high organic content would block up the geotextile pores Slow and takes up large area	Not suitable
Mechanical dewatering	Use mechanical devices such as centrifuge or belt press to dewater Low efficiency with moisture content > 65% after dewatering Suitable for small quantities such as sludge from WWTP Not suitable for large quantities of dredged sediment	Not suitable
Solidification	Use chemicals to flocculate then solidify the dredged sediment Suitable for sediment with low moisture content	Less suitable
Integrated solidification and dewatering	Combination of solidification followed by mechanical dewatering described above Suitable for treating large quantities of dredged sediment Suitable for reducing moisture content of clayey-silt sediment Fast (retention time about 10 days) and takes up less area Could reduce moisture content to approximately 40% Treated sediment could be stored for future re-use	Suitable and selected for treating Baitan Lake and river dredged sediment

Source: FSR

354. **Lake ring road bridge design**. Two types of bridge design were evaluated: hollow slab and cantilever. The use of pre-fabricated hollow slab for bridge construction was selected due to less on-site construction activities (and thus community health and safety issues), fast and economic reasons.

355. **Embankment design**. Three types of river embankment will be constructed depending on the locations. These are vertical, ladder-type, and slope-type embankments. Slope-type embankments will be the most common among the three. Slope type embankment is more ecologically beneficial compared to the other two types because it provides gradual linkage between terrestrial and aquatic habitats, resting places for waterfowls and easy passages for amphibians. Three types of slope

embankments were evaluated: ecological embankment, ecological wall embankment and hard wall with ecological features. Ecological embankment was selected for constructing the slope embankments, consisting of grass mats, ecological bags, and concrete gabions planted with local species. The proposed ecological embankment will provide more vegetated areas and more variety of vegetation than the other two types.

356. **Sluice gate design**. Five designs were evaluated for the two sluice gates on the Jinshui River and Linglong Bay respectively (**Table VI.4**). The steel gate was selected for its simplicity in structure, installation, operation and maintenance with long service life and good scenic effect, despite higher capital cost.

Table VI.4: Comparisons of sluice gate designs

Design	Pros and Cons
Steel gate	Simple structure and operation Easy to install and maintain with long service life Easy to open and close with adjustments on the tilt angle Good scenic effect with overflow looking like water fall High capital cost
Rubber dam	Easy to adapt to topography Easy to manage Less water resistance due to wide span but effective in blocking water flow Comparatively less sturdy and shorter service life Slow in opening and closing
Horizontal sliding gate	Less force needed to open and close Less capital investment Need space for the gate house Underwater rollers easy to malfunction and difficult to maintain and repair
Bottom lying gate	Sturdy with less water seepage Complex supporting shaft structure which is difficult to maintain and repair More force and longer time needed to open and close
Vertical open and close gate	Sturdy with less water seepage Easy to install and maintain Less capital investment Need space or room to house the open-close mechanism Poor scenic effect

Source: FSR

357. **Type of wetlands.** The choice of subsurface flow (SSF) wetlands for the treatment of stormwater inflows (first flush) to the Lakes was influenced by the maximum hydraulic loading rate

(HLR) of 50 cm/d recommended by the MEP presumptive criteria[29] which is significantly higher than the recommended HLR for free-surface water (FSW) wetlands of 20 cm/d. Utilizing the MEP HLR-based sizing criterion for SSF wetlands of 50 cm/d, the total area of SSF wetlands was found to be 3.84 ha. This equals 1.0% of the contributing watershed area. This is an acceptable minimum, as a range of 1-5% has been commonly observed for effective treatment wetlands. FWS wetland area would be 9.60 ha. This area would total 2.5% of the contributing watershed area, significantly larger than the proposed SSF wetland alternative, but acceptable. From the experience of PPTA wetland specialists, a 20 cm/d HLR for a FWS wetland is relatively high, although within range of experience in the literature. Reductions in COD would be similar in both systems and anticipated to achieve the Class IV criterion (25 mg/L). Reductions in TN and TP in the FSW wetlands would be less, however, and would require a larger wetland areas to achieve the same efficiency projected for the SSF wetlands (**Table VI.4**). The choice of SSF wetlands is justified.

Table VI.4: Comparison of SSF and FSW wetlands

	Contributing Basins	Watershed Area	First Flush Volume [a]	Average Event Flow	SSF wetlands [b]	Outflow concentration			FSW wetlands c	Outflow concentration		
Location		ha	m^3	m^3	m^2	COD (mg/L)	TN (mg/L)	TP (mg/L)	m^2	COD (mg/L)	TN (mg/L)	TP (mg/L)
1	7, 8, 9, 10	145.15	7,257.50	2,793.70	14,515	25	1.2	0.47	36,288	25	2.47	0.57
2	4, 5, 6	92.11	4,605.50	1,772.90	9,211	25	1.2	0.47	23,028	25	2.47	0.57
3	1, 2	53.7	2,685.00	1,033.60	5,370	25	1.3	0.48	13,425	25	2.47	0.57
4	11, 12,13,14	93.04	4,652.00	1,790.80	9,304	25	1.2	0.47	23,260	25	2.47	0.57
Total		384	19,200.00	7,390.90	38,400				96,000			
				38%	3.84 ha				9.6 ha			
Wetland: Watershed Area Ratio (WWAR)					1.00%				2.50%			
Notes												
a		Assumes 5 mm rainfall equals first flush volume										
b		50 cm/d hydraulic loading rate (HLR)										
c		20 cm/d hydraulic loading rate (HLR)										

Source: PPTA Consultant Report

358. **Sub-surface flow (SSF) wetland location and size**. The location and size of the SSF wetlands were reviewed by the PPTA consultant, to account for stormwater catchment areas and first flush volumes of different contributing basins in the Baitan Lake planning area (issues not considered in the original design). **Figure VI.2** compares the original and revised locations of the SSF wetlands. **Table VI.5** compares their original and revised sizes, indicating that PPTA consultant's optimization has achieved a reduction in the total size of the SSF wetlands by 65%.

[29] Ministry of Environmental Protection. 2012. Technical specification of constructed wetlands for wastewater treatment engineering. HJ 2005-2010. 13 pp. (In Chinese).

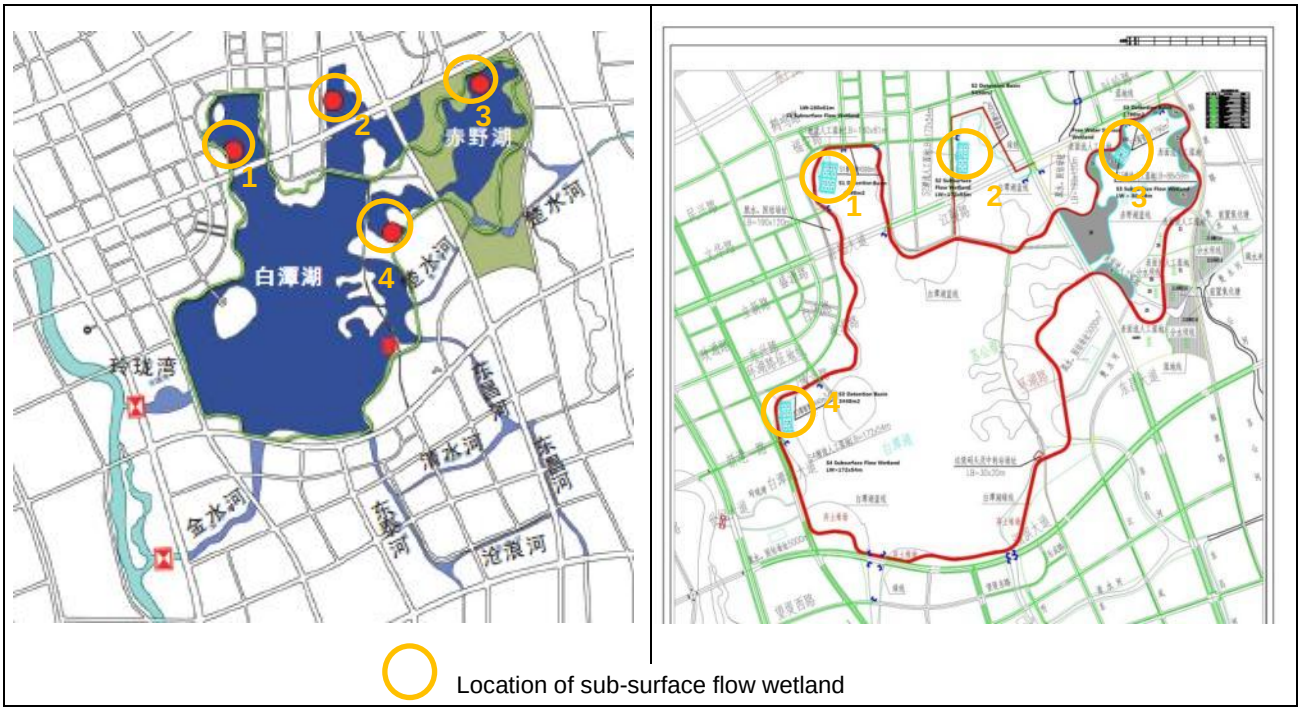


Figure VI.2: Comparison of original and revised locations of the SSF wetlands

Table VI.5: Comparison of the original and revised sizes of the SSF wetlands

	Original Proposal	**Revised Proposal**			
Location	Wetland Area	Watershed Area	First Flush Volume	Average Event Flow	Wetland Area
	m2	*ha*	*m3*	*m3*	*m2*
1	30,000	145.15	7,257.5	2,793.7	14,515
2	30,000	92.11	4,605.5	1,772.9	9,211
3	30,000	53.70	2,685.0	1,033.6	5,370
4	20,000	93.04	4,652.0	1,790.8	9,304
Total	**110,000**	**384.00**	**19,200.0**	**7,390.9**	**38,400**
	11.00 ha			**38%**	**3.84 ha**

359. **Supplementary water**. The FSR compared supplementary water needs of 1.5 m^3/s and 2.5 m^3/s, and adopted 1.5 m^3/s for the project indicating that this would satisfy the environmental water flow for Baitan Lake. The PPTA consultants reviewed these figures based on wetland vegetation water needs and hydraulic loading rates and further reduced the required water transfer to 1.1 m^3/s: Assuming the FWS wetland area of 80 ha, the system requires a corresponding hydraulic loading of 80,000 m^3/d. As the catchment area of the Xingfu River is about 28 km^2, there is little flow in the river if there is no rain. Therefore, the hydrologic modeling for the project has assumed that the required hydraulic loading of 80,000 m^3/d would be provided by transferring some 1.1 m^3/s from the Ba River

through the Xingfu gate/Hongqi pumping station.

VII. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

A. Legislative Framework for Information Disclosure, Consultation and Participation

360. Meaningful participation and consultation in the evaluation of project planning, feasibility study, environmental impact and mitigation, design and implementation is an important safeguard requirement, directly reflecting the public's perceptions of environmental quality in the project's area of influence. Relevant provisions in the *Environmental Protection Law* of PRC (1989) and the *Regulations on the Administration of Construction Project Environmental Protection* (Order of the State Council, No. 253) require that "Environmental Impact Report formulated by construction unit shall be in accordance with relevant laws to solicit the opinions of units concerned and inhabitants of project construction site". In January 2011, MEP circulated the draft *Technical Guidelines for Environmental Impact Assessment: Public Participation* for public commenting, which specifies the requirements of information disclosure and stakeholder opinion survey. ADB's SPS 2009 also requires meaningful participation, consultation and information disclosure. The consultation processes for this project therefore followed both the PRC requirements and the ADB requirements.

361. Meaningful information disclosure and public consultation on environment, health and safety issues have been conducted during preparation of the planning and project EIRs and this project EIA. Information disclosure and consultation included: (i) internet disclosure; (ii) informal communication with key stakeholders which included residents, local authorities and sector specific institutions and authorities; (iii) questionnaire surveys; and (iv) discussion forums attended by affected people and other concerned stakeholders.

B. Information Disclosure, Consultation and Participation during the Planning EIR Process

1. Information Disclosure

362. Information related to the planning EIR was disclosed twice (**Figure VII.1**). The first time was on the Huanggang Municipality Government (HMG) web-site in May 2012 upon commencement of the planning EIR. The second time was in June 2013 on the Hubei Environmental Protection Department (HEPD) web-site after completion of the planning EIR. Information disclosed included basic information on the Baitan Lake planning area, potential environmental impacts from developments in the planning area, comments and suggestions from the public on environmental protection, and contact information of the project proponent and local design institute conducting the planning EIR. No comment was received during and after both disclosures.

May 2012

June 2013

Figure VII.1: Information disclosure during the planning EIR process

2. Questionnaire Survey

363. A questionnaire survey was conducted in July 2012 targeting the affected persons, households, and industries in and adjacent to the Baitan Lake planning area. One hundred survey forms were distributed and all were returned. Of the 100 people surveyed, 50% were between the age of 40~60. Only 8% had university or above education, 46% were farmers, and 34% were females. The survey results are summarized in **Table VII.1**, showing that 74% would support the development of the NED with 4% against. Noise and air pollution were deemed as the major existing environmental problems in the Baitan Lake planning area, followed by water pollution. Approximately two-third of the respondents viewed that development of the Baitan Lake planning area would bring positive impacts to the area and 7% viewed that it would bring negative impacts. Resulting major environmental impacts would include water quality degradation and noise disturbance during construction, and that preventing and controlling water pollution and providing solid waste collection and transfer would be the key environmental protection measures. 86% of the respondents would agree or would not mind to be resettled, with the majority preferring to be resettled nearby within the NED or compensated by one off cash payment.

Table VII.1: Summary of questionnaire survey results during the planning EIR process

Opinion Surveyed		Respondent	
		Number	Percentage
What is your understanding of the Baitan Lake development plan within the New Eastern District?	Understand	14	14%
	Basically understand	64	64%
	Do not understand	12	12%
What is your most dissatisfaction on your existing working or living environmental condition?	Air pollution	18	18%
	Noise disturbance	66	66%
	Unsanitary environmental condition	15	15%
	Traffic congestion	1	1%
What are the major environmental problems that exist in this area (multiple answers possible)?	Water pollution	47	47%
	Air pollution	74	74%
	Noise pollution	68	68%
	Solid waste	38	38%
	Damage to ecosystem	13	13%
	Other	2	2%
What is the overall impact to the residents upon implementation of the Baitan Lake development plan?	Positive impact	64	64%
	Negative impact	7	7%
	No impact	15	15%
	Uncertain	14	14%
What are the environmental impacts upon completion of development in the Baitan Lake planning area (multiple answers possible)?	Overall air quality degradation	38	38%
	Water quality degradation in the lakes and rivers	70	70%
	Noise disturbance	55	55%
	Exhaust emissions from vehicles	29	29%
	Other	4	4%
What environmental protection measures should be emphasized in implementing the development plan (multiple answers possible)?	Protection of rare flora and fauna	7	7%
	Water pollution prevention and control measures	64	64%
	Solid waste collection and transfer	71	71%
	Noise reduction measures on major roads	33	33%
	Other	0	0%
What is your attitude towards the NED development?	Support	74	74%
	Against	4	4%
	Does not matter	22	22%
What is your attitude if you need to be resettled as a result of the development?	Agree	65	65%
	Disagree	14	14%
	Does not matter	21	21
What compensation method would you prefer if your homestead or your farmland were to be acquired?	Nearby resettlement within the NED	40	40%
	One off cash compensation	54	54%
	Land exchange	4	4%
	Other	2	2%

Source: Planning EIR

3. Interviews

364. Interviews were conducted in July 2012 with 50 stakeholders representing various industries and enterprises within the Baitan Lake planning area, and related government agencies in the Huangzhou District. Interview results are summarized in **Table VII.2**. Most viewed that development of the Baitan Lake planning area would change the urban landscape and traffic network, providing connection to the old urban center and promoting economic development. Most viewed resettlement and inadequate supporting infrastructure would be among the key constraints that would limit the development of the Baitan Lake planning area.

Table VII.2: Stakeholder interviews during the planning EIR process

Opinion		No. of Interviewee
How will the development of the Baitan Lake planning area impact on the development of the Huanggang Municipality?	Promote economic development	42
	Change the urban landscape	42
	Worsen the ecological environment	2
	Worsen the water environment	3
	Connect to the old urban center	25
	Change the urban traffic network	34
What are important environmental issues that might constraint the development of the Baitan Lake planning area?	Nature reserve	23
	Drinking water protection zone[30]	21
	Surrounding residential areas	35
	Forest park[31]	16
	Important cultural heritage[32]	4
	No constraint	2
	Not clear	3
	Other	9
Which of these issues could constraint the development of the Baitan Lake planning area?	Resettlement of residents	42
	Relocation of industries[33]	21
	Inadequate supporting infrastructure	36
	Sensitive ecology (脆弱)	17
	Carrying capacity of the water environment	23

Source: Planning EIR

[30] This refers to the Yangtze River which is outside the Baitan Lake planning area

[31] This refers to the Huangzhou Binjiang Forest Park which is approximately 6 km from the Baitan Lake planning area (see Figure IV.3)

[32] This refers to the Dongpo Red Cliff Scenic Area which is approximately 6 km from the Baitan Lake planning area (see Figure IV.3)

[33] Existing industries are described in Chapter IV: Baseline Environment, Section A: Existing Setting of the Baitan Lake Planning Area. The planning EIR addressed industrial relocation within the planning area. However, this project will not involve industrial relocation and is therefore not a project-specific issue.

4. Discussion Forum

365. A discussion forum was held on 25 October 2012 involving representatives from relevant HMG agencies including the Environmental Protection Bureau, Development and Reform Commission, Land Resources Bureau, Water Bureau, Construction Bureau, Planning Bureau, Forestry Bureau, Power Supply Bureau, Sanitation Department, as well as representatives from the water company and the Nanhu Wastewater Treatment Plant. The planning EIR raised 6 recommendations during the discussion for adjusting the planning of the Baitan Lake area, which were accepted by the Huanggang NED Command Center (**Table VII.3**), which is the headquarters for managing and supervising the NED development.

Table VII.3: Recommendations on planning adjustment in the Baitan Lake planning area

No.	Adjustment Intent	Recommendation
1	To establish safety protection zones along each side of the railway traversing through the planning area	(1) No establishment shall be built within the safety protection zone of at least 35 m from the edge of each side of the inter-city railway line.
2	To establish corresponding water pollution prevention plan for protecting the water environment within the planning area	(1) Departments responsible for greening and landscaping shall prepare landscape plans for the urban lakes according to the Baitan Lake Control Plan, and shall be responsible for carrying out landscape planting, increasing greenery areas, forming green belts along lake shores, and enforcement of greening activities. (2) The water administrative and other relevant departments in Huanggang Municipality shall follow the lake protection plan to establish lake planning control zones consisting of water area, greenery land use and perimeter control zone, and disclose to the public on this plan. The water area shall be the highest lake water control level. The greenery land use shall extend at least 30m from this highest lake water control level. The perimeter control zone shall extend at least 300 m from the edge of the greenery land use. Except for planned public facilities, no other structures are allowed to be built within the perimeter control zone. (3) Written application shall be submitted to the municipality's water administrative department for using Baitan Lake and other lakes in the planning area for any activity.
3	To protect Baitan Lake	(1) Install wastewater interception along the edges of Baitan Lake to prevent construction and domestic wastewater from entering the lake. (2) To prevent the wastewater generated during operation of the book exhibition center from entering Baitan Lake, wastewater pipeline network for the land to be used for the book exhibition center shall be installed concurrently with the main works for wastewater collection network to ensure that wastewater will be conveyed by the

No.	Adjustment Intent	Recommendation
		pipeline network to WWTP. (3) Implementation of the control plan will improve the connection of Baitan Lake with Santai River. Sediment dredging in Linglong Bay, Dongtai River, Sugong River and Qingshui River shall be planned accordingly to prevent secondary pollution to Santai River. (4) Should other piers be constructed (13 planned) in Baitan Lake, related transportation means must adopt strict environmental protection measures to ensure the total collection and treatment of wastewater with no direct discharge into Baitan Lake. Boats must use clean energy such as electricity and the use of fuel oil is forbidden.
4	To speed up implementation of the sewage treatment plan	(1) Nanhu WWTP expansion to 100,000 m3/d treatment capacity.
5	To prevent external environmental impact to the planning area	(1) The Lukou Industrial Park is to the north of the NED. Expansion of the Lukou Industrial Park should be to the north and a 300 m buffer distance shall be maintained between the industrial park and NED. (2) The Huanggang Petrochemical Park is to the northeast of the NED. Expansion of the petrochemical park should be to the east and a 1 km buffer distance shall be maintained between the petrochemical park and NED.
6	To speed up the construction of basic facilities	(1) The principle of prioritizing the construction of environmental protection and basic facilities shall be adopted. Near term construction plan shall include the wastewater collection network, solid waste collection and transfer facilities, solid waste pier, etc.
Note: all above recommendations were accepted by the Huanggang NED Command Center		

Source: Planning EIR

C. Information Disclosure, Consultation and Participation during the Project EIR Process

1. Information Disclosure

366. Information related to the project EIR was disclosed twice (**Figure VII.2**) on the Hubei Environmental Protection Department (HEPD) web-site. The first time was in December 2012 upon commencement of the project EIR. The second time was in July 2013 after completion of the draft project EIR. No comment was received during and after both disclosures.

December 2012

July 2013

Figure VII.2: Information disclosure during the project EIR process

2. Questionnaire Survey

367. A questionnaire survey was conducted in June 2013, targeting the affected persons in the Baitan Lake planning area. Fifty three survey forms were distributed and fifty were returned. Of the 50 people surveyed, 58% were between the age of 30~50 and 36% were above the age of 50, about 50% had senior high school or above education, and only 8% were females. The survey results are summarized in **Table VII.4**, showing that no respondent disagree with having this project. Water pollution was deemed to be the major existing environmental problem in the Baitan Lake planning area, followed by air pollution. Wastewater was deemed to be the major environmental problem during and after construction of the project. The project was deemed by 86% to result in obvious improvement to the water environment of the rivers and lakes, and almost all the respondents viewed that this project would promote economic development and improve their living standard.

Table VII.4: Summary of questionnaire survey results during the project EIR process

Opinion Surveyed		Respondent	
		Number	Percentage
What is your understanding of the Huanggang Urban Environment Improvement Project?	Understand	36	74%
	Basically understand	12	24%
	Do not understand	2	4%
What are the major environmental problems that exist in the project area?	Water environment	46	92%
	Air environment	5	10%
	Noise	0	0%
	Scenic environment	4	8%
	Other	0	0%

Opinion Surveyed		Respondent	
		Number	Percentage
What are the environmental problems of concern during construction and during operation?	Wastewater	42	84%
	Dust	6	12%
	Sediment, spoil and other solid waste	10	20%
	Noise	6	12%
	Management and measures	4	8%
What is your view on the water environment of Baitan Lake, Chiye Lake and other river channels after completion of this project?	Obvious improvement	43	86%
	Slight improvement	7	14%
	No obvious improvement	0	0%
	Adverse impact	0	0%
What is your view on the local function of this project?	Promote economic development	48	96%
	Increase employment opportunity	6	12%
	Improve living standard	50	100%
	Only limited function	0	0%
	Do not know	0	0%
Do you agree to have this project?	Agree	46	92%
	Acceptable	4	8%
	Disagree	0	0%

Source: Project EIR

3. Discussion Forum

368. A discussion forum was held on 7 June 2013 attended by representatives of the affected communities in the planning area and representatives from relevant government agencies. Discussion centered around project EIR findings on potential environmental impacts during construction and operation of the project and corresponding mitigation measures. The need to establish a project-specific grievance redress mechanism was explained to the participants. All representatives accepted the findings and supported the project. Discussions, suggestions and responses are summarized in **Table VII.5**.

Table VII.5 Discussion forum during the project EIR process

Organization	Comment and Suggestion	Proponent Response
Women's Union	What will be the daily dredged sediment treatment quantity? Where will the wastewater from NED go?	Sediment treatment from entering the treatment center to completion of dewatering will take approximately 10 days. Approximately 5,000 m3 of dredged sediment will be treated per day. The wastewater from NED will be conveyed by planned pipeline network and pump station to the existing

Organization	Comment and Suggestion	Proponent Response
		Nanhu WWTP for treatment.
Aquatic Products Bureau	The construction stage is too long.	Will liaise with the design institute to confirm the construction duration.
Water Bureau	The dredging works should be concentrated to shorten the dredging duration. How will construction and demolition waste be handled?	Will liaise with the design institute to confirm the dredging duration. Construction and demolition waste will be delivered to the Huanggang Spoil Management Office.
Forestry Bureau	The project is not located in nature reserve area, there is no old tree (protected tree). The cutting down of trees and the acquisition of forestry land will need submission of application for processing.	Noted.
Disease Control Center	There is no *shistosomiasis* disease presently in the project area. This project aims at improving environmental conditions. From a sanitation viewpoint, the project would potentially reduce the occurrence of diseases.	Noted.
Cultural Heritage Bureau	There is no culture heritage resource within the project area. The cultural departments will organize site investigation within the project area before commencement of construction to determine whether there is any buried cultural artefacts.	Noted.
Nanhu Farm Team and village representatives	Support the project.	Noted.
Development and Reform Commission	Support the project.	Noted.

Source: Project EIR

D. Future Plans for Public Participation

369. Meaningful consultation to safeguard the environment and local residents will continue throughout construction and operation phases. The IA and the HPMO will be responsible for organizing the public consultations, with the support of the Loan Implementation Environmental Consultant (LIEC) to be hired by the IA under the loan implementation consulting services. The contractors will be required to communicate and consult with the communities in the project area of influence, especially

those near NMT road alignments and river dredging and embankment works areas. Eye-catching public notice boards will be set at each work site to provide information on the purpose of the project activity, the duration of disturbance, the responsible entities on-site (contractors, CSCs, IA), and the project level Grievance Redress Mechanism (GRM). Contact information of all GRM entry points and the HPMO will be disclosed on the construction site information boards. Consultation will focus on public complaints about public nuisances from construction and operation activities, such as noise, asphalt fume nuisance, dust, construction and demolition waste, wastewater and muddy runoff from construction sites, traffic disturbance, as well as public concerns about the environment and resettlement.

370. Future consultation and participation will also include involvement of affected people during inspection and monitoring of EMP implementation during construction and operation phases through informal interviews and disclosure of monitoring reports. The EMP has accordingly provided plans for future public participation. The EMP for this project is included as **Attachment EMP** to this report.

371. The project environmental information will be disclosed by ADB as follows: (i) this project EIA is available at www.adb.org; (ii) copies of the domestic EIRs (in Chinese) are available on request at the HPMO; and, (iii) environment progress will be reported in the quarterly project progress reports and the annual environmental monitoring reports which will be disclosed on ADB's project website (www.adb.org).

VIII. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

372. An environmental management plan (EMP) has been prepared for the Project. It is an essential document to ensure the implementation of mitigation measures. The full EMP is presented in **Attachment EMP**. It will also be attached to the Project Administration Manual (PAM) of the Project. The EMP defines mitigation measures and describes the involved institutions and mechanisms to monitor and ensure compliance with environmental regulations and implementation of the mitigation measures. Such institutions and mechanisms will seek to ensure continuous improvement of environmental protection activities during preconstruction, construction, and operation of the project in order to prevent, reduce, or mitigate adverse impacts. The EMP draws on the domestic project EIR, this project EIA, the SEPP, and on the PPTA discussions and agreements with the relevant government agencies. The EMP will be reviewed and updated at the end of the detailed design in order to be consistent with the final detailed design. The updated EMP will be disclosed on ADB's project website.

IX. GRIEVANCE REDRESS MECHANISM

373. Public participation, consultation and information disclosure undertaken as part of the local EIR process, assessment and development of resettlement plans, and consultations undertaken by the project consultants have discussed and addressed major community concerns. Continued public participation and consultation have been emphasized as a key component of successful project implementation. As a result of this public participation and safeguard assessment during the initial stages of the project, major issues of grievance are not expected. However, unforeseen issues may occur. To settle such issues effectively, a transparent grievance redress mechanism (GRM) for lodging complaints and grievances has been defined for environment related issues.

374. The GRM has been designed to help achieve the following objectives: (i) open channel for effective communication, including the identification of new environmental issues of concern arising from the project; (ii) prevent and mitigate any adverse environmental impacts on communities caused by project construction and operations; (iii) improve mutual trust and respect and promote productive relationships with local communities; and (iv) build community acceptance of the project.

375. The HPMO will establish a complaints center with hotline for receiving both environmental and resettlement grievances.The details of the GRM are described in the EMP (**Attachment EMP**), and were also explained during public consultation with the participants of the public forum. The GRM will be operational prior to commencement of construction works.

X. CONCLUSION AND RECOMMENDATION

A. Expected Project Benefits

376. This project will directly benefit an existing population of approximately 12,000 and the projected population of approximately 100,000 in the 25.27 km^2 Baitan Lake planning area by 2020. Indirectly, this project will benefit the projected future population of approximately 500,000 in Huangzhou District of Huanggang. By expanding the old and congested urban center to the New Eastern District (NED), modern facilities and infrastructure will be available which will improve the administrative and management functions of the municipal government, conditions for commerce and trade, connectivity to other counties, townships and villages, and urban living environment. All these will provide the municipal government the hardware for driving socio-economic growth in Huanggang Municipality and reaping the benefits of national and provincial policies.

377. This project will enhance the environmental conditions of the rivers and lakes in the Baitan Lake planning area. Baitan Lake and Chiye Lake are both mesotrophic with worse than Category V and Category V water quality respectively due to high total nitrogen levels. This project will remove approximately 740,407 m^3 of nutrient laden sediment through dredging. Construction and operation of sub-surface flow and surface flow wetlands in Baitan Lake and Chiye Lake totaling approximately 84 ha will remove pollutants from the stormwater runoff (first flush) during rain events and polish lake water quality, removing approximately 171 t chemical oxygen demand, 1.1 t total phosphorus and 49 t total nitrogen from these water bodies each year. This would reduce the eutrophic potential of Baitan Lake and Chiye Lake to meet the planning targets of Category IV water quality in the near term for their scenic water function.

378. These wetlands, together with aquatic planting and ecological embankments constructed under this project would provide habitats to wildlife in the area, thus conducive to enhancing biodiversity in and around the rivers and lakes in the planning area.

379. The scenic function of the lakes, the lake ring road for non-motorized traffic, and landscaped strips along river banks and the lake ring road will improve the aesthetics of the area for the residents of Huanggang Municipality to relax and enjoy. The provision of the pier, solid waste collection and transfer vessels and vehicles, and a solid waste transfer station will improve the collection, transfer and disposal of solid waste floating in the lakes and rivers, as well as vegetation from wetland maintenance, will also reduce lake pollution and improve the scenic and aesthetic value of the Baitan Lake planning area.

380. River-lake connection and embankment construction will improve flood protection to 1-in-20 year storm events. This will reduce the flooding and water logging risk in the planning area, protecting local residents from property and economic losses.

B. Adverse Impacts and Mitigation Measures

381. This project will take up 166.44 ha of land permanently and 13.48 ha temporarily. Over 80% of the land take are fish ponds (61.8%) and dry farmland (19.8%). All these account for only a minute portion (less than 0.1%) of similar land use types in the Huanggang Municipality. Approximately 85% of the permanent land take will be for creating the wetlands and constructing the river-lake connection. These areas will be restored and re-vegetated after construction completion.

382. A population of 1,324 from 360 households will be affected by this project. House demolition will involve 4,736.5 m^2 of residential houses and 11,038 m^2 of non-residential houses. Compensation will be in accordance with the land acquisition and resettlement plan (LARP). No physical cultural resource would be affected by this project.

383. During construction, potential impacts mainly relate to earthwork, sediment dredging, and construction of embankments, bridges, ring road and the pier. The project may have soil erosion, air quality, noise, water quality, ecology, solid waste and occupational health and safety impacts. Potential air quality impact may occur due to fugitive dust generated on the construction site from stockpiles of uncovered earth materials and vehicles travelling on unpaved haul roads, as well as fumes from asphalt cement during road paving. The use of powered mechanical equipment during construction activities will generate noise. Construction activities will generate process wastewater and construction workers will produce wastewater. Dredging will stir up and re-suspend the sediment, affecting water quality as well as aquatic biota. Earthwork and construction activities will remove vegetation and ecological habitats, causing disruption and disturbance to nearby biota. Construction works will produce construction and demolition (C&D) wastes including excavated earth materials and dredged sediment. Workers will face occupational health and safety issues working on construction sites. Good housekeeping and effective mitigation measures will be implemented to reduce these impacts to acceptable levels. The temporary land take areas for construction staging areas, haul roads and borrow pits will be vegetated and landscaped upon completion of the construction stage.

384. Ecological data indicate that of the flora and fauna species recorded in the planning area, 84 species are on the national, provincial and/or IUCN protection lists. Of these, 4 species (2 plants and 2 reptiles) are Endangered (EN) and 7 species (2 mollusks, 1 fish, 1 reptile and 3 birds) are Vulnerable (VU) on the IUCN red list. The two endangered plant species, the Maidenhair Tree and the Dawn Redwood are both cultivated species in the planning area. The two reptiles, the Chinese Pond Turtle and the Yellow Pond Turtle, are deemed endangered due to human exploitation for food and medicine. The *Catalogue of Life China 2012 Annual Checklist* describes that both turtle species are widely distributed in many provinces in the PRC. The *Catalogue of Life China 2012 Annual Checklist* also describes that the 7 vulnerable species (two freshwater mussels, the Wild Carp, the Chinese Soft-shell Turtle, the Swan Goose, the Yellow-breasted Bunting and the Hooded Crane) are widely distributed in many provinces in the PRC. The Baitan Lake planning area is not the “type locality” of any of these protected species.

385. Ecological data also show that Baitan Lake is a popular wintering ground for water birds, although the major water bird wintering ground in Huanggang Municipality is at the Longgan Lake

Nature Reserve which is approximately 120 km to the southeast of the Baitan Lake planning area. Mitigation measures have been formulated and included in the EMP to restrict construction activities between 09:00-16:00 hours from November to next March to prevent disturbance of water birds' dawn and dusk feeding hours during their wintering period.

386. Other provincial protection areas in Huanggang Municipality, besides the Longgan Lake Nature Reserve, include the Lijiazhou Egretry Nature Reserve which is approximately 16 km to the northwest of the planning area, and the Huangzhou Binjiang Forest Park and Dongpo Redcliff Scenic Area which are both approximately 6 km to the southwest of the planning area. These provincial protection areas are far enough away from the Baitan Lake planning area and no impact on these protection areas is anticipated.

387. The project will mainly generate positive environmental impacts during operation. During operation of the connected river-lake system, the sluice gates at the confluences of Jiushui River and Linglong Bay with Santai River should not affect fish migration. Migrating fish generally move to fast flowing or shallow river water before the onset of the rainy season to spawn, then return in the fall after the rainy season to winter in the deeper water in the lakes. Since the sluice gates would only be closed in the winter to retain Baitan Lake's water level and occasionally when the Santai River water level is higher than that in Baitan Lake during storm events, which would only occur for short durations during high flow before which the migrating fish should have already exited Baitan Lake and before their return to the lake in the fall after the wet season for wintering. The extraction of 1.1 m^3/s from the Ba River would constitute less than 4% of the dry season flow in the Ba River and should not affect downstream water users.

388. Based on information gathered and assessments performed in the planning and project EIRs, it is concluded that environmental impacts during the construction and operational stages of the project would be acceptable and in compliance with PRC regulations and standards and ADB's Safeguard Policy Statement (2009) if the prepared EMP is implemented and monitored diligently. The EMP defines mitigation measures and monitoring requirements for the design, construction, and operational stages of the project. It is an appropriate environmental safeguard for the planned works and forms part of a comprehensive set of project management documents.

C. Risks and Assurances

389. The project has no unusual technical risks and conventional engineering designs with proven reliability and performance will be adopted for all the engineering components. From an environment safeguards point of view, the main risk relates to the failure of the HPMO, HUCIC and O&M units to monitor environmental impacts and implement the EMP during construction and operational stages. This risk will be mitigated by (i) providing training in environmental management under the project; (ii) appointing qualified project implementation consultants, (iii) following appropriate project implementation monitoring and mitigation arrangements, (iv) ADB conducting regular project reviews; and (v) project assurances covenanted in the loan and project agreement with ADB.

390. General and specific environmental project assurances are required to ensure that the project can achieve its envisaged outcome. The following section defines draft assurances that will included in the loan and project agreements.

391. HMG undertakes not to award any civil works contract under a project Component unless the project Environmental Management Plan (EMP) has been updated based on the final detailed design, as needed, and submitted to ADB for its concurrence prior to commencement of any related civil works, and disclosed to affected people in accordance with ADB's applicable information disclosure requirements for environment.

392. ***SPS, PRC laws and regulations.*** HMG will ensure that the preparation, design, construction, implementation, operation and decommissioning of the Project and all Project facilities comply with (a) all applicable laws and regulations of the PRC relating to environment, health and safety; (b) the Environmental Safeguards Policy Statement; and (c) all measures and requirements set forth in the EIA, the EMP, and any corrective or preventative actions (i) set forth in a Safeguards Monitoring Report, or (ii) which are reasonably requested by ADB to ensure safeguards policy compliance.

393. ***Design and Construction Quality and Management****.* HMG shall ensure, and cause HUCIC to ensure, that (a) all Works under the Project are designed by Class A design institutes and that sufficient funds are made available for the employment of such institutes; (b) shall cause HUCIC to ensure that (a) all Works under the Project are designed and constructed in accordance with the Borrower's national standards and specifications, and (c) construction supervision, quality control, contract management, and completion inspection and acceptance procedures are in accordance with all applicable national, municipal and local regulations of the Borrower.

394. ***Human Resources.*** HMG will make available necessary budgetary and human resources to fully implement the EMP and the RP. In particular, HMG will ensure or cause HUCIC to ensure that (a) an adequate number of full-time personnel and sufficient resources are provided to coordinate the implementation of the environmental monitoring program; (b) the loan implementation environment consultant (LIEC) is engaged in a timely manner; (c) a licensed environmental monitoring entity is contracted to conduct environmental impact monitoring in accordance with the approved EMP; and (d) the capacity-building program described in the EMP is implemented.

395. ***Project Implementation Consultants.*** HMG shall, and shall cause HUCIC to ensure that (a) the Project implementation consultants are engaged in a timely manner, including the international and national environment specialists; and (b) the capacity-building program described in the EMP is implemented as planned from the date of engagement of the consultants until Project completion.

396. ***Safeguards-Related Provisions in Bidding Documents and Works Contracts****.* HMG shall, and shall cause HUCIC to ensure that that all bidding documents and contracts for Works contain provisions that require contractors to:

(a) comply with the measures relevant to the contractor set forth in the EIA, the EMP and the RP (to the extent they concern impacts on Affected People during construction), and any corrective or preventative actions set forth in a Safeguards Monitoring Report;

(b) make available a budget for all such environmental and social measures;

(c) provide HUCIC with a written notice of any unanticipated environmental, or resettlement risks or impacts that arise during construction, implementation or operation of the Project that were not considered in the EIA, the EMP and the RP;

(d) adequately record the condition of roads, agricultural land and other infrastructure prior to starting to transport materials and construction; and

(e) reinstate pathways, other local infrastructure, and agricultural land to at least their pre-Project condition upon the completion of construction.

397. ***Economic Displacement.*** Without limiting the application of the Involuntary Resettlement Safeguards or the resettlement plan, HMG and HUCIC will ensure that no economic displacement takes place in connection with the project until a comprehensive income and livelihood restoration program has been established in accordance with the RP to enhance, or at least to restore, the livelihoods of all affected persons in real terms relative to pre-project levels and to improve the standards of living of the poor and other vulnerable groups.

398. ***Associated and linked facilities.*** HMG shall ensure that facilities associated and/or linked to the project, including the Nanhu Wastewater Treatment Plant expansion and the construction of the Hongqi and the Nanhu pumping stations, will be completed and operational before the completion of construction stage in this project, i.e. December 2019**.**

399. ***Planning EIR.*** HMG shall, or shall cause HUCIC to ensure that the seven stipulations of the Planning Environmental Impact Report approval document HEPD [2013] 547, issued by Hubei Province Environment Protection Department (HEPD) on 4 December 2013, will be implemented.

400. ***Stormwater pipes.*** HMG shall ensure that the design and construction of the storm water pipes in the New Eastern District shall be optimized to improve protection against water logging incidents, accounting for results of hydrological modeling and climate change projections.

401. ***Wetland design.*** HMG will ensure that: (i) technical design of the sub-surface flow and surface flow wetlands complies with Technical Specification of Constructed Wetlands for Wastewater Treatment Engineering (HJ 2005-2010); and (ii) planting of wetland and other aquatic species must use non-invasive species of local provenance. Under no circumstance shall exotic or invading species be used.

402. ***Protection of migratory birds.*** HMG shall (i) contract qualified ornithologist(s) to conduct bird surveys along the perimeters of Baitan Lake and Chiye Lake to record the number of wintering water bird species and individuals, and distribution in the Baitan Lake and Chiye Lake areas during construction and operation; （ii） ensure that construction activities are restricted between 09:00-16:00 hours from each November to the following March to prevent disturbance of water birds' dawn and dusk feeding hours during their wintering period; and (iii) ensure that no regular maintenance of sub-surface flow and surface flow wetlands in Baitan Lake and Chiye Lake is conducted during the water bird winter migrating period from 1 November to 31 March each year.

403. ***Lake Dredging.*** HMG shall ensure that: (a) prior to lake dredging activities, potentially Affected People and communities are involved and informed on these activities' risks and impacts through information disclosure; (b) dredging is conducted so that the re-suspension of sediments, the release of contaminants to the water column and air, and their transport, are reduced or controlled; (c) during dredging operations, performance standards are adopted based on which control or mitigation measures are applied; (d) disposal of treated sediments either for beneficial use or to a sanitary landfill is decided on the basis of results of the laboratory tests on the treated sediments.

404. ***Changes in Scope.*** HMG shall, and shall cause HUCIC to ensure that throughout the Project implementation (a) environment due diligence is conducted for any proposed change to the Project design, including to any Linked and/or Associated Facilities, that may potentially cause negative environmental impacts; (b) in consultation with ADB, environmental monitoring and mitigation measures are revised as necessary to assure full environmental compliance; and (c) to provide ADB within 60 days from the date of any emergency action, justification for any proposed changes to the mitigation measures required during design, construction and operation for safety or emergency reasons.

403. ***Safeguards Monitoring and Reporting***.HMG will:

(a) Submit Safeguards Monitoring Reports to ADB

(i) in respect of implementation of and compliance with Environmental Safeguards and the EMP, semi-annually during construction and the implementation of the Project and the EMP, and thereafter annually during operation, until the issuance of ADB's Project completion report unless a longer period is agreed in the EMP; and

(ii) in respect of implementation of and compliance with Involuntary Resettlement Safeguards and of the RP, semi-annually during the implementation of the Project and the RP until the issuance of ADB's Project completion report unless a longer period is agreed in the RP,

and disclose relevant information from such reports to the respective affected people under the Environmental Safeguards and the Involuntary Resettlement Safeguards promptly upon submission;

(b) if any unanticipated environmental and/or social risks and impacts arise during construction, implementation or operation of the Project that were not considered in the EIA, the EMP and the RP, promptly inform ADB of the occurrence of such risks or impacts, with detailed description of the event and proposed corrective action plan;

(c) no later than six months after loan effectiveness, engage qualified and experienced external experts or qualified institutions under a selection process and terms of reference acceptable to ADB, to verify information produced through the Project monitoring process, and facilitate the carrying out of any verification activities by such external experts;

(d) report any actual or potential breach of compliance with the measures and requirements

set forth in the EMP or the RP promptly after becoming aware of the breach.

405. ***Safeguards - Prohibited List of Investments.*** HMG shall ensure that no proceeds of the Loan are used to finance any activity included in the list of prohibited investment activities provided in Appendix 5 of the SPS.

406. ***Water quality modeling.*** HMG will (i) cause the Huanggang environment protection bureau (HEPB) to develop and operate a hydraulic and water quality model, as agreed with ADB,for the Chiye and Baitan Lakes, and (ii) ensure that its water resources bureau shares monitoring information on water quantity in the project lakes with HEPB.

407. ***Labor Standards.*** HMG shall, and shall cause HUCIC to ensure that the bidding document for Works contracts under the Project include provisions to require the contractors to (a) prioritize employment of women and the poor; (b) provide equal pay for equal work; (c) provide the timely payment of wages; (d) maximize the employment of local people who meet the job and efficiency requirements for Project construction and O&M; (e) provide such workers with adequate on-the-job training and safety training; (f) comply with core labor standards and the applicable labor laws and regulations of the Borrower, including stipulations related to employment; and (g) not employ child labor.

408. ***Grievance Redress Mechanism.*** HMG shall ensure that, within 2 months of the Effective Date, a grievance redress mechanism, acceptable to ADB and in accordance with the PAM, is established and functioning effectively to (a) review and document eligible complaints of Project stakeholders; (b) proactively address grievances; (c) provide the complainants with notice of the chosen mechanism/action; and (d) prepare periodic reports to summarize (i) the number of complaints received and resolved; (ii) chosen actions; and (iii) final outcomes of the grievances and make these reports available to ADB. Eligible complaints will include (a) those related to the Project; (b) any of the service providers; (c) any person responsible for carrying out the Project; (d) complaints on misuse of funds and other irregularities; and (e) grievances due to any safeguards and gender issues.

D. Overall Conclusion

409. The domestic planning and project EIRs and this EIA conclude that all identified environmental impacts can be mitigated to acceptable levels if the measures defined in the EMP are carefully implemented and monitored. The project is feasible from an environment safeguards point of view.

ATTACHMENT TO ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

For the proposed Hubei Huanggang Urban Environment Improvement Project

People's Republic of China

Prepared by the Huanggang Municipal Government for the Asian Development Bank.

A. Introduction

1. This Environmental Management Plan (EMP) is developed for the Hubei Huanggang Urban Environment Improvement Project (the project) and defines all potential impacts of the project components and the mitigation and protection measures with the objective of avoiding or reducing these impacts to acceptable levels. The EMP also defines the institutional arrangements and mechanisms, the roles and responsibilities of different institutions, procedures and budgets for implementation of the EMP. The EMP seeks to ensure continuously improving environmental protection activities during preconstruction, construction, and operation in order to prevent, reduce, or mitigate adverse impacts and risks. The EMP draws on the findings of the project EIA, the domestic planning and project EIRs, the SEPP, PPTA and ADB review mission discussions and agreements with the relevant government agencies.

2. The EMP will be reviewed and updated, as needed, at the end of the detailed design in order to be consistent with the final technical design. The final EMP, if updated, will be disclosed on the ADB project website and included in the Project Administration Manual (PAM). The EMP will also be included as a separate annex in all bidding and contract documents. The contractors will be made aware of their obligations to implement the EMP and to budget EMP implementation and monitoring costs in their proposals.

B. Institutional Responsibilities related to EMP implementation

3. As **Executing Agency** (EA), the Huanggang Municipal Government (HMG) will be responsible for the overall implementation and compliance with loan assurances and the EMP (including Environmental Monitoring Plan).

4. **Huanggang Project Leading Group (HPLG).** The HPLG has been established for the project comprising of senior officials from relevant government agencies, to facilitate inter-agency coordination, and to resolve any institutional problems affecting project implementation at municipal level.

5. The EA has established a **Huanggang Project Management Office (HPMO),** who will be responsible, on behalf of the EA, for the day-to-day management of the project. The HPMO will have the overall responsibility to supervise the implementation of environment mitigation measures, coordinate the project level Grievance Redress Mechanism (GRM) and report to ADB. By the time of project approval, the HPMO will be fully functional with minimum 15 skilled staff at 6 units for (a) technical and engineering, (b) financial management, (c) land acquisition and resettlement coordination, (d) environmental management, (e) social and gender development, and (f) grievance redress. The HPMO will appoint at least one environment specialist to supervise the effective implementation of the EMP (under unit (d)) and to coordinate the project level GRM (under unit (f)).

6. HPMO will engage the loan implementation consultants (LIC) services, and supervise the procurement process. HPMO will also hire experienced ornithologist(s) to undertake water bird surveys in the Baitan Lake and Chiye Lake areas. The HPMO will prepare semi-annual environment monitoring reports and submit them to ADB.

7. HPMO will also contract an External Environment Monitor (EEM) to conduct independent

verification of EMP implementation and environmental impact monitoring results during the construction and operational stages of the project.

8. **Implementing Agency (IA).** The Huanggang Urban Construction Investment Company Ltd. (HUCIC) will be the IA for the project. It will hire the technical engineering design institutes (DI), implement project components, administer and monitor contractors and suppliers, and be responsible for construction supervision and quality control. To ensure that the contractors comply with the EMP provisions, HUCIC with the help and technical support of a Tendering Agent and the Loan Implementation Environmental Consultant (LIEC) under the LIC services, will prepare and provide the following specification clauses for incorporation into the bidding procedures: (i) a list of environmental management and monitoring requirements to be budgeted by the bidders in their proposals; (ii) environmental clauses for contractual terms and conditions; and (iii) major items in the EIA, and the full EMP. HUCIC will appoint on its staff at least one dedicated, trained, and qualified environment specialist to (i) supervise contractors and their compliance with the EMP; (ii) conduct regular site inspections; (iii) act as local entry point for the project GRM; (vi) submit environmental impact monitoring results provided by the EMS (contracted by the contractors) to the HPMO and HEPB for verification and confirmation. HUCIC will hire licensed construction supervision companies (CSCs) to oversee construction works and compliance with contractor EMP, health and safety requirements.

9. **Construction contractors** will be responsible for implementing the mitigation measures during construction under the supervision of HUCIC (through the CSCs) and HPMO. Contractors will also contract the local environment monitoring station (EMS) to conduct environment impact monitoring in accordance with the environmental monitoring program described in Table EMP-4[1]. In their bids, contractors will be required to respond to the environmental management and monitoring requirements defined in the EMP. Each contractor will be required to develop site specific EMPs and will assign a person responsible for environment, health and safety. After project completion, environmental management responsibilities will be handed over to O&M units.

10. **Construction Supervision Companies (CSCs).** CSCs will have the principal responsibility for overseeing contractor construction activities, and for ensuring that these activities are accomplished in compliance with the Project's environment, health and safety requirements. The specific responsibilities of the CSCs will be to:

- Confirm that all plans, processes, approvals and requirements are in place to ensure EMP compliance prior to initiation of any work;
- Check the accomplishment of the environmental measures by Contractor crews against contractual obligations by: (a) evaluating contractor efforts and effectiveness; and (b) identifying circumstances requiring management decisions to evaluate variance or compliance issues.
- Prepare monthly Standard Review Sheet (SRS) related to contractors' efforts and achievement for the purpose of monthly payment certificate for environmental activities.

[1] The monitoring plan will be confirmed or revised, as needed, in the framework of the EMP update after detailed design

- Identify circumstances requiring special study or activity, such as: (a) a committed activity linked to a specific construction activity; (b) special requirements related to a specific resource observations, i.e. archaeological control during excavation works; and (c) communicate to LIEC to allow timely and efficient implementation of specific commitments.

- Interface with Contractor's construction liaison personnel (advisory role only) to: (a) help communicate requirements; (b) obtain a hands-on view of special problems so that implementation difficulties can be communicated to LIEC to aid in problem resolution; (c) request consideration of work stoppage or a redirection of effort in the event that imminent potential for damage to a sensitive resource or a serious non-compliance situation is observed.

11. **O&M Units.** During the operational phase, HUCIC and the HEPB will periodically verify and monitor (through a licensed monitoring entity) the environmental management and implementation of mitigation measures by the operators (O&M Units) of the project components. The cost of mitigation measures in this phase will be borne by the relevant O&M Units, including:

- Huanggang Landscaping Bureau (HLB): for the operation and maintenance of the sub-surface flow and surface flow wetlands, and aquatic planting and land side landscaped areas;

- Huanggang Environmental Sanitation Bureau (HESB): for the operation, maintenance and management of solid waste collection and transfer, including the vessels, vehicles and the transfer station;

- Huanggang Aquatic Products Bureau (HAPB): for controlling and managing fish culture within Baitan Lake and Chiye Lake, and the stocking of fish and benthic fauna in these lakes;

- Huanggang Water Bureau (HWB): for operation and maintenance of flood control infrastructure such as embankments and the sluice gates.

12. **Loan Implementation Environmental Consultant (LIEC).** Under the loan implementation consultancy (LIC) services, a LIEC will support the project. The LIEC will be contracted by the HPMO, and will:

- assess the project components' environmental readiness prior to implementation based on the readiness indicators defined in **Table EMP-3** in the EMP;

- support HPMO in updating the EMP including monitoring plan as necessary to revise or incorporate additional environmental mitigation and monitoring measures, budget, institutional arrangements, etc., that may be required based on the detailed design; submit to ADB for approval and disclosure; ensure compliance with the PRC's environmental laws and regulations, ADB's Safeguard Policy Statement (2009) and Public Communications Policy (2011);

- if required, update the EIA and EMP reports for changes in the project during detailed

design or project implementation (for example if there is a minor or major scope change) that would result in adverse environmental impacts not within the scope of the approved EIA/EMP;

- assist the HMG and HPMO to establish a Grievance Redress Mechanism (GRM), and provide training for the HPMO and GRM access points (including, but not limited to, HUCIC and contractors);
- conduct regular EMP compliance assessments, undertake site visits as required, identify any environment-related implementation issues, and propose and oversee implementation of necessary corrective actions;
- assist the HPMO to prepare semi-annual environmental monitoring and progress reports to ADB;
- provide training to HPMO, HUCIC, HLB, HESB, HAPB, HWB, HEPB and contractors on environmental laws, regulations and policies, SPS 2009, EMP implementation, and GRM in accordance with the training plan defined in the EMP (**Table EMP-7**); and
- assist the HPMO and HUCIC in conducting consultation meetings with relevant stakeholders as required, informing them of imminent construction works, updating them on the latest project development activities, GRM.

13. **External Environment Monitor (EEM**, also known as Environmental Monitoring Supervision). The environment performance of the project will be verified by an independent environment monitor, to be contracted by HPMO. The EEM will review EMP implementation and monitoring activities and results; assess EMP implementation performance; visit the project sites and consult potentially affected people; discuss assessment with the HPMO and HUCIC; and suggest corrective actions. The EEM will prepare semi-annual reports, to be attached to the semi-annual environment monitoring report to ADB (and summarized herein by the LIEC). The cost for EEM will be $49,000.

14. Overall environmental responsibilities are outlined in **Table EMP-1.**

Table EMP-1: Environmental responsibility

Phase	Responsible Agency	Environmental Responsibility
Project preparation	Design Institutes on behalf of HPMO	Prepare project FSRs, EIRs, RPs, conduct public consultation
	HPEPD	Review and approve the planning and project EIRs
	PPTA consultant	Provide technical assistance, review EIRs, prepare EIA report including EMP on behalf of EA
	ADB	Review and approve the EIA and EMP, including disclosure
Engineering detailed design	Design Institutes, HPMO	Incorporate mitigation measures defined in the EMP into engineering detailed designs; update the EMP as needed
	HUCIC, HPMO, LIEC	Review updated EMP, confirm that mitigation measures have been included in engineering detailed design
	ADB	Approve updated EMP as needed, including disclosure
Tender & contracting	HUCIC, HPMO, tendering agent and contractors	Incorporate EMP clauses in tender documents and contracts

Phase	Responsible Agency	Environmental Responsibility
	HPMO, tendering agent, ADB, LIEC	Review bidding documents; confirm project's readiness
Construction	HUCIC	Appoint dedicated, trained, and qualified environment specialist(s) on its staff; contract CSC to supervise contractors and ensure compliance with the EMP; coordinate construction supervision and quality control; act as local entry point for the project grievance redress mechanism (GRM).
	HPMO	Appoint one environment specialist on its staff; supervise the effective implementation of the EMP; contract EEM and ornithologist(s); coordinate the project level GRM; prepare semi-annual environment monitoring reports and submit them to ADB; conduct public consultation and inspect implementation of mitigation measures.
	Contractors	Assign EMP implementation responsibilities; develop and implement site-specific EMP; ensure health and safety; implement mitigation measures; contract Huanggang EMS to conduct monitoring on and around construction sites in accordance with approved monitoring plan.
	EEM (contracted by HPMO)	Undertake independent verification of project's environment performance and compliance with the EMP, submit semi-annual EEM reports to HPMO, HUCIC, HEPB.
	LIEC	Advise on the mitigation measures; provide comprehensive technical support to HPMO and HUCIC for environmental management; conduct training; conduct annual EMP compliance review; support HPMO in preparing semi-annual environmental monitoring reports.
	HEPB	Conduct inspections of all construction projects relative to compliance with PRC regulations and standards.
Operation	O&M Units: HLB, HESB, HAPB, HWB	Ensure proper operation, maintenance and management of component facilities according to design standards, and implement mitigation measures and public consultations
	HPMO, LIEC	Conduct EMP compliance review, instruct HUCIC and O&M units on environmental management requirements; prepare annual EMP progress report until a PCR is issued. Contract EEM to undertake environmental impact monitoring for the first three years of operation
	EMS (contracted by O&M Units)	Undertake environmental impact monitoring until a PCR is issued; submit monitoring results to HPMO, HUCIC, HEPB.
	EEM (contracted by HPMO)	Verify EMP compliance until a PCR is issued; submit EEM report to HPMO, HUCIC, HEPB.
	HEPB	Undertake periodic and random environmental monitoring and inspect environmental compliance
	ADB	Review and approve environmental progress report, disclose on ADB project website

Notes: **ADB** = Asian Development Bank; **EEM** = External Environment Monitor; **HAPB** = Huanggang Aquatic Products Bureau; **HEPB** = Huanggang Environmental Protection Bureau; **HEPD** = Hubei Environmental Protection Department; **HESB** = Huanggang Environmental Sanitation Bureau; **HLB** = Huanggang Landscaping Bureau; **HPMO** =Huanggang Project Management Office; **HUCIC** = Huanggang Urban Construction Investment Co., Ltd.; **HWB** = Huanggang Water Bureau; **LIEC** = Loan Implementation Environment Consultant.

C. Summary of Potential Impacts and Mitigation Measures

15. Potential environmental issues and impacts during the pre-construction, construction and operation phases, as identified in the EIA as well as corresponding mitigation measures designed to minimize the impacts are summarized in **Table EMP-2**. Mitigation or safeguard includes two types of environmental measures:

16. Those that will permanently become part of the infrastructure such as noise reduction materials and odor removal equipment for the solid waste transfer station. These will need to be included in the design of the facility by the design institutes, otherwise they won't be built. The costs of building and maintaining these systems have already been included in the infrastructure construction and operating costs and therefore will not be double-counted as part of the EMP costs.

17. Those that are temporary measures particularly during the construction stage, such as dust suppression by watering and wheel washing, the use of quiet / low noise powered mechanical equipment, flocculants used to facilitate sedimentation of suspended solids in construction site runoff, etc. These will need to be included in the tender documents, otherwise they are not budgeted by the contractor and they won't be done. The costs for implementing these measures are included in the EMP. The budgets for implementing these measures in this project add up to the amount of **$2,152,000**. This amount is made up of $1,111,000 for the implementation of soil erosion protection measures according to the SEPP (without double-counting the SEPP cost for vegetation/landscaping of permanent works areas, which have already been included in the civil works costs), and $1,041,000 for other mitigation measures.

18. The mitigation measures defined in the EMP will be (i) checked and where necessary re-designed by the design institutes; (ii) incorporated into tender documents (where appropriate), construction contracts, and operational management plans; and (iii) implemented by contractors, HUCIC or HPMO, as relevant. The effectiveness of these measures will be evaluated based on the daily site supervisions by the CSCs, the results of the environmental monitoring conducted by the HEMS, and through EMP compliance verification conducted by the HPMO, the LIEC and the EEM.

Table EMP-2: Summary of potential impacts and mitigation measures

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
Detailed Design Stage						
A1. Design of the NMT lake ring road	Health and safety	A1.1. Safety of pedestrians and cyclists	Design must ensure public health and safety with clearly marked and separate lanes for pedestrians and cyclists, and ensure barrier-free design for disabled people. Design shall include fences at 15 sections of the road running close to the lakeshore (3,450m). Design of the NMT ring road shall be based on the flood water level, and shall allow groundwater and surface water to flow (requiring installation of 27 culverts).	Design Institute	HUCIC, HPMO	Included in design contract
A2. Design of solid waste transfer station and waste collection boats and vehicles	Air quality	A2.1. Odor from the transfer station	Transfer station design shall comply with "Technical Specifications for Domestic Solid Waste Transfer Stations" (CJJ47-2006); including odor removal equipment / facility, and shall comply with GB 14554-93 (Emission Standard for Odor Pollutants).	Design Institute	HUCIC, HESB	Included in design contract
	Water quality	A.2.2. Effluent discharge	Technical design of the transfer station must have collection systems for conveying leachate to municipal sewers, and comply with GB 8978-1996 (Integrated Wastewater Discharge Standard).	Design Institute	HUCIC, HESB	Included in design contract
	Noise	A2.3. Noise during solid waste loading, unloading and compaction	Technical design of the transfer station must be able to contain the operational noises during loading, unloading and compaction of the solid waste, and comply with GB 12348-2008 (Emission Standard for Industrial Enterprises Noise at Boundary).	Design Institute	HUCIC, HESB	Included in design contract
	Climate change	A2.4. GHG emissions	All building and systems designs and equipment selection (including waste collection boats and vehicles) must take into account energy efficiency, energy conservation and low GHG emissions; Vehicles must comply with Limits and Measurement Methods for Emissions from Light-duty Vehicles (Phase III,IV) (GB18352-2005),	Design Institute	HUCIC, HESB	Included in design contract
A3. Design of pumping	Noise	A3.1. Noise during	The pumping station shall be constructed in form of	Design Institute	HUCIC, HPMO	Included in

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
station for hydraulic recirculation		operation of the pumping station	semi-buried structure, with efficient acoustic protection to comply with relevant noise standard at boundary.			design contract
A4.Design of the temporary storage sites for the Chiye Lake dredged sediment	Water quality	A4.1. Discharge of supernatant water	Design of the site must include treatment of supernatant water	Design Institute	HUCIC	Included in design contract
		A4.2. Site drainage for heavy rain storm	Design of the site must include perimeter drainage for diverting overland runoff during rain storm	Design Institute	HUCIC	Included in design contract
A5. Design of river and lake embankments and flood protection works	Flood protection	A5.1. Flood damage, downstream impacts, adaptation to climate change	Technical design of the flood control function of the river channels must take into consideration extreme storm events due to climate change; Technical design of embankments must ensure flood protection for 1 in 20 years flood flows, while at the same time ensure eco-friendly embankment; Conduct detailed analysis and calculations of design water levels accounting for the final embankment design; Confirm channel conveyance capacity and water surface elevation as required in the flood control plan, and demonstrate no net increase of risk of floods downstream.	Design Institute	HUCIC, HWB	Included in design contract
A.6. Design of wetlands and aquatic planting	Ecological communities	A6.1. Invasion by foreign or exotic species	Technical design of the sub-surface flow and surface flow wetlands and planting of wetland and other aquatic species must use local species with local provenance. Under no circumstance shall exotic or invading species be used.	Design Institute	HUCIC, HLB	Included in design contract
	Design in accordance to standard	A6.2. Under- or oversizing of subsurface-flow and surface-flow wetlands	Technical design of the sub-surface flow and surface flow wetlands must comply with Technical Specification of Constructed Wetlands for Wastewater Treatment Engineering (HJ 2005-2010)	Design Institute	HUCIC, HLB	Included in design contract
Pre-construction Stage						
B1. Institutional strengthening	-	B1.1. Lack of environment management capacities within HPMO	Appoint qualified environment specialist on its staff within the HPMO; Contract loan implementation environment consultants (LIEC) within loan implementation consultant services; Conduct environment management training (with support of	HPMO, LIEC	ADB	HMG, Loan implementation TA

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			HEPB).			
	-	B1.2. Lack of environment management capacities within HUCIC	Appointment of environment specialists; Conduct environment management training;	HUCIC, LIEC	HPMO , ADB	HUCIC, Loan implementation TA
		B1.3. External environment monitor (EEM)	Contract EEM to conduct independent verification of the project's environment performance and compliance with the approved EMP	HPMO	HPMO, ADB	Loan implementation TA
		B1.4. Lack of environment management capacities within HLB, HESB, HAPB, HWB	Conduct environment management training in accordance with training plan defined in the Project Administration Manual (PAM)	HPMO, HUCIC, LIC, HLB, HESB, HAPB, HWB	EA, ADB	HUCIC, Loan implementation TA
B2. EMP update	-	B2.1. EMP does not reflect final project design	Review mitigation measures defined in this EMP, update as required to reflect detailed design, disclose updated EMP on project website, and include updated EMP in all bid documents.	HUCIC, assisted by LIEC	HPMO, ADB	HUCIC, Loan implementation TA
B3. Land-take confirmation	Land acquisition and resettlement	B3.1. Resettlement Plan update	Update the Resettlement Plan with final inventory.	Design Institute, HUCIC	HPMO, ADB	HUCIC
B4. Grievance redress mechanisms	-	B4.1. Handling and resolving complaints	-Establish a GRM, appoint a GRM coordinator within HPMO; -Brief and provide training to GRM access points; -Disclose GRM to affected people before construction begins at the main entrance to each construction site; -Maintain and update a Complaint Register to document all complaints.	HPMO, HUCIC	ADB	HPMO budget, Loan Implementation TA
B5. Tender documents	Air quality	B5.1. Dust (TSP) impact to sensitive receptors	Put into tender documents dust suppression measures defined in Table EMP-2 (this table), Construction Stage, Impact No. C1.1.	Design Institute, Tender Agent	HUCIC, HPMO	Included in tendering agent's contract
		B5.2. Fumes and PM from the asphalt mixing plant and the concrete batching	Put into tender documents measures defined in Table EMP-2 (this table), Construction Stage, Impact No. C1.2.	Design Institute, Tender Agent	HUCIC, HPMO	Included in tendering agency contract

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
		plant				
	Noise	B5.3. PME noise impact to sensitive receptors	Put into tender documents the measures defined in Table EMP-2 (this table), Construction Stage, Impact No. C1.3.	Design Institute, Tender Agent	HUCIC, HPMO	Included in tendering agency contract
	Water quality	B5.4. Construction site wastewater impact on water bodies	Put into tender documents the measures defined in Table EMP-2 (this table), Construction Stage, Impact No. C1.4.	Design Institute, Tender Agent	HUCIC, HPMO	Included in tendering agency contract
	Earthwork, quarries, borrow sites	B5.5. Disposal or storage of excavated spoil, dredged sediments	Specify in tender documents the borrow site, spoil disposal or storage sites and that only these sites could be used. Put into tender documents the measures defined in Table EMP-2 (this table), Construction Stage, Impact No. C1.7.	Design Institute, Tender Agent	HUCIC, HPMO	Included in tendering agency contract
	Health & safety	B5.6. Occupational health & safety of workers	Specify in tender documents measures defined in Table EMP-2 (this table), Construction Stage, Impact No. C3.1, C3.2, C3.3, C3.4, C3.5.	Design Institute Tender Agent	HUCIC, HPMO	Included in tendering agency contract
		B5.7. Community health and safety	Specify in tender documents measures defined in Table EMP-2 (this table), Construction Stage, Impact No. C3.6, C3.7, C3.8, C3.9	Design Institute Tender Agent	HUCIC, HPMO	Included in tendering agency contract
	Ecological resources	B5.8. Protection of fauna and flora	Specify in tender documents measures defined in Table EMP-2 (this table), Construction Stage, Impact No. C2.1, C2.2.	Design Institute Tender Agent	HUCIC, HPMO	Included in tendering agency contract
B.6 Construction traffic	Traffic	B6.1. Construction vehicles causing traffic congestion	Plan transport routes for construction vehicles and specify in tender documents to forbid vehicles from using other roads and during peak traffic hours.	Design Institute, Local traffic police	HUCIC, HPMO	Included in tendering agency contract
Estimated cost for Design and Pre-construction stage: costs are included in the detail design fee and tendering agency contracts						

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
Construction Stage						
C1. Impact on Physical Resources	Air quality	C1.1. Dust (TSP, PM_{10}) during construction	- Spray water regularly on hauling and access roads to borrow pits (at least once per day) to suppress dust; and erect hoarding around dusty activities; - Minimize the storage time of construction and demolition wastes on site by regularly removing them off site - Mount protective canvasses on all trucks which transport material that could generate dust; - Build access and hauling roads at sufficient distances from residential areas, particular, from local schools and hospitals; - Assign haulage routes and schedules to avoid transport occurring in the central areas, traffic intensive areas or residential areas. For the areas with high-demand on environmental quality, transport should be arranged at night. - Keep construction vehicles and machinery in good working order, regularly service and turn off engines when not in use; - Vehicles with an open load-carrying case, which transport potentially dust-producing materials, shall have proper fitting sides and tail boards. Dust-prone materials shall not be loaded to a level higher than the side and tail boards, and shall always be covered with a strong tarpaulin; - Install wheel washing equipment or conduct wheel washing manually at each exit of the works area to prevent trucks from carrying muddy or dusty substance onto public roads; - In periods of high wind, dust-generating operations shall not be permitted within 200 m of residential areas. Special precautions need to be applied in the vicinity of sensitive areas such as schools, kindergartens and hospitals; - Equip material stockpiles with dust shrouds. For the earthwork management for backfill, measures will include surface press and periodical spraying and covering. The extra earth or dreg should be cleared from the project site in time to avoid long term stockpiling. The height of stockpiles should be	Contractor	CSC; HEPB; LIEC; EEM	Included in construction contract

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			less than 0.7m; - To avoid odor impacts caused by channel cleaning, transport the removed trash quickly to the local landfill. Transport of dredged sediments will be undertaken in closed tank wagons to prevent scattering along the way and impacting the urban area; - No unauthorized burning of construction and demolition waste material and refuse; - Conduct regular air quality monitoring at construction site boundary to confirm compliance with relevant emission and ambient air quality standards.			
		C1.2. Fumes and PM from asphalt mixing plant and concrete batching plant	- Enclose and equip these plants with fabric filters, wet scrubbers or similar air pollution control equipment - Site these plants at least 300 meters away from residential areas [*Note: concrete batching plant must be 1 km from the nearest sensitive receptor due to noise, see Noise Mitigation Measures below*] -Comply with *Air Pollutant Integrated Emission Standard* (GB 16297-1996)	Contractor	CSC; HEPB; LIEC; EEM	Included in construction contract
	Noise	C1.3. Noise from PME and vehicles	- During daytime construction, the contractor will ensure that: (i) noise levels from equipment and machinery conform to the PRC standard for *Noise Limits for Construction Sites* (GB12523-2011), and properly maintain machinery to minimize noise; (ii) equipment with high noise and high vibration are not used near village or township areas and only low noise machinery or the equipment with sound insulation is employed; (iii) sites for concrete-mixing plants and similar activities will be located at least 1 km away from the nearest sensitive receptor; and (iii) temporary anti-noise barriers or hoardings will be installed around the equipment to shield residences when there are residences within 50 m of the noise source; - No night time (between 2200 and 0600 hours) construction within 500 m of existing and future sensitive receptors;	Contractor	CSC; HEPB; LIEC; EEM	Included in construction contract

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			- Provide the construction workers with suitable hearing protection (ear muffs) according to the worker health protection law of the PRC; -Control the speed of bulldozer, excavator, crusher and other transport vehicles travelling on site, adopt noise reduction measures on equipment, step up equipment repair and maintenance to keep them in good working condition; - Limit the speed of vehicles travelling on site (less than 8 km/hr), forbid the use of horns unless absolutely necessary, minimize the use of whistles; - Maintain continual communication with the villages and communities in the Baitan Lake planning area; - Regularly monitor noise at sensitive areas (refer to the monitoring plan). If noise standards are exceeded by more than 3 dB, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation;			
	Surface water	C1.4. Uncontrolled wastewater and muddy runoff from construction sites and work camps, disturbance of river sediments and increase SS concentrations	- Provide portable toilets and small package wastewater treatment plants on construction sites for the workers and canteens; - If there are nearby public sewers, install interim storage tanks and pipelines to convey wastewater to those sewers; - Install sedimentation tanks on construction sites to treat process water (e.g. concrete batching for bridge construction) and muddy runoff with high concentrations of suspended solids. If necessary, add flocculants such as polyacryl amide (PAM) to facilitate sedimentation; - Avoid the rainy season from May to October for the construction of sluice gates and ring road bridge foundations. Adopt mitigation measures such as placement of sandbags or berms around foundation works areas to contain muddy water runoff. Pump the slurry from pile drilling in the river bed to shore and disposed of properly; - Plan the pier construction lay out in Baitan Lake to ensure	Contractor	CSC; HEPB; LIEC; EEM	Included in construction contract

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			adequate opening for water flow. - Repair and wash construction machinery at special repairing shops. No onsite machine repair and washing shall be allowed. - Store fuels, oil, and other hazardous materials within secured areas on impermeable surfaces, with bunds and cleanup kits. - The contractors' fuel suppliers must be properly licensed, follow proper protocol for transferring fuel, and must be in compliance with *Transportation, Loading and Unloading of Dangerous or Harmful Goods* (JT 3145-88). - Protect material stockpiles against wind and runoff waters which might transport them to surface waters - Clean up all spills are according to PRC norms and codes within 24 hours of the occurrence, with contaminated soils and water treated according to PRC norms and codes. Hand over records without delay to the HPMO and HEPB.			
	Sediment dredging	C1.5. Increased SS in the water column, supernatant water management, dredged material treatment and disposal.	- Conduct dry dredging in Linglong Bay, Jinshui River, Dongtai River and Chushui River; - Inspect and maintain the dredged sediment transport pipeline regularly to prevent spillage; - Test the supernatant water at the sediment treatment sites and temporary storage site for compliance with *Integrated Wastewater Discharge Standard* (GB 8978-1996), Class I standard; - Review dredging method in Baitan Lake and Chiye Lake when SS level at downstream impact monitoring station is ≥130% of the SS level at the upstream control station (*see Monitoring Plan*). If necessary, adopt different dredging equipment or reduce dredging rate; - conduct leaching test of dredged sediment to confirm that mud cakes comply with CJ/T 291-2008 (The Disposal of Sludge from Municipal Wastewater Treatment Plant – Sludge Quality for Land Improvement) and/or CJ/T 309-2009 (The Disposal of Sludge from Municipal Wastewater Treatment	Contractor	HUCIC; HEPB; LIEC; EEM	Included in construction contract

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			Plant –Control Standards for Agricultural Use); - Treat dredged sediment at dedicated treatment sites in the project area using chemical flocculation, solidification and dewatering technology; - Reuse dredged material for wetland construction and other project facilities.			
	Solid waste	C1.6. C&D waste, municipal solid waste	-Establish enclosed waste collection points on site, with separation of domestic waste and C&D waste; -Set up centralized domestic waste collection point and transport offsite for disposal regularly by sanitation department; -Reuse C&D waste for filling and foundations of other construction works specified by the municipal and planning departments, or transport in enclosed containers to designated C&D landfill site.	Contractor, HAOCW	CSC; HEPB; LIEC; EEM	Included in construction contract
	Earthwork, soil erosion protection	C1.7. Soil erosion, inadequate spoil storage, disposal and borrow site operation	Implement soil erosion protection measures as defined in the Soil Erosion Protection Plan and Table V.5 of the EIA report, including (but not limited to): - Confirm location of the borrow pit and temporary spoil storage and final disposal sites; - Develop borrow pit management and restoration plan, to be approved by responsible authority; obtain permit for the clearance of excavated earthwork s; - Construct intercepting ditches and drains to prevent runoff entering construction sites, and diverting runoff from sites to existing drainage; - Construct hoardings and sedimentation ponds to contain soil loss and runoff from the construction sites - Limit construction and material handling during periods of rains and high winds; - Stabilize all cut slopes, embankments, and other erosion-prone working areas while works are going on;	Contractor	CSC; HWB; Soil Erosion Protection Monitoring Entity; EEM	Included in construction contract

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			- Stockpiles shall be short-termed, placed in sheltered and guarded areas near the actual construction sites, covered with clean tarpaulins, and sprayed with water during dry and windy weather conditions; - All earthwork disturbance areas shall be stabilized with thatch cover within 30 days after earthworks have ceased at the sites; - Immediately restore, level and plant landscape on temporary occupied land upon completion of construction works; - Unauthorized extraction or disposal at other sites or deviating from established quota would be subject to withheld payments and penalties; - Restore pit following the completion of works in full compliance with all applicable standards and specifications. Approximately 97% of the 1.23 million m^3 earth cut materials will be re-used on site. Imported fill will total approximately 1.68 million m^3 for construction of embankments and landscaped strips.			
C2. Impact on ecological resources	Impacts on fauna and flora	C2.1. Destruction of habitats and wildlife	- Apply cutter suction dredger for lake sediment dredging to minimize stirring up of bottom sediments that might affect photosynthetic activity of phytoplankton, reduce primary production and potentially food availability to the herbivores and higher trophic levels preying on the herbivores; - Preserve existing vegetation on construction sites where no civil works are planned; - Protect existing trees and grassland during construction; where a tree has to be removed or an area of grassland disturbed, replant trees and re-vegetate the area after construction; - Remove trees or shrubs only as the last resort if they impinge directly on the permanent works or approved necessary temporary works; - Strictly prohibit construction workers from capturing any	Contractor	CSC, HEPB; LIEC, EEM	Included in construction contract

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			wildlife in the project area			
		C2.2. Disturbance to water birds wintering at Baitan Lake and Chiye Lake	-Restrict all construction activities within the Baitan Lake and Chiye Lake blue lines and within 1 km outside the Baitan Lake and Chiye Lake blue lines between 0900 hr and 1600 hr from 1 November to 31 March the following year to prevent disturbance to the dawn and dusk feeding periods and nesting of water birds.	Contractor	CSC, HUCIC; HEPB; LIEC, EEM	Included in construction contract
C3. Impact on socio-economic resources	Occupational health and safety	C3.1. Construction site sanitation, pest control	- Provide adequate and functional systems for sanitary conditions, toilet facilities, waste management, labor dormitories and cooking facilities; - Effectively clean and disinfect the site. During site formation, spray with phenolated water for disinfection. Disinfect toilets and refuse piles and timely remove solid waste; - Exterminate rodents on site at least once every 3 months, and exterminate mosquitoes and flies at least twice each year; - Provide public toilets in accordance with the requirements of labor management and sanitation departments in the living areas on construction site, and appoint designated staff responsible for cleaning and disinfection; - Work camp wastewater shall be discharged into the municipal sewer system;	Contractor	CSC, HUCIC; HEPB; HESB; LIEC, EEM	Included in construction contract
		C3.2. Personal Protective Equipment	- Provide safety hats and shoes to all construction workers and enforce their use by the workers; - Provide goggles and respiratory masks to workers doing asphalt road paving; - Provide ear plugs to workers working near noisy PME	Contractor	CSC; LIEC; EEM	Included in construction contract
		C3.3. Food safety	-Inspect and supervise food hygiene in cafeteria on site regularly; -Cafeteria workers must have valid health permits. -If food poisoning is discovered, implement effective control	Contractor	HUCIC; LIEC	Included in construction contract

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			measures immediately to prevent it from spreading.			
		C3.4. Disease prevention and safety awareness	-All contracted labor shall undergo a medical examination which should form the basis of an (obligatory) health/accident insurance and welfare provisions to be included in the work contracts; -The contractors shall maintain records of health and welfare conditions for each person contractually engaged; - Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents; -Specify (by HUCIC and contractors) the person responsible for health and epidemic prevention responsible for the education and propaganda on food hygiene and disease prevention to raise the awareness of workers.	Contractor	HUCIC; LIEC	Included in construction contract
		C3.5. Social conflicts	-Civil works contracts shall stipulate priorities to (i) employ local people for works, (ii) ensure equal opportunities for women and men, (iii) pay equal wages for work of equal value, and to pay women's wages directly to them; and (iv) not employ child or forced labor.	Contractor	HUCIC; LIEC	Included in construction contract
	Community health and safety	C3.6. Temporary traffic management	-A traffic control and operation plan will be prepared together with the local traffic management authority prior to any construction. -The plan shall include provisions for diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at road crossings with an emphasis on ensuring public safety through clear signs, controls and planning in advance.	Contractor, local traffic police	HUCIC, LIEC	BMG (traffic police department)

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
		C3.7. Information disclosure	-Inform residents and businesses in advance through media of the construction activities, given the dates and duration of expected disruption.	HUCIC	HPMO, LIEC	GBDIG
		C3.8. Access to construction sites	-Place clear signs at construction sites in view of the public, warning people of potential dangers such as moving vehicles, hazardous materials, excavations etc. and raising awareness on safety issues. All sites will be made secure, discouraging access by members of the public through appropriate fencing whenever appropriate.	Contractor	HUCIC, LIEC	Included in construction contract
		C3.9. Utility services interruptions	-Assess construction locations in advance for potential disruption to services and identify risks before starting construction; -If temporary disruption is unavoidable, develop a plan to minimize the disruption in collaboration with relevant local authorities such as power company, water supply company and communication company, and communicate the dates and duration in advance to all affected people.	Contractor, local service providers	HUCIC; LIEC	Included in construction contract
	Physical cultural resources	C3.10. Destruction of cultural relics in stream bed and soil	-Contractor must comply with PRC's *Cultural Relics Protection Law* and *Cultural Relics Protection Law Implementation Regulations* if such relics are discovered, stop work immediately and notify the relevant authorities, adopt protection measures and notify the Security Bureau to protect the site.	Contractor	HUCIC; HCB; LIEC	Included in construction contract
Estimated cost for the Construction Stage: $2,152,000 [which includes approximately $1,111,000 from the SEPP for implementation of soil erosion protection measures (the costs for vegetation measures only include those for re-vegetating temporary works/land take areas and do not include those costs in the SEPP for landscaping as part of the permanent works)]						
Operational Stage						
D1. Maintenance of sub-surface flow and surface flow wetlands	Disturbance to wildlife	D1.1. Disturbance to wintering water birds in Baitan Lake and Chiye Lake	-No regular maintenance of sub-surface flow and surface flow wetlands in Baitan Lake and Chiye Lake shall be scheduled during the water bird winter migrating period from 1 November to 31 March the following year	HLB	HPMO, EEM	HLB's operation budget

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
	Water quality and scenic aesthetics	D1.2. Solid waste pollution from trimming wetland vegetation	-All wetland vegetation removed during regular or ad hoc maintenance shall be immediately collected by the solid waste collection boats and transferred to the solid waste transfer station on land.			
	Siltation	D1.3. Sediment accumulation affecting wetland hydraulics	- Periodically remove localized sediment accumulation to sustain desirable hydraulics			
D2. Water quality in Baitan Lake and Chiye Lake	Fish culture in Baitan Lake and Chiye Lake	D2.1. Fish feed and wastes polluting lake water	-Strictly control the locations, fish species, quantity, and maximum amount of fish feed for fish culture in the lakes.	HAPB	HPMO, EEM	HAPB's operation budget
D3. Flood control works of rivers and lakes	Flood emergency preparedness and response	D3.1. Response to above-standard floods	-Update early flood warning and emergency response mechanism for the Baitan Lake planning area, taking into account new flood control and pump station works. The mechanism shall consider safety of evacuation routes and locations of safe temporary refuge, among other matters. -If necessary, increase storm water drainage pipe size in the Baitan Lake planning area to reduce water logging risk.	HWB	HPMO, EEM	HWB's operation budget
	River maintenance	D3.2. Dredging	-The stream will require maintenance dredging from time to time to restore flood flow capacity			
	Waterfront and water body sanitation	D3.3. Solid waste collection	-Solid wastes along the NMT lake ring road and river and lake banks will be regularly collected, and disposed of in local sanitary landfill; - Appoint sufficient personnel to regularly maintain the sanitary condition of the lakes and rivers, including removal of garbage and vegetation which may impair flood flow capacity;	HESB	HPMO	HESB's operation budget
	Sluice gate operation	D3.4 Impact on fish migration	- Strictly adhere to sluice operating procured defined in the EIA, Section 5.E. - The two sluice gates shall only be deployed in the dry season and winter to maintain the water level at the Baitan Lake to avoid negative impact on migratory fish species.	HWB	HPMO, EEM	HWB's operation budget
D4. Solid waste management	Solid waste transfer station	D4.1. Noise and odor nuisance, water	-The transfer station will be fully enclosed to minimize noise and odor released to the surrounding environment; the	HESB	HPMO	HESB's operation budget

Item	Impact Factor	Potential Impact and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
		quality impact	buildings will be designed with sound-absorbing and sound-insulating materials; -Air curtains will be installed at the inlet of the transfer station for unloaded MSW to prevent the emission of odor and dust; dust removal using the spray system plus gravity sedimentation technique will be installed; -Leachate from the transfer station will be collected and discharged into the municipal sewage network; the floor of the transfer station will be sealed to prevent any potential seepage and pollution of groundwater; -Equipment will be regularly cleaned with the spraying of disinfectant and deodorant to control odor generation and as pest control; - An odor control system will be installed for odor suction and treatment (using chemical spray plus activated carbon adsorption).			
Estimated cost for the Operational Stage: the cost will be included in the O&M budget						

Notes: **ADB** = Asian Development Bank; **EEM** = External Environment Monitor; **HAOCW =** Huanggang Administration Office of Construction Waste; **HAPB** = Huanggang Aquatic Products Bureau; **HESB** = Huanggang Environmental Sanitation Bureau; **HCB** = Huanggang Culture Bureau; **HEPB** = Huanggang Environmental Protection Bureau; **HLB** = Huanggang Landscaping Bureau; **HMG** = Huanggang Municipal Government; **HPMO** = Huanggang Project Management Office; **HUCIC** = Huanggang Urban Construction Investment Company, **HWB** = Huanggang Water Bureau; **LIEC** = loan implementation environmental consultant

D. Monitoring and Reporting

19. Monitoring will include **project readiness monitoring** (to be conducted by the HPMO with support of the LIEC), **environmental impact monitoring** (to be conducted by the External Environment Monitor (EEM); as well as by the contractors who will be required to conduct frequent noise and air quality monitoring around construction sites), and **EMP compliance monitoring** to verify EMP compliance during project implementation and project operation (to be conducted by HPMO and LIEC). Monitoring and reporting arrangements defined for this project are described below.

20. **Assessment of project readiness.** Before construction, the LIEC will assess the project's readiness in terms of environmental management based on a set of indicators (**Table EMP-3**) and report it to ADB and the HPMO. This assessment will demonstrate that environmental commitments are being carried out and environmental management systems are in place before construction starts, or suggest corrective actions to ensure that all requirements are met.

Table EMP-3: Project readiness assessment indicators

Indicator	Criteria	Assessment
EMP update	• The EMP was updated after technical detail design as needed, approved by ADB, and disclosed on the project website	Yes No
Compliance with loan covenants	• The borrower complies with loan covenants related to project design and environmental management planning	Yes No
Public involvement effectiveness	• Meaningful consultation completed • GRM established with entry points	Yes No Yes No
Environmental Supervision in place	• LIEC is in place • Environment specialist appointed by HUCIC • Environment specialist appointed by HPMO • EEM contracted by HPMO • Contractors have site-specific EMPs • CSCs contracted by HUCIC • HEMS contracted by contractors • Ornithologist(s) hired by HPMO	Yes No Yes No Yes No Yes No Yes No Yes No Yes No Yes No
Bidding documents and contracts with environmental safeguards	• Bidding documents and contracts incorporating the environmental activities and safeguards listed as loan assurances • Bidding documents and contracts incorporating the impact mitigation and environmental management and monitoring provisions of the EMP • Environmental requirements of EMP included in contract documents	Yes No Yes No Yes No
EMP financial support	• The required funds have been set aside by HPMO, HUCIC, contractors and the O&M units to support the EMP implementation	Yes No

21. **Environmental Impact Monitoring. Table EMP-4** shows the environmental impact monitoring program specifically designed for this project, defining the requirements, including, scope, location, parameter, duration and frequency of monitoring during the construction and operational stages. Environmental impact monitoring will include monitoring of air quality, noise and water quality as described in **Table EMP-4**. Environmental monitoring during construction and operation will be conducted by the Huanggang environment monitoring station (HEMS) and a soil erosion monitoring entity, contracted by the contractors. Wildlife monitoring will be conducted by experienced

ornithologist(s). The EEM will be hired by HPMO to verify monitoring results. The budget for environmental impact monitoring has been estimated at **$420,000**, which includes approximately $120,000 estimated in the SEPP for soil erosion and water conservation monitoring. The monitoring program will be included in the project tendering documents, as well as the construction and operation contracts.

22. The environmental monitoring results will be compared with relevant PRC performance standards (**Table EMP-5**), and non-compliance with these standards will be highlighted in the monitoring reports. Monitoring results will be submitted by HEMS to HPMO and HUCIC quarterly, and will be reported in the semi-annual environmental monitoring reports by HPMO (with the support of the LIEC, see reporting plan in **Table EMP-6**).

Table EMP-4: Environmental impact monitoring program

Item	Monitoring Parameter	Monitoring Location	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
Construction Stage					
Air quality	TSP, PM10 (SO_2 & NO_x only if there is asphalt mixing within 300 m of monitoring locations)	At boundaries of all construction sites, plus: 12 locations: 1. Shangshazui 上沙咀 2. Xiashazui 下沙咀 3. Shangyaojiawan 上姚家湾 4. ***Tujiadawan*** 涂家大湾 5. Liujiawan 刘家湾 6. ***Lijiawan*** 李家湾 7. Nanhu Resettlement Community (under construction) 南湖还建小区 8. Nanhu Team #5 南湖五队 9. ***Nanhu Farm*** 南湖农场 10. Baizhangzui Group #6 百丈咀六组 11. Baizhangzui Group #5百丈咀五组 12. ***Jianchuanwan*** 建川湾 ***Bolt: sensitive receptors***	1 day (24-hr continuous sampling) per month during construction period	HEMS (contracted through contractors)	EEM, HEPB
Noise	L_{Aeq}	12 locations (same as for air quality)	2 times per day (day time and night time); 1 day per month during construction period	HEMS (contracted through contractors)	EEM; HEPB
Water quality	SS	Baitan Lake and Chiye Lake dredging 2 monitoring stations for each dredger 1. 50 m up current of the dredger (control station) 2. 100 m down current of the dredger (impact station) River dredging/excavation: 2 monitoring stations at each dredging and/or excavation section: 1. 50 m upstream of the dredging section (control station) 2. 100 m downstream of the dredging section (impact station)	1 time per day; 1 day per month during construction period	HEMS (contracted through contractors)	EEM; HEPB

Item	Monitoring Parameter	Monitoring Location	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
Construction Stage					
		Dredged sediment treatment and storage sites: 1 location at the discharge point for supernatant water at each site. Bridge, sluice gate and pier construction sites: 2 monitoring stations at each site 1. 50 m upstream of the site (control station) 2. 100 m downstream of the site (impact station)			
Sediment quality	Cu, Pb, Hg, Cd, As, Ni, pH	Dredged material storage area	6 times during construction stage	HEMS (contracted through contractors)	EEM, HEPB
Soil erosion	According to Table 9-3 of SEPP	Location: 10 locations specified in Table 9-2 and Attached Figure 5 of the SEPP	According to Table 9-3 of SEPP covering pre-construction (baseline), construction and vegetation recovery periods.	Institute with qualification in soil erosion protection monitoring (contracted by contractors)	EEM, HUCIC; BWB
Ecology	Water bird counts and distribution	Conduct bird survey along the perimeters of Baitan Lake and Chiye Lake to record the number of wintering water bird species and individuals, and distribution in the Baitan Lake and Chiye Lake areas.	1 time per day in early morning hours; 2 consecutive days per month from October to next April during construction period.	Qualified ornithologist(s) (contracted through HPMO)	HUCIC, HEPB
Occup. Health & Safety	Audit of occupational health & safety of workers on construction sites	Construction sites	Daily during construction period Once per month during construction period	CSCs HUCIC	HPMO
Operational Stage (first three year)					
Water quality improvement in Baitan Lake and Chiye Lake	Permanganate index (I_{Mn}), BOD, COD, NH_3-N, TN, TP	4 locations: same 3 locations in Baitan Lake and 1 location in Chiye Lake where baseline water quality monitoring was undertaken by HEMS for the project EIR (see Figure IV.2 of the EIA report)	1 time per day; 1 day per month for 3 years Continuous water quality forecasting through WQM	HEMS, HEPB	HPMO, HEPB
Bird community of Baitan Lake and Chiye Lake	bird counts and distribution	Conduct bird survey along the perimeters of Baitan Lake and Chiye Lake to record the number of bird species and individuals, and distribution in the Baitan Lake and Chiye Lake areas.	1 time per day in early morning hours; 1 day per month for 3 years	Experienced ornithologist(s) (contracted through HPMO)	HPMO, HEPB
Total estimated cost: $420,000 （including $120,000 from SEPP for soil erosion monitoring）					

Notes: **EEM** = External Environment Monitor ; **HEPB** = Huanggang Environmental Protection Bureau; **HPMO** = Huanggang Project Management Office; **HUCIC** = Huanggang Urban Construction Investment Co.; **HWB** = Huanggang Water Bureau; HEMS = Huanggang Environmental Monitoring Station;

Table EMP-5: Monitoring indicators and applicable PRC standards[1]

Period	Indicator	Standard
Construction	TSP	Class II Ambient Air Quality Standard (GB 3095-1996)
	Fume from asphalt mixing plant (SO_2, NOx)	Air Pollutant Integrated Emission Standard (GB 16297-1996)
	Noise limits of PME at boundary of construction site	Emission Standard of Environmental Noise for Boundary of Construction Site (GB 12523-2011)
	Water quality during dredging and bridge and sluice gate construction (SS)	No PRC standard. Use upstream (of the dredging works) location as control station and downstream location as the impact station. If the SS level at the downstream location is >130% of the upstream location, mitigation measures such as reducing the dredging rate or changing the dredging equipment will be implemented
	Quality of dredged sediment for urban landscaping	Control Standards for Pollutants in Sludges for Gardens and Parks (GB/T23486-2009), and land improvement (GB3838-2002).
	Quality of wastewater from construction sites and supernatant water from dredged sediment disposal sites (SS, BOD, COD, LAS)	PRC's Integrated Wastewater Discharge Standard (GB 8978-1996), Class I standard (for discharging into Category III water bodies)
	Soil erosion	Class II Control Standards for Soil and Water Loss on Development and Construction Projects (GB50434-2008)
Operation	Surface water quality of Baitan Lake, Chiye Lake and the 7 rivers (DO, COD, BOD, NH_3-N, TP, TN fecal coliform bacteria)	Environmental Quality Standards for Surface Water GB 3838-2002. Category IV standard as the near term (2020) target

23. **EMP Monitoring.** EMP monitoring will be undertaken by the HPMO, with support of the LIEC. HPMO will report to ADB the project's adherence to the EMP, information on project implementation, environmental performance of the contractors, and environmental compliance through semi-annual environment progress reports (**Table EMP-6**). The LIEC will support the HPMO in developing the reports. The reports should confirm the project's compliance with the EMP, local legislation such as PRC EIA requirements, and identify any environment related implementation issues and necessary corrective actions. The performance of the contractors in respect of environmental compliance will also be reported. The operation and performance of the project GRM, environmental institutional strengthening and training, and compliance with all covenants under the project will also be included in the report.

24. **Environmental Acceptance Monitoring and Reporting.** Within three months after each component completion, or no later than 1 year with permission of the HEPB, environmental acceptance monitoring and audit reports of each component completion shall be: (i) prepared by a licensed environmental monitoring institute in accordance with the PRC *Management Method for Acceptance of Environmental Protection at Construction Project Completion* (MEP, 2001), (ii) reviewed for approval of the official commencement of individual component operation by environmental authorities, and (iii) finally reported to ADB (**Table EMP-6**). The environmental acceptance reports of the component completions will indicate the timing, extent, effectiveness of completed mitigation and of maintenance,

[1] The project applies PRC standards. A comparison of PRC standards with internationally accepted standards (as defined in the World Bank's Environment Health and Safety Guidelines) was conducted and is described in Chapter II. The comparison confirmed that PRC standards are either internationally accepted, or have comparable standard limits with internationally accepted standards. A deviation from PRC practices and standards would make the task of compliance monitoring authorities unnecessarily complicated, and is deemed not justified.

and the needs for additional mitigation measures and monitoring during operations.

Table EMP-6: Reporting plan

Reports		From	To	Reporting Frequency
Construction Phase				
Progress reports by contractors	Internal project progress report by construction contractors, including monitoring results by HEMS	Contractors, HEMS	HUCIC	Quarterly (including HEMS results)
External monitoring report	External monitoring report by EEM	EEM	HEPB, HPMO, HUCIC	Semi-annual
Bird survey report	Bird survey report	Ornithologist,	HEPB, HPMO, HUCIC	Yearly
Reports to ADB	Project progress report (including section on EMP implementation and monitoring)	HPMO	ADB	Quarterly
	Environment progress reports	HPMO	ADB	Semi-annual
Operational Phase				
External environment monitoring	External monitoring report	EEM	HEPB, HPMO, HUCIC,	Semi-annual for 3 years
Bird survey report	Results of bird count and distribution survey	Ornithologist	HEPB, HPMO, HUCIC,	Yearly for 3 years
Reports to ADB	Project progress report (including section on EMP implementation and monitoring)	HPMO	ADB	Semi-annual
	Environment progress report	HPMO	ADB	Annually until PCR

Notes: ADB = Asian Development Bank; **HEMS** = Huanggang Environment Monitoring Station; **HEPB** = Huanggang Environmental Protection Bureau **HPMO** = Huanggang Project Management Office; **HUCIC** = Huanggang Urban Construction Investment Co.

E. Institutional Capacity Building and Training

25. The capacity of HPMO, HUCIC, O&M units such as HAPB, HESB and HWB, and contractors' staff responsible for EMP implementation and supervision will be strengthened. All parties involved in implementing and supervising the EMP must have an understanding of the goals, methods, and practices of project environmental management. The project will address the lack of capacities and expertise in environmental management through (i) institutional capacity building, and (ii) training.

26. **Institutional strengthening.** The capacities of the HPMO and HUCIC to coordinate environmental management will be strengthened through a set of measures:

i. The appointment of qualified environment specialists within the HPMO staff to be in charge of EMP coordination, including GRM and coordination of environmental impact monitoring, training, reporting, etc.;

ii. The appointment of environmental specialists (international and national) under the loan implementation consultancy to guide HPMO and HUCIC in implementing the EMP and ensure compliance with ADB's Safeguard Policy Statement (SPS 2009);

iii. The appointment of environment specialist(s) by the HUCIC on its staff to conduct regular site inspections; and

iv. The contracting of an external environment monitor to verify environment performance of the project.

27. **Training.** The HPMO, HUCIC, contractors and O&M units will receive training in EMP implementation, supervision, and reporting, and on the Grievance Redress Mechanism (**Table EMP-7**). Training will be facilitated by the LIEC with support of other experts under the loan implementation consultant services. The budget for training is estimated at **$16,000**.

Table EMP-7: Training program

Training	Attendees	Contents	Times	Period (days)	No. of persons	Cost ($/person /day)	Total Cost
EMP adjustment and implementation	HPMO, HUCIC, contractors	Development and adjustment of the EMP, roles and responsibilities, monitoring, supervision and reporting procedures, review of experience (after 12 months)	Twice - Once prior to, and once after one year of project implementation	2	15	100	$6,000
Grievance Redress Mechanism	HPMO, HUCIC, contractors, HEPB	Roles and responsibilities, procedures, review of experience (after 12 months)	Twice - Once prior to, and once after one year of project implementation	1	10	100	$2,000
Environmental technologies and processes	HPMO, HUCIC, contractors, HAPB, HESB, HWB	Pollution control technologies, equipment selection and procurement	Twice (during project implementation)	2	15	100	$6,000
Environmental monitoring, occupational health & safety	HPMO, HUCIC, contractors	Monitoring methods, data collection and processing, reporting systems, occupational health & safety during construction	Once (at beginning of project construction)	2	10	100	$2,000
						Total estimated cost:	**$16,000**

Notes:; **HAPB** = Huanggang Aquatic Products Bureau; **HEPB** = Huanggang Environmental Protection Bureau; **HESB** = Huanggang Environmental Sanitation Bureau; **HPMO** = Huanggang Project Management Office; **HUCIC** = Huanggang Urban Construction Investment Co.; **HWB** = Huanggang Water Bureau.

28. **Capacity building.** In addition to training for EMP implementation, the project will provide a substantial capacity building package to ensure effective implementation of the project and sustainable O&M of the project facilities. The institutional components of the project will involve training by loan implementation consultants in operation and maintenance of completed facilities. Part of this training will focus on teaching staff how to use a set of indicators to monitor performance of the completed facilities. These indicators will be designed by loan implementation consultants prior to operation start-up. [A detailed capacity building program will be included after LFF].

F. Consultation, Participation and Information Disclosure

29. **Consultation during project preparation.** Chapter VII of the report has described the meaningful public participation and consultation implemented during project preparation.

30. **Future public consultation plan.** Plans for public involvement during construction and operation stages have been developed during project preparation. These plans include public participation in (i) monitoring impacts and mitigation measures during the construction and operation stages through informal interviews and disclosure of monitoring reports; and (ii) interviewing the public at project completion stage. These plans will include several types of public involvement, including site

visits, workshops, investigation of specific issues, interviews, and public hearings, as indicated in **Table EMP-8**. The budget for public consultation is estimated at approximately **$10,000**.

Table EMP-8: Public consultation plan

Organizer	Format	No. of Times	Subject	Attendees	Budget
Construction Stage					
HPMO	Public consultation & site visit	5 times: 1 time before construction commences and 1 time each year during construction	Adjusting of mitigation measures, if necessary; construction impact; comments and suggestions	Residents adjacent to components, representatives of social sectors	$5,000
HPMO, HUCIC	Expert workshop or press conference	As needed based on public consultation	Comments and suggestions on mitigation measures, public opinions	Experts of various sectors, media	$2,000
HUCIC	Resettlement survey	As required by relevant resettlement plan	Comments on resettlement, improvement of living conditions, livelihood, and poverty reduction; comments and suggestions	Persons affected by resettlement and relocation	Included in the resettlement plan update survey budget
Operational Stage					
HUCIC, O&M Units	Public consultation and site visits	Once in the first year	Effectiveness of mitigation measures, impacts of operation, comments and suggestions	Residents adjacent to component sites, representatives of residents and representatives of social sectors	$1,500
HUCIC, O&M Units	Expert workshop or press conference	As needed based on public consultation	Comments and suggestions on operational impacts, public opinions	Experts of various sectors, media	$1,500
				Total budget:	**$10,000**

Notes: **HPMO** = Huanggang Project Management Office; **HUCIC** = Huanggang Urban Construction Investment Co.; **O&M** = Operation and Maintenance

G. Grievance Redress Mechanism

31. Public participation, consultation and information disclosure undertaken as part of the local EIA process have discussed and addressed major community environmental concerns. Continued public participation and consultation has been emphasized as a key component of successful project implementation. As a result of this public participation and safeguard assessment during the initial stages of the project, major issues of grievance are not expected. However, unforeseen issues may occur. To settle such issues effectively, a Grievance Redress Mechanism (GRM) providing effective and transparent channels for lodging and addressing complaints and grievances has been defined. The GRM will be established prior to construction of the project components. The GRM is responsive to ADB's Safeguard Policy Statement (2009) and PRC legislation.

32. **The Proposed Project GRM.** In consultation with the HPMO, HUCIC, HEPB and potentially affected people, it was agreed that the HPMO will establish a complaints center and coordinate the GRM for the project for complaints related to both environmental and resettlement issues. The complaint center will direct all environmental complaints as appropriate to: (i) the contractors; (ii) HUCIC; (iii) O&M units. These are also entry points to whom the affected people could directly register their complaints. Complaints related to resettlement issues received by the complaints center will be directed to the relevant agencies in accordance with the resettlement GRM. Contact details for the complaints center and the entry points will be publicly disseminated on information boards at construction sites and nearby communities. Multiple means of using this mechanism, including face-to-face meetings, written complaints, telephone conversations, or e-mail, will be available. In the construction and the operational periods until ADB's project completion report (PCR), the HPMO will

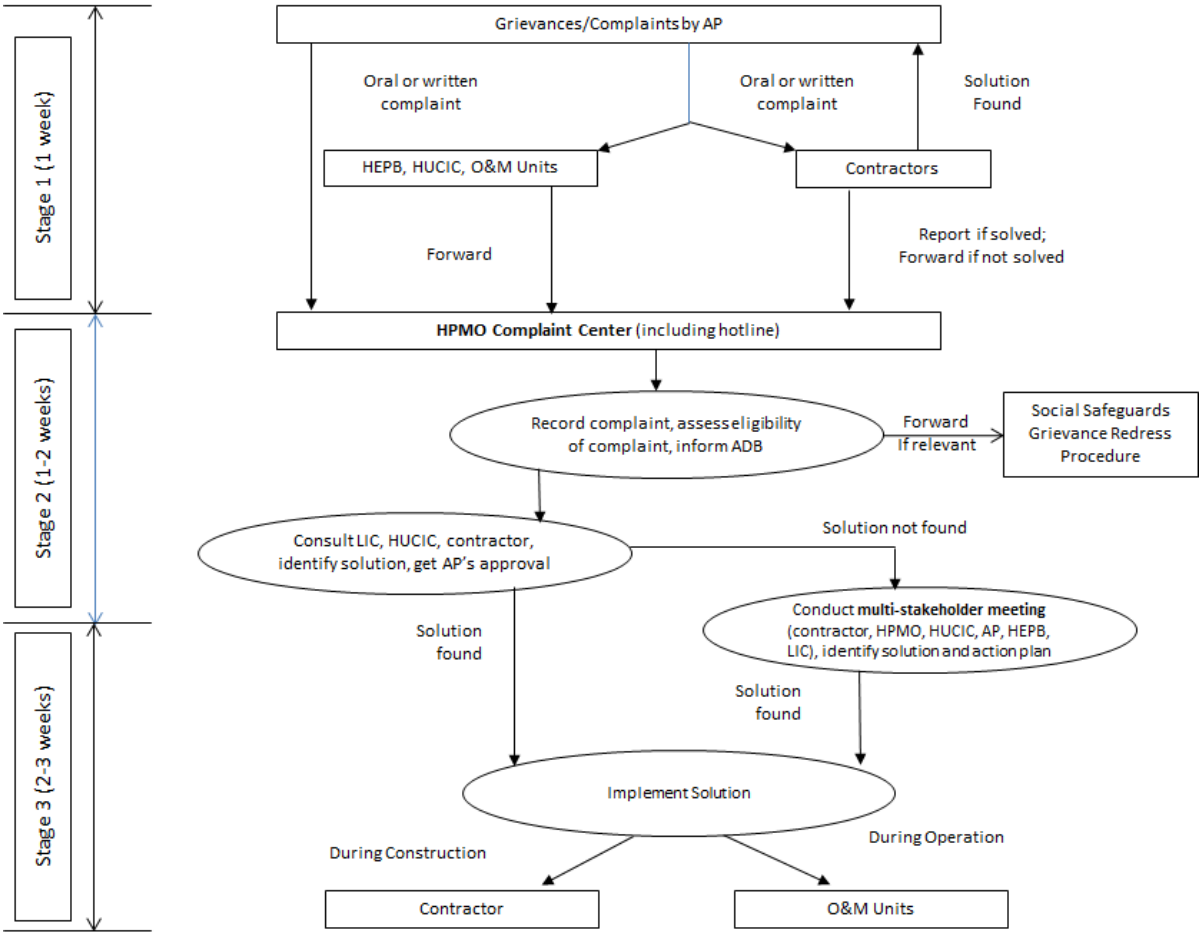
report progress to the ADB, and this will include reporting complaints and their resolution.

33. **Basic steps for resolving complains** are as follows and illustrated in **Figure EMP-1**:

Step 1: For environmental problems during the construction stage, the affected person (AP) can register his/her complaint directly with the contractors, or through GRM access points (HPMO complaint center hotline, HUCIC, local EPB hotline). Contractors are required to set up a complaint hotline and designate a person in charge of handling complaints, and advertise the hotline number at the main entrance to each construction site, together with the hotline number of the HPMO complaint center. The contractors are required to maintain and update a Complaint Register to document all complaints. The contractors are also required to respond to the complainant in writing within 7 calendar days on their proposed solution and how it will be implemented. If the problem is resolved and the complainant is satisfied with the solution, the grievance handling ends here. The contractors are required to report complaints received, handled, resolved and unresolved to the HPMO complaint center immediately, and to HUCIC and HPMO monthly (through progress reporting).

Step 2: If no appropriate solution can be found during step 1, the contractor has the obligation to forward the complaint to the HPMO complaint center. The AP may also decide to submit a written or oral complaint to the HPMO complaint center directly, by-passing step 1. A joint hotline for resettlement and environment issues will be established within the HPMO. For an oral complaint, proper written records will be made. Once a complaint is registered and put on file, the HPMO complaints center will immediately notify ADB. The HPMO complaint center will assess the eligibility of the complaint, identify the solution and provide a clear reply for the complainant within five (5) working days. Complaints related to land acquisition and resettlement issues will be directed to the relevant agencies in accordance with the resettlement GRM. The LIEC will assist the HPMO complaint center in addressing the complaint, and replying to the affected person. The HPMO complaint center will also inform the ADB project team and submit all relevant documents. Meanwhile, the HPMO complaint center will timely convey the complaint/grievance and suggested solution to the contractors, HUCIC and/or facility operator. The contractors during construction and the facility operator during operation will implement the agreed upon redress solution and report the outcome to the HPMO complaint center within fifteen (15) working days.

Step 3: In case no solution can be identified by the HPMO complaint center, or the complainant is not satisfied with the proposed solution, the HPMO complaint center will organize, within two (2) weeks, a multi-stakeholder hearing (meeting) involving all relevant stakeholders (including the complainant, HUCIC, contractors, facility operator, local EPB, HPMO). The hearing shall identify a solution acceptable to all, and formulate an action plan.



Note: AP = affected person; ADB = Asian Development Bank; HEPB = Huanggang environmental protection bureau, LIC = loan implementation consultant; HPMO = Huanggang project management office;

Figure EMP-1: Procedure and timeframe for the GRM

34. The tracking and documenting of grievance resolutions by HPMO (through its complaints center) will include the following elements: (i) tracking forms and procedures for gathering information from project personnel and complainant(s), and notification procedure to ADB; (ii) dedicated staff to update the database routinely; (iii) a system to periodically evaluate the overall functioning of the mechanism; (iv) processes for informing stakeholders about the status of a case; and (v) procedures to retrieve data for reporting purposes, including the periodic reports to the ADB through the semi-annual environment progress reports.

35. The HPMO complaint center shall accept the complaints/grievances lodged by the AP free of charge. Any cost incurred should be covered by the contingency of the Project. The grievance procedures will remain valid throughout the duration of project construction and until project closure.

H. Cost Estimates

36. Cost estimates for EMP implementation, including mitigation measures, environmental impact monitoring, public consultation and training as presented in **Tables EMP-2, EMP-4, EMP-7 and EMP-8** are summarized in **Table EMP-9**. Total budget for implementing these 4 items of the EMP is therefore $2,647,000. Excluded from the costs estimates are infrastructure costs which relate to environment and public health but which are already included in the project direct costs. Excluded are also capacity building packages, the remuneration costs for environment specialists who are staff members within HPMO and HUCIC, loan implementation consultants, and technical experts on equipment operation and maintenance, which are covered elsewhere in the project budget.

Table EMP-9: Estimated Budget for Implementation of the Environmental Management Plan

EMP Item	Estimated Cost
External environmental monitoring (= environmental monitoring supervision)	$49,000
Mitigation measures	$2,152 ,000
Environmental impact monitoring	$420,000
Training	$16,000
Public consultation	$10,000
Total	$2,647,000

37. The contractors will bear all environmental impact monitoring costs during the construction stage. O&M Units will bear the monitoring costs of the operational stage. HPMO will ensure the necessary budgets are available for the licensed environment monitoring entity (the external environment monitor) and the experienced ornithologist(s). Contractors will bear the costs for all mitigation measures during construction, including those specified in the tender and contract documents as well as those to mitigate unforeseen impacts due to their construction activities. The O&M units will bear the costs related to mitigation measures during operation. HUCIC and HPMO will bear the costs related to environmental supervision by their own staff. The project as a whole (through HPMO) will bear the costs for training, for coordinating the Grievance Redress Mechanism (GRM), and the Loan Implementation Environment Consultants under contract to HPMO.

I. Mechanisms for Feedback and Adjustment

38. The EMP will be updated as needed by HPMO with assistance from the LIEC when there are design changes, changes in construction methods and program, poor environmental monitoring results, and if mitigation measures prove to be ineffective or inadequate. Based on environmental monitoring and reporting systems in place, HUCIC (with the support of the LIEC) shall assess whether further mitigation measures or improvement in environmental management practices are required as corrective actions. HPMO will inform ADB promptly on any changes to the project and needed adjustments to the EMP. The updated EMP will be submitted by HPMO to ADB for review and approval, and will be disclosed on the project website.

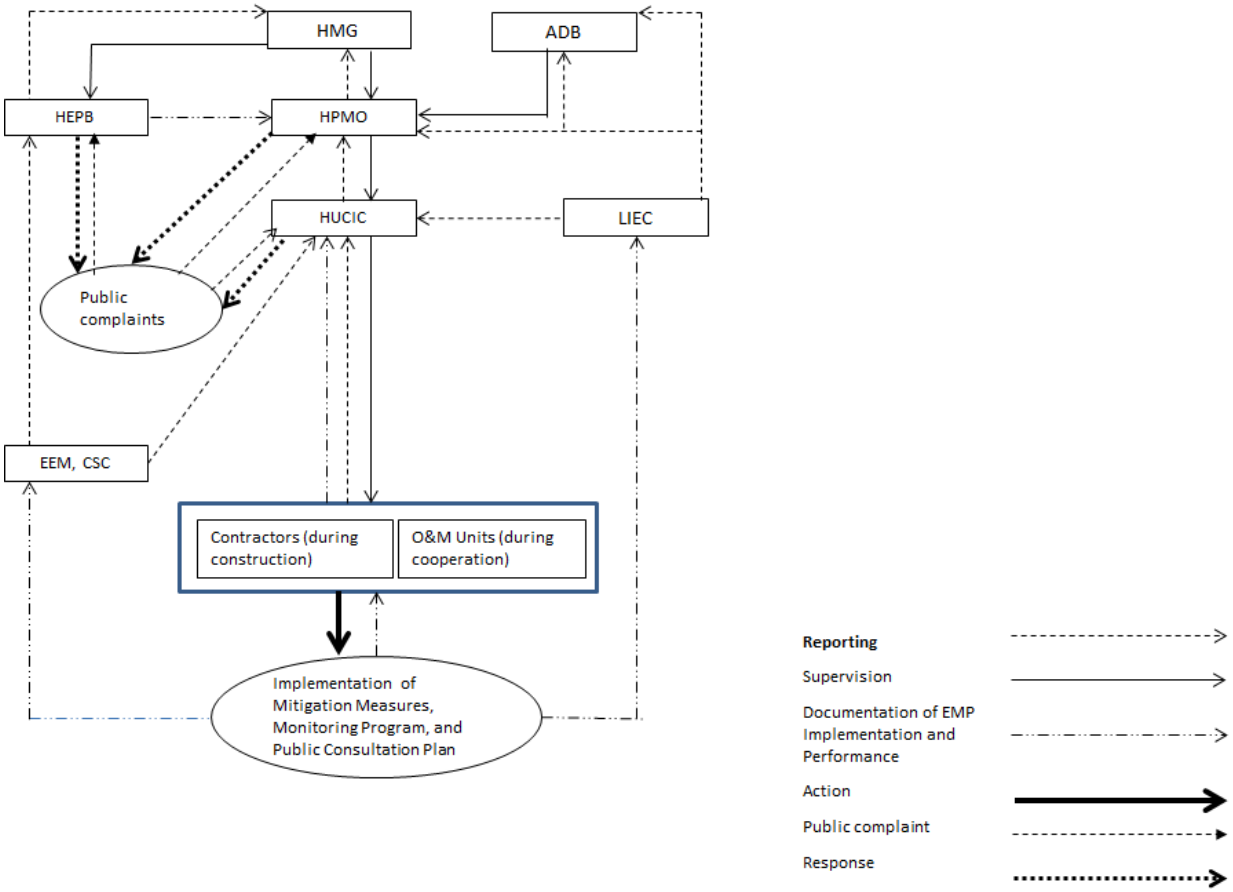


Figure EMP-2: Mechanism for Feedback and Adjustment

Activities	2014				2015				2016				2017				2018				2019			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
A. Design and Monitoring Framework																								
1. Urban lake and river enhancement																								
1a-1. Lake sediment dredging																								
Detailed design																								
Land acquisition and resettlement																								
Procure works and goods																								
Sediment dredging and pre-treatment																								
1a-2. Lake embankment, strengthening and ecological restoration																								
Detailed design																								
Land acquisition and resettlement																								
Procure works and goods																								
Construction and commissioning																								
1a-3. Wetlands																								
Detailed design																								
Land acquisition and resettlement																								
Procure works and goods																								
Construction and commissioning																								
1a-4 Multiuse nonmotorized pathway and bridges																								
Detailed design																								
Land acquisition and resettlement																								
Procure works and goods																								
Construction and commissioning																								
1b-1. River sediment dredging, excavation and embankment																								
Detailed design																								
Land acquisition and resettlement																								
Procure works and goods																								
Construction and commissioning																								
1b-2. Vegetated buffer strips and aquatic planting																								
Detailed design																								
Land acquisition and resettlement																								
Procure works and goods																								
Construction and commissioning																								
1b-3. Sluice gates																								
Detailed design																								
Procure works and goods																								
Equipment installation and commissioning																								

Activities	2014				2015				2016				2017				2018				2019			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Equipment installation and commissioning									■	■	■	■												
2. Solid waste collection and transfer system																								
Detailed design									■	■														
Procure works and goods											■	■												
Construction and commissioning													■	■	■	■								
Public awareness campaign and education for solid waste management																	■	■	■	■				
3. Capacity development and institutional support																								
Initial project implementation support		■	■	■																				
Project management and consultancy service implementation					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Water quality model and Xingfu catchment water pollution management plan																	■	■	■	■	■	■	■	
B. Management Activities																								
Complete EA, IA, and PMO organizational arrangement	■	■	■	■																				
Recruit and mobilize implementation support		■		■								■				■								
Implementation of monitoring activities (including EMP, GAP, RP, and SAP)			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Submit progress reports					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Project completion report																								■

EA = executing agency, EMP = environmental management plan, GAP = gender action plan, IA = implementing agency, PMO = project management office, RP = resettlement plan, SAP = social action plan.

Figure EMP-3: Project Implementation Schedule

Attachment 2 to the Project EIA

Hydraulic and Water Quality Modeling

Contents

Appendixes

List of Tables

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1 Introduction

1. As part of the technical due diligence review of the Hubei Huanggang Urban Environment Improvement Project, a hydraulic a water quality model have been developed for the Baitan and Chiye Lakes and associated rivers by the PPTA consultant on behalf of the Huanggang Municipal Government.

2. In particular, the **objective of hydraulic model** was to assess the hydraulic feasibility of the proposed design options and their robustness as well as the project's individual and cumulative impact on flooding and waterlogging in the New Eastern District (NED), Phase 1 (i.e. Baitan Lake planning area). The scope of work included: (1) undertaking storm water flow analyses to delineate flood/water logging risk areas for a series of storm return periods (20, 50 and 100 years); (2) assessing the retention capacities of the Baitan and Chiye lakes and their resilience to climate change impacts; (3) testing and evaluating the hydraulic feasibility of proposed river rehabilitation schemes and their robustness; (4) determining flood water flows and drainage requirements and optimize the drainage pipe diameters; and (5) ascertaining the impacts of lakes and rivers rehabilitation in terms of flood management and water circulation.

3. The **objective of water quality model** was to assess the project's individual and cumulative impact on water quality of the Baitan and Chiye lakes for the pollutants of concern (COD, NH_3-N, TP, TN). The scope of work included: (1) developing a water quality model covering the Baitan and Chiye lakes' area of influence; (2) calibrating the model based on available water quality data and supplemented by additional samplings and water quality analysis; (3) undertaking water quality analyses to refine the size of the constructed wetlands; (4) assessing the long-term water quality profiles under different scenarios; and (5) ascertaining the impacts of scheme development in terms of lake water quality improvement.

4. The main purpose of the modeling studies was to clarify investment decisions by bringing environmental considerations into the development planning at the lake basin level for Huanggang, most notably at the level of Baitan/Chiye Lake and to provide supporting justification to the final selection of engineering options to be financed under the Project.

5. However, it should be appreciated that at the PPTA phase there have been limitations in terms of both data availability to support the development of the analysis reported herein and also time in relation to the development and application of the modeling techniques. A key subcomponent of the capacity building component is designed to continue and develop further these activities and analysis within an integrated water resources management framework.

6. This report summarizes the baseline conditions and assumptions, the development of the models and tools used, and the simulation results.

2 Baseline Conditions

7. This section provides some information on the baseline conditions pertinent to the modelling studies focusing particularly on the existing hydrology, hydraulics and water quality conditions associated with the Baitan and Chiye lake catchment.

2.1 Geology and Topography

8. The project area is located in the north on the lower and middle reaches of the Yangtze River, typical lake plains, of which the terrain is relatively flat. In general the northern part is slightly higher than the southern part. The project area features low-lying terrain, densely covered with urban drainage channels and lakes, and ground elevation generally ranges from 15 to 25 m.

9. Huanggang City is characterized by alluvial sediments, forming into Grade I terraces, consisting of sandy loam, sand and sand gravel, in thickness of 30-60 m. The lower part consists of medium and fine sands, coarse sand, sand and gravel, and particles of coarse to fine from bottom to top. The gravel consists mainly of quartzite, pyroxenite veins, etc., with a radius of 2~4cm. The off-round to sub-angular gravel has a general thickness of 4.53-17.00cm. The upper part consists of sandy loam, locally inter-bedded with silt loam texture, and the structure is relatively soft, in a thickness of 2.71-10 m. The aquifer thickness varies between 0.58 and 5.5 m, and features a thicker front edge and thinner rear edge of terraces in a planar direction. The aquifer roof is buried at a depth of 10-30m, single well water inflow at rate of 500-1000 tons / day, medium water abundance. The terrace front edge of the aquifer is composed of relatively coarse particles and has a greater thickness and adequate lateral recharge. The aquifer provides an abundant water supply with lateral recharge the primary source, followed by vertical replenishment by precipitation. The slopes of aquifer surface layers and the water table are similar to the terrace surface, therefore, the groundwater runs off and discharges in the direction from upstream to downstream.

2.2 Climate

10. The climate of the Baitan Lake Basin is subtropical continental, typically cold in winter and hot in summer with plentiful rainfall. The annual average temperature around Baitan Lake is 17.6℃. There is no major change of average humidity between months. The average annual rainfall in Huanggang is 1288 mm, mainly concentrated in April - July. Tables 2.1 to 2.3 summarize the monthly average temperature and wind, climate data and wind direction frequency.

Table 2.1: Monthly average temperature and wind （1990~2009）

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Temperature℃	4.2	7.1	11.3	17.8	22.9	26.5	29.4	28.5	24.5	18.6	12.3	6.6
Wind m/s	1.1	1.2	1.3	1.4	1.4	1.3	1.5	1.5	1.4	1.1	1.0	1.0

Source: Huanggang meteorological Bureau

Table 2.2: Huanggang Climate Data (1990~2009)

	Item	Unit	Value
1	Annual average wind velocity	m/s	1.3
2	Maximum wind velocity	m/s	12.0
3	Average temperature	℃	17.6
4	Extreme temperature	℃	39.6
5	Annual average humidiy	%	74
6	Annual average precipitation	mm	1286.7
7	Maximum daily rainfall	mm	285.7
8	Average sunshine (hr)	d	1843.4

Source: Huanggang meteorological Bureau

Table 2.3: Wind Direction Frequency (1990~2009)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	C
Win Direction frequency (%)	6	7	12	7	6	4	3	2	3	2	3	3	4	2	4	5	28

Source: Huanggang meteorological Bureau

2.3 Hydrology and Water Resources

11. The Yangtze River is an important river flowing through the Huanggang City, in the direction of northwest to southeast, west inbound into the river from the Tuanfeng Town of Tuanfeng County, east outbound at Duanyao Village of Liuzuo Town, Huangmei County, flowing through 6 counties (cities and district) of Tuanfeng, Huangzhou, Xishui, Qichun, Wuxue, and Huangmei in length of 201k m, and the average annual discharge volume is 721.86 billion m^3. There are some 3731 tributaries of different sizes, among which 513 of the rivers are in the length of more than 5km; 201 more than 10km, 57 more than 20km, and 6 more than 100km. All the six major river systems including Daoshui, Jushui, Bashui, Xishui, Qishui and Huayang are originated from Dabie Mountains, and flow from north to southeast through the Huanggang City before discharge into the Yangtze River. The total catchment area of the six rivers is 15,555km^2, representing 89.2% of the city's total area.

12. There are more than 260 lakes in the Huanggang Municipality, with a total area of 556,300mu, among which the important lakes are Huangcao Lake, Baitan Lake, Yi'ai Lake, Chiye Lake, Chidong Lake, Wushan Lake, Taibai Lake, and Longgan Lake. The total water surface area is 193.96 km^2.

13. Ba River originates from Lifeng Mountain of Macheng, southwest of Dabie Mountain at the boundary between Hubei and Anhui provinces, flowing southward from east of the Macheng City, west of Luotian County, then southwestward, through Huangzhou District, and then to the

Xiaba River, Xishui County before joining the Yangtze River. The mainstream of the Ba River is 148km long and the catchment area is 3697km^2. The Huangzhou segment of the Ba River inbounds from Huzikou Village of Chencelou Town, flows through four towns, namely Chencelou, Taodian, Lukou and Donghu, and turns south to Huangwuli before joining the Yangtze River, with a water course of 27km. Ba River has annual average river discharge of 507million m^3 and provides water for irrigation and drinking water supply.

14. Baitan Lake is located approximately 10km southeast of Huangzhou District, 4km from the city centre, and closely linked with the urban area. The lake is in an elongated shape from south to north with a water surface area of 15,800 mu, which is characterized by flooding in summer and drying in winter. In 1950, Changsun embankment was constructed at Tusi Port, isolating the lake from the river, so that the lake became clear. The Tusi Port was built in 1953, which brought the water level under control, and facilitated irrigation when droughts and discharge when floods. The catchment area of the Baitan Lake is approximately 18 km^2, in which 2.67 km^2 is mainly used for fish farming. The elevation of the lake bed is between 13 and 15.5m and the normal water level is 16.63m and the total storage capacity is approximately 6,130,000m^3 and the perennial water depth of 1.5m. The Baitan Lake is connected to both the Changhe River and Chi River and its outflow discharges to the Yangtze River. During floods, the water can be discharged to the Yangtze River via the Baitan pumping station.

15. The Changhe River is divided into two sections at Tungfeng. The upper part is 16.7 km long with a catchment area of 195 km^2. It interconnects to the Zhanjia Lake, Yangpocha Lake, Chingtsaohu Lake and Niupi Lake, and two main reservoirs, Jinpen, and Fuhe. The lower part Huangzhou Segment starts from Luojiagou transverse dike, flowing to the east and converging at the Ba River estuary with the Ba River flowing past the Tusi port gate before joining the Yangtze River. The total length is 33.25km with a catchment area 289.5 km^2. It interconnects with 8 lakes, including Caijiatan, Yujiatan, Xiaocha Lake, Baitan Lake, Yi'ai Lake, and Qingzhuan Lake. The water intake and discharge of Changhe River are mainly controlled by the Tusi Port Gate (connecting with Ba River) and Baitan Lake irrigation and discharge stations (connecting with the Yangtze River), East Lake pump station (connecting with the Yangtze River). The total capacity of discharge is up to148m^3/s. The Tusi Port gate is opened during drought periods, allowing for water from the Yangtze River to flow into the river through Ba River. The Santai River is located in the Huangzhou district section. The normal water level is approximately 16.6 m. During the wet season the flood control level is at 17.13m while during the dry season the water level is between 13.63 to 13.94 m.

2.4 Water and Sediment Quality

16. According to the review on the water-quality report by the Huanggang Municipal Bureau of Environmental Protection (HEPB), the main pollutants were identified as chemical oxygen demand (COD), total nitrogen (TN) and total phosphorus (TP).

2.4.1 Water Quality in Baitan and Chiye Lakes

17. As the major lakes in Huanggang for urban landscape and ecological regulation, Baitan and Chiye lakes have been suffering from water pollution since early 1990's due to discharges from untreated wastewater, agricultural non-point pollutants and excessive fish farming in the lakes and surrounding area.

18. There was no historic water quality monitoring record available for either the Baitan or Chiye Lake. Only Santai River was monitored for baseline water quality on an irregular basis

as the other urban rivers in the Project area are either small and flow-interrupted ditches or dry land.

19. However, a few samples were taken by Huanggang Municipal Environmental Monitoring Station in March 2013 and the results of the analysis were attached in **Appendix 1**. The monitoring data indicates that the water quality of Baitan and Chiye Lakes is overall Class V or even worse, in particular:

- **Organic Pollution**: Organic pollution as represented by BOD and ammonia (NH_3-N) are typically high in both the Baitan and Chiye Lakes.

- **Nutrient levels**: nutrients (N and P) are typically high in both the Baitan and Chiye Lakes with N in Class V or worse and P typically Class IV.

2.4.2 Sediment Quality in Baitan and Chiye Lakes

20. With a long history of pollution by domestic and non-point source pollution, the Baitan and Chiye lakes have accumulated significant amounts of nutrient-led sediments, representing an important internal pollution source to the lakes. The latest sampling data showed that the sediment thickness of Baitan and Chiye Lakes is between 0.4m and 1.5m while the thickness of the polluted top layer is between 0.1m and 0.5 m and the light polluted mid layer is between 0.10 and 0.70 m and the bottom layer is approximately 0.2m. Baseline monitoring data of the lake sediments, as listed in **Appendix 2**, show low levels of heavy metals but high levels of nitrogen and phosphorus.

2.5 Water Pollution Loads in the Lakes and Surrounding Area

21. According to the latest environmental monitoring data, the total pollutant loads of the key constituents are estimated as shown in Table 2.4.

Table 2.4: Estimated total pollutant loads in Baitan and Chiye lakes [tons in stock]

Pollutants	COD_{Cr}	BOD_5	NH_3-N	TN	TP
tons	174.29.	34.85	8.414.	12.43	0.43

Source: PPTA estimate based on water quality monitoring data by Huanggang Municipal Environmental Monitoring Station, 2013

2.5.1 External Pollution Sources

22. There is very little quantitative data concerning non-point source pollution in the Baitan/Chiye Lake basin. Pollutants entering into the lakes come from several sources, including storm-water runoff, agricultural and soil erosion, air pollution deposition and trash discarded or blown into the lake. Fish farming also contributes to the pollution of the Baitan and Chiye lakes and their surrounding waters.

Agricultural Non-point Sources

23. Based on the total farmland area in the surrounding area of the lakes which is 10.81 km^2, it is estimated that the total agricultural pollution loads are as follows: COD 51.47 ton/year, TN 10.84 ton/year and TP 0.60 ton/year. Pollution from livestock is understood to be minimal in the lake basin.

Domestic Wastewater Discharges

24. Currently, the annual pollutant loads entering into the Baitan and Chiye Lakes from domestic households are estimated shown in Table 2.5.

Table 2.5: Table estimated annual pollutant load inputs

Pollutants	COD_{Cr}	BOD_5	SS	NH_3-N	TN	TP
Annual input (tons/year)	71.00	40.87	44.64	5.073	4.39	0.616

Source: Planning EIA report for Baitan Lake planning area, 2013

Pollution Loads from Fish Farming

25. According to the resettlement planning report, the total area of fishing ponds is estimated to be 1.94 km^2. It is estimated that the total annual pollution loads from fish farming in the lake and surrounding area are as follows: COD 99.24 ton/year, TN 12.19 ton/year and TP 2.80 ton/year.

Dust Pollution Loads

26. According to testing results carried out at different areas in Wuhan and reported by Professor Jiang Yinghu from Wuhan University (Chen, 2009; Zhang, 1996), the urban pollutant indicators from dust are as follows: COD = 0.0463mg / (m^2•day); TN = 0.0191mg / (m^2•.day); TP = 0.5593mg / (m^2•day). Based on these, the estimated annual pollution loads are: COD = 68.506 ton/year; TN = 28.0 ton/year; TP = 0.883 ton/year. Considering the difference in urbanization levels between Wuhan and Huanggang, it is assumed that that dust pollution loads in 2020 would be similar to the current levels in Wuhan.

Urban Runoff Pollution

27. With reference to data from other cities in the PRC (Ye, 2006; Liu, 2010), the pollutant concentrations of COD, TN and TP from the first flush of urban runoff were assumed to be 150 mg/l, 8 mg/l and 1.5 mg/l, respectively (Table 2.6).

Table 2.6: Pollutant concentration in urban runoff

City	Beijing	Tianjin	Kunming	Wuhan	This Study
DOC_{cr}(mg/l)	1200	677.8	122-167	26.54-127.38	108
SS(mg/l)	1934	640.6	45-78	115.93-363.61	150
TP(mg/l)	5.6	1.07	2.4-3.6	0.16-0.64	1.68
TN(mg/l)	13	4.10	22-33	1.69-3.75	10.96

Source: Project Feasibility Report by Wuhan Municipal and Engineering Design Institute

28. According to the planned drainage network of the NED Phase 1, the total area where the drainage discharges directly to the lakes is approximately 3.84 km^2 (see Appendix 3 to Attachment 2). Based on the rainfall data in 1988, the estimated total annual pollution loads from the first flush of urban runoff are as follows: COD = 113.047 ton/year, TN = 11.447 ton/year, TP = 1.756 ton/year.

2.6 Water Pollution Loads from the Xingfu River Catchment

29. The Xingfu river, upstream of the Baitan and Chiye Lakes, is 8.3 km long with a catchment area of 28.3 km^2, excluding Xingfu Reservoir which has a catchment area of 11.5 km^2. The land use composition includes agricultural farm land (4.25 km^2), fish ponds (4.44 km^2), lakes and rivers (0.81 km^2), building area (7.09 km^2) and green fields (11.71 km^2). The total estimated annual pollution loads from domestic, agricultural non-point sources and fish farming sources are COD 321.35 ton/year, TN 52.38 ton/year and TP 1.928 ton/year.

2.7 Internal Pollution Sources

30. **Pollution released from sediment deposit.** Huanggang Municipal Environmental Monitoring Station took sediment samples at 6 locations in Baitan and Chiye lakes in March 2013 and the reported analysis results are listed in **Appendix 2**.

31. With reference to the experimental data from other relevant domestic lakes in the PRC (Chen, X, 2009; Jiang, 2006; Hua, 2011; Liu, 2006; Wang, 2002), the pollutant release rates were assumed as follows: COD 30mg/(m^2•d); TN = 15 mg/(m^2•d); TP = 3 mg/(m^2 • d). Therefore, the annual pollution loads from Baitan and Chiye Lakes were estimated to be COD 44.469 ton/year; TN 22.234 ton/year; TP 4.446 ton/year.

2.8 Existing and Planned pollution control measures

32. According to the Development Plan of the New Eastern District and the Detailed Control Plan for the Baitan Lake and Its Surrounding Area of 25km^2, the on-going and planned water pollution control interventions in the NED include:

- Interception of all wastewater by a sewer-pipe network separated from the drainage-pipe network. The wastewater will be transmitted to the existing Nanhu wastewater-treatment plant which is to be upgraded to a capacity of 200,000t/day. Therefore, when completed, it is expected that no wastewater will be directly discharged into the Baitan and Chiye lakes, nor into the urban rivers;

- Relocation of existing factories and fish farms elsewhere;

- Interception of all non-point pollution sources from the urban area by urban drainage pipeline.

33. The HMG has provided documented evidence and assured that structured measures have been implemented and/or scheduled to deal with the water quality of major water bodies in Huangzhou District, including: Chang (including Santai) River Environmental Improvement Project and Yiai Lake Ecological Restoration Project. With the completion of both schemes, it is expected the water quality problems in other parts of the urban area will be substantially improved.

3 Engineering Measures of the Project

34. The expected project impact is socially-inclusive and environmentally-sustainable urbanization in Huanggang. The intended project outcome is improvement in the urban environment infrastructure and management services in Huanggang. The proposed components will provide much-needed assistance for environmental protection and local social and economic development.

35. Based on the recommendations from the ADB Inception Mission, HMG has adjusted the scope of the Project as proposed previously. The revised structured measures are listed in Table 3.1.

Table 3.1: Project Components and sub-components

Output 1: Urban lake and river enhancement				
1a: Lake enhancement				
(i) removing 539,405 cubic meter (m^3) of sedimentary deposits from Baitan and Chiye lakes and re-establishing natural hydraulic circulation between lakes; (ii) constructing 14 km of ecological embankments with 69 hectare (ha) of vegetated buffer strips, 2.8 km of embankment strengthening in Baitan and Chiye lakes; (iii) establishing 80 ha of natural wetland in Chiye lake and Chushui river; (iv) establishing 4 natural wetlands with a total area of 3.8 ha and 4 detention basins with a total area of 1.525 ha in Baitan and Chiye lakes; (v) constructing 13.3 km of non-motorized ring road along the Baitan lakeshore and 9 bridges across the rivers; and (vi) purchase of equipment for waste collection (boats) and water quality monitoring and maintenance.				
1a-1: Lake sediment dredging				
1	Baitan lake sediment dredging	Quantity	404,405 m^3	
2	Chiye lake sediment dredging	Quantity	135,000 m^3	
1a-2: Lake embankment, strengthening, and ecological restoration				
		Embankment strengthening (m^3)	**Vegetated buffer strips (m^2)**	**Aquatic vegetation (m^2)**
1	Baitan lake embankment and ecological restoration	9,310 (cement soil mixing pile) 15,000 (concrete retaining wall)	890,244	1,120,000
2	Chiye lake ecological restoration			142,800
	Total		**890,244**	**1,262,800**
1a-3: Natural (surface flow) wetland				
1	Chiye lake surrounding areas		Area	80,000 m^2
1a-4: Engineering (subsurface flow) wetland				
		Number	**Subsurface flow wetland (m^2)**	**Detention basin (m^2)**
1	Baitan lake	3	33,030	13,460
2	Chiye lake	1	5,197	1,790
	Total	**4**	**38,227**	**15,250**
1a-5: Non-motorized ring road and bridges				
1	Ring road along the Baitan lakeshore			13.3 km
2	Bridges			9
1a-6: Purchasing equipment for waste collection (2 boats), water quality monitoring and maintenance				
1b: River enhancement				

(i) removing 201,000 m^3 of sedimentary deposits from 4 rivers, excavating 343,000 m^3 of river bank soil and widening the river course in 7 rivers and re-establish natural hydraulic circulation between lakes and rivers; (ii) constructing 21.6 km of ecological embankments with 42.6 ha of vegetated buffer strips, 17.7 ha of aquatic vegetation, and 2.5 km of embankment strengthening in 7 rivers; (iii) constructing and upgrading 2 sluice gates in Linglong and Jinshui rivers; and (iv) constructing 3 bridge walkways in Jinshui and Chushi rivers

1b-1: River sediment dredging

		Sediment Dredging (m^3)	**Excavation and widening (m^3)**
1	Linglong	51,035	62,210
2	Jinshui	87,190	2,240
3	Dongtai	9,295	23,113
4	Qingshui		48,662
5	Changlang		31,089
6	Dongchang		158,433
7	Chushui	53,482	17,714
	Total	**201,000**	**343,461**

1b-2: Embankment strengthening and ecological restoration

		Ecological embankment (m)	**Embankment strengthening (m^3)**	**Vegetated buffer strip (m^2)**	**Aquatic vegetation (m^2)**
1	Linglong	1,200	4,200	11,279	13,091
2	Jinshui	3,460	12,250	119,436	45,170
3	Dongtai	3,000	10,500	74,054	21,157
4	Qingshui	2,220	7,770	78,506	15,190
5	Changlang	2,000	7,000	24,935	8,025
6	Dongchang	5,000	26,250	87,064	34,954
7	Chushui	4,680	16,380	31,005	39,396
	Total	**21,560**	**84,350**	**426,278**	**176,983**

C1b-3: Constructing and upgrading 2 sluice gates in Linglong and Jinshui rivers

C1b-4: Constructing 3 bridge walkways in Jinshui and Chushi rivers

1	Jinshui	Number	1
2	Chushui	Number	2

Output 2: Solid Waste Management

1	Constructing a transfer station with 30 ton/d capacity
2	Purchasing 2 vehicles to collect, transport, and compact waste, as well as waste-separation rubbish bins
3	Public awareness campaigns on solid waste management and environment protection

Output 3: Capacity development and institutional strengthening

(i) project management support for smooth and timely implementation of the project in line with ADB procedures and guidelines, (ii) external resettlement monitoring; (iii) external environmental monitoring; (iv) (iv) water quality monitoring and forecasting system for Xingfu river and Baitan and Chiye lakes; (v) initial implementation supports.

36. The consequences of “doing nothing” are: (a) continued and increased outflow of wastewater in residential areas, drainage channels and lakes; (b) drainage channel bank scouring and erosion; (c) continued water-quality deterioration of the Baitan and Chiye lakes; (d)continued/increased risk of damage to individual homes and businesses from flooding ; and (e) adverse effects on the total municipal economy due to financial losses and added costs of water-quality deterioration.

4 Storm Water Hydraulic Modelling

4.1 Introduction to Storm Water Management Model

37. The US EPA storm water management model (SWMM) is a dynamic rainfall-runoff simulation model that can be used for management, analysis and design of storm water. It can be used for single event or long-term (continuous) simulation of runoff quantity and quality from primary urban areas.

38. Compared with other models, the advantages of the SWMM are as follows: It can be used not only to simulate process of rainstorm water transportation and runoff under the designed rainstorm, but also to forecast and manage the process under the actual rainstorm; It can simulate continuously; It integrates several modules and has integrated user interface which can be operated easily; It is suitable for simulation of urban drainage system whose hydrologic and hydraulics conditions are complicated.

39. SWMM conceptualizes a drainage system as a series of water and material flows between several major environmental compartments. These compartments include atmosphere, land surface, transport and groundwater.

40. Land surface compartment receives precipitation from atmosphere compartment in the form of rain and snow, and then it sends outflow in the form of infiltration to groundwater compartment, and also in the form of evaporation to atmosphere compartment; at the same time it sends surface runoff to the transport compartment. The groundwater compartment transfers a portion of inflow from land surface compartment to the transport compartment. The transport compartment is consisted of a network of conveyance elements (channels, pipes, pumps, and regulators) and storage units. Not all compartments need to appear in a particular SWMM model. The schematic of each compartment is shown in Figure 4.1 as follows:

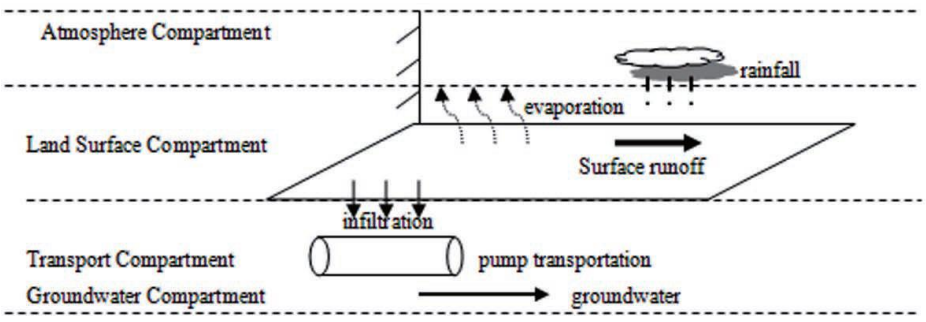


Figure 4.1: Schematic of the SWMM components

41. SWMM is widely used for planning, analysis and design related to storm water runoff, combined sewers, sanitary sewers, and other drainage systems in urban areas, with many applications in non-urban areas as well.

4.2 Modelling Domain

42. The computational domain of the storm water management model covers a total area of 25 km^2 in the NED Phase 1, including the Baitan and Chiye lakes. The upstream boundary of the model is the Xingfu River which has a total length of 14.5 km with a catchment area of 39.8

km^2, including the Xingfu reservoir of which the catchment area is 11.5 km^2. The downstream boundaries of the model are the Santai River in the west and the planned Nanhu pumping station in the east. The schematic of the model is shown in Figure 4.2.

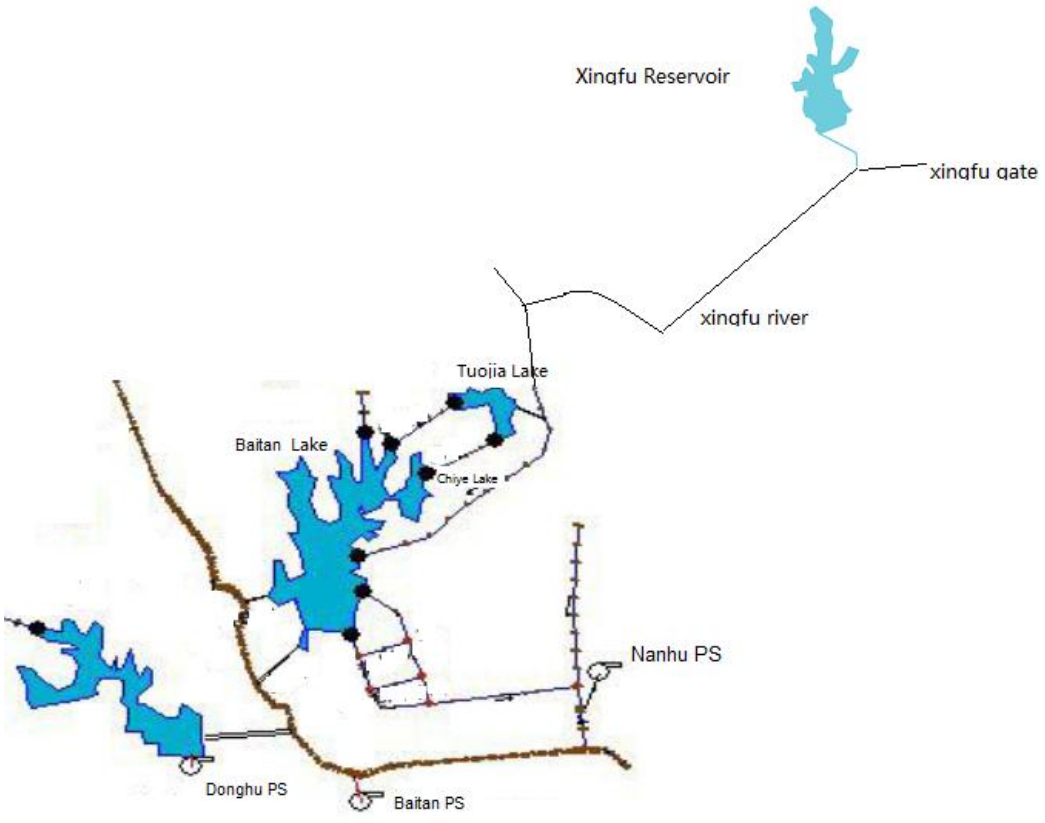


Figure 4.2: Schematic of the interconnected water system and model domain

43. The study area, based on SWMM, was divided into a total of 207 sub-catchments, representing the drainage pipe connection based on the urban drainage network plan as shown in Figure 4.3. A map showing full details of the drainage pipe network is attached in **Appendix 3.**

44. In order to simulate the hydrology and hydraulics in the water system, a set of parameters was estimated. The main parameters required are shown in Table 4.1.

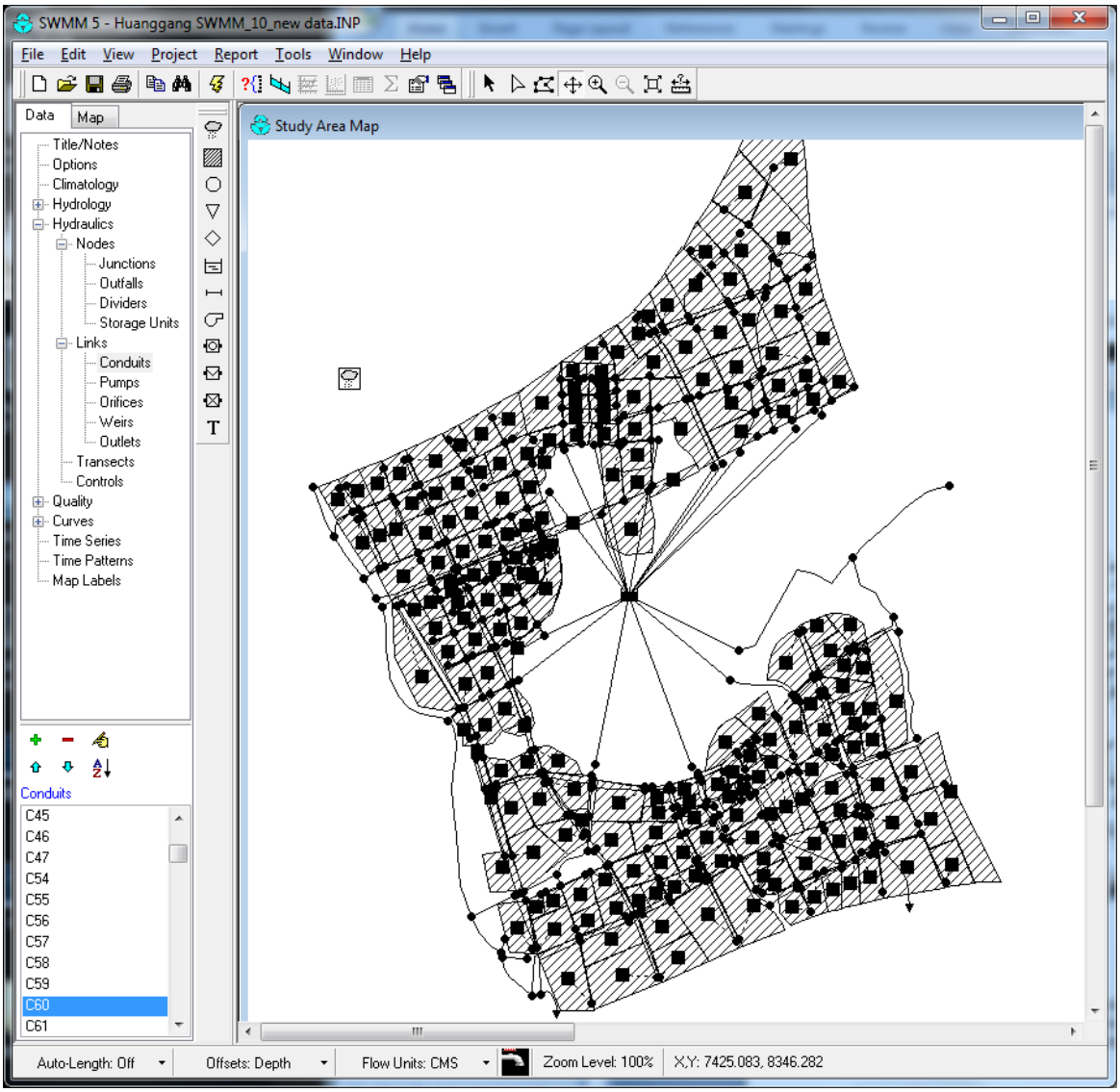


Figure 4.3: Model domain and sub-catchments

Table 4.1: List of model parameters

Category	Model data	Model parameters
Sub-catchment	Area, width, slop, rain gauge, outlet, etc.	%Imperv, N-Imperv, N-Perv, S-Imperv, S- Perv, %Zero, Infiltration parameters, etc.
node	invert elevation, maximum depth, etc.	initial depth, ponded area, etc.
conduit	inlet node, outlet node, type, length, maximum flow, etc.	Manning's n, initial flow, etc.
rain gauge	time step, value, etc.	

45. In this study, the model data were obtained from the drainage pipeline design and local geographic information. For the model parameters, the method is to initially choose values from the Manuals by taking the local characteristics into consideration, followed by a realistic check.

46. According to the local characteristics, the following parameters are chosen for the Horton's equation: S-imperv as 0.05, N-imperv as 0.03, S-perv as 2, N-perv as 0.015. For the drainage pipe, the Manning's roughness is chosen as 0.012 while for the urban river channels, this value was assumed to be 0.2 to take account of the vegetated embankments and aquatic plants in the river channels.

4.3 Modelling and Analysis

4.3.1 Hydraulic Feasibility

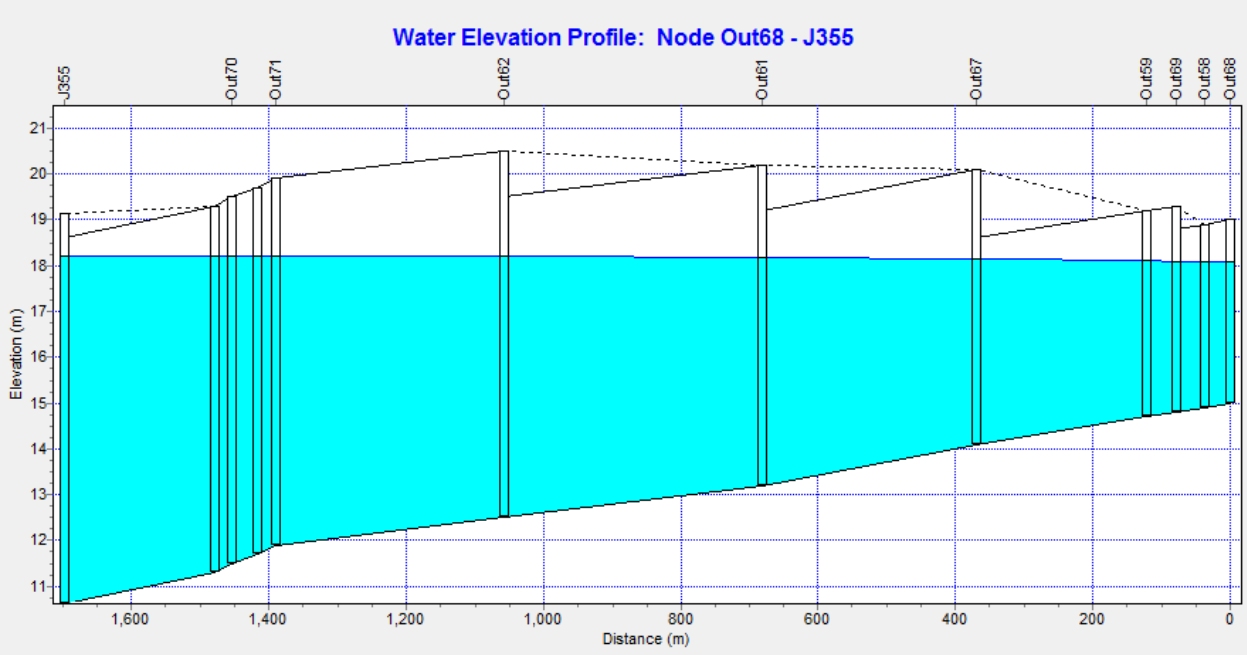
47. The SWMM model was used to test the hydraulic feasibility of the proposed design of the urban rivers and interconnection with the Baitan and Chiye Lakes. The technical features of the proposed 7 river channels are listed in Table 4.2.

Table 4.2: Technical features of the re-constructed channels

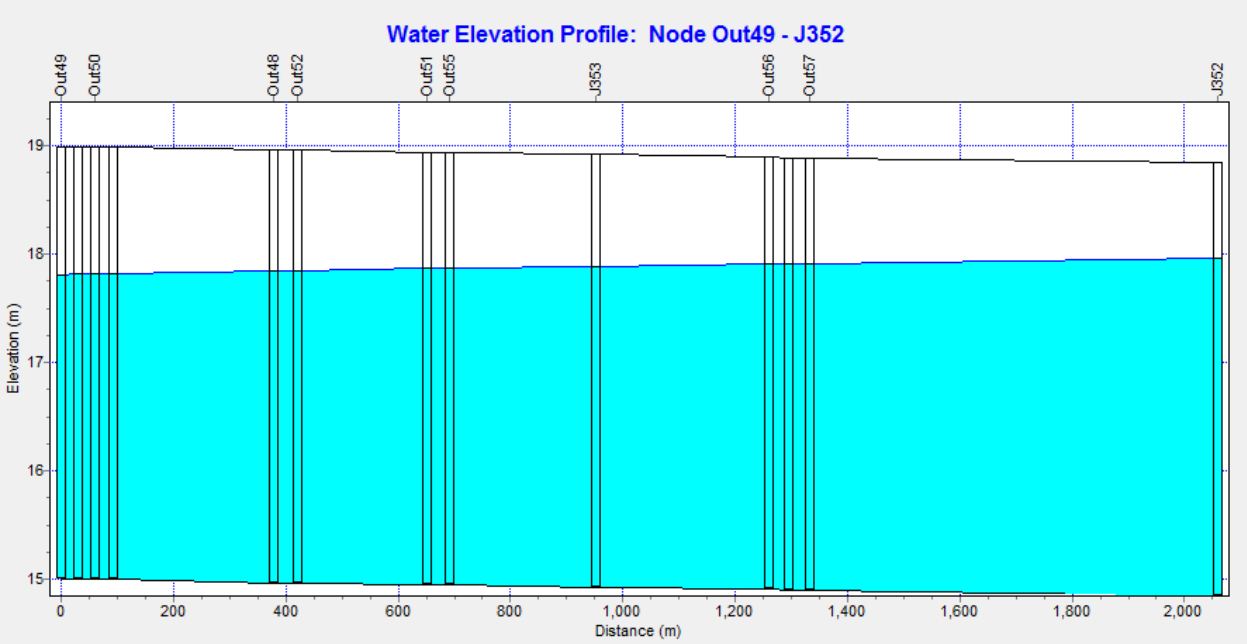
Channel	River length (km)	Designed width(m)	River bed elevation (m)	Normal water level(m)	Maximum water level(m)	Flood of 1 in 20 year event (P=5%)	
						Flow (m3/s)	Flood control level(m)
Baitan Lake							18.04
Jinshui	1.6	50	15	16.70	18.54	16.40	18.04
Linglong	0.75	50	14	16.70	18.54	16.40	18.04
Chushui	2.25	30	15	16.70	18.54	9.6	18.04
Qingshui	1.16	15-25	15	16.70	18.54	5.0	18.04
Changlang	0.992	15	15	16.70	18.54	5.0	18.04
Dongcang	3.27	25	15	16.70	18.54	13.70	18.04
Dongtai	2.14	20-30	15	16.70	18.54	20.30	18.04

48. The hydraulic feasibility of the rivers was tested based on the daily rainfall data in July 1998[1]. The hydraulics of the inter-connected lake and channel system were simulated and the results of the hydraulic profile of the representative channels are shown in Figure 4.4.

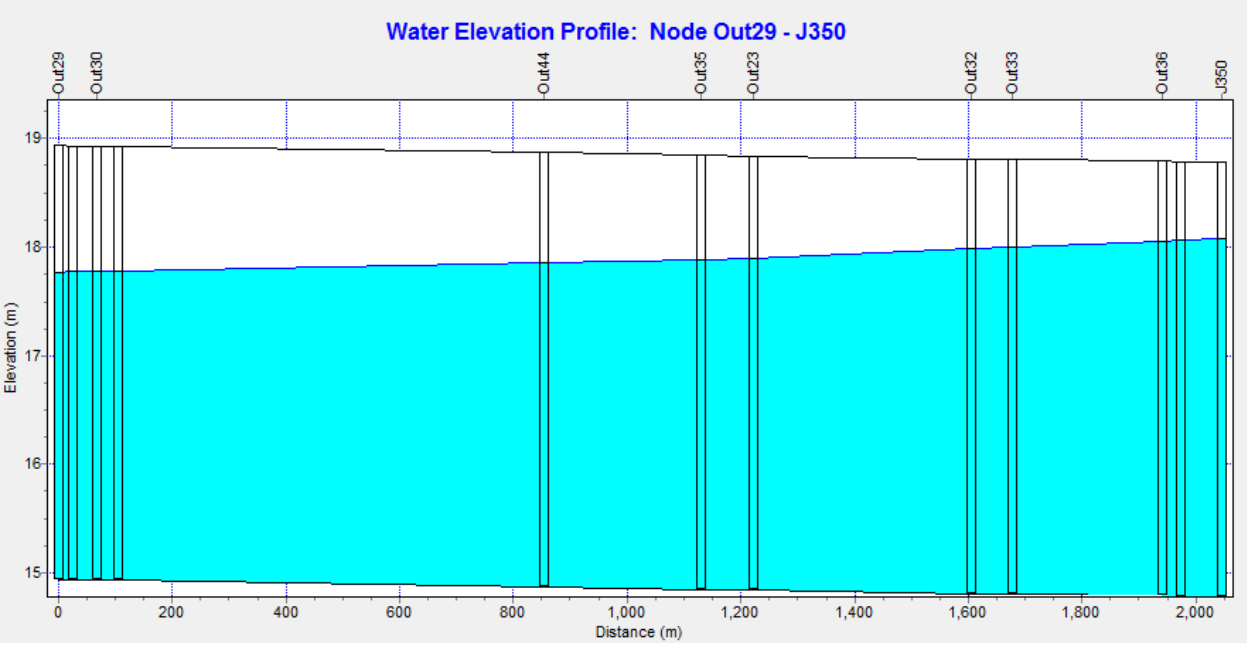
[1] According to hydrological statistics, the July 1998 flood in Huanggang as regarded as a 1 in 20 year return event, representing a probability of 5%.



(a) Jinshui River



(b) Dongtai River



(c) Dongchang River

Figure 4.4: Hydraulic profile of the urban rivers

49. The model results show that the maximum water level in the inter-connected water system is 17.98 m, which is approximately 6 cm below the proposed control level of 18.04m, indicating that the system is feasible and the hydraulic capacity is adequate.

4.3.2 Flood and Water-logging Analysis

50. The SWMM model was also used to analyze the flood and water-logging in the Project area. The model was run based on the daily rainfall data in July 1998 and the simulated water levels of the Baitan Lake are shown in Figure 4.5.

51. The results show that for the 20 year return flood event, the maximum water level is 17.98, which is some 37 cm below the recorded water level for the same period in 1998. As compared with the existing system ("without project option"), the potential benefit in flood protection is the reduction of some 37 cm in the system water level.

52. The modeling results also show that **water-logging risks are significant at some locations in the urban area** as shown in

53. Figure 4.6, indicating that the size of the drainage pipes or the connections need further optimization. The HMG was made aware of the findings; the design institute responsible for the drainage pipe design is reviewing their detailed designs.

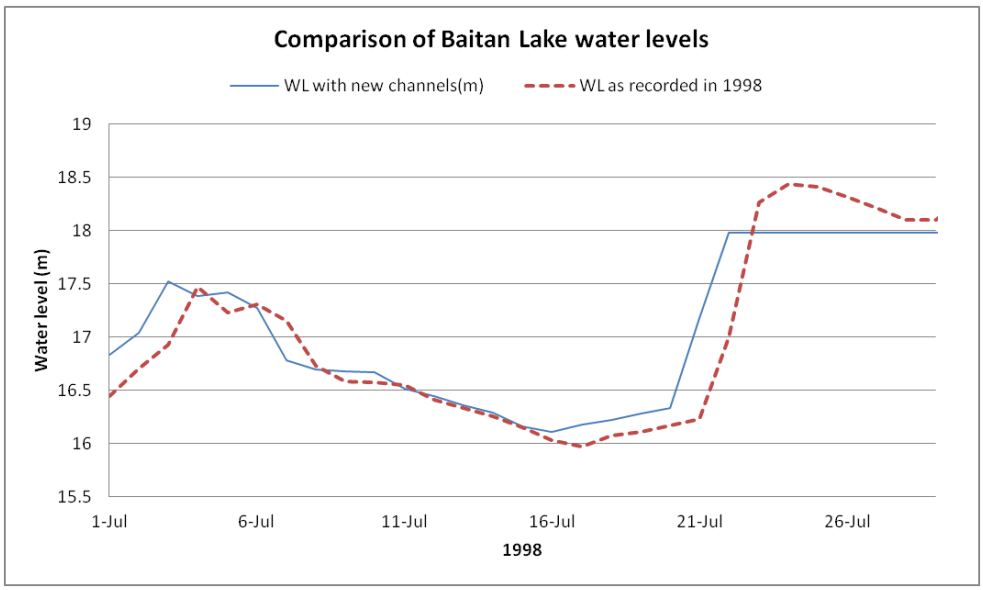


Figure 4.5: Simulated lake water levels

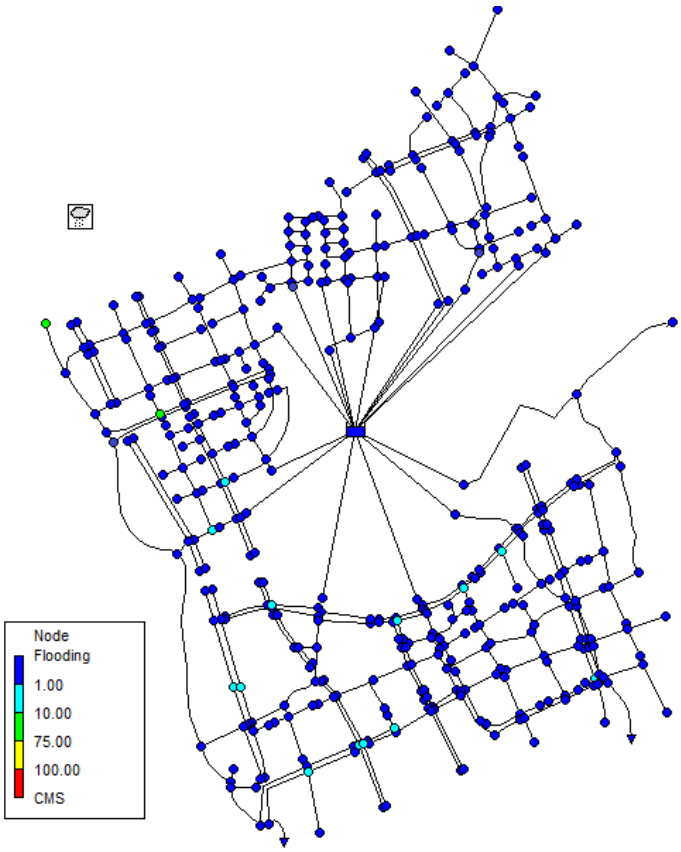


Figure 4.6: Locations of potential water-logging

4.3.3 Impact of Climate Change

54. In order to assess the impact of climate change on the project, in particular to the risk of flooding in the new district, the hydraulic model was run by increasing the precipitation intensity by 6% according to the recent research by UK Hadley Centre[1]. The research findings from the UK Hadley centre as part of the Adaptation to Climate Change in China (http://www.ccadaptation.org.cn/) shows (Figure 4.7) that the temperature and precipitation in Hubei province could increase by 2 ^{o}C and 6% by the end of 2050 as compared with the UK CRU data (http://www.cru.uea.ac.uk/) recorded during the period 1960-1990.

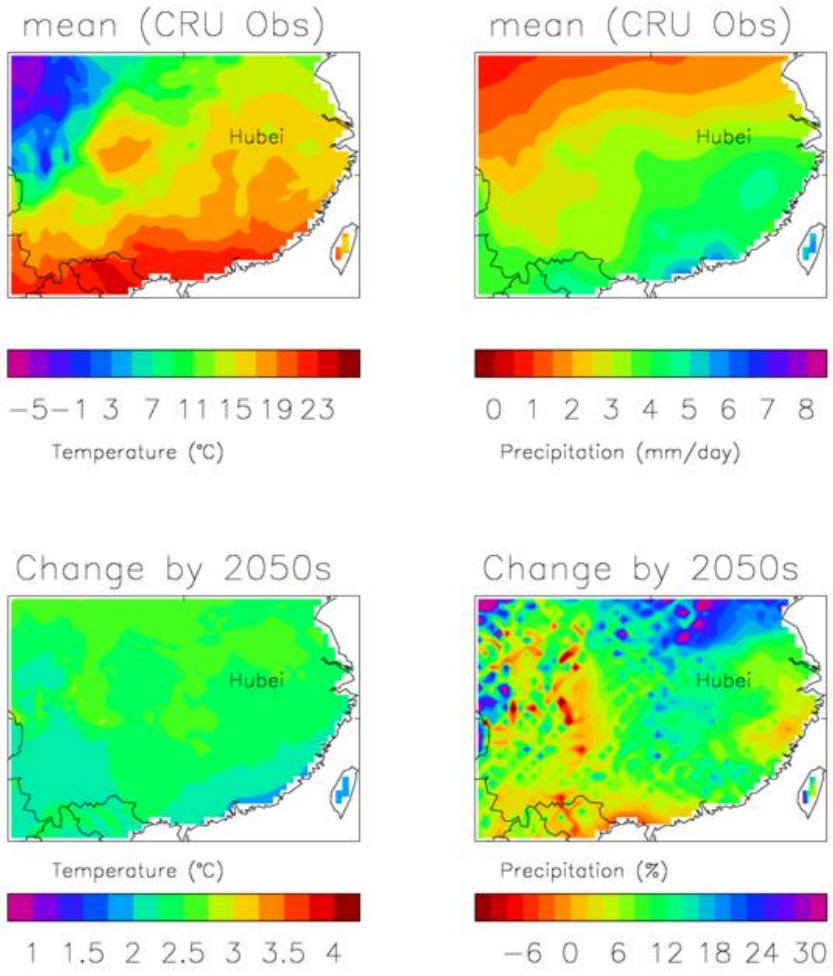


Figure 4.7: Predicted Changes in Temperature and Precipitation In Hubei Province

[1] The UK Hadley Centre participated in the UK DFID funded project Adaptation in Climate Change in China (http://www.ccadaptation.org.cn/)

55. As shown in Figure 4.8, the impact of climate change could result in an increase of maximum water level by some 4 cm and the maximum water level could reach to 18.02 m, which is approximately 2 cm below the adopted flood protect level of 18.04m. Therefore, the hydraulic capacity of the re-established water system of lakes and rivers is capable of coping with the additional flows and is resilient to climate change.

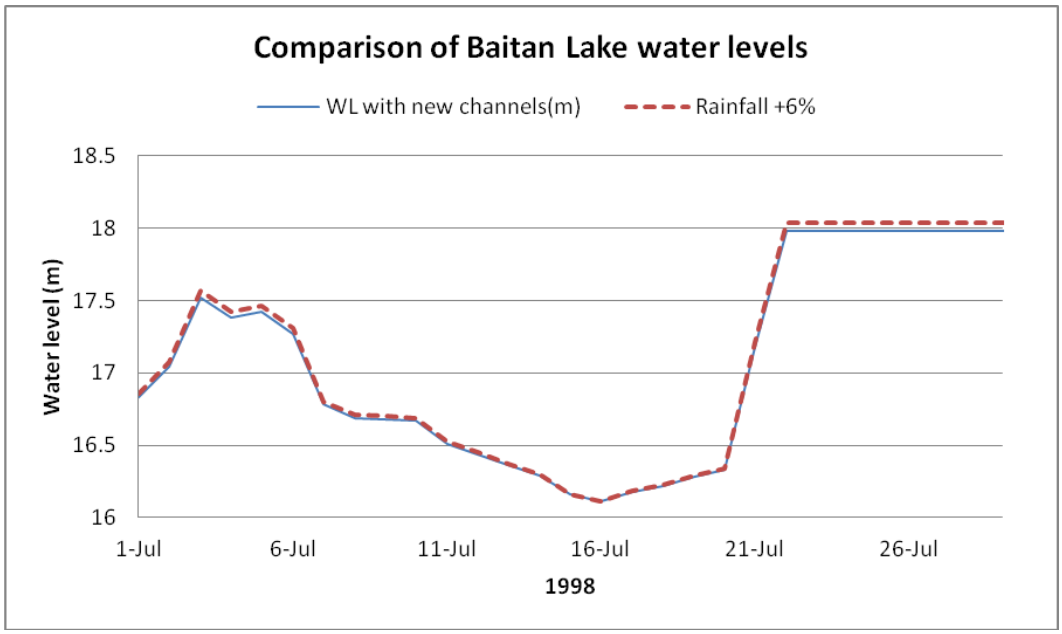


Figure 4.8: Comparison of water levels in Baitan Lake under climate change scenario

4.3.4 Impact of Nanhu Pumping Station

56. According to the master plan of the water system in the Changhe river basin, Nanhu pumping station with an installed capacity of 30 m^3/s is required to abstract storm water from the Baitan and Chiye lake and the Nanhu district during the storm event when the water level in Santai is higher than 17.98 m. Huanggang Municipal government provided document evidence, showing that this pumping station has been listed in the government funded project pipeline and is scheduled to start in 2016 and compete in 2019.

57. In order to assess the impact on risk of flood in the new district, the hydraulic model was run under a scenario when the completion of the pumping station is delayed. As shown in Figure 4.9, the simulation results indicate that without the Nanhu pumping station, the water level is Baitan Lake would reach to 18.58 m, which is some 54 cm higher than the maximum water level when the pumping station is operational.

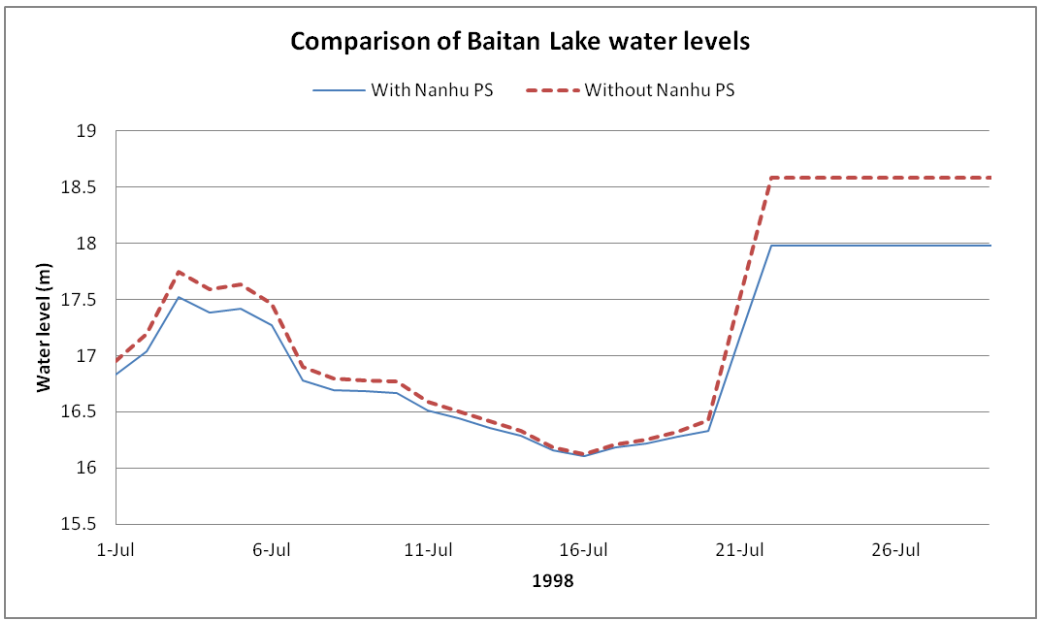


Figure 4.9: Comparison of water levels in Baitan Lake for with and without Nanhu pumping station

4.3.5 Rainfall –Runoff Modelling

58. The SWMM model was used to generate surface runoff information which was not historically recorded in the Project area. Based on the daily rainfall record in 1988[1] which was provided by the Huanggang Meteorological Bureau, the corresponding runoff data were generated as show in Figure 4.10, which is key input data for the water quality modeling.

[1] According to statistics, the total rainfall in 1998 was 978.4 mm in Huanggang. As compared with the annual average rainfall of 1286.7mm, it was regarded as the “dry” year with an exceeding probability of 90%.

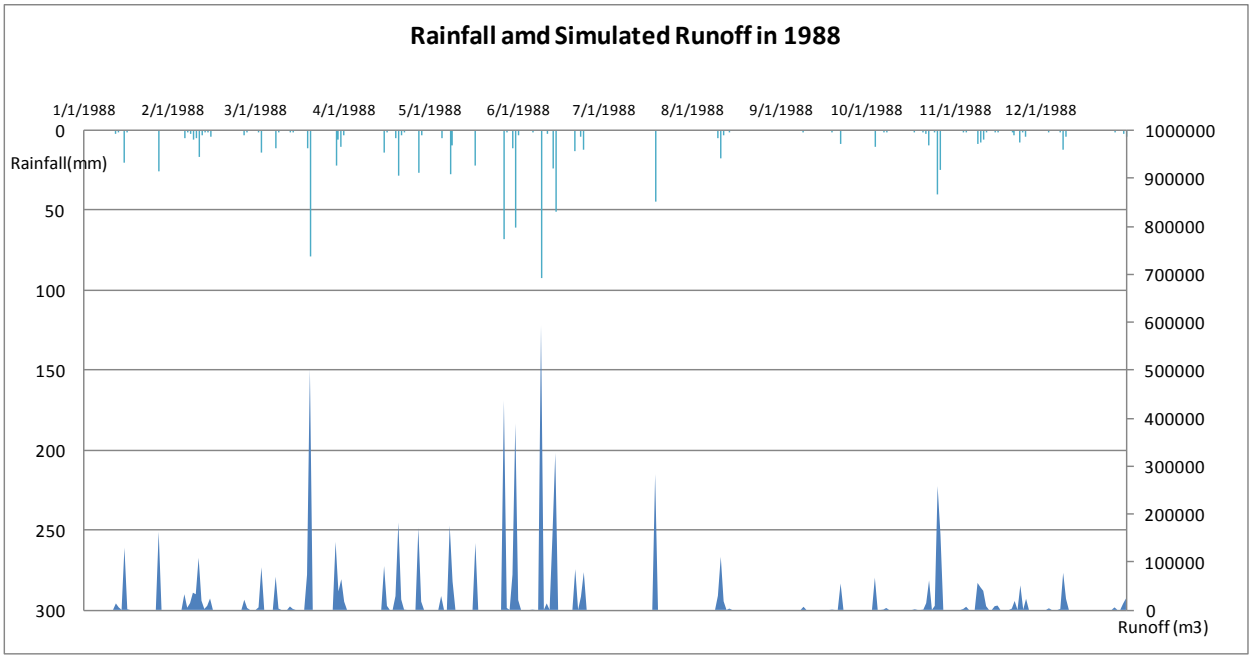


Figure 4.10: Simulated runoffs based on rainfalls in 1988

5 Water Quality Modelling

5.1 Computational Domain

59. The numerical water quality model of the Baitan and Chiye Lakes has been developed as a two dimensional model based on bathymetric data, covering both the Baitan and Chiye lakes, as shown in Figure 5.1.

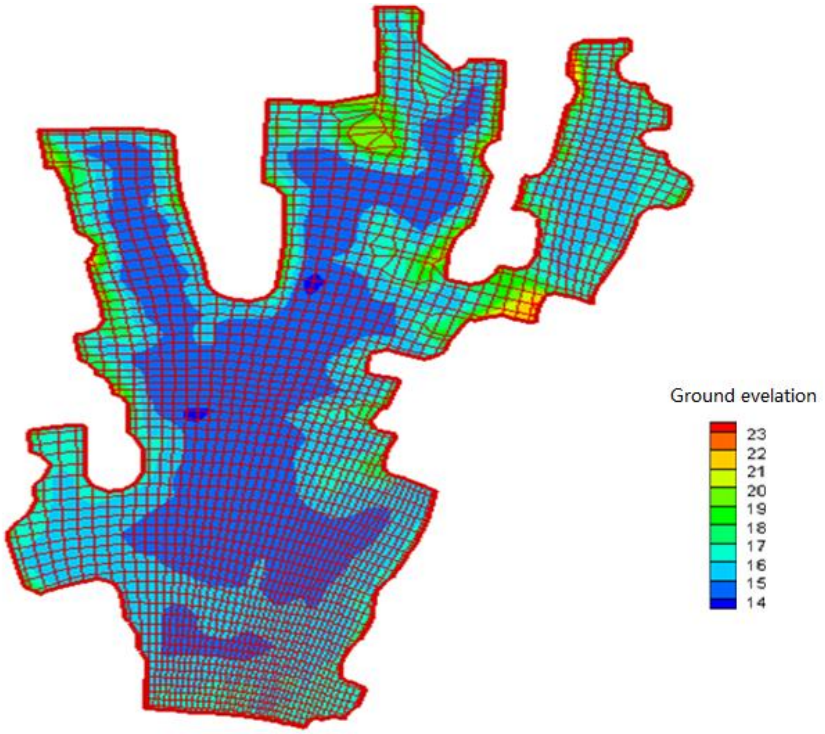


Figure 5.1: Water quality model domain and computational grids

5.2 Model Calibration

5.2.1 Model parameter estimation

60. The main model parameters to be estimated are hydraulic roughness, COD degradation coefficients, nitrification and denitrification coefficients, phosphate adsorption and desorption coefficients degradation and pollutant release rates from sediment deposit. In this study, the hydraulic roughness was estimated based on measured inflows and outflows. As no laboratory tests were carried out for the degradation coefficients and sediment releasing rates, a set of initial values were taken from studies of lakes with similar characteristics and pollution condition, followed by model calibration. The constituents used for model calibration are COD, TP and TN.

61. The model was calibrated based on the field measurements on 12 May when 14 samples were taken at various locations in Baitan and Chiye Lakes as shown in Figure 5.2. Subsequently, the samples were analyzed at the laboratory by researchers from the School of

Resources and Environmental Science, Wuhan University.

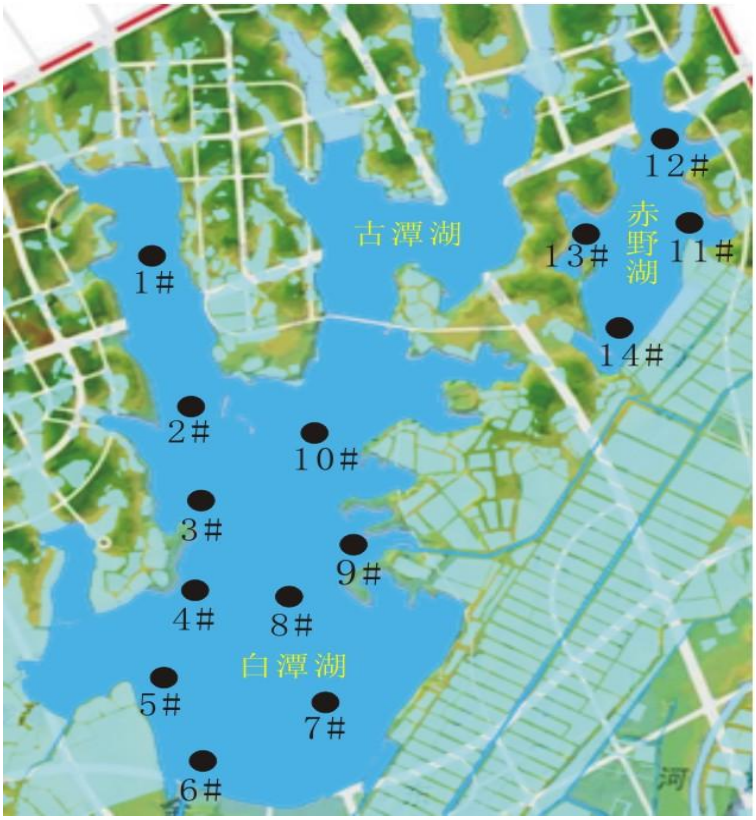


Figure 5.2: Locations of the water quality sampling

Roughness coefficients

62. Hydraulic roughness in natural lakes is affected by many factors, such as bed composition, shape, coverage and other factors. The estimated roughness value for the Baitan and Chiye lakes is 0.022. Table 5.1 lists its comparison with roughness values from similar lakes in the PRC.

Table 5.1: Roughness coefficients

Lake	Roughness	Sources
Taihu Lake	0.01-0.03	11th FYP MWR research
East Lake, Wuhan	0.027	Study of the lake operations for water quality improvement
Baitan/Chiye Lake	0.022	Calibrated

Coefficients of Pollutant Degradation and Release from Sediment

63. Degradation coefficients are affected by temperature as the temperature in different seasons varies in a lake. The relationship is that $K_T = K_{20} * 1.047^{T-20}$, where K_T and K_{20} are the degradation coefficients when water temperatures are at T and 20ºC, respectively; and T is the temperature. Different water bodies have different degradation coefficients (K_{20}). Table 5.2 lists the K_{20} values from relevant researches.

64. With reference to the degradation coefficients in Taihu and Poyang Lakes (Zhang, 2010; Zhao, 2011), the model was calibrated based on the sampled data. With regard to pollution release rates from the sediment deposit, the research results from East Lake in Wuhan and other similar lakes (Sources: Zhang (1996); Chen (2009); Jiang (2006); Fan(2002); Liu(2006), Hua(2011)

65. Table 5.3) were used as reference (Zhang, 1996; Chen, 2009; Jiang 2006; Fan, 2002; Liu 2006, Hua, 2011), followed by model calibration exercise. The estimated model parameters for different regions of the Baitan and Chiye lakes are listed in Table 5.4.

Table 5.2: Coefficients of Pollutant Degradation

	Poyang Lake	Taihu Lake	Chaohu Lake	Guanting Reservoir	Danjiangkou Reservoir	Three Gorge Reservoir
COD(1/d)	0.026	0.02	0.05	0.005	0.004	0.02 ~ 0.1
TN(1/d)	-	-	-	-	0.015 ~ 0.05	0.015 ~ 0.08
TP(1/d)	-	-	-	-	0.01 ~ 0.04	0.01 ~ 0.04

Sources: Zhang (1996); Chen (2009); Jiang (2006); Fan(2002); Liu(2006), Hua(2011)

Table 5.3: Pollutant releasing rate from sediment

Lake	Area(km^2);Average Depth (m)	Pollutant releasing rate from sediment ($mg/(m^2 \bullet d)$)	Reference
East lake, Wuhan, Huebei	32.0, 1.9	TP:2.97	Xie, 2008
Xuanwu lake, Nanjing, Guangxi	3,71; 1.2	TP:1.296 – 1.521	Gong, 2006
Dongqian lake, Ningbo, Jiangsu	19.9; 2.0	TP:0.6 – 1.4 NH3-N: 6-16	Shang, 2007
Fubao Bay, Dianchi Lake, Kunming, Yunnan	1.0;1.5	NH3-N: 22.941-163.117 TP: 0.90-2.06	Li, 2008
Caohu lake, Anhui	770, 3.06	TP: 0.053- 0.2	Wang, 2002

Table 5.4: Estimated model parameters for different regions of the Baitan and Chiye lakes

Location		Degradation Coefficient(s^{-1})			Pollutant release rates from sediment(s^{-1})		
		COD	TP	TN	COD	TP	TN
1	Baitan	6.75E-07	2.97E-05	1.35E-05	3.36E-05	2.02E-05	2.52E-05
2	South Baitan	8.40E-06	6.60E-05	7.40E-05	1.88E-05	1.35E-05	0.0000216
3	Gutan	6.40E-06	3.40E-05	7.20E-05	3.36E-05	1.34E-05	2.52E-05
4	Chiye	9.90E-06	3.46E-05	7.20E-05	1.02E-05	1.34E-05	2.52E-05

5.2.2 Model verification and sensitivity tests

66. **Model verification**. The water quality model was tested against the monitoring water quality data recorded on March 7, 8 and 9, 2013. Table 5.5 lists the comparison between the measured and modeled concentrations and their relative errors. Figure 5.3 shows modeled and measured COD, TN and TP at locations 1# in Baitan Lake and 1# in Chiye lakes, respectively. The testing results show that the relative errors range from -14% to 12 %, in which the error is between -10% to 10% for 90% of the samples.

Table 5.5: Comparison of modelled and measured values

Verification location	Date	COD (mg/l)			TN (mg/l)			TP (mg/l)		
		measures	modelled	error%	measures	modelled	error%	measures	modelled	error%
Baitan 1#	7/3/2013	29	26	10.34	2.15	1.97	8.37	0.08	0.077	3.75
	8/3/2013	27	29	-7.41	1.01	1.09	-7.92	0.12	0.129	-7.50
	9/3/2013	22	20	9.09	1.34	1.46	-8.96	0.07	0.077	-10.00
Baitan 2#	7/3/2013	28	30	-7.14	2.5	2.66	-6.40	0.08	0.085	-6.25
Baitan 3#	8/3/2013	28	31	-10.7	2.55	2.88	-12.9	0.08	0.091	-13.75
	22/5/2013	27	25	7.41	1.9	2.07	-8.95	0.1	0.094	6.00
Baitan 4#	8/3/2013	29	31	-6.90	2.51	2.66	-5.98	0.07	0.078	-11.43
Chiye Lake	8/3/2013	25	22	12.00	1.92	2.04	-6.25	0.07	0.074	-5.71
	22/5/2013	30	33	-10.0	1.72	1.82	-5.81	0.1	0.105	-5.00

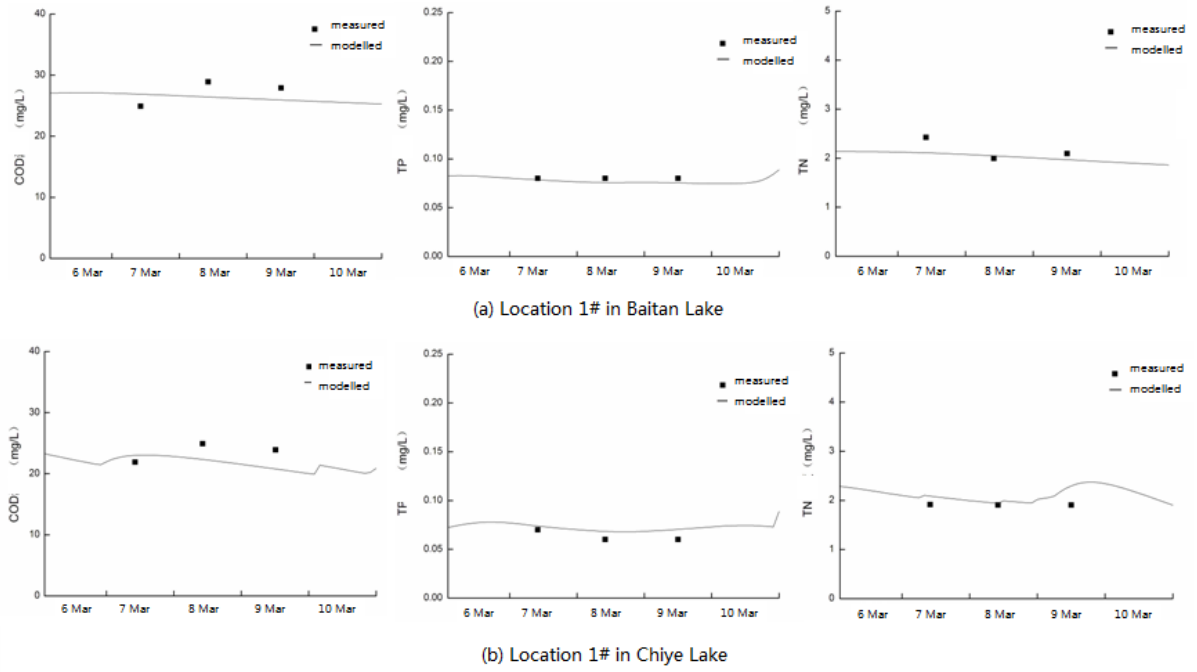


Figure 5.3: Measured and modelled COD, TN and TP concentration at 2 monitoring points

67. **Sensitivity analysis.** Sensitivity tests of the model were carried out by changing the model parameters, such as COD degradation coefficient and nitrogen dynamic coefficient, by -10% and +10%. Figure 5.4 shows the sensitivity test results, indicating that the COD degradation coefficient is more sensitive than nitrogen dynamic coefficient.

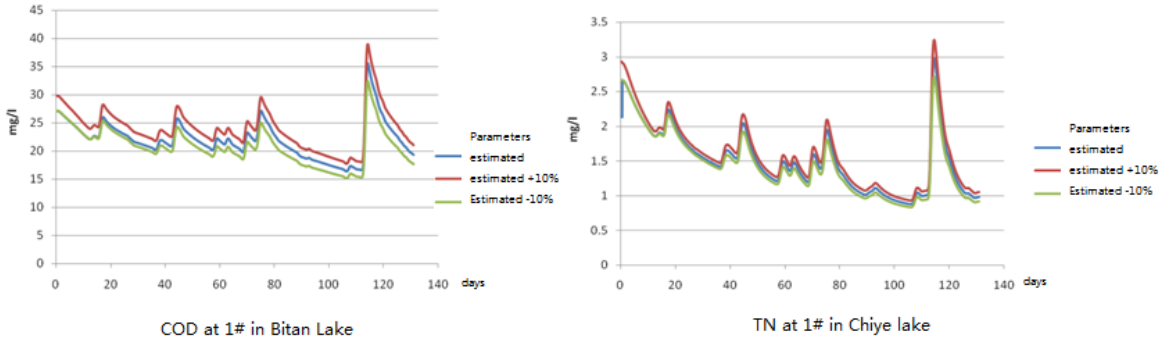


Figure 5.4: Sensitivity analyses of the model parameters

68. From the verification, it was concluded that the developed model was capable of simulating the water quality dynamics of the studied area with a reasonable accuracy.

5.3 Modelling Scenarios

69. To test the impact of the proposed Project on the lake water quality, a number of separate scenarios have been tested. In general, two broad sets of scenario can be distinguished:

- "Without Project" scenarios which serve to provide the baseline conditions against which the impact of the Project can be compared with based on pollution loads in 2013 and 2020;

- "With Project" scenarios which include specifically the assumed impact of the proposed Project based on pollution loads in 2020.

70. These scenarios are generally not the same as before Project and after the Project as often other conditions (such as background conditions and other inputs) may well change during the implementation of the Project. The following scenarios as listed in Table 5.6 were used for modeling and analysis, which contain different combinations of the engineering measures proposed for the Project.

Table 5.6: Scenarios for water quality simulation and analysis

Option		Scenarios	Sediment Dredging	Surface flow-wetland, buffer zone and aquatic plants	Subsurface wetlands with detention ponds	Water transfer
Without project	2013 loading	1				
	2020 loading	2				
With engineering measures, 2020 loading		3	539,405 m^3	-	-	-
		4	915,000 m^3	-	-	-
		5	539,405 m^3	80 ha	-	1.1m^3/s
		6	539,405 m^3	80 ha	3.8 ha	1.1m^3/s
		7	915,000 m^3	80 ha+9.6 ha	-	1.1m^3/s
		8	915,000 m^3	80 ha,	3.8 ha	1.1m^3/s

5.4 Assumptions

71. In this study, it has been assumed that all the existing and planned interventions as described in Section 2.8 will be implemented as planned.

5.4.1 Pollution load conditions

72. For 2013, under the no project scenario, it was assumed that existing untreated domestic wastewater, agricultural and fishery pollutants would discharge directly into Baitan and

Chiye Lakes from the area surrounding the lakes and the Xingfu River catchment. The total annual pollution loads discharging to the lakes are COD 577.34 ton, NH3-N 57.56 ton, TN 67.60 ton and TP 5.86 ton. Table 5.7 and Figure 5.5 show the composition of the pollution loads.

Table 5.7: Summary of Pollution Loading discharging to Baitan and Chiye Lakes in 2013

Source	COD (t/year)	NH_3-N (t/year)	TN (t/year)	TP (t/year)
Domestic waste water	71.00	5.07	4.39	0.62
Agricultural non-point sources	51.47	8.67	10.84	0.60
Fish farming	99.24	10.36	12.19	2.80
Dust deposition	34.28	11.20	14.00	0.88
Xingfu river catchment	321.35	22.25	26.18	0.96
Total (t/year)	577.34	57.56	67.60	5.86

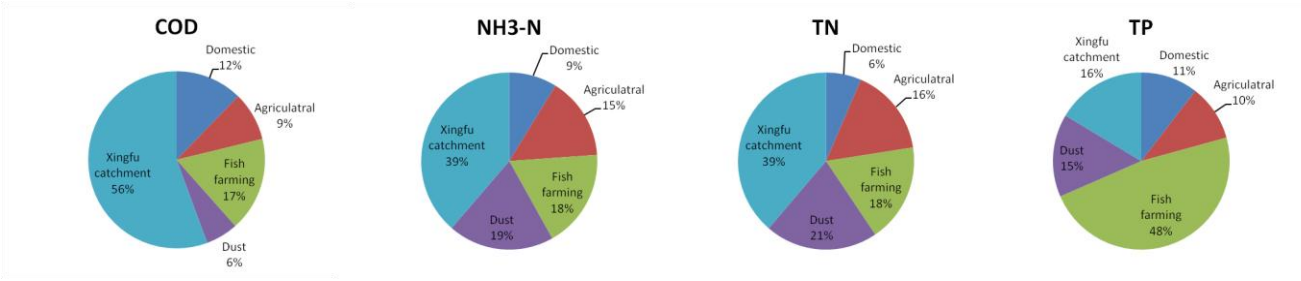


Figure 5.5: Pollution loading composition in 2013

73. For 2020, under the no project scenario, it was assumed that the point and non-point pollution loads (domestic wastewater, agricultural and fishery) from the Xingfu River catchment would continue to discharge into both lakes. Domestic wastewater from the Baitan and Chiye lake area would be intercepted via sewer pipeline and connected to the Nanhu sewer treatment plant. The main pollution source in the area surrounding the lakes is from the first flush of the urban runoff generating form rainfalls. The total annual pollution loads discharging to the lakes are COD 502.95 ton, NH_3-N 60.77 ton, TN 77.88 ton and TP 4.57 ton. Table 5.8 and Figure 5.6 show the composition of the pollution loads.

Table 5.8: Summary of Pollution Loading discharging to Baitan and Chiye Lakes in 2020

Source	COD (t/year)	NH3-N (t/year)	TN (t/year)	TP (t/year)
Urban Runoff	113.05	5.07	11.45	1.76
Dust deposition	68.56	11.20	14.00	0.88
Xingfu river catchment	321.35	44.50	52.35	1.93
Total (t/year)	502.95	60.77	77.80	4.57

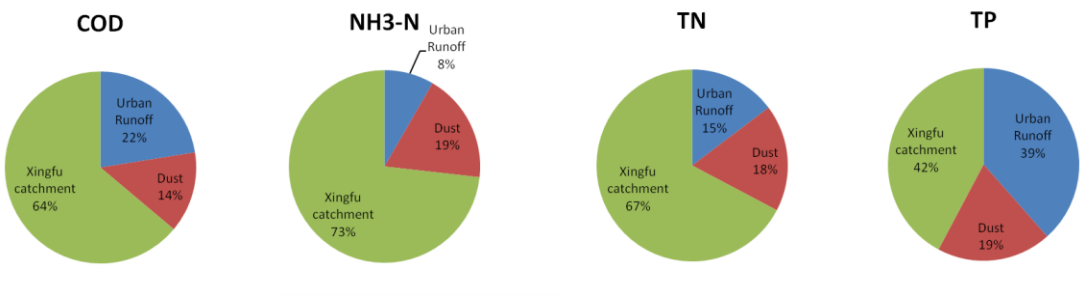
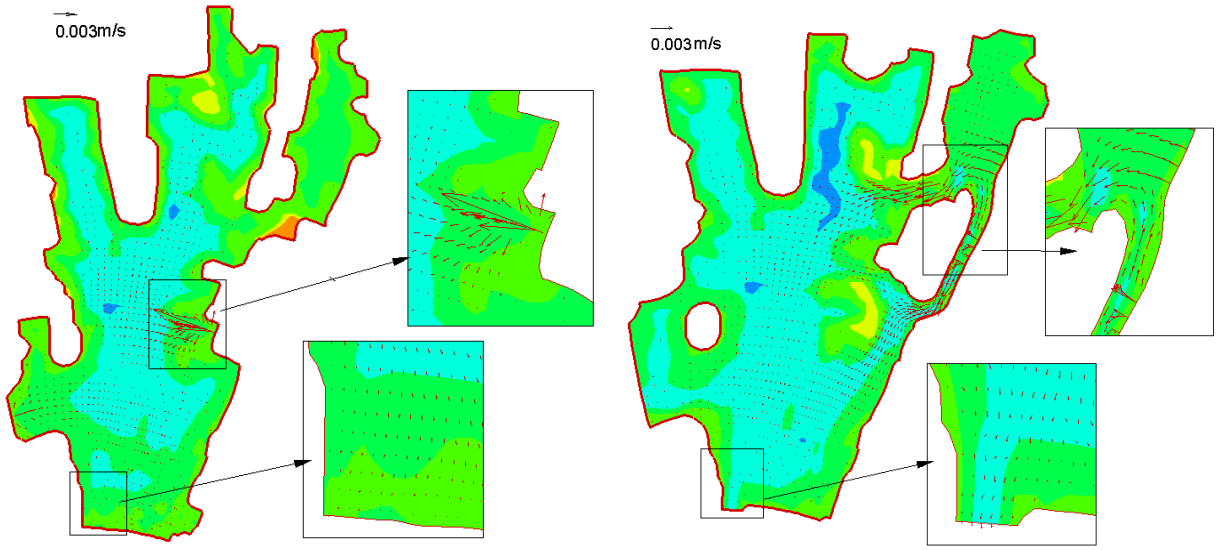


Figure 5.6: Pollution load composition in 2020

5.4.2 Hydraulic profiles

74. The hydraulic velocity profiles for the 2013 and 2020 pollution loading scenarios are shown in Figure 5.7.



(a) 2013 **(b) 2020**

Figure 5.7: Hydraulic velocity profiles

5.4.3 Wetland treatment efficiency

75. For the constructed wetlands the following treatment efficiencies were assumed in the water quality model.

76. **Surface flow wetland** – assuming that the hydraulic loading is 0.1m^3/m^2.d and the hydraulic retention time is between 4 to 8 days, the treatment efficiencies of the surface wetlands are listed in Table 5.9.

Table 5.9: Treatment efficiency of the constructed surface-flow wetland

	COD	TN	TP
Inflow quality (mg/l)	≤125	≤100	≤3
Treatment Efficiency(%)	34	71	27
Class IV standard(mg/l)	30	2	0.1

77. During the water quality simulation, it was assumed that the surface flow wetlands, as shown in Figure 5.8, were on a scale of 800,000 m^2, the corresponding hydraulic loading was 80,000 m^3/d. As the catchment area of the Xingfu River is 28.3 km^2, there is little flow in the river if there is no rain. Therefore, it was assumed that the required hydraulic loading of 80,000 m^3/d would be provided by transferring some 1.1 m^3/s from Ba River through the Xingfu gate/Hongqi pumping station via Xingfu River.

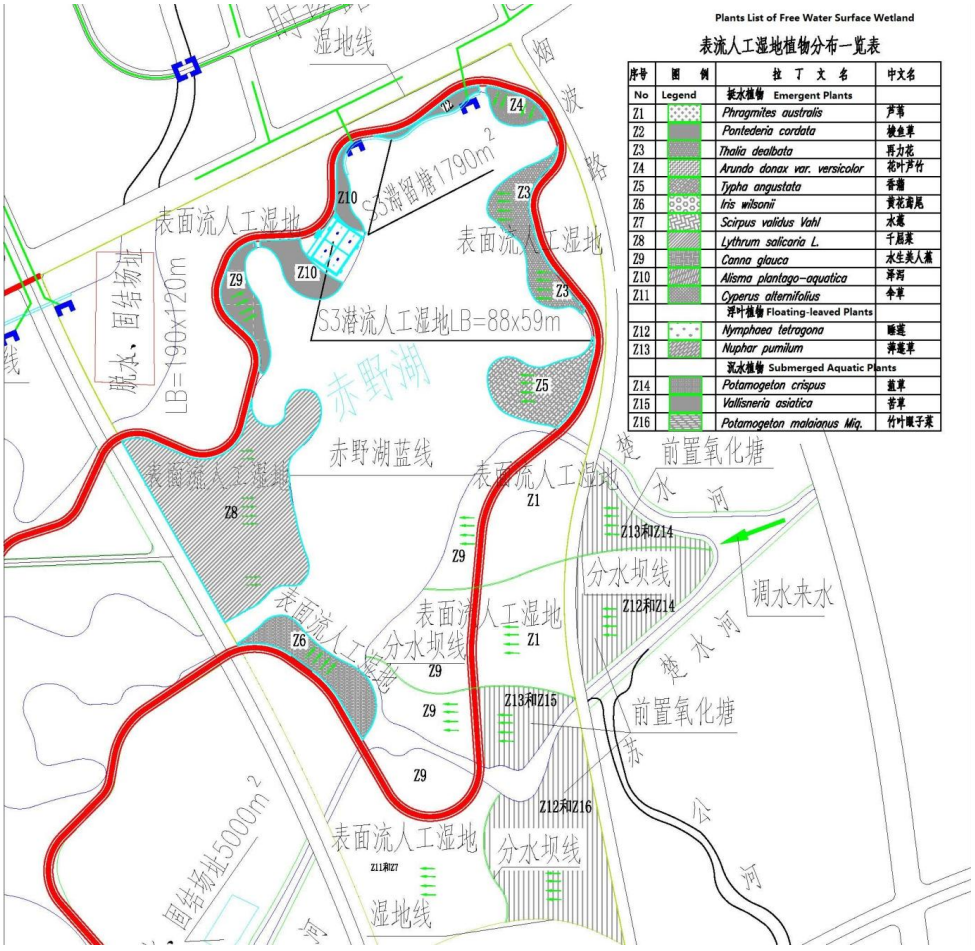


Figure 5.8: Locations of the surface flow wetlands

78. **Subsurface Flow Wetlands** – assuming that the hydraulic loading is less than 0.5m^3/m^2.d and the hydraulic retention time is between 1 to 3 days, the treatment efficiencies of the subsurface wetlands are listed in Table 5.10.

Table 5.10: Treatment efficiency of the subsurface flow wetland

	COD	TN	TP
Inflow quality (mg/l)	≤125	≤100	≤3
Treatment Efficiency(%)	34	71	27
Class IV standard(mg/l)	30	2	0.1

79. In the water quality model, it is assumed that 4 subsurface flow wetlands, each being connected via a detention pond to the drainage discharges, are built with the configuration as listed in Table 5.11. Figure 5.9 shows the locations of the subsurface flow wetlands.

Table 5.11: Subsurface flow wetland and detention ponds

Location	Watershed	Wetland	Pond
	ha	m^2	m^2
S1	145	14,515	5,915
S2	92	9,211	3,754
S3	54	5,197	2,118
S4	93	9,304	3,791

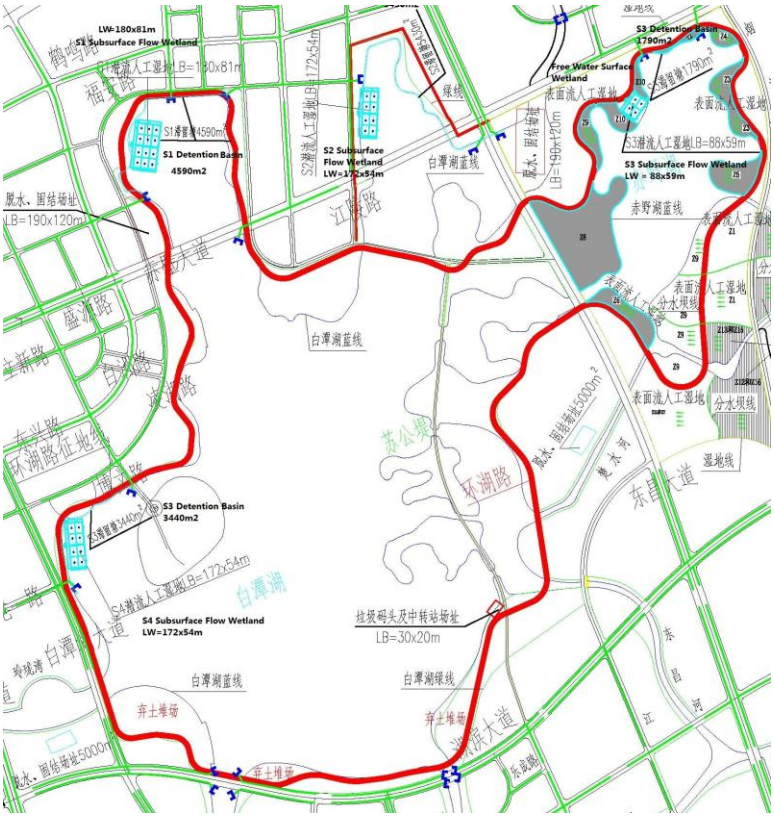


Figure 5.9: Locations of Subsurface flow wetlands and detention ponds

5.4.4 The pollutant removal efficiencies of the vegetated buffer zone around the lakes and in-lake aquatic plants

80. According to data provided by the Design Institute, the total vegetated area of the off-shore buffer zone is 64,000 m^2 and the total area of aquatic plant is 80,000 m^2, including 960 m^2 of floating wetlands. The estimated annual pollutants removed are COD = 6.0 t/year; TN = 25.32 t/year; TP = 6.06 t/year.

5.4.5 Effect of Sediment Dredging

81. After the sediment is dredged, the release of pollutants from the sediment deposit will be significantly reduced. During the water quality simulation, it is assumed that the pollutant release rates will be reduced to 1/5 of that before dredging. After sediment dredging, the lake storage volume will be increased, further improving the water quality.

5.5 Water Quality Simulations and Result Analysis

82. The calibrated water quality model was used to assess the Project engineering measures' individual and cumulative impact on lake water quality for the pollutants of concern (COD, NH_3-H, TP and TN). The simulations were undertaken for 1 year under a dry hydrologic condition scenario as experienced in 1988. The water quality simulation results were summarized in the attachment at the representative locations 1, 2, 3 and 4 as shown in Figure 5.10.

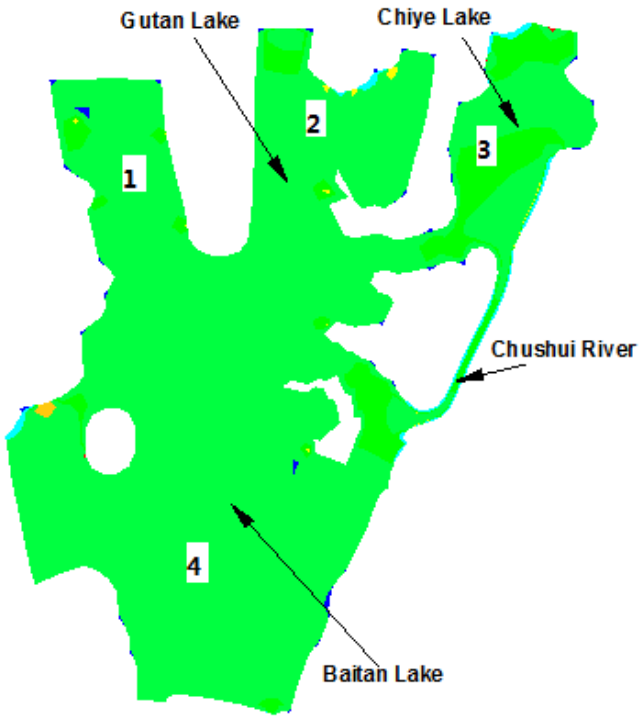
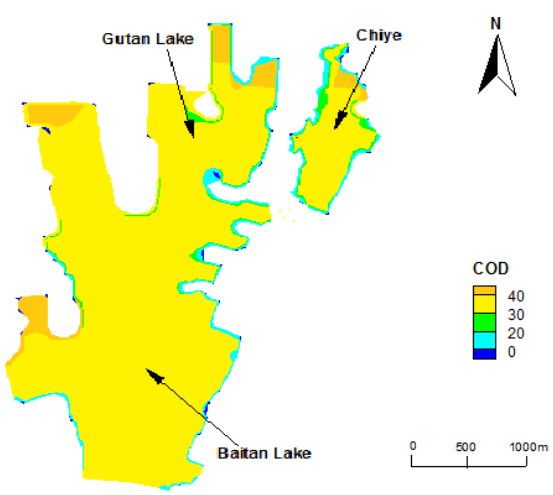


Figure 5.10: Representative locations of the water quality simulation results

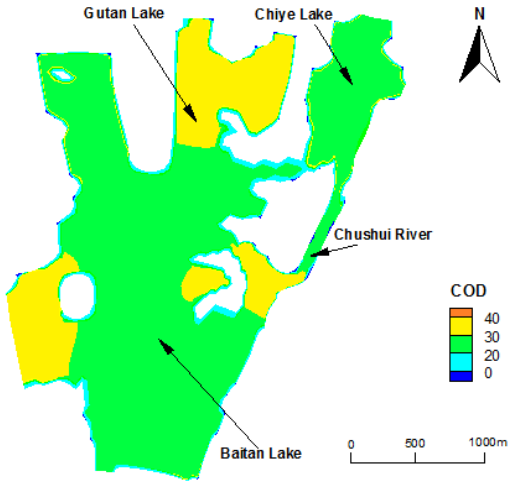
83. The following sections present the main findings for each of the scenarios.

Without Project Option – Scenarios 1 and 2

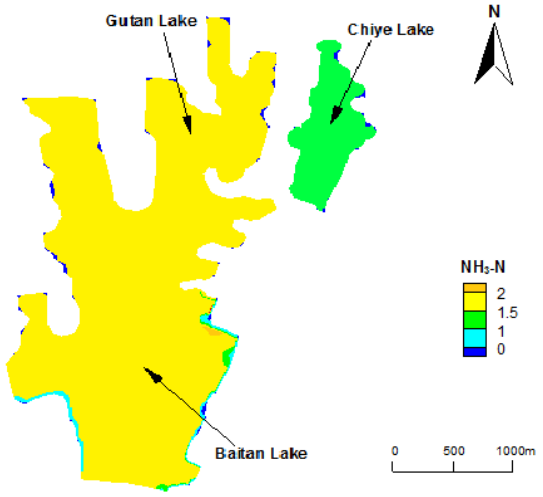
84. The water quality simulation results for the without-project scenarios in 2013 and 2020 indicated that the water quality in both lakes would deteriorate to some extent. Table 5.12 and Table 5.13 summarize the maximum concentration values of the pollutants at 4 representative locations of the lakes under the 2013 and 2020 pollution loadings, respectively and also the rate of annual compliance in Class IV (i.e., the percentage of days in a year when the concentration of an individual water quality constituent is below the threshold for Class IV). Figure 5.11 shows the concentration contours at the end of year for each water quality indicator.



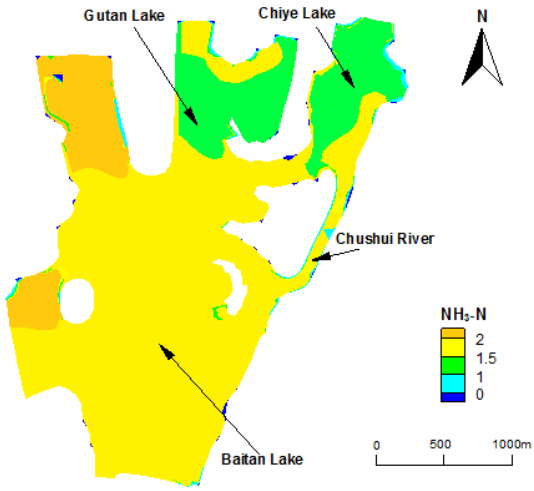
COD(mg/l) in 2013 loading



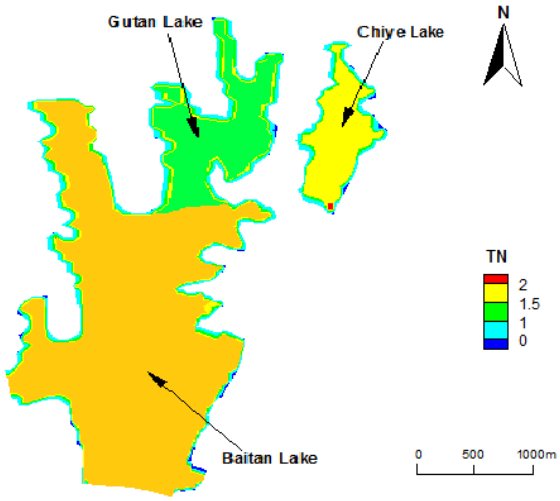
COD(mg/l) in 2020 loading



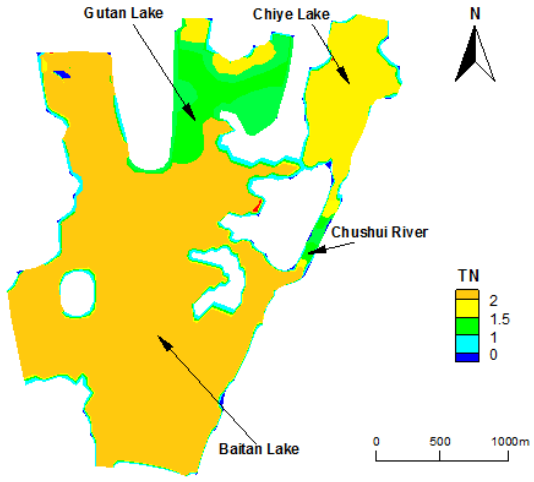
NH_3-N(mg/l) in 2013 loading



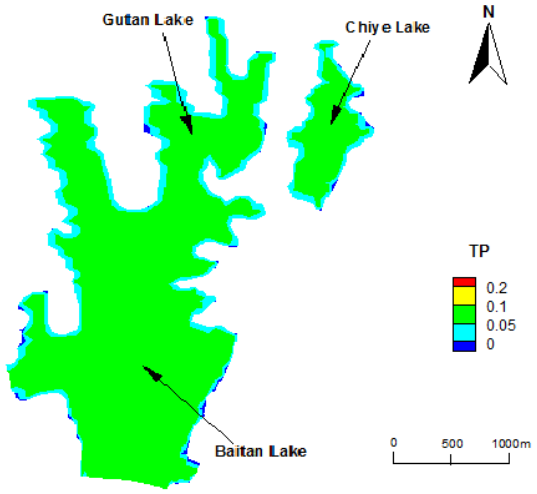
NH_3-N (mg/l) in 2020 loading



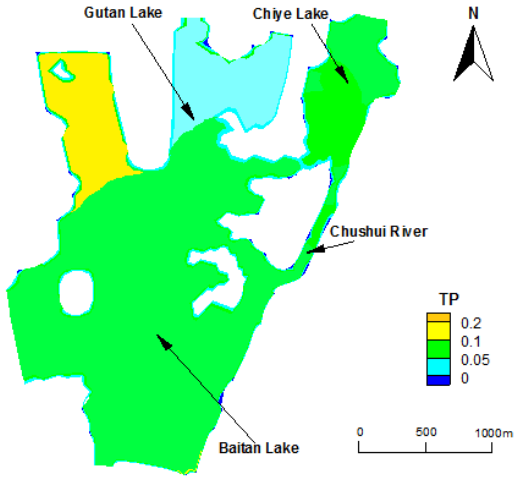
TN (mg/l) in 2013 loading



TN(mg/l) in 2020 loading



TP (mg/l) in 2013 loading



TP(mg/l) in 2020 loading

Figure 5.11: Pollutant concentration contours at the end of year

Table 5.12: The maximum pollutant concentrations in 2013 and the rate of compliance in Class IV

Location	1		2		3		4	
	Maximum mg/l	% time in Class IV	Maximum mg/l	% time in Class IV	Maximum mg/l	% time in Class IV	Maximum mg/l	% time in Class IV
COD	25.71	100.0	37.40	6.0	32.25	51.4	39.85	58.5
NH3-N	1.60	40.2	1.60	47.3	1.29	100.0	1.89	82.5
TN	2.01	0.0	2.67	0.0	1.92	0.0	2.74	1.9
TP	0.094063	100.0	0.12	29.8	0.07	100.0	0.10	91.0

Table 5.13: The maximum pollutant concentrations in 2020 and the rate of compliance in Class IV

Location	1		2		3		4	
	Maximum mg/l	% time in Class IV	Maximum mg/l	% time in Class IV	Maximum mg/l	% time in Class IV	Maximum mg/l	% time in Class IV
COD	33.26	47.8	41.93	29.8	29.54	100.0	40.78	64.5
NH3-N	2.43	14.2	1.53	99.5	1.62	41.3	2.15	50.5
TN	2.64	0.0	2.22	76.8	2.34	0.0	2.89	0.0
TP	0.204376	4.4	0.17	86.6	0.11	87.7	0.15	60.4

Scenarios 3 and 4 – Dredging of Sedimentary Deposits

85. For scenario 3, the dredging locations are the blue zones in the lakes as shown in Figure 5.12. The total area is 1,182,730 m^2 with a total volume of 539,405 m^3. For Scenario 4, the dredging locations are both the blue and grey zones as shown in Figure 5.12, covering a total area of 1,933,559 m^2 with a total volume of 915,000 m^3.

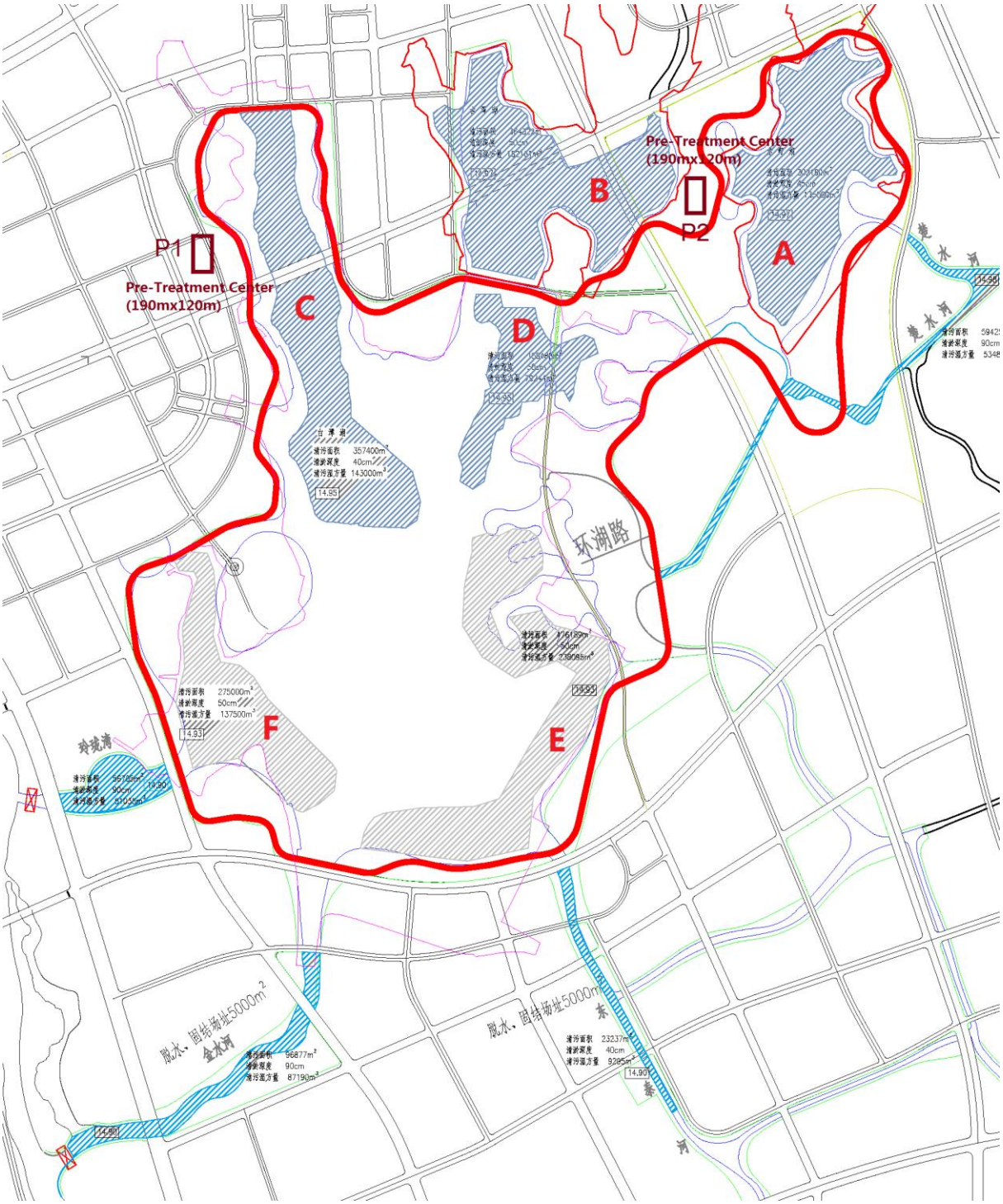
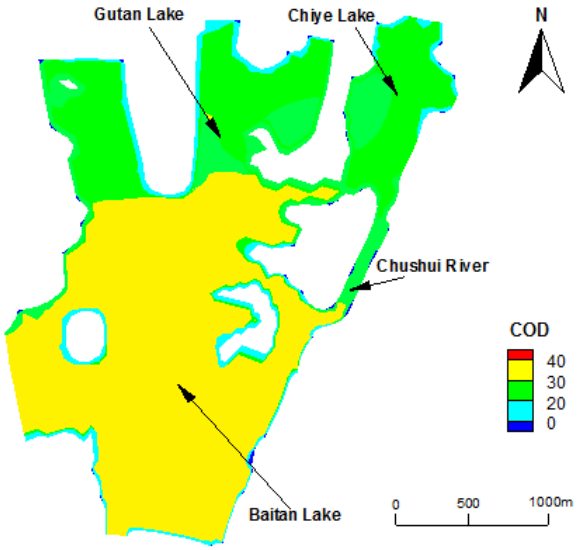
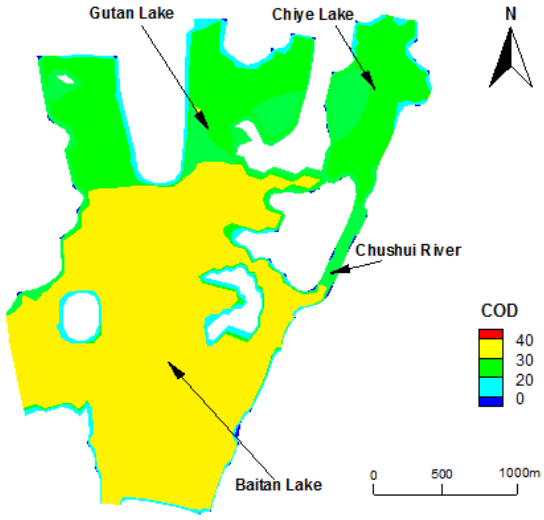


Figure 5.12: Locations of sediment dredging

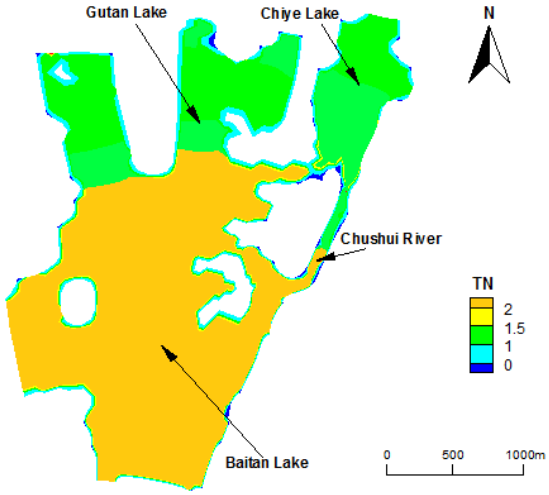
86. Table 5.14 summarizes the maximum values of the pollutants at 4 representative locations of the lakes and also the rate of annual compliance in Class IV for dredging a total of 539,405 m^3 of lake sediment. Figure 5.13 shows the concentration contours at the end of year for each water quality indicator.



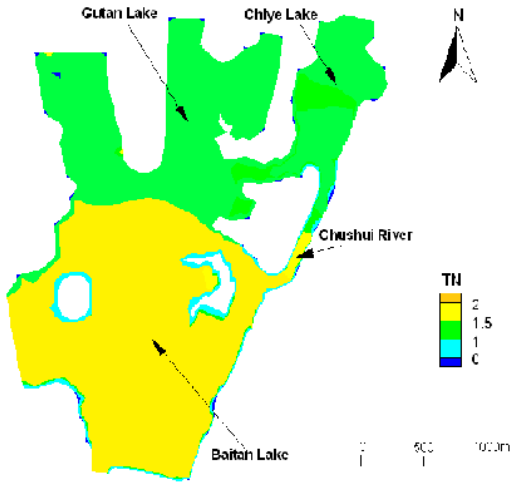
COD (mg/l) - Scenario 3



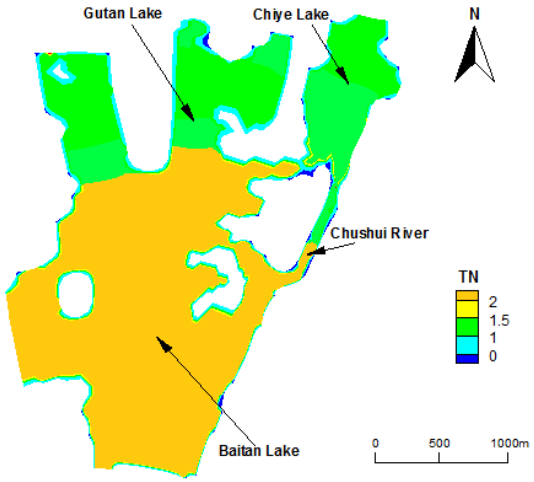
COD(mgl/) - Scenario 4



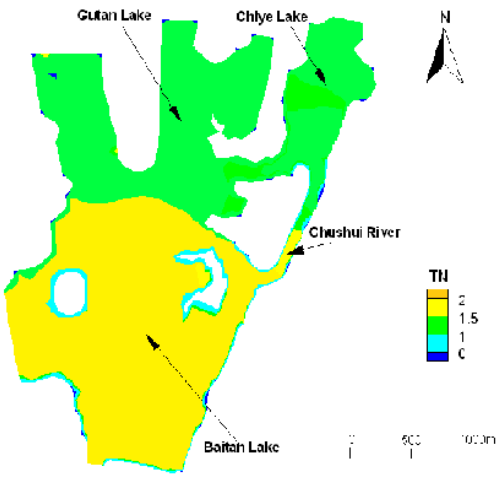
NH_3-N (mg/l) - Scenario 3



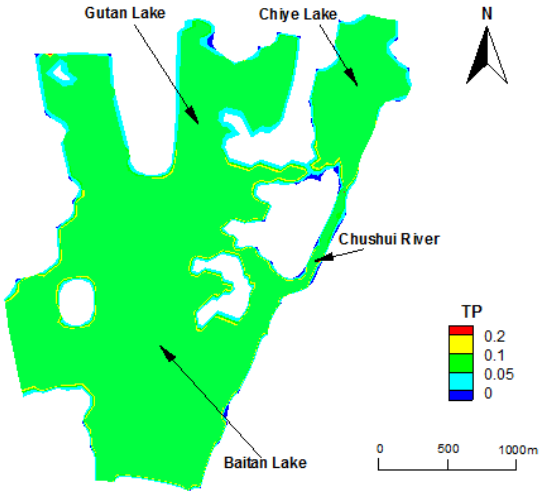
NH_3-N(mg/l) - Scenario 4



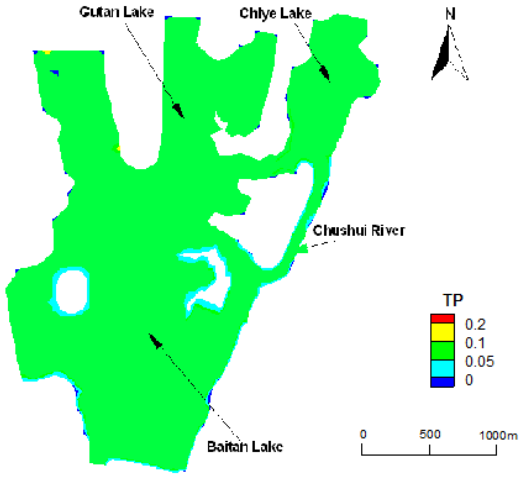
TN(mg/l) - Scenario 3



TN(mg/l) - Scenario 4



TP (mg/l) - Scenario 3



TP (mg/l) - Scenario 4

Figure 5.13: Pollutant concentration contours at the end of year

Table 5.14: The maximum pollutant concentrations and the rate of compliance in Class IV

Location	1		2		3		4	
	Maximum	% time in	Maximum	% time in	Maximum	% time in	Maximum	% time in
	mg/l	Class IV	mg/l	Class IV	mg/l	Class IV	mg/l	Class IV
COD	21.26	100.0	24.09	100.0	24.36	100.0	39.27	65.6
NH3-N	1.13	100.0	1.89	82.2	1.24	100.0	1.87	59.6
TN	1.65	10.7	2.06	59.6	1.87	71.9	2.54	0.0
TP	0.085473	100.0	0.13	95.9	0.07	100.0	0.14	90.2

Scenario 5

87. Under this scenario, the combination of the following measures is to be applied：

88. Sediment dredging with a total volume of 396,400 m^3

89. A total of 80,0000 m^2 surface-flow wetlands with 1.1 m^3/s water being transfered from Ba River through Xingfu gate

90. A total vegetated area of the off-shore buffer zone is 64,000 m^2 with a total area of aquatic plant is 80,000 m^2, including 960 m^2 of floating beds.

91. Table 5.15 summarizes the maximum values of the pollutants at 4 representative locations of the lakes and also the rate of annual compliance in Class V.

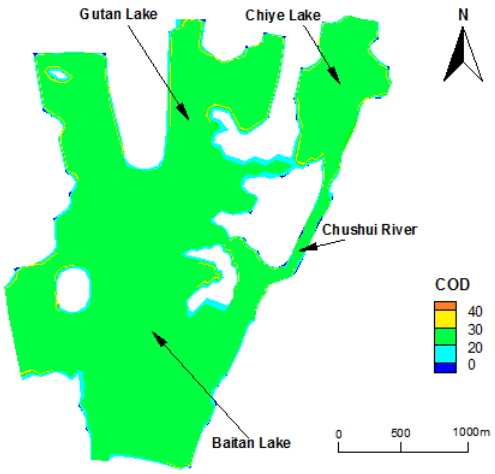
Table 5.15: The maximum pollutant concentrations and the rate of compliance in Class IV

Location	1		2		3		4	
	Maximum	% time in	Maximum	% time in	Maximum	% time in	Maximum	% time in
	mg/l	Class IV	mg/l	Class IV	mg/l	Class IV	mg/l	Class IV
COD	21.04	100.0	25.49	100.0	24.14	100.0	28.85	100.0
NH3-N	1.13	100.0	2.06	73.2	1.24	100.0	1.38	100.0
TN	1.65	10.7	2.27	46.2	1.86	66.9	2.05	42.9
TP	0.09	100.0	0.16	91.8	0.08	100.0	0.11	95.4

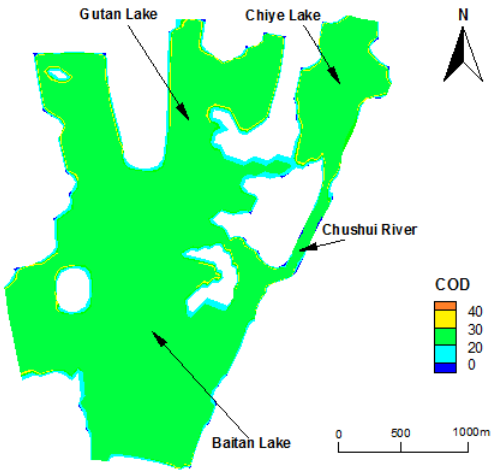
Scenario 6

92. Under this scenario, all measures under Scenario 5 are retained with the addition of 4 subsurface-flow wetlands of 38,000 m^2 and detention ponds.

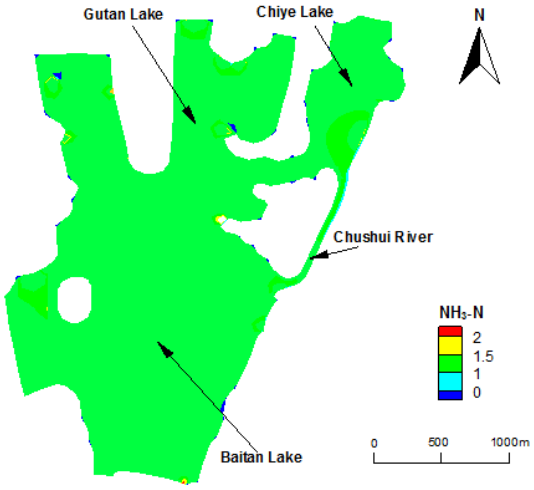
Table 5.16 summarizes the simulation results which include maximum values of the pollutants at 4 representative locations of the lakes and also the rate of annual compliance in Class IV. Figure 5.14 shows the concentration contours at the end of year for each water quality indicator.



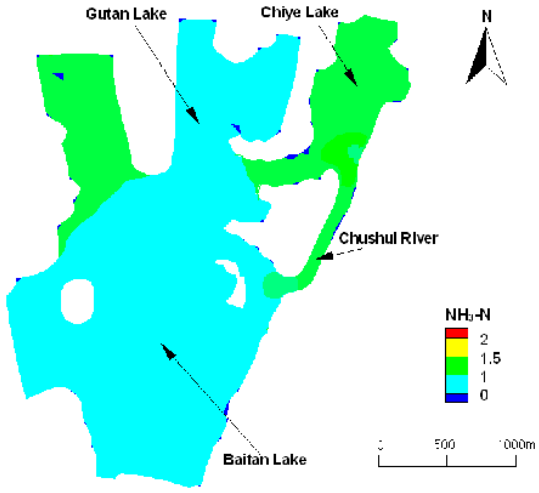
COD (mg/l) - Scenario 5



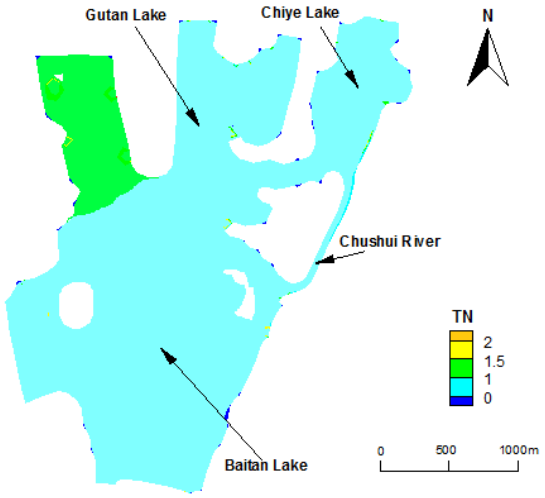
COD(mgl/) - Scenario 6



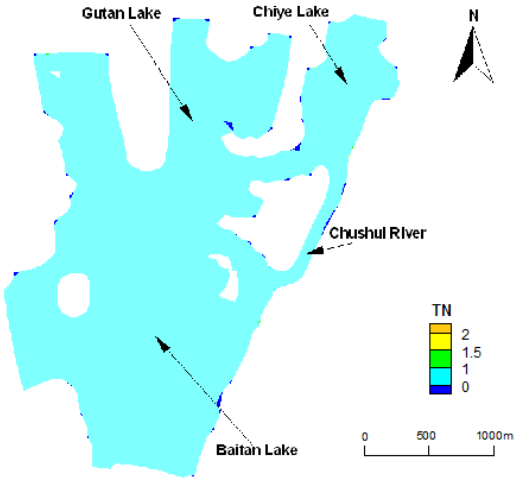
NH_3-N (mg/l) - Scenario 5



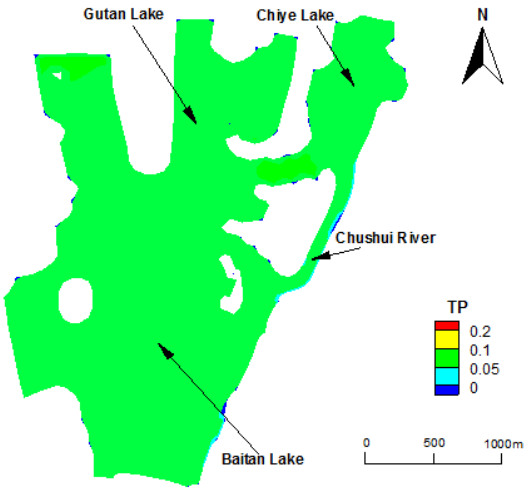
NH_3-N(mgl/) - Scenario 6



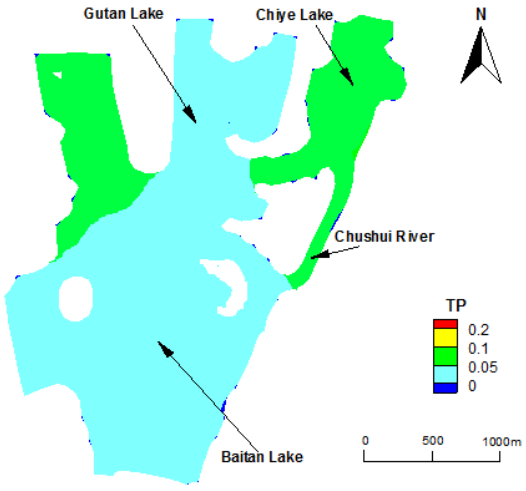
TN (mg/l) - Scenario 5



TN(mg/l) - Scenario 6



TP (mg/l) - Scenario 5



TP(mgl/) - Scenario 6

Figure 5.14: Pollutant concentration contours at the end of year

Table 5.16: The maximum pollutant concentrations and the rate of compliance in Class IV

Location	1		2		3		4	
	Maximum mg/l	% time in Class IV	Maximum mg/l	% time in Class IV	Maximum mg/l	% time in Class IV	Maximum mg/l	% time in Class IV
COD	20.91	100.0	20.84	100.0	24.17	100.0	28.82	100.0
NH3-N	1.00	100.0	0.88	100.0	1.17	100.0	1.38	100.0
TN	1.61	94.3	1.58	98.1	1.86	83.6	2.04	92.1
TP	0.07	100.0	0.11	98.9	0.07	100.0	0.11	99.2

Scenarios 7 and 8

93. As compared with Scenario 6, two alternative Scenarios 7 and 8 were tested. For Scenario 7, the surface flow wetlands with a total area of 9.6 ha are used to replace the subsurface wetlands of 3.8 ha. Other engineering measures listed in Scenario 5 are retained.

Table 5.17: Surface flow alternative to subsurface flow wetlands

Location	**Contributing Basins**	**Wetland Area (**$m^{2)}$
1	7, 8, 9, 10	36,287.5
2	4, 5, 6	23,027.5
3	1, 2	13,425
4	11, 12,13,14	23,260
Total		96,000

94. For Scenario 8, all engineering measures are the same as in Scenario 6 except the sediment dredging which covers a total area of 1,933,559 m^2 with a total volume of 915,000 m^3 as shown in Figure 5.12.

95. The simulation results for the Scenarios 7 and 8 show that:

- The water quality in the lake is expected to achieve the water quality target of Class IV under both scenarios. Figures 5.15 – 5.18 show the concentrations of COD, NH3-N, TN and TP at the centre of Baitan Lake (location 4 as shown in Figure 5.10). The pollutant concentrations at other areas of the lake are almost unchanged under Scenarios 6, 7, and 8.

- As compared with Scenario 6, the impact of Scenario 8 is the reductions of pollution loads COD 20.181 ton, NH3-N 4.036 ton, TN 6.054 ton and TP 1.210 ton per year as the result of additional dredging.

- As compared with Scenario 7, the impact of Scenario 6 is the reduction of pollution loads COD 31.90 ton, NH3-N 3.17 ton, TN 3.60 ton and TP 0.08 ton per year as the subsurface wetland can also treat the water in the lake during when it is not raining.

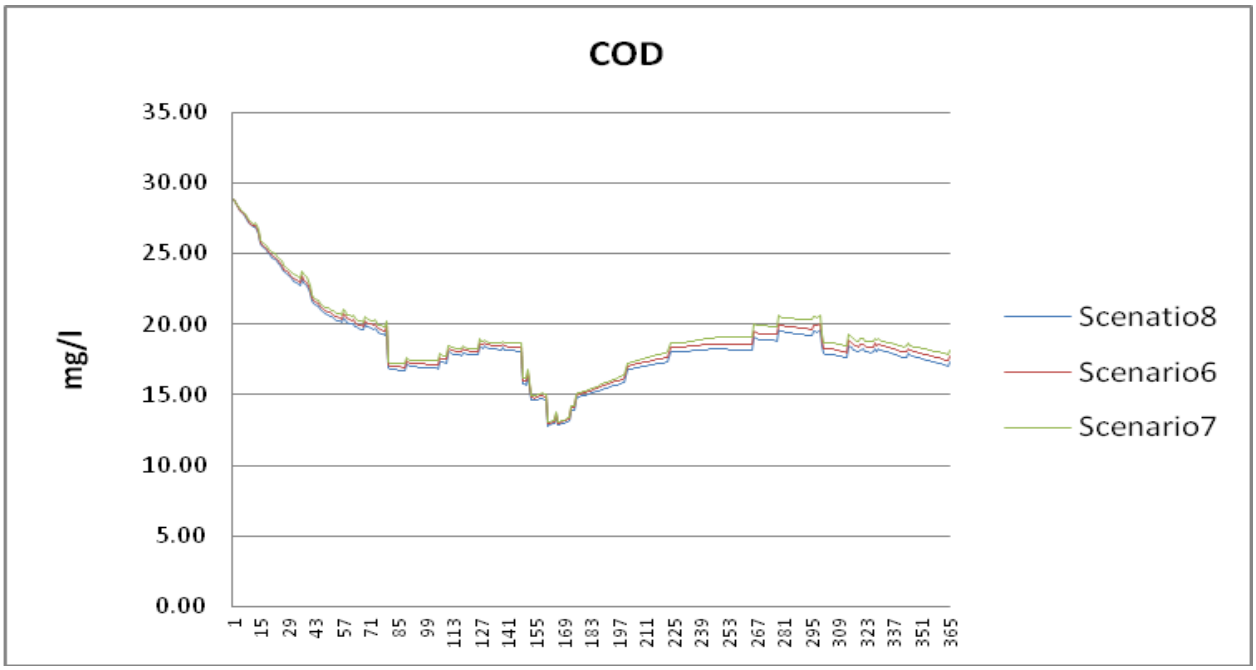


Figure 5.15: Comparison of COD concentration in Baitan Lake under Scenarions 6, 7 and 8

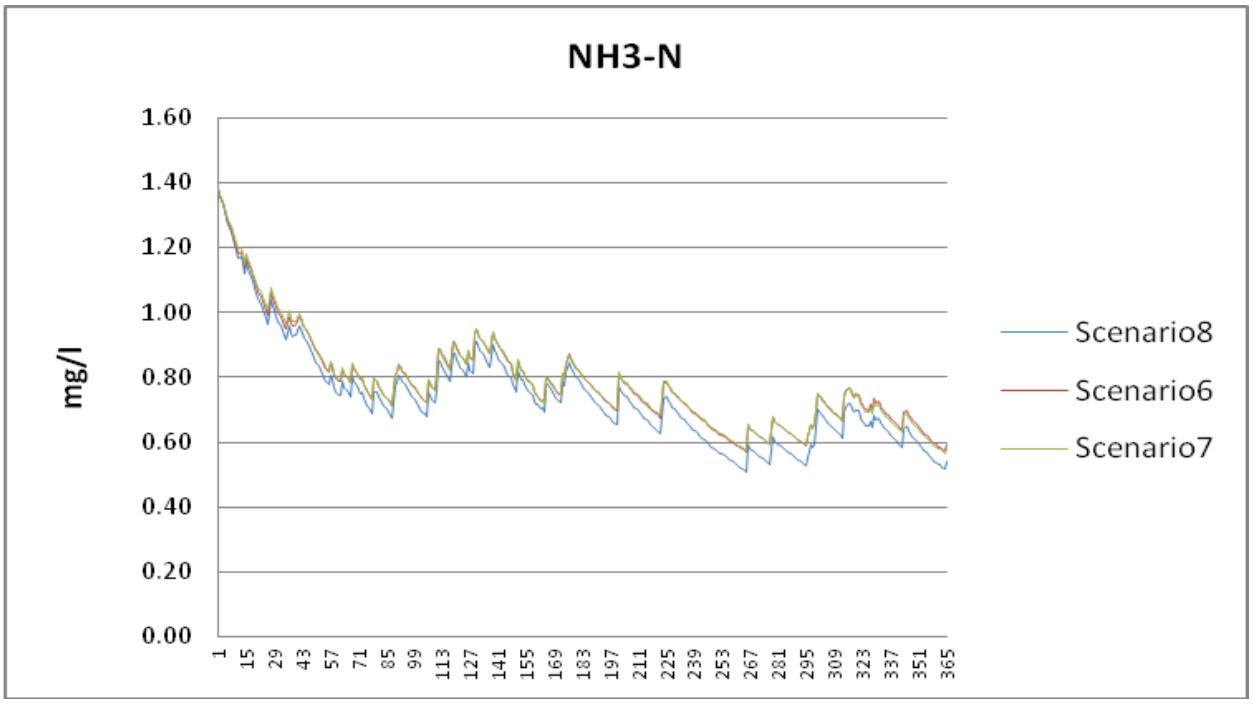


Figure 5.16: Comparison of NH_3-N concentration in Baitan Lake under Scenarions 6, 7 and 8

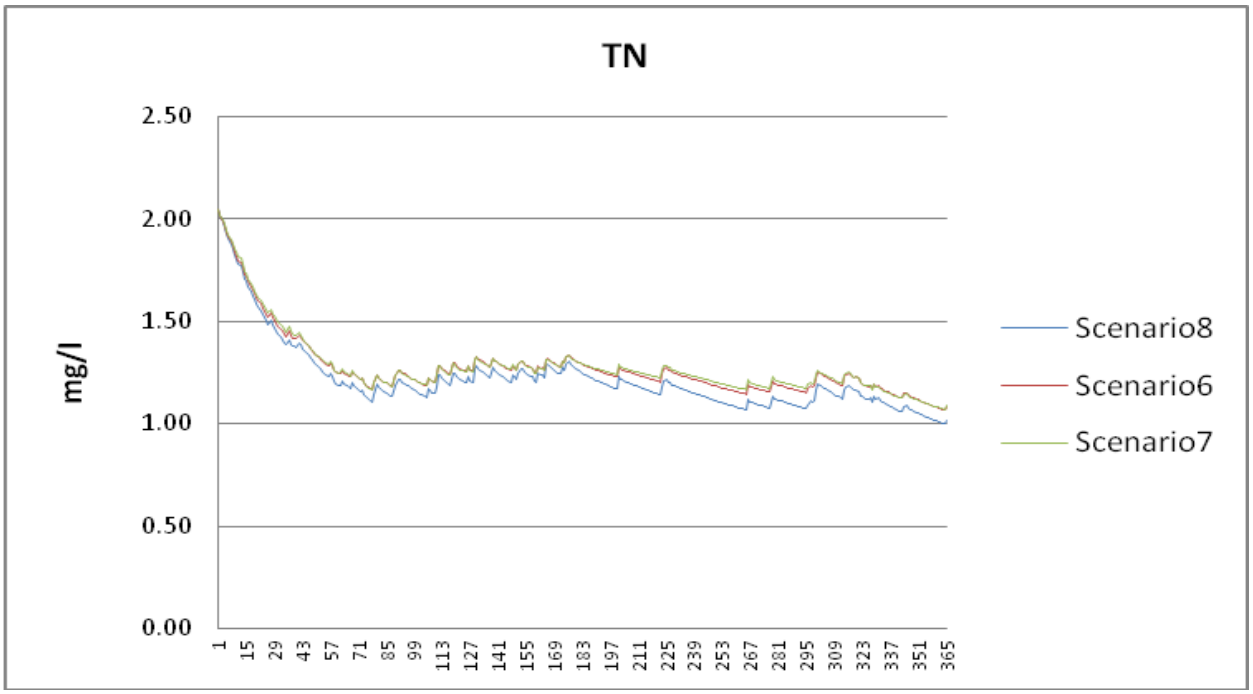


Figure 5.17: Comparison of TN concentration in Baitan Lake under Scenarions 6, 7 and 8

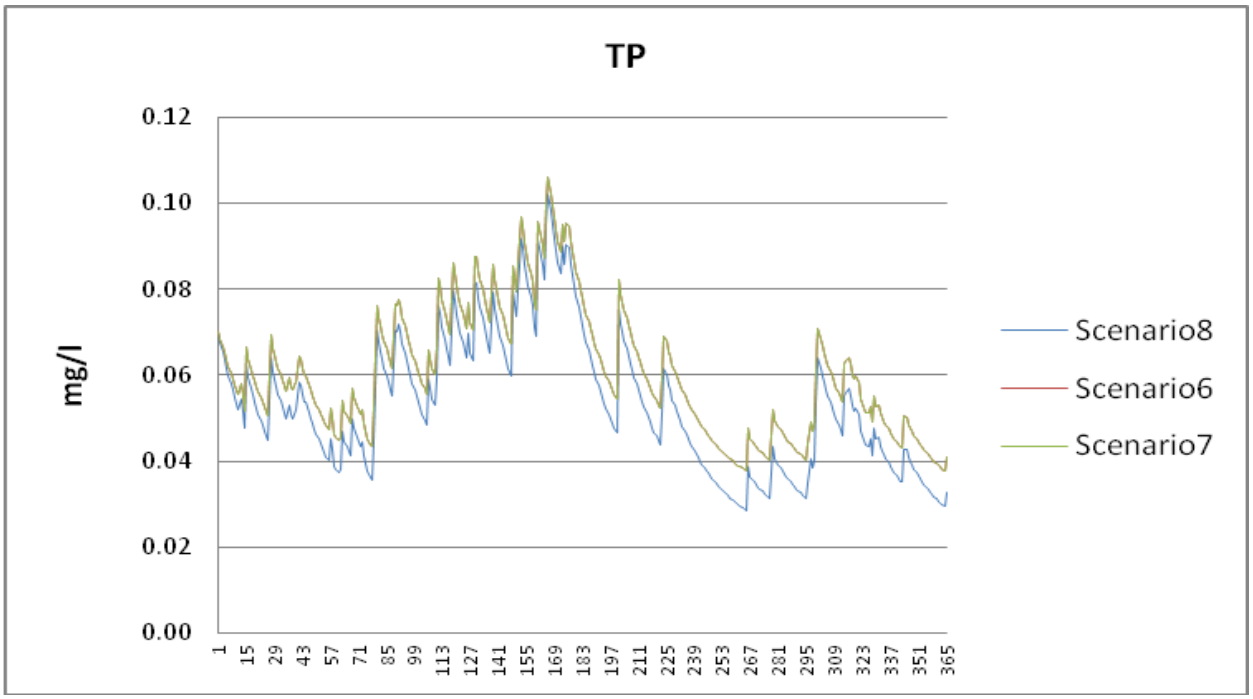


Figure 5.18: Comparison of TN concentration in Baitan Lake under Scenarions 6, 7 and 8

5.6 Impact Assessment

96. The following Table 5.18 summarizes the main results from the water quality impact simulations undertaken as part of this study. The water quality model simulation analysis indicates that:

- Without the engineering intervention, sediment dredging or constructed wetlands, the water quality in the lakes would remain in Class V and likely worsen.

- The sediment dredging, surface-flow and subsurface-flow wetlands individually can improve the water quality in the lakes to some extent. However, for the sustainable water quality improvement, the combination of sediment dredging, surface-flow wetlands with water transfer, aquatic planting and subsurface wetlands are all required.

- 3 sets of the combined engineering measures, listed as Scenarios 6, 7 and 8 in the following Table, are technically feasible to achieve the water quality target of Class IV in the lakes and sustainable.

- Based on the investment costs of all 3 set of feasible measures, as listed in Table 5.19, Scenario 6 is the least cost option and recommended.

- Table 5.20 summarizes the pollution loads in the Baitan and Chiye lakes and reductions and removals as the results of engineering measures. The impact of the project is expected to lead to the annual reduction of COD 192.03 ton, NH3-N 63.86 ton, TN 78.84 ton and TP 8.06 ton to the lakes and subsequently the Santai River and the Yangtze River.

Table 5.18: Summary of Water Quality Simulation of the Impact Study

Model Scenario	Engineering Measures	Pollution Loading (Year)	Horizon (Year)	Water Quality Category				Comments
				COD	NH3-N	TN	TP	
1	Do non-thing	2013	2013	V	IV	V	IV	
2	Do non-thing	2020	2020	V	V	V	V or V	
3	Sediment dredging 539405 m3	2020	2020	V	V	V	V	
4	Sediment dredging 915000 m3	2020	2020	V	IV	V	IV	
5	Sediment dredging 539405 m3 Surface flow wetlands 80ha + water transfer 1.1 m3/s Vegetated buffer strips, aquatic plants	2020	2020	IV	IV	IV or V	IV	V in Baitan north area
6	Sediment dredging 539405 m3 Surface flow wetlands 80 ha + water transfer 1.1 m3/s Vegetated buffer strips, aquatic plants Subsurface flow wetlands 3.8 ha + detention ponds 1.5 ha	2020	2020	IV	IV	IV	IV	Recommended combination of measures
7	Sediment dredging 915000 m3 Surface flow wetlands 80ha + water transfer 1.1 m3/s Vegetated buffer strips, aquatic plants Surface flow wetland 8.26ha in Baitan and 1.34 ha in Chiye lake	2020	2020	IV	IV	IV	IV	Alternative 1
8	Sediment dredging 915000 m3 Surface flow wetlands 80 ha + water transfer 1.1 m3/s Vegetated buffer strips, aquatic plants Subsurface flow wetlands 3.8 ha + detention ponds 1.5 ha	2020	2020	IV	IV	IV	IV	Alternative 2

Table 5.19: Capital costs of the combined engineering measures

Engineering Measures	Scenario 6		Scenario 7		Scenario 8	
		CNY (1000)		CNY(1000)		CNY(1000)
Baitan Lake dredging and pre-treatment	404405 m3	50550.63	780000 m3	97500.00	780000 m3	97500.00
Transport of the De-watered dredged material	190070 m3	4751.76	366600 m3	9165.00	366600 m3	9165.00
Baitan Lake Subsurface Flow wetlands for treating urban runoff	33030 m2	21054.20			33030 m2	21054.20
Chiye Lake Subsurface Flow wetland for treating urban runoff	5197 m2	3588.23			5197 m2	3588.23
Baitan Lake surface flow wetlands for treating urban runoff			82575 m2	14037.80		
Chiye Lake surface flow wetland for treating urban runoff			13425 m2	3588.20		
Chiye Lake dredging and pre-treatment	135000 m3	8100.00	135000 m3	8100.00	135000 m3	8100.00
Surface flow wetland and water transfer for treating pollutant from Xingfu river catchment	800000 m2	142340	800000 m2	142340	800000 m2	142340
Vegetated Buffer strips and aquatic plants		10584.00		10584.00		10584.00
Total (CNY 1000)		**240968.81**		**285315.00**		**292331.43**

Table 5.20: Comparison of pollution loads in 2012 and reductions by the Project

		COD (t/year)	**NH_3-N** (t/year)	**TN** (t/year)	**TP** (t/year)
Pollution Sources in 2020	Non-point pollution loads from urban runoff	113.05	5.07	11.45	1.76
	Dust deposition	68.51	22.40	28.00	0.88
	Xingfu River catchment pollution loads	321.35	41.90	52.38	1.93
	Pollution loads released from Sediments	44.47	14.82	22.23	4.45
Total Pollution loads		**547.38**	**84.19**	**114.06**	**9.02**
Pollution load Reduction/Removal	Reduction in pollution released from sediment due to dredging	15.10	3.02	4.53	0.9
	Surface flow wetlands with water transfer	102.83	32.73	37.19	0.52
	Subsurface wetlands with detention pounds for treating urban runoff	36.20	7.22	8.20	0.5
	Subsurface wetlands with detention pounds for treating in-lake water	31.90	3.17	3.60	0.08
	Vegetated buffer strips and aquatic plants	6.00	17.72	25.32	6.06
Total Pollutant Reduction/Removal		**192.03**	**63.86**	**78.84**	**8.06**

6 Summary

97. The preliminary results from modeling storm water and hydraulic modeling of the inter-connected lake and channel system show that the proposed design of the channel reconstruction and rehabilitation scheme is hydraulically feasible. The flood-control capacity of urban water systems is expected to be increased substantially, resulting in lower water levels in the lake and channels during the extreme rainfall events.

98. Based on the preliminary water quality modeling results, the proposed project has been shown to have a substantial impact on improving water quality in the Baitan/Chiye Lake. However, to meet the planned target of restoring the water quality to the Class IV, all three measures, i.e., sediment dredging, constructed wetlands and water transfer during the critical dry season should be combined.

7 References

Chen Qiuwen, Tan Kui, Zhu Chuanbao, Li Ruonan, Development and application of a two-dimensional water quality model for the Daqinghe River Mouth of the Dianchi Lake, Journal of Environmental Sciences 21(2009) 313–318

Chen Xiang Zhi and Wang Fang, The causes of water pollution in East Lake, Features and Comprehensive Control Measures, Urban Planning Forum (In Chinese), No 7, 2009, pp 209-212

Fan C X, Zhang L, Yang L Y, Huang W J, Xu P Z. Simulation of internal loadings of nitrogen and phosphorus in a lake. Oceanologia and Limnologia Sinica, 33(4) 2002: 370–378.

Gong Chunsheng, Yao Qi, et al, Release flux estimate pf phosphorus in a urban shallow lake: Lake Xuanwu, Nanjing, Journal of Lake Science, 18(2), 179-183, 2006

Jiang J, Shen Y, Estimation of the natural purification rate of a eutrophic lake after pollutant removal. Ecological Engineering, 28:166–173, 2006

Kaiming Hua, Yong Panga, Hua Wanga, Xianmin Wanga, Xinwei Wua, Kun Baoa, Qi Liua, Simulation study on water quality based on sediment release flume experiment in Lake Taihu, China. Ecological Engineering 37 (2011) 607–615

Liu Bao, Ding Shiming, et al, Estimate of releasing fluxes of sediment nitrogen and phosphorus in Funao Bay in Dianchi Lake, Envoronmental Science, 29(1), 1140120, 2008

Liu Wei, Hu Jinxing, Analysis and Dynamic Simulation of Urban Rainstorm Waterlogging, Bulletin of Advanced technology, Vol. 4 No.4/ Apr. 2010

Liu Yali, Zhang Zhi and Duan Xiujun, Prediction model and the control of Nitrogen Releasing from Sediment of Lake, Journal of Agro-environment Science, 2006, 25(6), pp 16-3-1606

Luo Kai, Wu Shenglie, et al, Experimentation of Release of organic and nutrients from sediment of an urban lake, Proceedings of China Environmental Science Association, 2009

Shang Weichun and Pan Peifeng, Release of organic and nutrients from sediment of an urban shallow lake, Environmental Pollution and Protection, 29(8), 602-604, 2007

Wang Jiaquan, Sun Yamin, et, al, Simulated study on phosphorus release of Chap lake sediment, ACTA Scientiae Circumstance 22(6), 738-742, 2002

Xie Liqiang, Xie Pung and Tang Huijuan, The Concentration and Dynamics of Sediment Phosperorus in various lake regions of Lake Donghu,

Ye Min, Yang Guosheng, Zhang Wanshun, Features of urban non-point pollutions and prediction model, Environmental science and technology, 29(2), 67-69, 2006

Y.Y. You, W.B. Jin, Q.X. Xiong, L. Xue, T.C. Ai, B.L. Li, Simulation and Validation of Non-point Source Nitrogen and Phosphorus Loads under Different Land Uses in Sihu Basin, Hubei Province, China, Procedia Environmental Sciences 13 (2012) 1781 – 1797.

Zhang Beiping, Mathematical model for non-point source loads, Journal of Wuhan Urban Construction Institute, 13(1), 1-8, 1996

Zhang Wanshun, Yan Wang, Hong Peng, A coupled water quantity-quality model for water allocation analysis. Journal of Water Resource Manage, 2010 (24) :485-511

Zhang X Q, Yang Z F, Xia X H. An experimental study on nitrification in natural water of the Yellow River, China. Environmental Chemistry, 24(3) 2005: 245–249

Zhao Xiaorong, Gao Ting, Su Qingqing, Luo Yuphong, and Liu defu, Simulation of the Reslease of Notrogen from Lake Sediment in to water, Journal of Anhui University of Technology, 26(3), 282-287

Zhao Yaxing, Zhang Wanshun, et el, Numerical study of coupled one-dimensional and two-dimensional hydrodynamic and water quality model for complex lake and river networks regions, 2011 (http://www.hwcc.gov.cn/pub2011/hwcc/wwgj/bgqy/201110/t20111031_337477.htm)

Appendix 1 Water Quality Monitoring Data in March 2013

Locations	Date	T	Ph	DO	permanganate index	COD	BOD5	NH3-N	TP	TN
Baitan Lake 1	3.7	9.7	7.9	5.7	8.2	25	4.8	1.19	0.08	2.44
	3.8	9.6	7.8	5.9	9.6	29	5.8	1.21	0.08	2.09
	3.9	9.8	7.9	6.1	7.9	28	5.5	1.22	0.08	2.11
Baita Lake 2	3.7	9.8	7.7	6.3	8.9	27	4.9	1.31	0.08	2.51
	3.8	9.4	7.5	5.9	9.1	27	5	1.56	0.08	2.49
	3.9	9.6	7.9	6.2	9.1	30	5.2	1.44	0.07	2.5
Baitan Lake 3	3.7	9.7	7.8	6.1	8.8	29	5.3	1.39	0.06	2.55
	3.8	9.8	7.7	6.5	9.2	27	4.9	1.41	0.08	2.59
	3.9	9.1	7.5	6.3	9	28	5.1	1.35	0.07	2.49
Baitan lake 4	3.7	9.5	7.8	6.3	8.9	31	5.4	1.32	0.08	2.49
	3.8	9.3	7.8	6.4	9.6	26	5.6	1.29	0.07	2.5
	3.9	9.7	7.6	6	8.4	27	4.9	1.26	0.06	2.53
Chiye lake	3.7	9.6	7.4	6.5	7.1	22	5.1	1.18	0.07	1.93
	3.8	9.7	7.5	6.8	7.9	25	4.4	1.2	0.06	1.92
	3.9	9.7	7.4	6.9	7.6	24	4.1	1.19	0.06	1.92
Jinshui River	3.7	10.2	7.6	7.5	6.2	22	4.4	0.2	0.07	0.89
	3.8	10	7.7	6.9	6.2	25	4.6	0.16	0.09	0.9
	3.9	9.7	7.6	6.8	6.9	21	4.2	0.19	0.08	0.79
Santai River	3.7	9.9	7.8	7.3	6.7	26	5.3	0.68	0.12	1.34
	3.8	9.7	7.9	7.4	6.8	27	4.8	0.79	0.15	1.54
	3.9	10.2	7.8	7.2	6.3	29	5.5	0.88	0.18	1.78

Source: Huanggang Municipal Environmental Monitoring Station

Appendix 2: Nutrient content from the sediment analysis

	Location	pH	TP(mg/kg)	TN(mg/kg)	Water Content (%)
Baitan Lake	1	6.9	1380	5280	68.3
	2	6.9	1410	5368	64.3
	3	6.9	1301	5955	61.9
	4	6.8	1305	5472	60.1
	5	6.8	1272	5417	60.2
Chiye Lake	1	7	1055	4047	60.2
	2	6.9	928	4144	61.2
	3	6.9	1093	4027	61.4
Jinshui River	1	6.8	950	3452	39.4

Source: Huanggang Municipal Environmental Monitoring Station

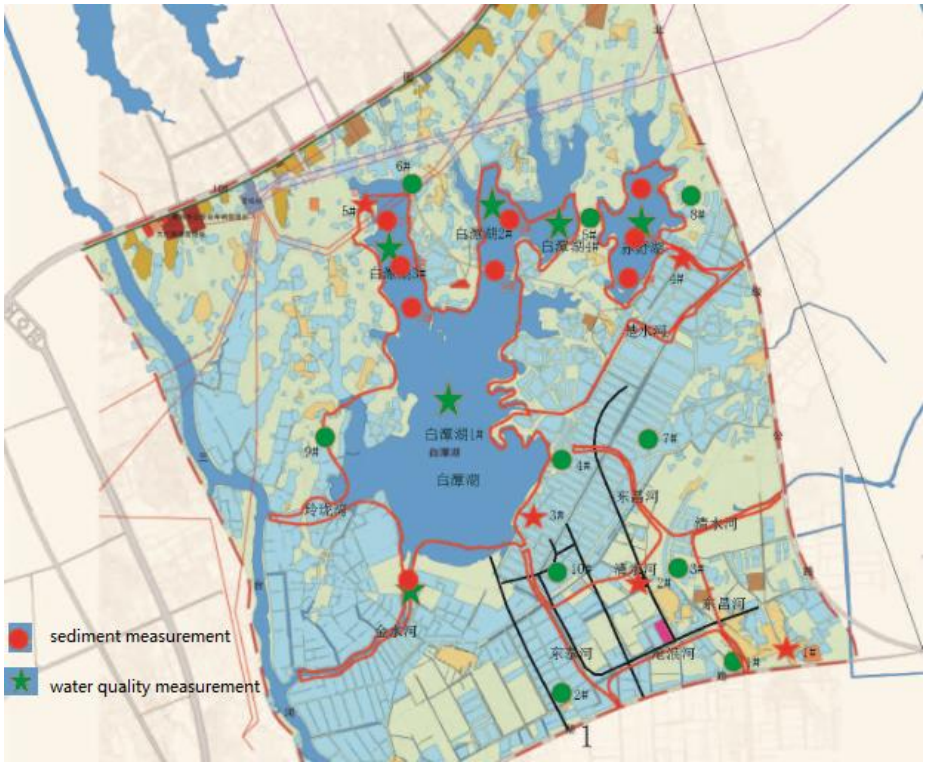


Figure 1: Water quality and sediment measurement locations

Appendix 3: Planned drainage pipe network

The following drainage points discharge rainwater directly to the lakes in the north. Others discharge either to the Santai River or to urban rivers in the south. The total catchment area of the project lakes is is 3.84 km2, as defined bellow.

Drainage discharge No.	**Catchment Area**
1	27.25 ha
2	26.45 ha
3	NOT in current development plan
4	4.58 ha
5	40.58 ha
6	46.95 ha
7	17.12 ha
8	24.57 ha
9	50.22 ha
10	53.24 ha
11	41.67 ha
12	51.37 ha
Total catchment area	***3.84 km^2***