CHINA: ZHUZHOU BROWNFIELD REMEDIATION PROEJCT

ENVIRONMENTAL ASSESSMENT
Executive Summary

JULY 2015

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1. INTRODUCTION

Qingshuitang Industrial Zone (QIZ), an old industrial base in Zhuzhou of Hunan Province, China, was developed by the government in 1950s. The major industries include lead and zinc smelting and heavy chemical industry. Due to over fifty-year history of industrialization, QIZ has been known for its heavy-metal contamination. The remediation of heavy-metal contaminated area in QIZ has become an urgent need to protect human health and the living environment of local residents, and to eliminate the potential hazards entering Xiang River.

With strong support of the central government and Hunan Provincial Government, Zhuzhou Municipal Government has made significant progress in remediation and environmental management of QIZ, including industrial pollution control, management of wastewater and waste residue, and cleanup of the contaminated channels and soils. However, contamination in QIZ requires next phase of remediation and environmental management efforts.

The Zhuzhou Brownfield Remediation Project funded by the World Bank will support further remediation and management of contaminated sites (aka. brownfields) in QIZ drawing on international experiences. The project area is located in the southern portion of QIZ in the Shifeng District of Zhuzhou City, with an area of approximately 8.48 km^2 (project area). Based on detailed site investigation and risk assessment, 2.73km^2 of the total project area will need immediate remediation, while the rest parts are either areas with acceptable risks or areas where risks are above acceptable level but controllable.

The proposed physical activities under the project include: (1) Remediation of contaminated sites, including land plots, closed industrial sites, waste piles, ponds, and open soils; and necessary supporting infrastructure such as access roads and wastewater treatment works; (2) Temporary treatment facilities, including a stabilization and solidification site, a dewatering site, and a storage site; (3) Construction of a landfill; (4) Construction of an environmental information and demonstration center.

The project itself is an environmental cleanup project by nature, thus it will have significant environmental and social benefits by remediating site contamination and reducing risks to human health and the environment. Given the complexity of the project and potential environmental, social and health risks related to handling of soil contamination, the project is classified as a Category A project as per OP4.01. The following safeguards policies are triggered: (1) OP4.01 Environmental Assessment; (2) OP4.04 Natural Habitats; (3) OP4.12 Involuntary Resettlement; and (4) OP4.11 Physical Cultural Resources.

An Environmental Impact Assessment (EIA) report has been prepared for the project, based on which a stand-alone Environmental Management Plan (EMP) has been developed. The preparation of EIA and EMP followed the relevant laws and regulations of China, World Bank safeguards policies, as well as EHS guidelines. In addition, a Resettlement Action Plan (RAP) has also been prepared following the requirement of OP4.12. An Environmental and

Social Management Framework (ESMF) is prepared to provide guidance on possible future remediation activities. The full draft EA was locally disclosed in website of Zhuzhou Municipal Government and communities, and was also disclosed in the World Bank InfoShop.

This document summarizes key findings of the EIA, EMP, ESMF and RAP. In summary, the project itself is an environmental improvement activity with significant long-term positive environmental and social impacts. The potential adverse impacts are mainly related to the remediation process where managing these impacts are integral part of the project activities.

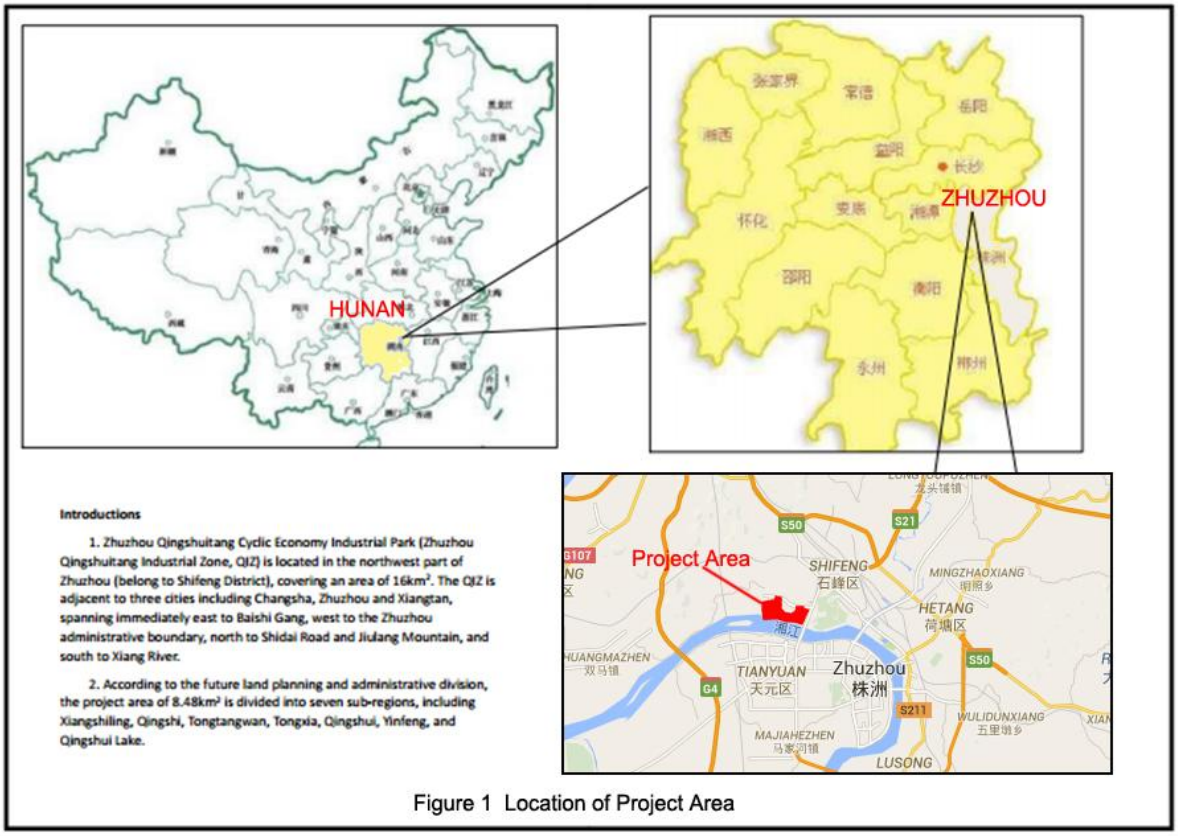

Figure 1 Location of Project Area

2. PROJECT DESCRIPTION

The project will include four components:

- **Component 1: Remediation of contaminated plots in the proposed project Area.**
- **Component 2: Treatment/disposal facilities**
- **Component 3: Capacity building and knowledge management.**
- **Component 4: Project management, monitoring and evaluation**

The project focuses on QIZ with a total area of 8.48km^2. According to administrative zoning, the project area is divided into seven sub-areas, i.e. Xiangshiling, Qingshi, Tongtangwan, Tongxia, Qingshui, Yinfeng and Qingshuihu. Based on the site investigation and risk assessment, the project area is classified into three parts: risk acceptable area (2.02km^2), risk controllable area (3.73km^2) and remediation area (2.73km^2).

The remediation works under the project will focus on the 2.73 km^2 remediation area and 0.11 dispersed open soil plots outside the remediation area. While, as part of the overall project area, the future remediation works in the non-remediation area will follow the same environmental and social framework requirements set by this project, as documented in the ESMF.

The detailed remediation works are shown in **Table 1**.

Table 1 Detailed Remediation Activities in QIZ

Item	Activities
Land clearing and soil remediation	Land clearing and dismantlement of buildings of six closed enterprises (total building dismantlement areas: 9546.8m^2; total demolition waste: 6532m^3; building areas to be cleaned: 7710.8m^2). Relocation of 94 families (total demolition area: 21993m^2; total waste: 39310m^3).
	Clean soil replacement for residential areas (total area of 0.11km^2, and clean soil of 55427.5m^3).
	Soil remediation: remediation of heavy metal contaminated soil (2.29km^2 with total amount of 1374874m^3) using various technologies; and remediation of sites of 6 closed companies, with total area of 0.13km^2 including Solidification/stabilization (S/S) treatment of heavy-metal contaminated soil of 74313m^3, and incineration of 8274m^2 (with total amount of 16548m^3) organic pollution soil in Tiancheng Chemical Co.
	S/S remediation and landfill disposal of waste piles in the project area and closed companies (total amount of 84700m^3).
Water ponds sediment treatment and ecological restoration of channels/ponds	Dewatering, S/S remediation and eco-restoration of 26 ponds (total area: 0.17km^2; total sediment: 173,000m^3)
	Ecological restoration of Old Xiawangang channel after dredging (total area 54279m^2)
Supporting facilities	Rental of existing Xinqiao waste pile site as S/S site (4000m^2, with capacity of 400m^3/d)
	Rental of existing Xiawangang dewatering site for dewatering and storage

Item	Activities
	site (dewatering site 4000m^2, storage site 1500m^2)
	New construction of dewatering site (4200m^2, including 4000m^2 for dewatering and 200m^2 for storage)
	New construction of temporary soil storage site besides the Xinqiao S/S site (with an area of 10000m^2, and capacity of 150,000m^3)
	Solid waste landfill: use an abandoned quarry pit as landfill site (total area of 38265m^2, with capacity of 2 million m^3)
	Temporary access roads: renovation of village roads (13832m) and construction of new temporary access roads (1802m)
Environmental demonstration center	Construction of Environmental Demonstration Center, including the office building, environmental protection museum and engineering test field. Total area is 7970m^2.

The total cost of the project is 242 million USD, with a World Bank loan of 150 million USD. The project plans to complete the preparation work in 2015, and start the construction from 2016 to 2022.

The locations of the project activities are shown in **Figure 2**. Most of the project activities will take place within the project area, except that 1) excavated soils from Tianchen Chemical Plant will be moved to a cement plant outside QIZ for treatment because the soils contain organic pollutants, and 2) backfilling clean soils will come from other places in Zhuzhou. These off-site impacts and measures have been included in the project EA.

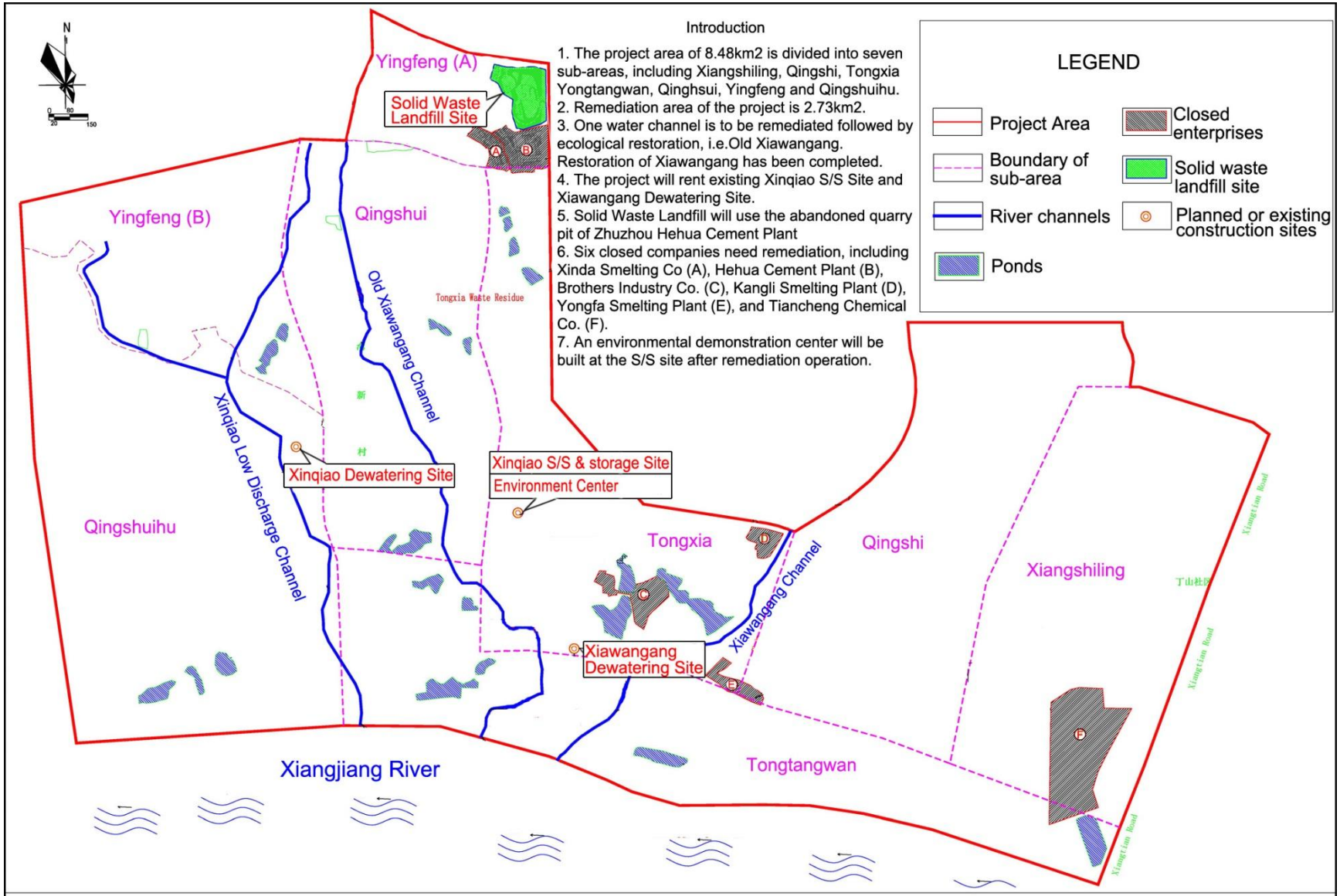

Figure 2 General Layout of the Project

3. REGULATORY AND LEGAL FRAMEWORK

The Environmental Impact Assessment (EIA) for the project is conducted in accordance with Chinese EIA laws/regulations/guidelines, and the World Bank safeguards policies, as well as Environmental, Health and Safety guidelines of World Bank Group.

World Bank Safeguard Policy Requirements

Of the World Bank Groups ten safeguards policies, the following are triggered: 1) OP4.01 Environmental Assessment; 2) OP4.11 Physical Cultural Resources; 3) OP4.12 Involuntary Resettlement; and (4) OP4.11 Physical Cultural Resources. The World Bank Group Environmental, Health and Safety Guidelines (WGB EHS Guidelines) also apply to the project. The general principles and measures in the Guidelines are consistent with the requirements of Chinese laws, regulations, guidelines and construction management norms. Compliance with these policies and guidelines is summarized in **Table 2**.

Table 2 Compliance with World Bank Safeguards Policies

Safeguard Policies	Compliance
OP/BP 4.01 Environmental Assessment	- Category A project. - Full EIA and EMP have been prepared. - Two rounds of public consultation conducted as part of EIA process. - An ESMF is prepared to guide possible future remediation activities.
OP/BP4.04 Natural Habitats	- The proposed remediation activities, including land clearing, earth excavation and dredging of ponds will have potentially adverse impacts on terrestrial and water ecology in the project area. Rehabilitation of these sites are integral part of the project. Both positive and negative impacts on natural habitats are covered in the EIA and EMP
OP/BP4.11 Physical Cultural Resources	- There are a few physical cultural resources in the project area, including graves, Dawang Temple and Wuniang Temple. While, these sites will not be undertake remediation or construction activities, thus not directly affected by the project. Precautious measures are incorporated into the EMP. - Chance-find procedure has been developed in EMP
OP/BP 4.12 Involuntary Resettlement	- Resettlement Action Plans have been prepared as per OP4.12.
EHS General Guidelines	- EIA/EMPs addressed the environmental issues of air, noise, wastewater, waste management, occupational and community health and safety, and construction related impacts
EHS Guidelines Waste Management Facility	- Proper measures developed in the EIA/EMPs addressing waste collection and transport, unloading, processing and storage; landfill disposal; physiochemical and biological treatment and remediation

Chinese Laws and Regulations

The EIA is prepared fully in compliance with relevant China national laws, regulations, technical guidelines and procedures. Compliance with a selective list of key Chinese regulations and EIA technical guidelines are summarized in **Table 3**.

Table 3 Compliance with Key China Domestic Laws and Regulations

China Laws and Regulations	Project Compliance
Environmental Impact Assessment Law	• EIA prepared by licensed EIA consultant, reviewed and approved by local environmental protection agency. • Two rounds of public consultations and disclosure.
Environmental Protection Law	• Soil contamination remediation.
Notice on Strengthening EIA Management for Construction Projects Funded by Loans from International Financial Institutions	• EIAs and EMPs are prepared in compliance with World Bank safeguards policies.
Culture Property Protection Law	• Identified cultural resources are not within the remediation area; • Chance find procedures have been developed in EMP
Interim Measures for the Public Participation in Environmental Impact Assessment	• Two rounds of public participation conducted in surrounding villages/towns, and info disclosure through website of Guilin Municipal Government.
Opinions on Strengthening Soil Pollution Control (Huanfa[2008] No.48)	• Risk assessment conducted for the site based on which remediation plan is developed.
Notice on Ensuring Environmental Safety of Re-development of Industrial Sites (Huanfa[2012]No.140)	• QIZ is a national priority for heavy metal-contaminated site remediation and re-development following new land use planning.
Implementation Plan of Heavy-metal Pollution Control in Xiangjiang River Basin	• This project is the key action of the implementation plan
The 12th Five-Year-Plan for Environment Protection in Zhuzhou	• This project is the key action of the plan.

4. ENVIRONMENTAL BASELINE OF THE PROJECT REGION

4.1 Natural Environment

Location: Zhuzhou is in the eastern part of Hunan Province, between E125°57'30"~ 114°07'15" and N26°03'05"~28°01'27". The total area of Zhuzhou Municipality is 11272km^2. The project is located in the south end of the Qingshuitang Industrial Zone (QIZ), Shifeng District of Zhuzhou.

Topography: The topography of Zhuzhou is mainly surrounded by mountains and rolling hills with low river basin in the middle.

Meteorology: The project region belongs to a warm and humid subtropical monsoon climate. The average temperature is 17.4°C (min. -11.5°C and max. 40.2°C), and the average precipitation is 1442.7mm, which mainly occurs during April – August. The dominant wind direction is NWN, with annual average speed of 2.0m/s.

Hydrology: The project region belongs to Xiangjiang River basin. Xiangjiang River is a major tributary of Yangtze River and has a total length of 856km. It flows through Zhuzhou city where the river is about 500-800m wide and 2.5-3.5m deep, with annual average flow of 1780m^3/s. The river section falling under the QIZ is 8km long, with five small branches feeding to the river.

Hydrogeology: Two geological structures dominate the project area. One is exposed bedrock with very scarce fissure and pore water; the other is alluvial material layer that lies in the south-middle of the project area, of which the upper section is dense silty-sandy clay with poor water permeability; the under layer is loose sands with rich groundwater. In the project area there is also thick fill soils on top of bed rock; both with deficient groundwater. Overall, the groundwater is deficient with poor migration in the project area. The groundwater flows NE-SW toward the Xiang River, is primarily replenished by precipitation, and presents an annual variation of 0.5-1m.

Ecology: The project area has been exposed to industrial pollution for a long history. The eastern part has been urbanized while the western part is primarily rural with good vegetation. Farmland in the project area is not suitable for agricultural production. Ecological survey shows there is no critical habitats or endangered species identified. The project area is by the north side of Xiangjiang River, a major tributary of the Yangtze River.

4.2 Socio-economic Context

The project area is a portion of QIZ's core zone that holds a majority of QIZ's industries. QIZ belongs to Shifeng District of Zhuzhou City. Shifeng District has a total area of 92km2, with a population of 0.25 million and a urbanisation rate of 97.3%. QIZ was developed since 1950s is known as a symbolic industrialized region and a major smelting and chemical industry base. According to social survey, the project area of 8.48km^2 has a total population

of 6237. In 2009 the farmland within the project area was turned into construction land per central government's requirement. Accordingly the farmers were turned into urban residents and incorporated into the corresponding employment and social security system.

4.3 Ambient Environmentally Quality

Ambient Air Quality: According to historical records and air quality monitoring during the EA preparation, the main air pollutants are CO, NO_2 and PM10 which exceed the applicable ambient air quality standard, indicating relatively poor air quality of the project region. The air concentration of fluoride, mercury, lead and its compounds, arsenide, chromium (+6), manganese, phenol and NH3 can meet the applicable Industrial Sanitation Standards.

Surface Water Quality: Monitoring of water quality in Xiangjiang River, Xinqiao Low Discharge Channel, Xiawangang and Old Xiawangang indicates that the concentration of pH, SS, cyanide, volatile phenols, Cd, Hg, Zn, Pb, As, Ni, Cr6+ and Cu can all meet the surface water quality standards. While, TP, NH_3-N are found exceeding standards at some locations.

Sediments: Monitoring results of sediments of Xiangjiang River and channels at the project area indicates pollution of As, Hg, Cu, Pb, Cd and Zn. Sediments in channels in the project were analyzed and showed heavy metal contamination.

Groundwater Quality: Groundwater monitoring samples were collected in the project area, and the analytical results show that the main pollutants exceeding reference standards include sulfate, nitrate, nitrite, ammonia and fluoride, indicating influence from agriculture and domestic sewage. Some locations were detected with beryllium and manganese above the reference standards, indicating presence of certain industrial pollution.

Noise: Monitoring results show the overall compliance of the ambient noise in the project area.

4.4 Environmentally and Socially Sensitive Sites

The project area is an industrial area, and land use is dominant by industrial enterprises and communities. The sensitive receptors are 11 communities within or near the project area which are subject to potential impact of noise and air quality. The sensitive receptor of surface water is the Xiangjiang River by the south side of the project area.

There are a few physical cultural resources within the project area, including Dawang Temple, Wuniang Temple and about 2300 family graves. These cultural resources sites are all located on the hills, and are outside the project remediation areas. The project civil works and remediation activities will not have direct impact on these sites.

4.5 Industrial Enterprises and Pollution Emission

Currently, there are over 80 industrial enterprises within the Qingshuitang industrial zone which are dominated by non-ferrous metal smelting and chemical industries. There are 39 operating enterprises (mainly chemical, metallurgical and machinery) and 6 closed enterprises within the 8.48km^2 project area.

The main pollution emission of the area include: 26.4 million tons of wastewater (including COD and NH_3-N emissions of 2756 tons and 543 tons respectively); 29499 tons of SO_2, 5080 tons of dust, 25199 tons of NOx; 2.4 million tons of industrial solid waste (with recycling rate of 98.4%); and 19952 tons of hazardous waste (with recycling rate of 51.1%).

Main pollution emitting enterprises are subject to routine monitoring by Zhuzhou Environmental Monitoring Center (ZEMC). Other enterprises are required to provide emission compliance monitoring reports for their yearly renewal of emission permits. Based on monitoring results of ZEMC, the emission compliance of major enterprises has been improving gradually, and full compliance of wastewater and waste gas emission has been achieved in 2015.

4.6 Completed and Ongoing Remediation Works

Zhuzhou has completed/is conducting a number of soil pollution remediation projects in Qinghsuitang Industrial Zone with funding support from central and provincial governments. These included completed projects of Xiawangang (water channel) heavy metal contamination remediation, waste piles disposal project, Dahu (water pond) remediation project and construction of Tongxia Road. The ongoing remediation projects include heavy metal pollution remediation of Xinqiao Low Discharge Channel (sediments dredging, S/S treatment and landfill disposal, and ecological restoration the channel) and Old Xiawangang channel (Phase I). The ongoing Old Xiawangang channel remediation project includes sediment dredging, treatment and disposal. The World Bank-funded project will support the post-clean up activities for Old Xiawangang, which is the ecological restoration of the river banks.

5. SITE INVESTIGATION AND RISK ASSESSMENT

5.1 Environmental Site Investigation

For the convenience of site investigation, the project area is divided into seven sub-areas, i.e. Xiangshiling, Qingshi, Tongtangwan, Tongxia, Qingshui, Yinfeng and Qingshuihu sub-areas (Figure 2). The current land use is shown in **Figure 3**. According to the land use survey conducted during the project preparation, the project area has a mix of land uses that can be categorized into 5 types, i.e. industrial/infrastructure, residential, farmland/idled land, waters and woodland.

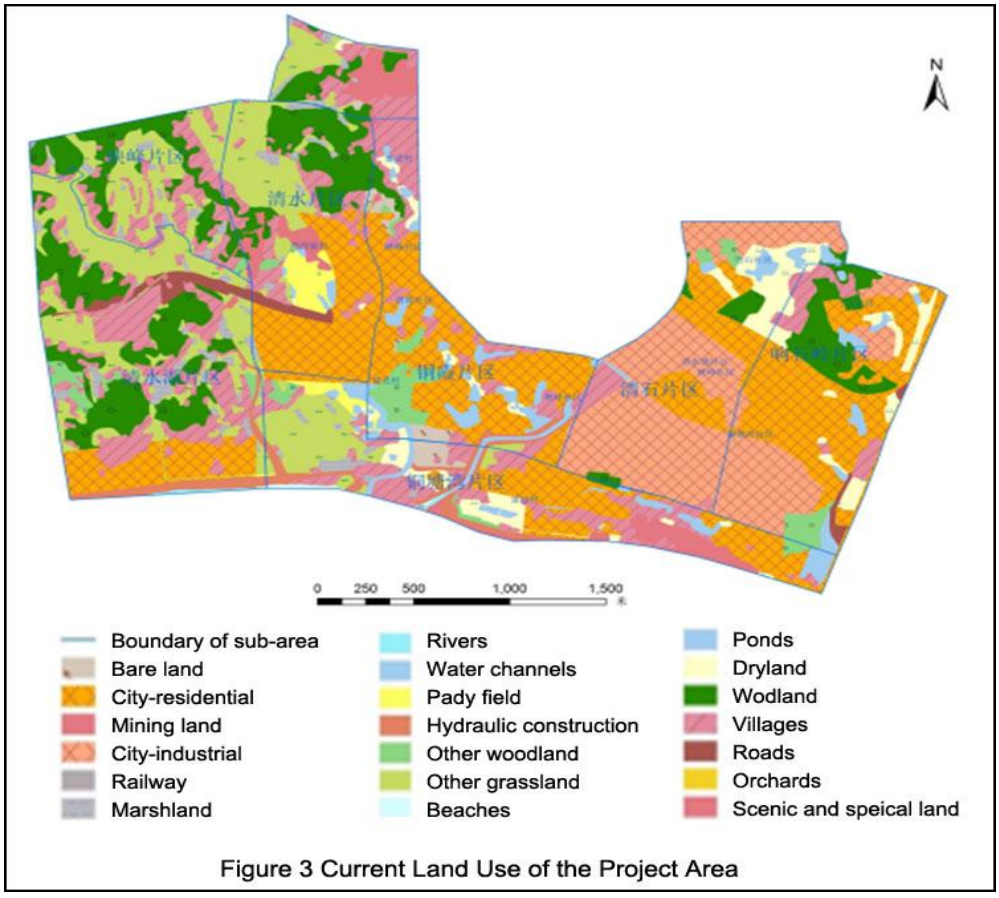

Figure 3 Current Land Use of the Project Area

Detailed site investigation was conducted during 2011 – 2014, which covers soil, groundwater, surface water, sediment, and solid waste piles, closed facilities and the project area comprising seven sub-regions to identify the characteristics and distribution of the regional contamination. The key findings of site investigation are summarized as follows:

5.1.1 Soil

Soil sampling was conducted in 407 locations within the seven sub-areas, with total sample of 1144. Based on analysis results and risk assessment, the primary heavy metal pollutants

of concerns are Pb, As and Cd, with depth of contamination up to 50cm (some locations over 60cm). The concentration contours maps illustrating the distribution of Cd, As and Pb are provided in **Figure 4, 5 and 6**.

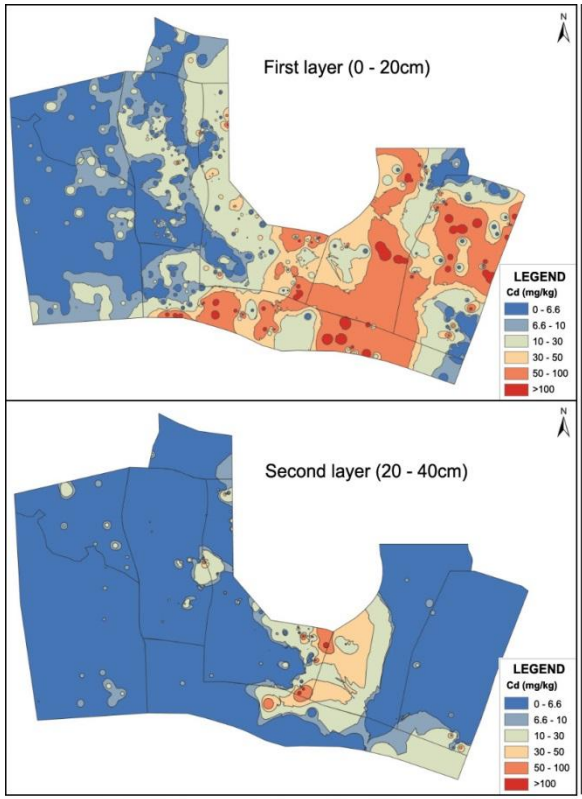

Figure 4 - Concentration Countour Map of Cd Contamination

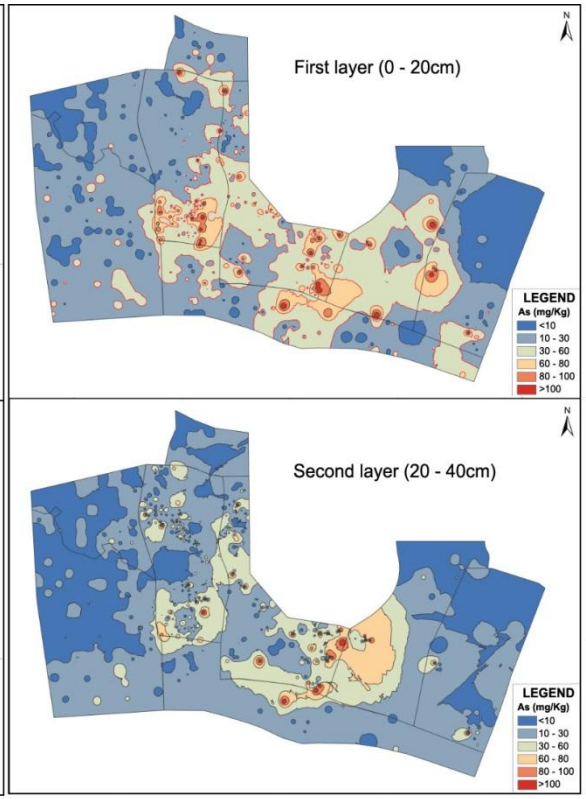

Figure 5 - Concentration Countour Map of As Contamination

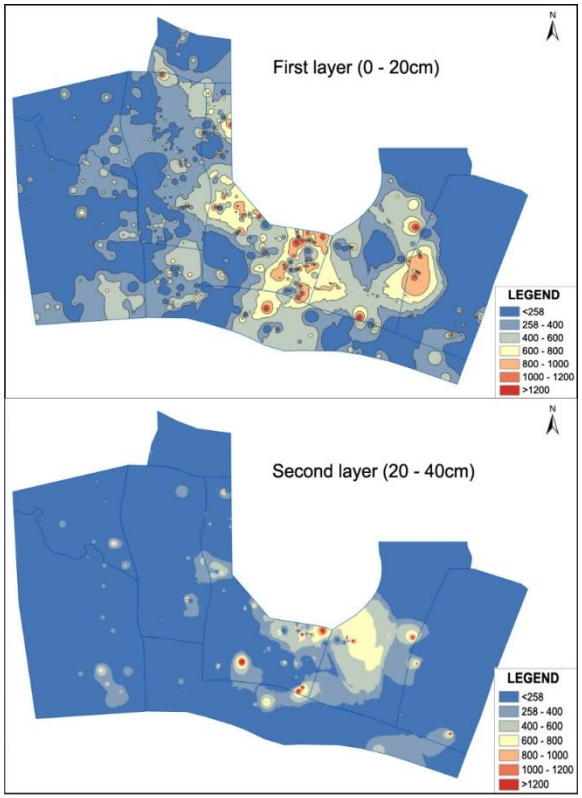

Figure 6 - Concentration Countour Map of Pb Contamination

5.1.2 Water Channels and Ponds

There are three water channels in the project area, including Xiawangang, Old Xiawangang, and Xinqiao Low Discharge Channel. The remediation of Xiawangang has been completed in 2013 and remediation of Xinqiao Low Discharge channel and Old Xiawangang (Phase I) is ongoing. Investigation focused on the old Xiawangang and ponds (distributed in Qingshui, Tongxia and Tongtangwan sub-areas). The water quality of the channels and ponds meets the Class V of "Surface Water Quality Standards (GB3838-2002)" and the main pollutants in the sediment are Pb, Cd, As and Zn, which can be classified identified as Class II of general industrial solid waste according to national standard (i.e. non-hazardous solid waste).

5.1.3 Solid waste piles

There are two industrial waste piles left within the project area. The total area of the two piles is 16815m^2, with total amount of waste of 84652m^3. Sampling analysis results show the high concentration of heavy metals in these waste piles, i.e. Cd (27.63 – 263.6mg/kg), Pb (348.78 – 5956.7mg/kg), Zn (135.27 – 77724mg/kg), As (44.61 – 220.3mg/kg) and Cu (5.80 – 1317.8mg/kg).

5.1.4 Closed Enterprises

Soil investigation has been conducted in six closed industrial enterprises (smelting, machinery, chemical and cements plants). The results show the contamination of Pb, Cd, As, Zn, Cu. At Tiancheng Chemical Plant organic pollutants benzopyrene and aniline were detected. The total area of these sites is 220819m^2.

5.1.5 Soil Investigation in the Surrounding Communities

The pavement of the residential areas in the project area is mostly concrete, and no exceedance of heavy metals was detected in the subsurface soil beneath the concrete pavement in the residential area. Supplemental investigation was conducted to collect soil samples from open lands (flower and vegetation gardens, small farmlands, idled open space) within the residential areas with no pavement and from the surrounding neighborhoods of closed facilities in Xiangshiling Region, Qingshi Region and Tongtangwan Region. The investigation results show that Cd and Pb were detected above the remedial goals in some soil samples and the added contamination areas of about 0.11 km^2 which needs clean soil replacement.

5.1.6 Surface Water and Groundwater Water

Based on baseline information, the surface water quality in the project region can meet applicable standards for all heavy metals, while, TP, NH_3-N are found exceeding standards at some locations.

The investigation has installed 21 groundwater monitoring wells and groundwater samples were collected. The analytical results some parameters including sulfate, nitrate, nitrite, ammonia and fluoride, and beryllium were detected above the reference standards. Other historical groundwater monitoring were reviewed as well, which shows localized exceedance of other heavy metals at some locations. Given the hydrogeological conditions in the project area, and the fact that groundwater of the project area is not used as drinking water source, human health risk assessment indicates potential groundwater contamination does not pose unacceptable risk levels to human health, no immediate remediation measure is proposed at this point but a long-term monitoring of groundwater quality will be conducted.

5.1.7 Agricultural Products

In accordance with *Pollutants Thresholds in Food Products (GB2762-2005)* and relevant food products standards for Zn and Cu, sampling results of vegetables in the project area indicate that the concentration of Cd, Pb and Zn is 0.103-0.541mg/kg (with non-compliance rate of 46.7%), 0.072-4.32mg/kg (with non-compliance rate of 46.7%) and 10.0-29.0mg/kg (with non-compliance of 26.7%) respectively.

5.2 Risk Assessment

5.2.1 Methodology

Risk assessment was undertaken for the project area based on the site investigation results, following the national Technical Guidelines for Risk Assessment of Contaminated Sites (HJ253-2014), as well as other tools and data sources such as USEPA Integrated risk information system (IRIS), Risk Assessment Information System (RAIS), US Risk Based Corrective Action (RBCA) and ASTM etc.

Based on the site investigation, the primary pollutants of concerns are Pb, Cd and As. Risk assessment was conducted for these pollutants according to different land uses purpose with main consideration of human health risks. Following the Technical Guidelines for Risk Assessment of Contaminated Sites, two types of land use are considered, i.e. sensitive land use (e.g. residential area) and non-sensitive land use (e.g. industrial area).

The acceptable risk level is determined as follows: (1) for non-carcinogenic risk, the total acceptable Hazard Quotient is 1; (2) for carcinogenic risk, the acceptable level for a single pollutant is 10^{-6}. When the carcinogenic risk for a single pollutant at one sample location exceeds 10^{-6}, or the Hazard Quotient is above 1, then the area represented by the sampling location is classified as contamination areas with unacceptable risk.

5.2.2 Risk Characterization

According to the Zhuzhou Qingshuitang Circular Economy Industrial Zone Planning (2010-2030) and Zhuzhou Qinghsuitang New Eco-industrial City Planning, the future land use of the project area will mainly include residential area, administration and office, business, cultural and recreation, sports, medical care and hospital, education and research, industries, logistics and storage warehouse etc. The future land use is shown in **Figure 7.**

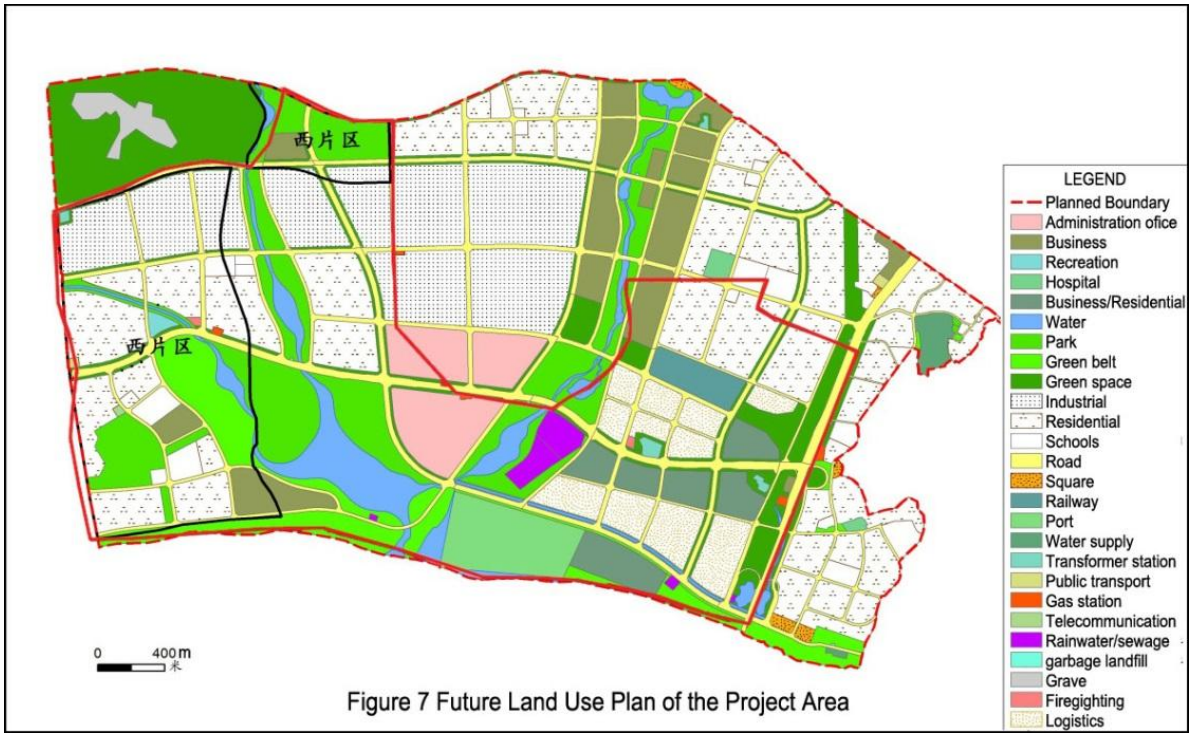

Figure 7 Future Land Use Plan of the Project Area

Based on the future land use (i.e. sensitive and non-sensitive land use), risk assessment was undertaken for the project area. According to the risk assessment results, the 8.48km^2 project area is divided into three parts to prevent excessive remediation on the basis of risk control: (1) risk acceptable area: 2.02km^2; (2) risk controllable area: 3.73km^2; and (3) remediation area: 2.73km^2. The spatial distribution of contamination risks are presented in **Figure 8**.

- **Risk acceptable area**: Identified as risk acceptable areas in the risk assessment reports;
- **Risk controllable area**: Identified as risk unacceptable areas in the risk assessment reports but the exposure risk has been reduced based on the site conditions, including 1) the residential areas with concrete pavement (no contamination in the subsurface soil); 2) the current producing companies without exceedance of emissions; 3) completed or ongoing remediation areas.
- **Remediation area**: Identified as risk unacceptable areas in the risk assessment report and not included in the risk controllable area. This is the area that the project will conduct remediation actions.

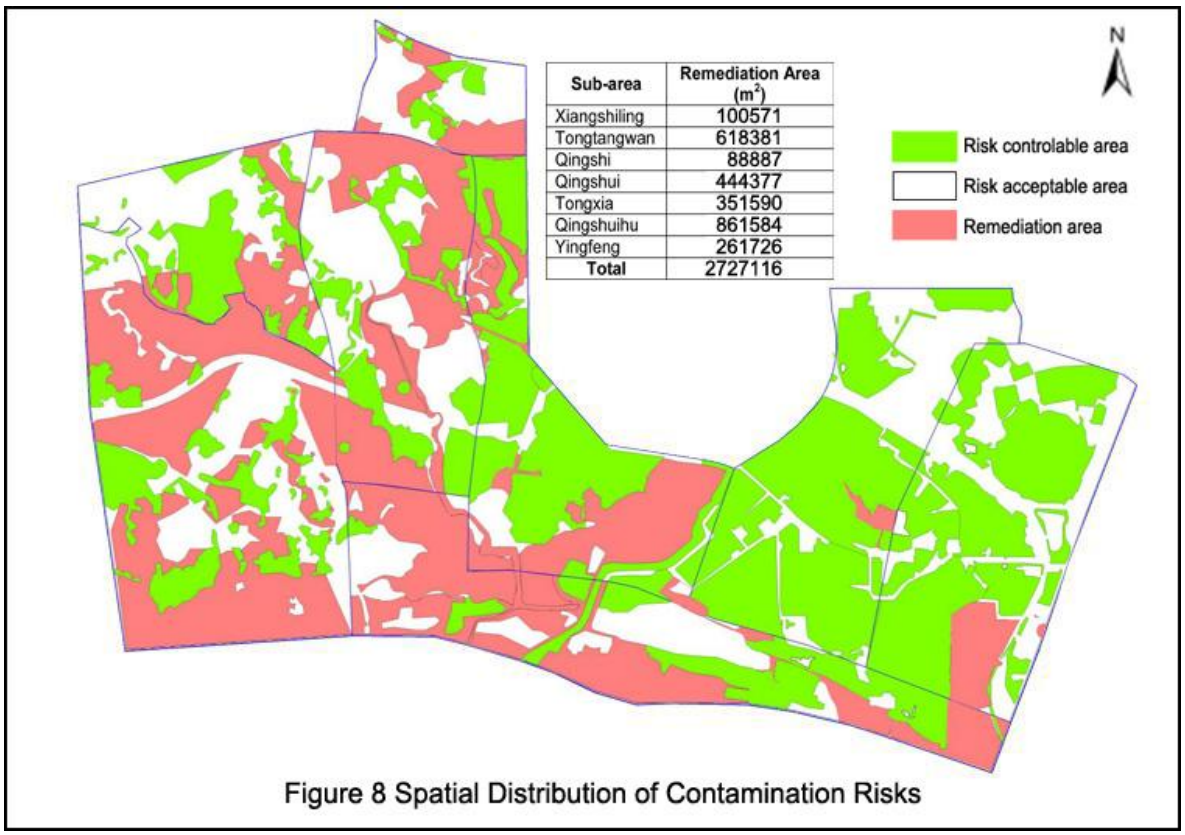

Figure 8 Spatial Distribution of Contamination Risks

5.2.3 Remediation Targets

Soil remediation action needs to be undertaken for the 2.73km^2 remediation area. Based on the acceptable risk level of 10^{-6} and hazard quotient of 1, the soil remediation targets were calculated and determined, which were approved by Zhuzhou Municipal Environmental Protection Bureau during the project preparation.

Table 5 Soil Remedial Targets

Pollutants	Target Value for Soil (mg/kg)	
	Sensitive Land Use (Residential Area)	Non-sensitive Land Use (Non-residential Area)
Cd	10	30
As	30	60
Pb	400	600
Ni*	90	/
Benzopyrene*	0.3	/

* Specific to Tiancheng Chemical Plant site

Based on the results of environmental investigation and risk assessment, the remediation engineering quantity is summarized as **Table 6**.

Table 6 Summary of Remediation Quantity

Item	Remediation Construction	Remediation Area/m^2	Quantity /m^3	Total /m^3
Site Cleanup	Construction waste cleanup of closed companies	9547	6532	45842
	Construction waste cleanup of residential area	126811	39310	
	Surface cleanup	2291457		
Remediation of closed companies	Site remediation of 6 plants	191579	90861	90861
Soil remediation of other sites	Yinfeng Sub-area	183376	110026	1374874
	Qingshuihu Sub-area	754516	537569	
	Qingshui Sub-area	401154	247189	
	Tongxia Sub-area	252189	138790	
	Qingshi Sub-area	31528	16890	
	Tongtangwan Sub-area	638986	323273	
	Xiangshiling Sub-area	8208	1137	
Waste pile remediation	Waste Pile in Tongxia Sub-area	16815	81652	84652
	Waste pile in closed companies	-	3000	
Channels and ponds remediation	Old Xiawangang ecological restoration			172986
	Ponds sediment remediation	172986	172986	
Soil remediation of residential areas[1]	Soil replacement	110855	55428	55428

6. REMEDIATION PLAN

The remediation works to be undertaken by the project include site clearing, contaminated soil remediation, remediation of Industrial waste piles, sediment remediation, soil remediation of residential areas, construction of supporting facilities (S/S site, dewatering site, landfill site). In addition, an environmental demonstration center will be built. The locations of the project sites and facilities are shown in **Figure 2.**

6.1 Site Clearing

The site clearing work includes demolition and asset recovery of residential buildings and buildings of six closed enterprises; washing the building of closed facilities and other construction waste, and removal of debris and tree stumps. The total solid waste generated

[1] The soil samples collected from the residential areas indicated soil contamination and the size of impact is approximately 0.11 km^2. The impact of residential areas is not included in the 2.73 km^2 remediation area, but will be remediated.

is about 45843m^3, including 6532m^3 of demolition wastes from six closed enterprises (with demolition building of 9546.8m^2) and 39310m^3 waste from residential building demolition (21993m^2).

Large trees will be recovered and other debris will be sent to landfill for disposal. The construction waste from residential building will be reused as material for road construction, cement production or backfilling material in the project region. The construction waste from closed enterprises will be prior washed before reused as construction material or backfilling material. Recyclable materials will be separated from the construction waste. The wash water will be treated by in-situ treatment facility and recycled for washing operation.

6.2 Contaminated Soil Remediation

According to the risk assessment, the total area that needs soil remediation action is 2.3km^2, with total contaminated soil of 1.37million m^3. Based on different land use planning and considering different levels of contamination, a series of remediation technologies are compared and six methods were finally selected for various contaminated areas, including in-situ stabilization + capping, in-situ stabilization + vegetation covers, ex-situ S/S, transport to planned industrial land, vegetation cover, phytoremediation interception barriers. The application of different remediation technologies in the project area is illustrated in **Figure 9** and **Table 7**.

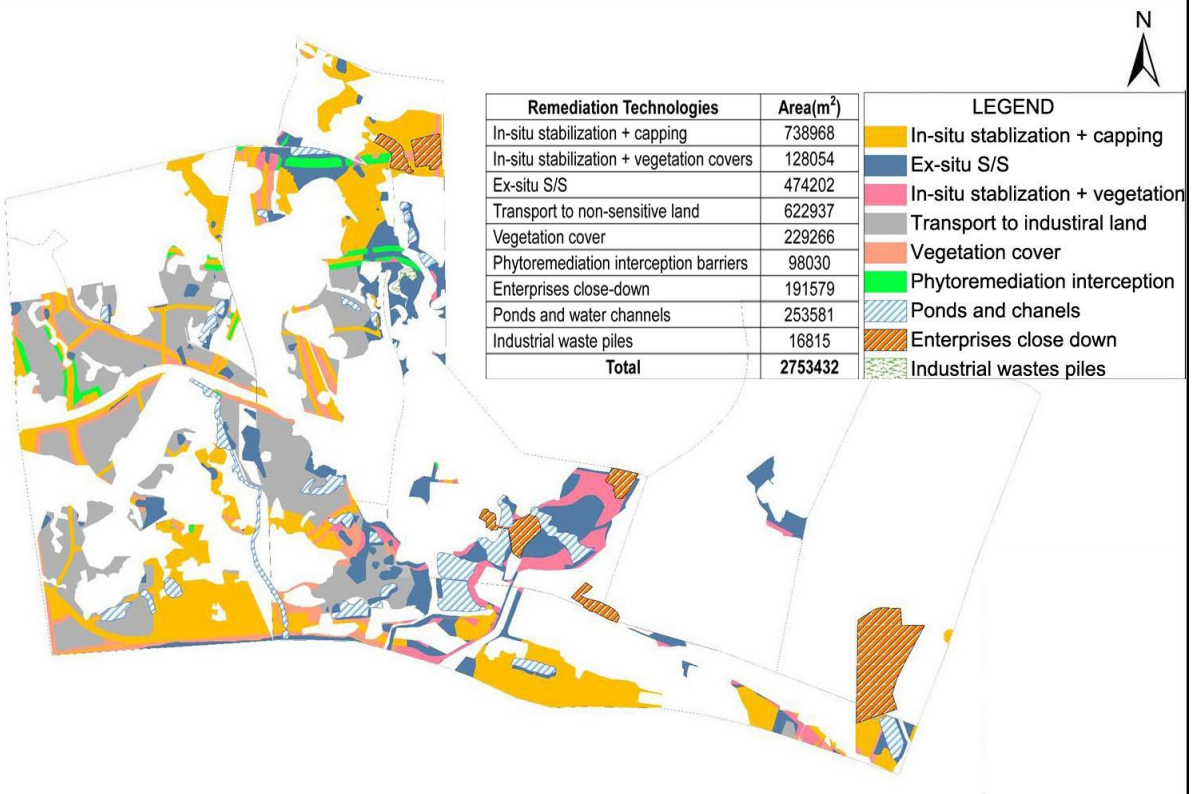

Figure 9 Distribution of Different Remediation Methods in the Project Area

Table 7 Remediation Technologies for Soil Remediation

	Area(m^2)	Volume (m^3)
In-situ stabilization + capping	738968	443381
In-situ stabilization + vegetation covers	128054	76832
Ex-situ S/S and disposal in industrial waste landfill	474202	284521
Transport to non-sensitive area (reused as roadbed materials in the project area, or disposed of in the landfill)	622937	373762
Vegetation cover	229266	137560
Phytoremediation interception barriers	98030	58818
Total	**2291457**	**1374874**

In addition, soil remediation will also be conducted in the 6 closed enterprises, with total remediation area of 0.19km^2 and total amount of soil remediation of 90861m^3. The heavy metal contaminated soil (total 74313m^3) will be treated with S/S technology and disposed of in landfill. For the organic soil contamination within the closed Tiancheng Chemical Company site, the contaminated soil will be excavated and incinerated in the Zhongcai Zhuzhou Cement Plant for final disposal. The total area of organic contamination within the company is 8274m^2, with total amount of contaminated soil of 16548m^3.

6.3 Industrial Waste Piles Remediation

Industrial waste piles in Tongxia sub-area and Yongfa Plant will be remediated by ex-situ S/S and transported to the new industrial solid waste landfill for disposal, with total disposal amount of 93,100 m^3.

6.4 Ponds Sediment Remediation

The total area of contaminated 26 ponds covers an area of 0.17 km^2, and about 259,500 m^3 of pond water and 173,000 m^3 of sediment will be cleaned up and dredged. The pond water will be pumped out, treated with mobile treatment facility to meet relevant discharge reference standard, and then be discharged directly into the drainage channels. The dredging sediment will be dewatered by gravity and transported to the landfill for disposal after ex-situ S/S treatment. Dredged ponds bottom will be backfilled with gravel/sand material to facilitate restoration of aquatic ecology.

In addition, ecological restoration works for river bed and banks of Old Xiawangang channel (which is being remediated with local fund as Phase I) will also be conducted, with total restoration area of 54279m^2.

6.5 Soil Remediation of Residential Areas

Soil replacement will be used and the removed soil will be transferred to non-sensitive areas or S/S treatment facility based on its contamination levels. The total remediation area is 0.11km^2, with a soil replacement depth of 0.5m and total amount of 55427.5m^3. After the replacement, the site will be restored to the original conditions and covered with vegetation to prevent soil erosion.

6.6 Supporting Facilities for Soil Remediation

Xinqiao S/S Treatment Site

The project will use the existing Xinqiao S/S Site for stabilization and solidification treatment, which was used for the treatment of Xinqiao waste piles. The total S/S treatment soil amount will be 584,700m^3, which will then be sent to industrial solid waste landfill. Upon the project completion, the S/S facility will be dismantled and the site will be used for the planned Environmental Demonstration Center.

Dewatering Sites

The project will use an existing Xiawangang dewatering site (4000m^2 dewatering area and 1500m^2 storage area), and construct a new Xinqiao Dewatering site (4000m^2 dewatering area and 200m^2 storage area). The new site is near the Xinqiao S/S site, and is currently a piece of non-used waste land. The site will be designed with anti-seepage floor with wastewater collection system to avoid potential pollution to soil and groundwater.

Temporary Storage Site

Based on project schedule, a temporary storage site will be constructed besides the Xinqiao S/S Site (with an area of 10000m^2 and storage capacity of 150,000m^3) to store the S/S waste before the new landfill construction is completed. The site will be designed with anti-seepage surface to avoid potential pollution to soil and groundwater.

Temporary Access Roads and Transport Routes

The project use existing roads/streets for material transportation. Some village roads (14 roads, total 13.832km) will be renovated/strengthened as access roads, and some roads will be newly constructed (3 roads, with total length of 1.802km).

6.7 Solid Waste Landfill

The project will construct a new solid waste landfill site for accommodate the construction waste, treated soil/sediments and industrial waste residues from the project. According to the leaching test, the treated soil belongs to Class II general industrial solid waste, therefore the landfill is designed according to the standards for Class II general industrial solid waste.

The total volume of the construction waste, together with the soil, sediment and waste residue after stabilization is 643200 m^3. The abandoned quarry pit of Zhuzhou Hehua Cement Plant will be used to build a solid waste landfill of 200 million m^3 in volume of capacity and 38,265 m^2 in area, according to “General Industrial Solid Waste Storage and Disposal Site Pollution Control Standards (GB 18599-2001)”.

According to monitoring results, the pH and NH_3-N concentration in the water of the pit is not in compliance with wastewater discharge standards, therefore, before the remediation construction, the drainage channels will be built around the site and the water of 200 million m^3 volume in the pit will be treated by a 500m^3 chlorination reaction tank to be constructed by the pit. The treated water will be discharged into a local channel that feeds into the Xiangjiang River.

The new landfill is designed with anti-seepage foundation with leachate collection and treatment system. After the completion of this project, the landfill will be used for solid waste disposal of future company closure and site remediation in the region.

6.8 Environmental Demonstration Center

The project will establish an environmental demonstration center, which is designed with functions of integrated environmental database platform, environmental protection experience communication, environmental museum, post monitoring and warning system. It will include an Environmental Demonstration Center building, environmental museum and engineering testing field.

The center will be located in the Xinqiao waste pile site which has been remediated by Zhuzhou city and where the existing Xinqiao S/S site is located. The Xinqiao S/S will continue to serve this project, and then will be turned into an environmental protection museum afterwards. The total land area of the center is 71934m^2, and the area of the building is 7970m^2. The demonstration center will provide non-profit environmental public services for QIZ. The operation expenses will be provided by Zhuzhou Cycle Group from the local or higher level government funding.

7. ANALYSIS OF ALTERNATIVES

Alternative analysis has been conducted for the project with comprehensive considerations of environmental, social, technical and economic factors, based on which the overall optimum option is selected. The main analysis of alternatives is summarized as follows:

7.1 With/Without Project

Under the "Without project" scenario, the land use of the project area will remain unchanged, with mixed industrial and residential lands. The soil contamination of the area has resulted in food safety and public health problems, and threatens the drinking water safety in the downstream of Xiangjiang River. The future development of the area will not be sustainable. The implementation of the project will bring significant positive environmental and social benefits by cleaning up the area, removing the contamination risk to environment and public health, and facilitating sustainable development of QIZ. The adverse environmental impacts during remediation process is manageable, and can be adequately avoided, minimized and mitigated through efficient implementation the EMP.

7.2 Alternative Analysis of Site Selection

Environmental Demonstration Center

Two location options were considered for the center: Option 1 is at Xinqiao waste pile location which just completed site remediation; and Option 2 is besides the quarry pit of Hehua Cement Plant where the landfill will be located. Through comprehensive comparison, Option 1 is selected mainly due to no-resettlement, close to treatment facilities, convenience of converting on-site facility into museum, and convenience of monitoring and management.

Solid Waste Landfill

Two options were considered for the landfill: Option 1 to use an abandoned quarry pit in the area; and Option 2 is to construct a new above-ground tray-type landfill in the planned green space of the project area. Reuse the quarry pit will avoid occupation of new land, fully utilize the non-usable industrial legacy site to accommodate the project waste as well as long-term disposal of solid waste for the city. New construction of above-ground landfill, though is easier for construction, will take large green space, require construction enclosure dams and will have more chance of public exposure. With comprehensive comparison, Option 1 is selected.

Soil Remediation Technologies

Soil remediation technologies are carefully compared and selected following the relevant national norms and guidelines, as well as the principles of US EPA Superfund program. Main considerations include technical, environmental, social and economic factors, based

on which a number of possible remediation technologies were selected for feasibility comparison:

Remediation of heavy metal-contaminated soil: four technologies were studied, including S/S, excavation and ex-situ landfill, phytoremediation and soil washing with consideration of technical feasibility, period of remediation, land use plan and economics. Finally, a combination of in-situ stabilization + capping, in-situ stabilization + vegetation remediation, ex-situ S/S, removal to industrial land and phytoremediation interception barriers was selected.

Remediation of organic contamination soil: three technologies were studied, including biodegradation, excavation and ex-situ landfill, and incineration. The incineration technology is selected due to consideration of proper scale, remediation time and cost. The Zhuzhou Cement Plant, about 18km from the project, has the appropriate process and emission treatment facilities that meet the national standards of *Technical Specifications for Co-incineration of Solid Waste by Cement Kiln(HJ662-2013)*, therefore, is selected for incineration treatment.

7.3 Treatment of Water in the Quarry Pit

The quarry pit water contains NH3-N higher than applicable standards and requires prior treatment before discharge. Two treatment options were considered: Option 1 is to send the water to the existing Qinghsuitang Industrial Treatment and Recycling Plant; Option 2 is chemical treatment by adding chemicals to remove NH3-N (breakpoint chlorination method). Option 1 is limited by the capacity of existing plant and requires construction of a connection pipeline. While, Option 2 only requires construction of one treatment tank near the pit (which will later be used as leachate collection tank for the landfill). Therefore, Option 2 is selected.

7.4 Transportation of Waste inside the Landfill

The quarry pit is 60m deep. For better transportation and dumping of soil waste into the landfill, three ways of transportation were considered: Option 1 is to use slideway (either one whole slideway or multiple slideways forming a zip-zag shape); Option 2 is to use tower crane; Option 3 is to strengthen the existing simple mining road down to the quarry pit. Given the low cost and amount of transportation, Option 3 is selected.

8. ASSESSMENT OF IMPACTS

The project is a pollution cleanup and environmental improvement activity, thus it will have significant environmental and social benefits by remediating site contamination and improving environmental quality of the project area. However, the remediation works will also have potentially adverse environmental and social impacts during the construction and operation stage. These impacts are thoroughly addressed in the EIA, and mitigation measures have been developed in the EMP, which can effectively avoid, minimize, mitigate or otherwise compensate potential environmental and social impacts.

8.1 Construction Stage

8.1.1 Impacts on Ambient Air Quality

The main temporary environmental impact on ambient air quality comes from dust of earth excavation, on-site storage, backfilling and secondary dust from material/waste transportation, exhaust emission from vehicles and equipment, and odor from sediment dredging operation. Based on survey statistics from similar construction projects, construction dust may have an impact scope up to 100m. The odor from dredging operation is hardly sensed at 80m distance and has little impact over 100m. There are limited number of construction vehicles and equipment of which the exhaust emission is small and quickly dispersed.

Such air quality impacts are temporary, and can be effectively mitigated good construction management and mitigation measures developed in the EMP.

8.1.2 Impacts on Surface Water

The main water pollution sources during construction include domestic sewage from workers, washing water of closed enterprises' buildings and construction equipment, initial rainwater runoff at closed enterprises, wastewater from dredging operation and accumulated water in the quarry pit.

- **Accumulated water in the quarry pit**: an on-site treatment tank will be constructed to remove NH3-N in compliance with applicable standards before discharge into local drainage channel. The tank will later be turned to leachate collection and treatment facility for the solid waste landfill.
- **Wastewater from dredging operation**: mobile treatment facility will be used to treat the wastewater (mainly suspended solid) up to applicable standard and discharge into Xiawangang channel.
- **Washing water of enterprise buildings and construction vehicle/equipment**: waste water will be collected in sedimentation tank and treated with mobile wastewater treatment equipment, then discharged into municipal wastewater network.
- **Initial rainwater at the enterprise sites** will be collected and reused for dust suppression.

- **Sewage from workers:** no camp is needed for workers, therefore, the living sewage of workers is limited of concern.

In summary, the wastewater generated during the construction stage can all be properly managed with little environmental impacts envisaged.

8.1.3 Impacts on Groundwater

The main concerns of groundwater pollution will be wastewater from dewatering site, S/S site and temporary storage site. To avoid potential groundwater pollution, anti-seepage floor design is adopted for all these sites with necessary wastewater collection and treatment facilities. Therefore, the potential impact on groundwater can be adequately mitigated.

8.1.4 Impacts of Solid Waste

Construction wastes from demolition will be disposed of in landfill after collection of recyclable materials. Contaminated soil and dredging sludge will be treated at S/S site and sent to landfill for disposal. With proper management of the waste, the potential environmental impacts can be adequately mitigated.

8.1.5 Impacts of Noise

Noise impact mainly comes from construction vehicles and equipment, which may have impacts up to 200m. Many sensitive communities are 14-42m from the construction sites, thus noise impact can be a nuisance to the surrounding communities. To mitigate noise impacts, measures have been developed in the EMP, including use of low noise equipment, proper schedule of construction, no construction at night, proper planning of material transportation route etc. The noise impact is temporary in nature, and can be mitigated with effective implementation of EMP measures.

8.1.6 Impacts on Ecology

The project area is mainly an industrial area with mixed rural farmland and communities. There is no important environmental sensitive site (e.g. natural habitats, protected area etc.) and no protected plant and wildlife species in the project area. The main ecological impacts will be loss of surface vegetation (which are mainly agricultural crops and local common species of plants) and soil erosions. To address these impacts, a dedicated water conservation and soil erosion control plan has been developed in the EMP.

Dredging of ponds will have impacts on aquatic life in the ponds. There is no protected or endangered fish species in those ponds. Such impacts are temporary and limited to the vicinity of dredging area. After dredging operation, ecological restoration works will be carried out to facilitate the restoration of ecological conditions of these ponds.

8.1.7 Social Impacts

- **Land acquisition and resettlement:** The project will need land acquisition of 18.17ha, and require demolition of 31539.8m^2 building, with involvement of 21993m^2 residential buildings (94 affected families). A Resettlement Action Plan (RAP) has been developed to address the compensation issue, with special consideration of vulnerable groups. The RAP is in compliance with the World Bank OP4.12.
- **Disturbance of utilities:** the project construction may have temporary impacts on utility lines that cause inconvenience of public life.
- **Traffic impact:** The site excavation, material storage and transportation will have adverse impact on road traffic, and cause disturbance to local communities.
- **Visual impact:** improper handling of construction debris and wastes will have negative visual impacts on urban landscape and aesthetics.
- **Camp impact:** the workers camp may have adverse impacts on local communities in terms of daily life disturbance and public health (e.g. transmittable diseases such as HIV/AIDS, STD etc.). This project is located within the urban context, and there is no camp planned. Education will be provided to the workers to minimize the potential social impacts.

To address social impacts, a series of mitigation measures have been developed in the EMP, including prior information disclosure, arrangement of temporary utility supply, enforcement of safety requirement, proper routes planning, necessary traffic diversion, provision of safe temporary access for communities, education of works, compensation measures developed in the RAP, etc. In summary, the social impacts during construction stage are temporary in nature, and can be adequately mitigated with the mitigation measures developed in the EMP and RAP.

8.2 Operation Stage

8.2.1 Impacts on Ambient Air Quality

The main air quality impact during operation comes from the fugitive dust and odor emission from the operation of dewatering site, S/S site and landfill. Dispersion modelling for NH_3, H_2S and dust was conducted and concluded that the concentration of these pollutants can meet the applicable standards at the boundary of the sites. Sanitation protection distance is set for these sites, i.e. 100m for Xinqiao S/S Site; 50m for Xinqiao Dewatering Site and Xiawangang Dewatering Site; 50m for the landfill site.

There are residential buildings within the protection zone of the Xinqiao S/S Site, Xinqiao Dewatering Site and the Xiawangang Dewatering Site. While, as these sites are temporary facilities, which will be dismantled after completion of the project. Mitigation measures will be taken during the operation, e.g. water spraying on access road, use cover where appropriate, plant trees around the site, proper arrangement of transportation routes, cover of the trucks etc. There are four households near the landfill site, while as the land is planned to be industrial and office building land, they will be relocated in the future along

with the implementation of the city master plan. Similar protection measures will be adopted before these families are relocated.

8.2.2 Impacts of Noise

The noise impacts during operation stage mainly comes from the operation of facilities such as crusher, mixer, shaker in Xinqiao S/S site, excavator and bulldozer in landfill and operation transportation trucks. Noise impact modeling has been conducted for Xinqiao S/S site which concluded that noise levels at the boundary of the site can meet relevant standards. With implementation of mitigation measures such as proper arrangement of operation schedule, transportation routes and maintenance of equipment etc., noise impacts from landfill and transportation trucks can be adequately mitigated.

8.2.3 Impacts on Surface Water and Groundwater

The wastewater during operation stage mainly comes from the operation of dewatering, S/S site, landfill site and the new environmental demonstration center. All these wastewater are treated before discharged: wastewater from dewatering sites will be treated through mobile treatment facility to achieve applicable standards for discharge, and the leachate will be collected and sent to Qingshuitang Industrial WWTP; initial rainwater collection tanks will be constructed at Xinqiao S/S Site, Xinqiao Dewatering Site, Xiawan Dewatering Site and the temporary storage site, and the collected rainwater will be reused for operation or dust suppression. Washing sewage from the environmental center will be treated and reused for green space and toilet flushing, and toilet wastewater will be discharged into Xiawan Municipal WWTP through sewage network.

To protect groundwater, all the dewatering, S/S, storage and landfill sites are designed with anti-seepage floor, with necessary wastewater collection and treatment facilities.

With proper operation management, the potential environmental impact on surface and groundwater during the operation of project sites can be adequately mitigated.

8.2.4 Impacts of Solid Waste

During the operation, limited garbage will be generated from the new environmental demonstration center, which will be handled through municipal garbage collection and disposal services. As mentioned before, the treated soil from dewater sites and the S/S site are to be disposed of in the landfill. Therefore, solid waste generated during the operation of project facilities will be are properly managed.

8.2.4 Social Impacts

The implementation of the project will resolve legacy pollution issues in the area and facilitate long-term sustainable urbanization and industrial development. It will

significantly improve the living environment of the project area, facilitate development of cleaner industries and create employment opportunities for local communities.

8.3 Landfill Site Closure Stage

The landfill site of the quarry pit will continue to serve the city as industrial solid waste landfill up to 2026. After the completion of landfill service, if not well managed and restored, the site may pose potential environmental impacts as a source of pollution in terms of dust, wastewater and safety. It is planned that the site will be closed with carefully designed closure measures, including multi-layers of clay and top soil with plantation of surface vegetation. Warning signage will be established around the site. Leachate collection and monitoring system will keep working until the quality remains stable. Groundwater monitoring will be kept running after closure. Future development of the land is subject to special safety review and approval by relevant agencies.

8.4 Cumulative Impacts

The project area is the core area of QIZ and is subject to significant change of land use and development according to the city's master plan, which will be facilitated by the site remediation efforts in the area. Therefore, there will be significant induced and cumulative impacts envisaged for the project area from a long-term point of view.

8.4.1 Future Development Plans

Currently, there are 39 operating enterprises (mainly chemical, metallurgical and machinery) and 6 closed enterprises within the 8.48km^2 project area. The total area of industrial enterprises is 1.32km^2, ca. 15.6% of the total project area, while , the residential area is 0.32km^2 (ca. 3.8% of project area).

According to *Detailed Plan for Core Zone of Qingshuitang Industrial New City*, the core zone will be 15.17km^2 (see **Figure 7**). The main function of the core zone will include business, industries (rail industries and environment-friendly industries), logistics and residential area. Industrial land will be reduced from current 429ha to 64ha, i.e. 4.24% of the total area.

According to the *Concept Plan of Zhuzhou Qingshui Lake Eco-city (2021-2030)*, the new eco-city will have an area of 47km^2 (see **Figure 10**). The objective is to become a resource-efficient and environment-friendly eco-city. The industrial land will be 199ha (ca. 4.23% of the total area), with mainly environmental industries and innovative industries. Green space and parks is planned to be 642ha, 21% of the area.

8.4.2 Preliminary Assessment of Cumulative Impacts

Preliminary assessment has been undertaken in the environmental assessment of the project, with key findings as follows:

- **Pollution emission:** With closing down and relocation of most enterprises, the future industrial land is only 4.24% of the area, with mainly environmental equipment industries, logistics and non-pollution urban industries. It is expected that pollution emission will decrease.
- **Land use change**: There will be significant change of land use change in the planned eco-city. Industrial land will decrease from 839ha to 199ha, a decrease of 76%. Land for business, green space and residential area will increase. With urbanization and industrialization, there will be no rural farmland in the region.
- **Environment and resource carrying capacity**: preliminary assessment indicates that there is adequate water and land resources carry capacity, as well as enough water and atmospheric environmental capacity in the region to accommodate the future development of the region.
- **Regional hydrology and drainage**: The planned development will not occupy natural river channels, thus will not have significant impact on regional hydrological patterns. While, due to land use change and increased paved ground, there will be certain impacts on rainwater runoff and replenishment of groundwater from precipitation.
- **Regional ecology**: the eco-city construction, especially the creation of Qingshui Lake wetland will bring significant ecological benefits in terms of habitats, biodiversity and aesthetic values, as well as improvement of water quality of Xiangjiang River system.
- **Social impact:** the objective of resource-efficient and environment-friendly eco-city will create a low carbon, beautiful and livable society for local people with significant positive social effects.

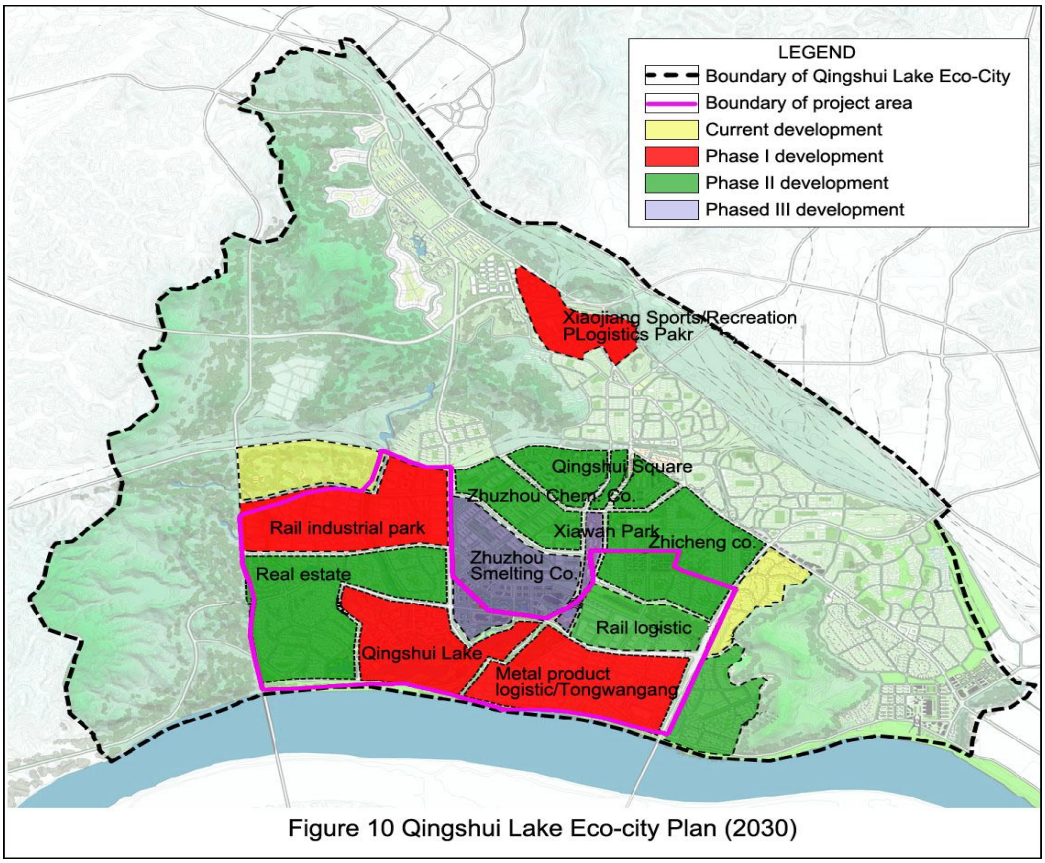

Figure 10 Qingshui Lake Eco-city Plan (2030)

8.4.3 Detailed Induced and Cumulative Impact Assessment

Though preliminary assessment of induced and cumulative impacts assessment was undertaken in the process of project environmental assessment, this assessment is incomplete due to lack of adequate information at this time when relevant city and industrial development plans are being improved and finalized. To address the cumulative impacts in a more scientific and thorough approach, the project will support a second phase detailed cumulative impacts assessment as part of the Technical Assistance program. The study will, based on preliminary assessment, carry out further data collection, research and consultation for a strategic cumulative impacts assessment. A Terms of Reference for this study has been developed, and included in the EMP.

9. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

Public consultation and information disclosure have been conducted following national laws and regulations, as well as World Bank safeguards policies. Two rounds of consultation and information disclosure were carried out during July 2014 – May 2015 through a combination of public meetings, field interviews and questionnaire surveys in the project affected communities.

Prior to consultations, brief project information, environmental impacts and mitigation measures as well as linkage of full environmental impact assessment reports were disclosed through the website of Zhouzhou Municipal Government (www.zhuzhou.gov.cn). Meanwhile, posters were placed in main communities of the project areas. Following the information disclosure, public consultations were conducted among project affected communities, including field interviews, public meetings and questionnaires surveys among the public.

The project received broad support from the public consulted, most of which expressed strong wishes to implement the remediation project to improve the local environment. The key environmental concerns by the public mainly focus on:

- Lack of relevant knowledge;
- Impacts of dust, odor and noise;
- Concerns of potential soil pollution outside the remediation area;
- Wish of relocation of industries out of the area, or relocation of community out of contaminated area, etc.

These public concerns have been given due considerations and responded during the consultation and in the EIA/EMP, including explanation and disclosure of relevant information on-site; development of mitigation measures for dust, odor and dust control; additional clean soil replacement at residential areas outside the remediation area; information on local development plan of industrial relocation etc. All necessary mitigation measures have been incorporated into the project design and the Environmental Management Plans (EMPs).

The full draft EIA report has been locally disclosed on April 27, 2015 at the website of Zhuzhou Municipal Government (http://www.zhuzhou.gov.cn/gk/zwdt/xsqdt/313229.htm).

10. ENVIRONMENTAL MANAGEMENT PLAN

A stand-alone Environmental Management Plan (EMP) has been developed, which specifies environmental management and supervision roles and responsibilities, mitigation measures, contractor management and supervision, environmental monitoring, capacity training programs and EMP budget estimates.

10.1 Roles and Responsibilities

The implementation of the EMP requires the involvement of multi stakeholders (**Figure 11**), each fulfilling a different but vital role to ensure effective environmental management for the project.

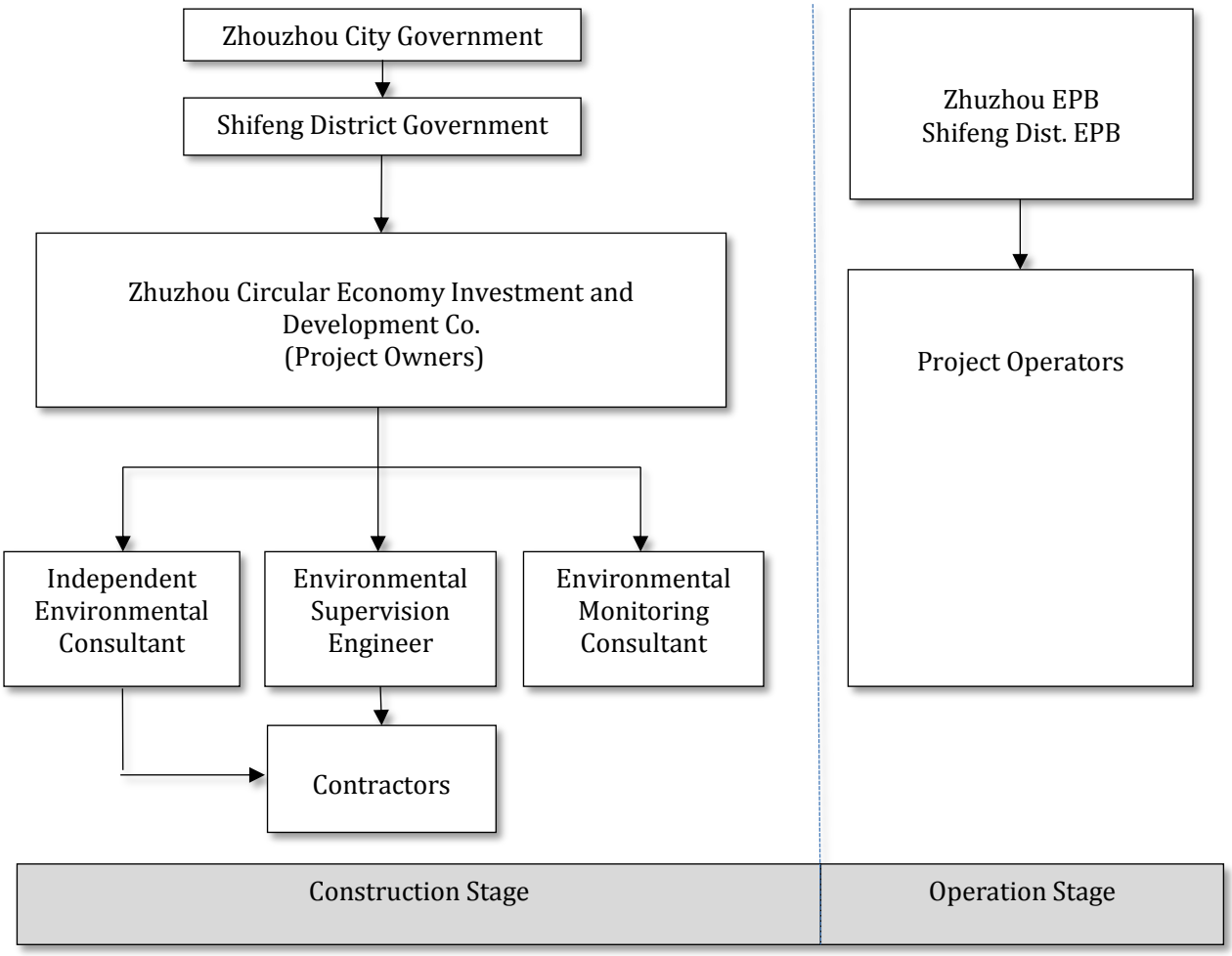

Figure 11 Environmental Management Structure of the Project

The key environmental management roles and responsibilities of each stakeholder is shown in **Table 8.**

Table 8 Key Environmental Management Responsibilities

Stakeholder	Responsibility
Zhuzhou Government /World Bank PMO	• Overall management of EMP implementation; • Ensure environmental supervision requirements be incorporated into supervision contracts; • Supervise the implementation of environmental mitigation measures by contractors; • Entrust external environment consultant to monitor the EMP implementation; • Entrust external environment monitoring institute to monitor ambient environment; • Organize and coordinate safeguards trainings; • Liaison and report to World Bank on implementation of EMP.
Shifeng Dist. EPB	• Governmental supervision and management of environment protection in the project area; • Investigate and resolve public complaints against project • Environmental acceptance upon completion.
Zhuzhou Circular Economy Investment and Development Co.	• Supervise environmental performance of contractors; • Track the EMP implementation progress and report to PMO.
Construction contractors	• Develop detailed environmental management plans for construction; • Implement mitigation measures as contract and EMP; • Conduct public consultation during construction
Environmental Supervision Engineers (ESE)	• The project will have dual supervision arrangement; one on construction supervision, the other on environmental supervision which will monitor the remediation process and ensure required quality standards will be met. • Review design to ensure compliance with EMP requirements; • Supervise the implementation of EMP measures by contractors as per contract requirements and provide guidance; • Verify the effectiveness of contractor's implementation EMP; • Report to project owners about the EMP implementation; • Verify and approve payment based on EMP implementation.
Independent Environmental Consultant (IEC)	• Conduct periodic independent supervision on the environmental performance of contractor and supervision engineers; • Provide recommendations to project owners on improvement of EMP implementation; • Assist PMO to provide environmental report to the World Bank.
Environment Monitoring Consultant	• Conduct environmental monitoring according to the monitoring plan in EMP.
Operators	• Manage the operation of waste treatment facilities and other environmental management works.

10.2 Mitigation Measures

Comprehensive mitigation measures have been developed in the EMP, including detailed measures, generic contractor environmental specifications, water conservation and soil erosion control plan, emergency plan and monitoring plan for cumulative impacts. The key mitigation measures are summarized and illustrated in the **Table 9.**

Table 9 Summary of Mitigation Measures for Construction Stage

Item	Impact/ issue	Mitigation measures	Reference	Implement by	Monitor by	Monitoring indicators	Monitoring frequency
Design Stage							
Land acquisition	Loss of land and house	• Preparation of EAP	RAP	Wuhan University	PMO WB	WB Approval	Before appraisal
Environment impacts	Noise, dust, water and ecological	• Preparation of EIA and EMP	EMP Ch 7 & 8	EA consultant	PMO WB	Zhuzhou EPB, WB approval	Before appraisal
Construction Stage							
Social environment	Traffic and safety	• Traffic diversion plan, safety measures, temporary access roads and signage, and prior notice through mass media; • Coordination with other agencies for proper schedule; • Warning lights installed.	EMP Ch 7	Contractors	ESE, IEC	Environment specifications followed;	Before and during construction
	Cultural relics	• Chance-find procedure in EMP.	EMP Ch 7	Contractors	ESE, IEC	Record of chance-fine	Daily
Ecological environment	Loss of vegetation Soil erosion Impacts on wildlife	• Relocate existing trees/lawns/flower pads; • Limit construction within boundary; • Cutting/backfilling balance; • Timely remove debris and wastes; • Avoid concentrated massive activities in one area; • Avoid rainy day construction; • Posters/bulletins and education of workers; • Punishment on environmental damage behaviors	EMP Ch 8	Contractors	ESE, IEC	Environment specifications followed;	Daily
Acoustic environment	Noise impact	• Enforcement of noise control regulations; • No high-noise activity at night (22: 00~6: 00); Permit and prior notice for nighttime construction; • Low noise equipment with adequate maintenance; • Use commercial cement, no on-site mixing; • Arrange material transportation routes and limit speed; • Proper site layout, time schedule near resident area;	EMP Ch 6 & 7	Contractors	ESE, IEC	Environment specifications followed;	Daily
Air environment	Dust vehicle	• Enclosure walls around construction sites; • Covered transportation and storage of bulk materials	EMP Ch 6 & 7	Contractors	ESE, IEC	Environment specifications followed;	Daily

Item	Impact/ issue	Mitigation measures	Reference	Implement by	Monitor by	Monitoring indicators	Monitoring frequency
	emissions dredging odor	• Wheel washing at exit of construction sites; • Water spraying at construction sites and access roads; • Timely restoration of disturbed land; • Maintenance of vehicles and machines; • Dredging during dry season (winter) with prior notice; • No on-site storage of dredged material; • Personal protection equipment for workers; • Sealed truck for dredging material transportation.					
Surface water environment	Pollution from wastewater	• Initial rainwater collection for demolition site; • Settling tank with oil separation, reuse washing water; • Mobile treatment facility for dredging tail water; • Properly treat construction wastewater; • Chlorination treatment tank for quarry pit water.	EMP Ch 7	Contractors	ESE, IEC	Environment specifications followed;	Daily
Groundwater environment	Waste water from dewatering, storage, S/S site	• Anti-seepage floor design for project facilities; • Anti-seepage design for the constructed wetland; • Ongoing monitoring.	EMP Ch 6	Contractors	ESE, IEC	Environment specifications followed;	Daily
Solid wastes	Garbage and waste soil	• Timely removal of waste; • Covered transportation of waste; • Disposal is designated landfill sites; • No mixing of industrial, domestic and hazardous wastes.	EMP Ch 7	Contractors	ESE, IEC	Environment specifications followed;	Daily
Water and soil loss	Impact on water and soil conservation within the region	• Proper schedule avoiding rainy days; • Adequate drainage; • Time removal of excavated soil; • Timely restoration of disturbed areas with greening plantation; • Carefully plan the balance of earthworks to minimize spoil wastes.	EMP Ch 7	Contractors	ESE, IEC	Environment specifications followed;	Daily
Operation Stage							
Ecological environment	Aesthetics	• Maintenance of landscape, green space, eco-islands	EMP Ch 8	Project owner	Zhuzhou EPB	Monitoring plan	Project completion
Acoustic	Noise	• Low noise equipment, inside building, vibration	EMP Ch 6	Project	Zhuzhou	Environment	Project

Item	Impact/ issue	Mitigation measures	Reference	Implement by	Monitor by	Monitoring indicators	Monitoring frequency
environment	impacts	reduction foundation and installation • Proper layout of S/S site • Proper operation schedule, no night-time operation • Maintenance of equipment • Traffic management, no horning,		owner	EPB	specifications followed; Monitoring plan	completion
Air environment	Odor, dust	• Cover of odor sources and closed building • Tree plantation • Water spraying • Access road maintenance and cleaning	EMP Ch 6	Project owner	Zhuzhou EPB	Environment specifications followed;	Monthly
Water environment	Leachate from landfill, Sewage of environment center	• Anti-seepage design of landfill site; • Leachate collection tank system; • Initial rainwater collection system for project facility sites; • Sewage from environmental center reused and into sewage network.	EMP Ch 6	Project owner	Zhuzhou EPB	Leachate and groundwater Monitoring	Monthly
Solid waste	Garbage	• Municipal garbage collection service.	EMP Ch 7	Project owner	Zhuzhou EPB	Waste cleaned	Monthly
Risk	Secondary pollution	• Water spraying, soil/site and truck cover, wheel washing • Zoning management to avoid cross contamination • Management of used tools/equipment	EMP Ch 9	Project owner	Zhuzhou EPB	Accidents records	Yearly
Social environment	Grievance system	• Establish grievance system with disclosure of info.	EMP Ch 11	PMO	Zhuzhou EPB	Public complaints	Monthly
Cumulative impacts	Cumulative impacts in project region	• Strategic environmental impact assessment planned in the project; • Measures in the city plan; • Best Management Practice to be adopted by Zhuzhou; • Consultation mechanism	EMP Ch 10	Zhuzhou government/ PMO	Zhuzhou EPB	Strategic EA approval.	Yearly
Landfill Closure Stage							
Ecological environment	landscape	• Top soil cover • Vegetation cover plantation	EMP Ch 8	Project owner	Zhuzhou EPB	Vegetation restoration	After closure
Surface /Groundwater	Leachate pollution	• Leachate monitoring program is kept running until stable quality is achieved. • Groundwater monitoring remains long-term.	EMP Ch 6	Project owner	Zhuzhou EPB	Compliance monitoring results	Monthly

10.3 Environmental Monitoring Plan

Detailed environmental monitoring plans have been developed to monitor the soil erosion, noise impact, surface water and groundwater quality and air quality at the at the project sites during project implementation stage. Long-term groundwater monitoring for the landfill site will continue till after the closure of the site. (Details in EMP)

In addition, Zhuzhou EPB will conduct routine monitoring on wastewater and waste gas emission from enterprises (monthly for major industrial pollution sources, and quarterly for normal enterprise), as well as long-term groundwater monitoring at the downstream locations of the operating enterprises.

10.4 Acceptance of Remediation

After site remediation, acceptance check will be conducted by Zhuzhou EPB following the following procedures based on which approval will be granted:

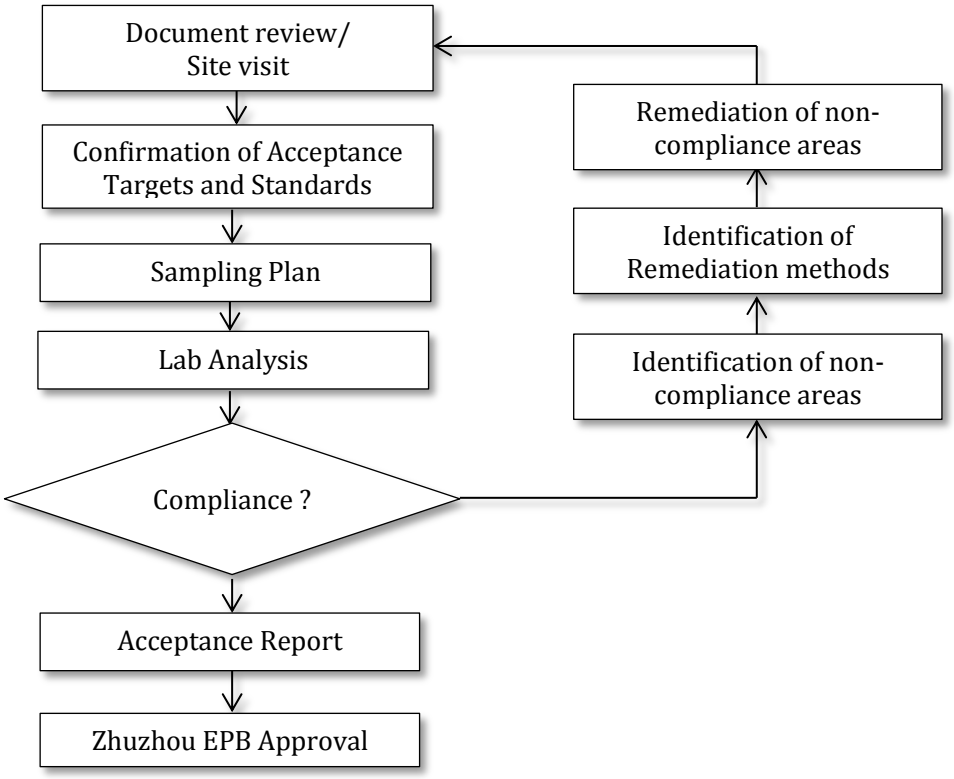

Figure 12 Remediation Acceptance Procedure

10.5 Post-remediation Management

Post-remediation management will be conducted by the project owner, including long-term operation and facility maintenance, monitoring, record keeping and reporting, periodic review and site inspection. Post review and site inspection will be conducted by qualified

entity and reported to local EPB. The first post review and inspection will be conducted after 5 five years of remediation acceptance, based on which the frequency of future reviews will be decided.

10.6 Study on Industrial Pollution Compliance Framework

The project will include a technical assistance on the compliance framework for QIZ environmental quality and industrial pollution control. Outside the project remediation area and in the QIZ, there will be industrial facilities in operation in coming years, notably the Zhuzhou smelter plant. Keep monitoring the industrial emissions and regional environmental quality is needed to ensure their compliance, mitigate the risks of recontamination and protect future development. This study will include, (i) regional groundwater monitoring and modelling, (ii) monitoring of industrial emissions, secondary pollution analysis and data analysis for environmental management. TOR for the study has been agreed during project preparation.

10.7 Environmental Framework for Future Remediation Works

An ESMF was prepared to deal with potential other remediation activities in the project area. The ESMF sets principles, screening, environmental documentation, public consultation and information disclosure, and review requirements for new activities.

10.8 EMP Budget Estimates

Environmental protection budget has been developed and incorporated in project costs including mitigation measures, monitoring and supervision and management costs. It is worth noting that the project itself is an environmental improvement project, a large portion of environment-related cost is integral part of physical works, and could not specifically separated and shown in this table. The total EMP budget estimate for the project is 74,036,900 RMB, about 4.9% of the total project cost. The detailed EMP budget is shown in **Table 10**.

Table 10 EMP Budget Estimate

Item	Measures		Budget (RMB)
Ecological protection, Erosion control	Bush and grass plantation, drainage facility, site restoration		35,948,600
Acoustic environment	Construction	Temporary noise reduction measures	500,000
	Operation	Noise reduction measures	100,000
Air	Construction	Measures (e.g. water spraying)	500,000
		Dust suppressing, sealing packaging and excavation pit cover on organic contamination site	500,000
		PPE for workers	50,000
	Operation	Water spraying, cover	50,000
		Greening at sites	500,000
Surface water	Construction	Rainwater collection tanks for closed enterprises	300,000
		Oil separation settling tank	50,000

Item	Measures		Budget (RMB)
		Mobile wastewater treatment system	2,000,000
		Chlorination treatment tank for quarry pit water	450,000
	Operation	Rainwater collection for S/S and dewatering sites	500,000
		Sewage treatment system for environmental center	1,000,000
		Leachate treatment system for landfill	720,000
Groundwater	Construction	Anti-seepage ground for project facility sites	5,000,000
	Operation	Rainwater collection and anti-seepage design	1,876,600
		Anti-seepage measures for dewatering facilities	1,304,200
		Landfill anti-seepage measures	15,133,100
	Closure	Leachate monitoring	1,250,000
		Site sealing	3,354,400
	Post remediation	Groundwater monitoring	1,800,000
Solid waste	Construction	Recycling of construction waste	500,000
		Landfill disposal	500,000
		Sludge S/S treatment and disposal	50,000
	Operation	Routine garbage collection and disposal	100,000
Total			74,036,900