

E4566 v2 REV

China: Guilin Integrated Environment Management Project

ENVIRONMENTAL IMPACT ASSESSMENT

Executive Summary

JUNE 2014

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1. INTRODUCTION

This document summarizes the potential environmental and social impacts of the proposed Guilin Integrated Environment Management Project. It highlights the key environmental and social safeguards issues related to the project construction and operation, describes the main findings and conclusion of impact assessment, and summarizes main mitigation measures to avoid, minimize, mitigate and compensate adverse impacts.

The project is located in Guilin city, northeast of Guangxi Zhuang Autonomous Region (GZAR) in southwest of China. Following the success of previous Guangxi Urban Environment Project (GUEP) which focused on improving the water quality of the Lijiang River and its tributaries in Guilin, the World Bank is cooperating with GMG in this proposed project to further improve the water and sanitation service in Guilin. The proposed Guilin Integrated Environment Management Project will support water supply, wastewater water treatment, sludge management, and water quality monitoring and pollution management system.

Considering its potential environmental and social impacts, this project is classified as a Category A as per OP4.01. The following World Bank safeguards policies are triggered: (1) OP4.01 Environmental Assessment, (2) OP4.04 Natural Habitats; (3) OP4.12 Involuntary Resettlement.

Environmental impact assessment (EIA) reports have been prepared for individual components, based on which a Comprehensive Environmental Assessment (CEA) is developed by Guangxi Environmental Science Institute (GESI), a certified EA institute with recent experience in other World Bank projects in the region. Based on the findings and recommendations of the EIA reports, a stand-alone Environmental Management Plan (EMP) has been developed. The preparation of EAs and EMP followed the relevant laws and regulations of China, World Bank safeguards policies, as well as EHS guidelines, with comments and guidance from the World Bank task team.

2. PROJECT DESCRIPTION

The overall development objective of this proposed project is to improve water and sanitation services in Guilin. It includes five inter-related components supporting the project development objectives:

- **Component 1: Water Supply.** This component will allow the water supply system to meet the growing demand by domestic consumers, commercial and industrial enterprises. It will include: (i) installation of about 37 km of drinking water mains and distribution pipelines; (ii) construction of a booster pumping station with a capacity of 40,000 m³/day to supply water to the residents in the vicinity of the Liangjiang Airport; (iii) purchasing of monitoring and inspection equipment for pipeline inspection; (iv) establishment of a management information system (MIS) platform for the comprehensive water supply operation.
- **Component 2: Wastewater Management.** The component focuses on reducing discharge concentrations from Guilin's Waste Water Treatment Plants (WWTPs). It will include: (i) upgrading and renovation of facilities of five existing WWTPs to meet higher level of discharge standards, odor control and sludge dewatering; (ii) replacement of aged equipment of existing 20 sewage/storm water pumping stations and additional odor control facilities; (iii) rehabilitation of ca. 40km sewer networks and construction of 12km sewer networks; (iv) procurement of monitoring and maintenance equipment.
- **Component 3: Sludge Management.** The component will establish a sludge management plant (composting facility with a capacity of 130 tons/day, and a solar drying facility with a capacity of 20 tons/day) to treat all sludge from existing WWTPs.
- **Component 4: Water Quality Monitoring and Pollution Management.** This component will include: (i) strengthening the water quality monitoring system in Guilin; (ii) establishing a pollution sources management system; (iii) piloting a pollution source analysis of Lijiang River (urban stretches).
- **Component 5: Project Management and Supervision.**

Among these components, Component 4 and Component 5 only support technical assistance and capacity building activities, therefore, have no environmental and social safeguards issues envisaged. The detailed physical activities of Component 1, 2 and 3 are listed in the following **Table 1**.

The location of the project is shown in Figure 1.

Table 1 Detailed Project Activities of Component 1, 2 and 3

Project Component		Activities
Water Supply		<ol style="list-style-type: none"> 1. Construction of 37km water supply pipelines 2. Construction of a new booster pumping station with a capacity of 40,000 m³/day
Wastewater Management	Upgrading of existing WWTPs	<p>Shangyao WWTP, Qilidian WWTP and Beichong WWTP:</p> <ol style="list-style-type: none"> a) Replacement of screen, grit chamber equipment, sludge scrapper assembly; b) New advanced treatment facility (cloth filter + UV) to reach Class 1A effluent standard; c) New dewatering equipment to achieve 60% water content; d) Sealing of influent pump room, fine screen, grit chamber, biological reaction tank, sludge dewatering system and odor collection and treatment facility. <ol style="list-style-type: none"> 2. Yanshan WWTP: <ol style="list-style-type: none"> a) New advanced treatment facility to reach Class 1A effluent standard; b) Sealing of influent pump room, fine screen, grit chamber, biological reaction tank, sludge dewatering system and odor collection and treatment facility; 3. Lingui WWTP: <ol style="list-style-type: none"> a) Sealing of biological reaction tank and odor collection and treatment equipment.
	Upgrading of existing pumping stations	<ol style="list-style-type: none"> 1. Replacement of pumps, screens, valves and flow meters, installation of odor treatment system and upgrading automatic control system for 18 sewage and 2 storm water pumping stations.
	Renovation of sewage pipelines	<ol style="list-style-type: none"> 1. Rehabilitation of 40km existing sewage pipelines; 2. Construction of 14km sewage pipelines in Lingchuan Balijie community and old town area of Lingui
Sludge Management		<ol style="list-style-type: none"> 1. Construction of a central sludge management plant, including composting facility with a capacity of 130 tons/day, and a solar drying facility with a capacity of 20 tons/day, to treat all sludge from existing WWTPs in Guilin. The specific location of the plant will be identified during the project implementation stage.

3. REGULATORY AND LEGAL FRAMEWORK

The Environmental Impact Assessment (EIA) was conducted in accordance with Chinese EIA laws/regulations and the World Bank safeguards policies.

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 2.

Table 2 Compliance with Key China Domestic Laws and Regulations

China Laws and Regulations	Project Compliance
<i>Environmental Impact Assessment Law</i>	<ul style="list-style-type: none"> EIA prepared by licensed EIA consultant, reviewed and approved by local environmental protection agency.
<i>Classified Directory for Environmental Management of Construction Project</i>	<ul style="list-style-type: none"> Individual EIAs have been prepared according to proper classification
<i>Interim Measures for the Public Participation in Environmental Impact Assessment</i>	<ul style="list-style-type: none"> Two rounds of public participation conducted in surrounding villages/towns, and info disclosure through website of Guilin Municipal Government.
<i>EIA Technical Guidelines on Atmospheric Environment (HJ/T2.2-2008), Surface Water Environment (HJ/T2.3 -93), Noise Impact Assessment (HJ/T2.4-2009), Ecological Environment (HJ/T19-2011).</i>	<ul style="list-style-type: none"> Impact assessment follows the technical requirements of these guidelines

Key applicable discharge standards in China

Table 3 Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant (GB 18918-2002)

Effluent Discharge Standards (mg/l)	Class IA	Class IB	Class II
COD	50	60	100
BOD ₅	10	20	30
SS	10	20	30
Oil	1	3	5
Petroleum	1	3	5
anionic surfaceactive agent	0.5	1	2
TN	15	20	-
NH ₃ -N	5	8	25
TP	0.5	1	3
Color (dilution times)	30	30	40
pH	6-9	6-9	6-9
Coliforms (n/l)	10 ³	10 ⁴	10 ⁴
Ambient Air Quality at Borders of WWTP (mg/l)			
NH ₃	1.5		

H ₂ S	0.06
Odor (dilution times)	20

Table 4 Emission Standards for Odor Pollutants (GB14554-93) - Class II

Parameters	Standards	Application
NH ₃ (mg/m ³)	1.5	Wastewater (pumping stations and sewer network), Sludge management 20
Odor (dilution times)	20	
H ₂ S (mg/m ³)	0.06	

Table 5 Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008) - Class II

Class	Daytime	Nighttime	Applicable Projects
Class II	60 dB	50 dB	Water supply (water supply network), wastewater (WWTP, pumping station, sewer network), sludge management

Key Applicable Ambient Quality Standards in China

Table 6 Environmental Quality Standards for Surface Water (GB3838-2002) (Partial)

Parameters	Class III (mg/L)		Class IV(mg/L)	
NH ₃ -N ≤	1.0	XiaoTaipinghe River (Lingui WWTP), Tributary of Taipinghe River (Sludge management project)	1.5	Taohuajiang River (Beichong WWTP), Lijiang River (Qilidian WWTP), Nanwan River (shangyao WWTP), Liangfeng River (Yanshan WWTP)
TP	0.2		0.3	
TN	1.0		1.5	
SS	30		60	
DO ≥	5		3	
COD ≤	20		30	
COD _{mn} ≤	6		10	
BOD ₅ ≤	4		6	
Coliforms	10000		20000	

World Bank Safeguard Policy Requirements

Of the ten safeguards policies, the following are triggered: 1) OP4.01 Environmental Assessment; and 2) OP4.04 Involuntary Resettlement. In addition, the World Bank/IFC Environmental, Health and Safety General Guidelines (EHS Guidelines), and sectoral EHS Guidelines for Waste Management Facilities and Guidelines for Water and Sanitation are applied during the preparation of the project and the EIA.

4. ENVIRONMENTAL AND SOCIAL BASELINES

4.1 Natural Environment

Location

The project city of Guilin is located in the northeast of Guangxi Zhuang Autonomous Region, at the south end of China. Guilin is a world famous scenic tourist city and a famous historic and cultural city. The geographic extent of Guilin municipality is between E109°36'~111°29' and N24°15'~26°23'.

Topography

Guilin is located at the southwest of Nanling Mountain system, and in the basin surrounded by the mountain ridges with an altitude of more than 1,000m, like Yuecheng Mountain, Haiyang Mountain, Jiaqiao Mountain and Tianping Mountain, etc. The topography is low and flat, and tilts slightly from the north to the south generally; and the ground altitude is 140~160m. In the urban area, there are two major of landforms, namely karst landform and fluvial landform. The main landform is plain, accounting for 65% of the total area of Guilin, followed by mountains (30%) and hills (5%).

Meteorology

Guilin City is located in the north of the Tropic of Cancer, and belongs to subtropical warm and humid monsoon region. According to the data provided by Guilin Weather Station, Guilin has a multi-year average rainfall of 1,917mm and evaporation of 1,949mm. The annual average temperature is 18.8°C, with highest temperature of 39.4°C and lowest -4.5°C. The average relative humidity is 75.8%. The average wind speed is 2.6m/s (max. 31.9m/s), with a prevalence direction of WNW.

Hydrology and Hydrodynamics

The main rivers in Guilin include the Lijiang River, Taohua River, Xiangsi River, Yijiang River, Dajiang River, Jinbao River, and Dayuan River, etc., all of which belong to Xijiang River Water System in the Pearl River Basin. The rivers are of 692.97km in total length, and cover a total catchment area of 3,971.09km². The main regions belong to the Lijiang River Basin, while some parts belong to the Liujiang River Basin. The annual runoff and the annual total rainfall of the rivers in the whole city are 16.958 billion m³ and 9.2 billion m³ respectively, and these rivers are the main source of water supply for surface water and underground water. The total quantity of water resources in the whole city is 12.072 billion m³.

Lijiang is the major river and the tourist attraction in Guilin. The total length of Lijiang River within Guilin municipality is 116km, including 40km in urban area; and the upstream catchment area is 2,860km². The annual average rainfall is 1,897mm, the maximum flow rate is up to 7,800 m³/s, and the annual average flow rate is 128 m³/s. In the Lijiang River

Basin, there are sufficient rainfall and water yield, but there are great differences of rainfall and flow rate in rainy season and dry season. Upstream area is among the central-west rainstorm areas in Guangxi Province, where multi-year average rainfall is above 2,000mm with flood period of March ~ August, especially in May and June. With average sediment content of 0.020~0.091kg/m³, Lijiang River is among the clearest rivers in Guangxi.

Ecological Environment

Within Guilin municipality, there are 1,516,500 ha forests with 1,500 kinds of plants. The forest coverage rate is 61.08%. There are a variety of wild animals that are mainly distributed in the remote mountainous areas of Guilin.

The proposed project activities are all within the urban and suburban areas of Guilin, where there is no natural habitat and wildlife affected. In urban area of Guilin, the total greening area is 1,930ha, the greening coverage ratio is 35.1%, and the per capita public green space is 6.1m². The tree species are all common species, including Osmanthus, camphor tree, Cinnamomum pedunculatum Nees, Ligustrun lucidum Ait, Chinese scholar tree, paulownia fortunei, chinaberry, wild jujube, and Chinese tallow tree, etc., which are mainly from city nursery garden.

The upgrading of existing WWTPs will either be inside the boundary of existing plants or occupy nearby farmland. There is no sensitive ecological environment affected. Given the positive impacts of the project to river systems in the project area, OP4.04 is triggered.

4.2 Socio-economic Context

Guilin has a total population of 4.98 million, including 0.9 million in the urban area. There are five districts (Xiangshan, Xiufeng, Diecai, Qixing, Lingui and Yanshan) and 12 counties (Yangsuo, Lingchuan, Xing'an, Quanzhou, Ziyuan, Guanyang, Longsheng, Yongfu, Pingle, Gongcheng and Lipu). Average population density is close to 200 /km². In 2012, the urban area of Guilin achieved a GDP of RMB149.205 billion, per capita GDP reaching RMB29,960/a. Urban residents' per capita disposable income was RMB22,300, in which the per capita net income of rural farmers was RMB7,328. The urbanization rate is 41.8%.

Tourism is a main revenue resource of Guilin. The total tourism income in 2012 was RMB27.687 billion, with a total of 13.61 million tourists. The number of tourists has been increasing at an average rate of 12% over the past few years.

4.3 Water Supply, Drainage and Sludge Disposal Planning

Water Supply Plan

According to draft Water Supply Plan of Guilin (2013-2020), it's estimated that, by 2020, Guilin will have had a population of 1.2 million, and a maximum water supply demand of 583,100m³/d. Considering the actual operation ability of these four existing water

treatment plants, Guilin will have a water supply gap of 181,300~206,900 m³/d by 2020. To address this water shortage, Guilin is implementing an expansion of Chengbei Water Treatment Plant, increasing its capacity from 100,000m³/d to 300,000m³/d, which is expected to be in operation in early 2014. The proposed installation of 37km water distribution network (transmission main) will link the newly expanded Chengbei WTP to Lingui District and other cluster areas in the south and west of Guilin. It is consistent with the overall urban development plan and the water supply plan.

Related activity and due diligence review

As a water source for the Bank-funded pipeline, the expansion of Chengbei WTP is considered as an associated project to the Bank-funded project. Due diligence review has been conducted for the expansion of Chengbei WTP. The expansion of Chengbei WTP includes water intake facility (200,000m³/d) and water treatment plant (200,000m³/d) besides the existing intake and treatment plant, as well as ancillary pipeline and facilities. Environmental impact assessment has been prepared for the expansion of Chengbei WTP which includes adequate assessment of potential environmental impacts and proper mitigation measures to avoid, minimize and mitigate the adverse impacts. This EIA has been approved by Guilin Environmental Protection Bureau (EPB) in November 2012 and is found satisfactory by the WB. The construction of this project is expected to be completed by January 2018. As a linkage project, its land acquisition and resettlement has been covered by the Resettlement Action Plan of this Bank funded project. Therefore, it is concluded that expansion of Chengbei WTP will not result in un-manageable environmental and social impacts and it is fully in compliance with national laws/regulations, thus will not pose a potential reputational risk to the Bank-funded pipeline network project.

Drainage Plan

At present, there are five WWTPs in Guilin, including Qilidian, Beichong, Shangyao, Shangyao and Yanshan WWTPs. By the end of 2012, the total capacity is 415,000m³/d. According to the drainage plan and the Feasibility study for Guilin Integrated Environmental Management Project, the total amount of sewage within the catchment of the sewage systems in 2020 is predicted to be 381,900t/d. Therefore, it concluded that the present sewage treatment capacity is sufficient to meet the future demand in 2020.

However, there are problems for the existing WWTPs that can not provide effective treatment of wastewater and protection of water quality of Lijiang River. These include:

- **Relatively low standard adopted in original design:** the existing WWTPs basically adopt Class IB standard of *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant*, some older ones even adopt Class II standard. Due to the importance of Lijiang River, Guilin government requires all WWTPs to meet highest (IA) discharge standard, which basically is stricter on SS, TN and TP (see Table 3) .
- **Nuisance of odor problem.** These existing WWTPs were mostly constructed on urban fringe areas few decades ago. However, with rapid urbanization process and expansion of urban area, these WWTPs are increasingly surrounded by residential areas.

Therefore, it's necessary to adopt measures to reduce their environmental impacts, in particular control of odor nuisance.

- **Aged equipment.** Most WWTPs have operated for more than 10 years, some even more than 20 years, many facilities have been severely aged, and have resulted in higher energy consumption, lower efficiency and poor reliability.
- **Poor dewatering efficiency of sludge.** The existing WWTPs basically employ direct sludge thickening, and the resulted sludge has high water content (average 82%~85%). This brings difficulties for sludge transport and disposal.

Sludge Management Plan

According to the statistical data provided by Guilin Drainage Company, the total quantity of sludge generated from existing WWTPs in 2012 is 157m³/d (82.6% water content). In order to find a way to dispose of the sludge, Guilin city has constructed a high-temperature aerobic composting sludge disposal plant inside the existing Shangyao WWTP in December 2009. The treatment capacity is 120m³/d (dewatered sludge with water content of 80%). After composting, the sludge meets the national standards of land application in terms of dry sludge content, health and heavy metal indicators (the heavy metal contents of sludge is also well below that of US federal standards for land application), and is used as soil conditioner in forest lands and urban landscaping.

The existing sludge treatment plant has a semi-open design. This makes odor collection, water washing, and ion deodorization system ineffective and caused fairly serious environmental impacts on ambient environment. It also occupies the reserved land of Shangyao WWTP, which prevents the future expansion of the WWTP to accommodate increase of sewage.

Based on statistics, the total amount of sludge generated from existing WWTPs in Guilin is 122.75m³/d (82.6% water content). It is estimated that by 2020, the total sludge amount generated from WWTPs will be 175m³/d (80% water content). Therefore, Guilin is planning to construct a new sludge management plant (with capacity of 130m³/d composting and 20m³/d solar drying). The specific location of the proposed sludge management plant is to be determined during the project implementation stage. Before the construction and operation the newly proposed sludge management plant, the existing sludge management plant within Shangyao WWTP will remain operation.

4.4 Environmentally and Socially Sensitive Receptors

During EA preparation, detailed survey of environmentally and socially sensitive sites within in the area of influence has been conducted through field investigation and consultation with local agencies and communities. It is concluded that there is no special protected area, ecological sensitive area, natural habitat and physical culture resources within the area of influence of the proposed project.

The sensitive sites in the vicinity of the project are residential communities, schools, kindergartens and hospitals near the WWTPs, pumping stations and new water supply pipelines. The retrofit of existing sewers will use non-excavation pipeline lining technology through existing manholes, therefore, has little social disturbance. The list sensitive sites identified during EA preparation are included in the EA and the EMP to guide implementation.

4.5 Ambient Environmental Quality

Source of information include routine monitoring by local EPB, discharge testing at the WWTPs and WTP, and site monitoring conducted during EIA preparation.

Wastewater Management Component

Ambient Air Quality

Ambient air quality (NH₃, H₂S and odor) was monitored around the existing five WWTPs and a few pumping stations. The testing results show that NH₃, H₂S and odor at boundaries of these WWTPs and pumping stations are 0.025 – 0.625mg/m³, 0.001-0.042mg/m³ and 10-19 respectively, in compliance with the Class -II standard for WWTPs (see Table 4).

Surface Water Quality

Water quality monitoring of five receiving rivers for the existing five WWTPs was carried out during EA process. Samples were collected from both upstream and downstream of the discharge outlets. Parameters analyzed include temperature, SS, COD, BOD₅, DO, permanganate index, ammonia nitrogen, TN, TP and coliform.

The monitoring results show that all the rivers can not meet their function zoning standards, with some parameters exceeding applicable standards. These standards-exceeding parameters are mostly organic pollutants, i.e. ammonia nitrogen, TN, TP and coliform, as well as COD and BOD₅, resulting from domestic sewage and agricultural surface-sourced pollution. Most sewage treatment plants are located at urban-rural fringe areas, and the sewage discharge outlet is affected by agricultural irrigation, livestock farms and farmhouse restaurant business in the surrounding areas.

Ambient Noise

Ambient noise monitoring was conducted at the borders of all existing WWTPs and a few sewage pumping stations. The monitoring results show that the noise level at all WWTPs boundaries can meet the *Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008)*. While, the noise level at two pumping stations can not meet this standard.

Water Supply Component

Ambient noise monitoring was conducted around the border of the proposed site for the new Airport Road pumping station and at two nearby communities (50m and 80m away respectively). The current land use of this site is farmland. The noise monitoring results are 46.3 – 56.9dB for daytime and 40.9-44.6dB for nighttime, which are in compliance with relevant standards.

5. 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:

5.1 With/Without Project

With/Without project scenarios were compared, with main consideration of environmental and social perspectives. Without project, water supply, wastewater treatment and sludge management in Guilin will remain as “status quo”. The water supply network can not fully cover the new urban areas. The existing WWTPs are being operated with low efficiency aged facilities, and their effluents can no longer meet the new discharge standards required by national regulations. The odor nuisance is becoming more and more serious public concerns with expansion of new urban residential areas around the WWTPs. The sludge dewatering facilities in existing WWTPs are inefficient, and current composting plant has simple equipment with inadequate design and has serious impacts on ambient environment. Existing sewer network has serious leakage problems due to aged pipelines, and can not serve the new areas of urban expansion. Therefore, it is absolutely necessary and timely to implement the proposed project, which will secure the water supply to support urban development, increase wastewater collection and treatment efficiency to protect ecological environment, especially the water quality of Lijiang River.

5.2 Water Supply Component

The main alternatives considered for water supply component are the choice of disinfection agent. The commonly used disinfectants include liquid chlorine, bleaching powder and chlorine dioxide. The comparison of two disinfectants, i.e. liquid chlorine and chlorine dioxide, is considered and shown in Table 7.

Table 7 Comparison of Two Disinfectants: Liquid Chlorine and Chlorine Dioxide

Type	Liquid chlorine	Chlorine dioxide
Advantages	<ol style="list-style-type: none"> 1. Has sustained disinfection effect as that of residual chlorine. 2. Low price of raw materials and less operating costs. 3. Simple operation and accurate dosage. 4. No need of large facility 	<ol style="list-style-type: none"> 1. Good disinfection effect. 2. No secondary pollution during the disinfection process. 3. Small footprint, fully automatically running, safe and reliable.
Disadvantages	<ol style="list-style-type: none"> 1. Chlorine is toxic and attention to safety must be paid when using. 2. Absorption device for leaking chlorine gas is needed. 3. Produce disinfection by-products and cause secondary pollution. 	<ol style="list-style-type: none"> 1. Chlorine dioxide is harmful to human bodies, but it is produced online and once it is leaking, the system will stop running automatically. 2. Needs to be kept in dark places with good ventilation.

Because Guilin Water Supply Company has many years of experiences in using liquid chlorine as disinfectant, and has well established operation management and safety procedures, therefore, it is suggested to use liquid chlorine as disinfectant of the pump station.

5.3 Wastewater Management Component

Advanced Wastewater Treatment Process

Three options for advanced treatment process have been studied, i.e.:

- (1) Option 1: Secondary effluent + direct filtration + disinfection
- (2) Option 2: Secondary effluent + coagulation/sedimentation + filtration + disinfection
- (3) Option 3: Secondary effluent + coagulant sedimentation + filtration + activated carbon adsorption + disinfection

Given the the limited land in the plant, Beichong WWTP, Shangyao WWTP Phase I and II and Qilidian WWTP Phase I shall adopt direct filtration process. While, the land for the upgrading of Yanshan WWTP is abundant, the coagulation – sedimentation – filtration process shall be used.

Phosphorous Removal Process and Agents

According to the biological dephosphorization principles and operational experiences of WWTPs, the biological denitrification and dephosphorization process can remove 1.5~2.0mg/L of phosphorous under normal functioning of the wastewater treatment plant, and to enable the phosphate (measured by P) in effluent of the wastewater treatment plant to reach the Class IA discharge standard (<0.5mg/L) steadily, chemical dephosphorization must be used.

Three mineral salts could be used to remove phosphorous: calcium salt, iron salt and aluminum salt. Through comprehensive considerations of technical and environmental factors (especially potential soil structure impact of land application), the polyaluminium chloride (PAC) is recommended as the chemical agent for phosphorus removal.

Odor Removal Process

Four methods were comprehensively compared in terms of technology and application, including chemical absorption, reactive oxygen ionization, biological filter and liquid nebulization. In terms of the chemical absorption process, because its raw materials are NaOH and H_2SO_4 , the dangerous goods warehouses that have high firefighting and explosion-proof requirements are needed, it is not suitable to be established in the existing WWTPs. The biological filtration process has a big footprint, with difficulties in operation and management and high operating costs. The liquid atomization and reactive oxygen ionization processes are suitable for deodorization of moderate- and low-concentration smelly gases and can overcome

the difficulties of the above processes well. However, the liquid atomization process needs to purchase working liquid regularly from a single procurement source, which is not good for operating management of the plant. In summary, the project intends to adopt the reactive oxygen ionization process for odor removal.

5.4 Sludge Management Component

Disposal Options of Treated Sludge

Five sludge disposal options were compared, including: direct land application; dewatering + landfill; incineration; use as construction material; composting + land application. Pros and cons of these five options were considered, and at last, the composting + land application is considered as a main disposal approach given the current situation in Guilin, with consideration of incineration as future options and landfill disposal as an emergency backup option. Sludge composting has the advantage of low cost, reduced volume and weight, reuse of nutrients and mature operational experience of existing sludge plant in Guilin. The composted sludge meets various standards for land application, i.e. the heavy metal contents of the treated sludge is well below the national standards, as well as the US federal standards for land application. Therefore, it is safe to apply the composted sludge in urban landscaping. However, with concerns of long-term accumulation impacts of heavy metals, the treated sludge will not be allowed for fertilizing farming crops in any case.

Based on this conclusion, four detailed technical schemes were considered, including:

- (1) Sludge from WWTP (80% water) – composting in sludge management plant – land application in forest land/urban landscaping;
- (2) Sludge from WWTP (80% water) – drying in sludge management plant to achieve 40% water content – landfill disposal (or incineration in the future)
- (3) Advanced dewatering in WWTP to 60% water content - composting in sludge management plant - land application in forest land/urban landscaping options;
- (4) Advanced dewatering in WWTP and solar drying to 40% water content – landfill or incineration.

Through feasibility study among these technical options, the (3) and (4) options are found to be appropriate as main solutions for near and mid-term in Guilin.

Central vs. Separate Treatment

Through technical renovation and upgrading, dewatering efficiency in the WWTPs will be increased from 80% water content to 60%. Following this, two options for further treatment were considered:

- (1) Separate treatment: further drying with solar energy at each WWTP separately, followed by land application and landfill disposal;
- (2) Central treatment: all sludge will be sent to a central treatment facility for composting and drying.

The separate treatment has the advantage of cost saving and less risk on sludge transportation, however, it will require large land area in existing WWTPs which is prohibitively not available under the current situation, while, the central treatment requires less investment and management staff. With availability of proper plant site, the environmental risk of sludge disposal can be adequately managed. Therefore, the central treatment option is selected.

Alternatives of Composting Processes

Three technical technologies were considered for composting, including:

- (1) Open air windrow composting
- (2) Composting cells: including sun-roof cell method and closed tunnel cells
- (3) Dano drum composting

With overall consideration of investment, odor control and process management, the composting cells process was selected.

Sludge Drying Options

Partial sludge will be further dried to achieve 40% water content for incineration or landfill disposal. Two sludge drying options were considered, including:

- (1) Solar drying technology
- (2) Drying using conventional heating sources

Using conventional energy sources will require large investment on equipment and expensive operating cost. While, solar drying technology - given the availability of land - is more environmental-friendly with benefits of energy saving and emission reduction. It also requires less investment and will significantly reduce the operating costs. Therefore, solar drying technology is selected.

Locations of Sludge Management Plant

The feasibility study concluded that a new sludge management plant will be constructed, with composting facility of a capacity of 130 tons/day, and a solar drying facility with a capacity of 20 tons/day, to treat all sludge from existing WWTPs in Guilin. However, the location of the new sludge management plant was not finally determined during the project preparation stage. It is planned that detailed site selection will be finalized during the project implementation stage, for which site-specific environmental impact assessment will be conducted following the framework procedures defined in the EIA.

6. ASSESSMENT OF IMPACTS

As an environmental enhancement effort, the project will have significant positive environmental and social benefits by providing safe drinking water to the public, improving efficiency of existing WWTPs and sewer network, and safely managing the sludge problem. It will reduce the total pollution load discharged into the Lijiang River, thus contribute to maintaining the water environment, crucial for this world-class tourism city of Guilin. However, there will be potential adverse environmental and social impacts during the project construction and operation stages. These manageable impacts include:

Table 8 Potential Impacts during Construction and Operation

Potential Environmental and Social Impacts during Construction	Potential Environmental and Social Impacts during Operation
<ul style="list-style-type: none"> • Land acquisition and resettlement • Construction nuisance of dust and noise • Construction wastewater and sewage • Construction spoil and solid waste management • Soil erosion • Loss of surface vegetation • Traffic disturbance • Health and safety 	<ul style="list-style-type: none"> • Compliance of wastewater discharge from WWTPs; • Proper sludge management; • Odor management of WWTPs • Noise of WTP, WWTPs and pumping stations • Risk of accident in WWTPs • Health and safety • Cumulative impacts

These impacts are carefully assessed in EIA and Resettlement Action Plan (RAP), and adequate measures have been developed in EMP/RAP. In summary, the project will not have significant adverse environmental and social impacts, will not result in significant degradation or conversion of natural habitat, will not have significant impact on any physical cultural resource. The mitigation measures have been developed in the EMP, which can effectively avoid, minimize, mitigate or otherwise compensate the potential environmental and social impacts.

6.1 Impacts during Construction Stage

6.1.1 Impacts of Land Acquisition and Resettlement

This project needs to use 38.2mu (2.6ha) national construction land, and requires permanent acquisition of 5.3mu (0.06ha) rural land, with total 5 families (24 people) affected. During construction stage, the project will need temporarily occupy 103.44mu (6.9ha) national land of roads. There will be demolition of 400m² non-residential building, with one family (4 people) affected.

To address land acquisition and resettlement, Project Management Office (PMO) has prepared a Resettlement Action Plan (RAP) to address involuntary resettlement impacts caused by project constructions following the relevant Chinese laws/regulations and World Bank *OP 4.12 Involuntary Resettlement*. The RAP also covers the associated project of

expansion of Chengbei WTP funded by domestic funding sources. A Resettlement Policy Framework (RPF) has also been prepared to address potential involuntary resettlement for pipeline network construction during the implementation stage.

6.1.2 Impacts of Wastewater

During construction, there will be limited amount of wastewater generated from construction site cleaning, slurry from pipe-jacking, cement production and sewage from workers. The main pollutants of construction wastewater are suspended solid (SS) and small amount of oil. Without proper collection and treatment, randomly discharged wastewater water at construction site will have adverse impacts on environment and community.

6.1.3 Impacts of Dust

A major environmental impact of construction of pipelines, pumping stations and WWTPs is construction dust, mainly from earth excavation, on-site storage, backfilling and secondary dust from material/waste transportation. Based on survey statistics from similar construction projects, main dust source is the dust from transportation vehicles (ca. 60% of total dust). Under normal weather condition, the dust from construction site and transportation roads may have impact scope of 100m.

For the proposed project, construction activities in the existing WWTPs are relatively far from residential areas, with green space surrounding the sites, thus the impact is relatively small. However, the construction of pipelines along the urban streets will have larger dust impact on the nearby sensitive receptors.

6.1.4 Impacts of Noise

Construction noise mainly comes from construction machines and transportation vehicles. Noise impact scope is estimated, based on empirical statistics, within 22m during the day and 190m during the night time. Similar to dust, new pipeline construction will have the most noise issue.

6.1.5 Impacts of Solid Waste

Solid waste during construction mainly comes from excavated spoil, debris from building demolition, construction debris of sand/aggregate/cement, as well as garbage generated by construction workers.

It is estimated that about 58,000m³ construction waste (spoil, sands, construction materials etc.) will be generated from the project construction. If not properly managed, such waste will cause significant impact on urban environment and community life, as well as aesthetic beauty of Guilin city as a world-class tourism destination. Similarly, the

garbage from construction workers is also of particular concern, and may have similar adverse impact on the city.

6.1.6 Impact of Soil Erosion

Earth excavation activities in the project will disturb the original land surface, and if not well managed, will cause soil erosion problems during rainy season. The upgrading of existing WWTPs will have limited soil erosion problem as all construction activities are within the existing WWTPs, and soil erosion impacts can be well contained and managed. The construction of water supply pipelines will excavate soil at a large scale and scatter along longer routes in the city.

6.1.7 Impact of Ecological Environment

The new construction of the Airport Road pumping station will change the current land use of the project sites. Currently, the land of proposed Airport Road pumping station is agricultural farmland, without presence of natural habitat. Land use has been intensively modified by human agriculture activities for long history. Therefore, no significant ecological impact is envisaged.

Extensive greening is planned for the WWTPs, sludge management plant and along the routes of water supply/sewer pipelines upon completion of civil works, which will restore the loss of urban green spaces during construction.

6.1.8 Health and Safety

During construction period, if wastewater is randomly discharged and garbage is not well contained, or puddles not well drained, they may cause increase of vectors such as flies and mosquitoes and result in increase of infectious diseases. Increase of labor force may also increase the opportunities of infections.

In addition, construction activities will also pose potential health and safety hazards, e.g. construction noise may damage hearing ability of workers and dust may affect respiratory system of workers. Operation of construction machines, vehicles and tools is of particular concern for vocational safety, e.g. operation of heavy equipment like excavators, bull dozer and crane etc., use of electricity, fire hazards etc.

6.1.9 Traffic and Social Disturbance

Construction activities of the project will have adverse impact on urban traffic and community accessibility due to construction of pipelines and transportation of material/spoils. Though pipelines can be laid section by section, there will be temporary excavation at certain sections, and soil/materials be temporarily stored on-site which will affect road traffic and disturb the community accessibility. In particular, when the pipelines traverse urban roads, there will be larger traffic disturbance if open excavation method is used. As

an alternative to open excavation, pipe-jacking can be used for such sections. While, this will also require restriction of heavy load vehicles during pipe-jacking operation. According to experiences, pipeline crossing roads will require a time period of ca.20 days during which road traffic will be affected.

6.2 Impacts during Operation Stage

Operation of WWTPs and associated pumping stations and pipelines will have impacts on residents and the surrounding environment, such as odor from aeration, sedimentation and sludge condensation tanks, and noise from pumps. More potentially serious concerns include impacts from sludge treatment and outflow from the WWTP in cases of malfunction or failure.

6.2.1 Wastewater Treatment Plants and Sewage Pumping Stations

Wastewater Discharge

To ensure compliance of effluent discharge, complete operation procedures have been developed and enforced. Monitoring of water quality at various process steps will be conducted. Routine maintenance of WWTP and pipelines will be carried out following the procedures to ensure good operation condition of WWTPs. In addition, on-line monitoring equipment have been installed at the discharge outlets of these WWTPs to continuously monitor the water quality effluent discharge, with real-time data transmission to Guilin EPB. In cases of black-out or operation failure, see section on risk of WWTP operation.

Sludge Management

The sludge produced from these WWTPs will continue to be sent to the existing sludge management plant for central composting, and final composted sludge is used for urban green space plantation. However, this existing sludge management plant within Shangyao WWTP site does not have adequate odor control system, and thus poses adverse impacts on ambient environment and surrounding communities. Though ambient air quality monitoring at the boundary of the plant indicates general compliance (approaching the standard thresholds), it is becoming clear that this existing sludge plant can not meet future demand and ensure public acceptability in the long-term. To ensure high-efficient and environmental friendly sludge treatment, a new sludge management plant is planned to be constructed under the project. The location of the plant is to be determined during the implementation stage. The final product of sludge compost will be only used for urban landscaping purpose, and will not be used for farmland application to fertilize crop plants due to concerns of long-term cumulative impacts of heavy metals.

Solid Waste

The solid waste from WWTPs includes solid waste from screen and grit chamber, dewatered sludge and limited garbage from management staff. Inadequately dewatered sludge may pose potential risk of spills and leakage during transportation. More long term

impacts come from the final disposal of treated (composted and sun-dried) sludge. This will have adverse impacts on environment, and pose health risk to the general public due to pathogens contained in the sludge, and potential pollution transfer from sludge to soil and water environment if not disposed of properly.

Air Emission and Odor Control

Odor nuisance is a major issue for the operation of WWTPs. Organic matters will decompose to generate odor gases under anaerobic condition, with main contents of NH_3 and H_2S . The main sources of odor include screen, grit chamber, aeration tank, sludge thickening tank, sludge dewatering house and storage tank.

The project will install sealing equipment and odor gas collection/treatment system in the existing WWTPs, to collect fugitive odor emission from various processes of pump room, screen, grit chamber, biological reaction tank and sludge dewatering system. Through analysis of a number of odor removal technologies, oxygen ionization technology is selected in these WWTPs.

Furthermore, extensive trees, bushes and lawns have been planted within the WWTPs to further absorb and mitigate the odor impacts.

According to monitoring of ambient air quality at the boundaries of all the existing WWTPs, the current odor level is in compliance with applicable standards, but very close to the standard limits at certain plants. Therefore, it is envisaged that, upon completion of the project, the odor impact of these WWTPs will be further reduced and will be fully in compliance with applicable standards.

Noise

The main noise sources of WWTPs are pumps, air compressors and wind blowers. These equipment are installed inside buildings. With noise insulation and reduction measures adopted for the building sealing and equipment installation, the noise level will be significantly reduced.

For the existing WWTPs, the noise level from operation of existing WWTPs is confirmed to be in compliance with relevant standards by actual monitoring of ambient environment. Based on EIA analysis, upgrading and renovation in these WWTPs will not result in increase of noise level around the boundary of the plants.

Health and Safety

The operation of WWTPs may pose health and safety risks to the workers in the plant. The major safety risk is the presence of toxic gases, such as H_2S , CH_4 and CO_2 , inside treatment facilities (e.g. pipes and tanks during). In case of equipment breakdown or routine maintenance, workers may need to enter these facilities and thus expose to potential safety

risks. Experiences have shown that presences of toxic and flammable gases inside sewers have caused a number of accidents in other cities in China. The workers inside WWTPs and sludge management plant are also exposed to potential contamination of pathogens in the sewage, sludge and moistures.

To address vocational health and safety issues, all WWTPs have established vocation health and safety plans as per requirement of national laws/regulations. These plans defined specific requirements for safety risk identification, precautions measures, personal protection equipment requirements, and emergency response plans.

Environmental Risk of WWTPs Operation

The potential environmental risks for WWTPs operation mainly include accidents of WWTPs (e.g. power-off, equipment breakdown, or natural disasters), and sudden change of influent water quality (e.g. significant overload of pollution load or contamination from industrial wastewater).

Accidents of power-off, equipment breakdown or other unexpected natural disasters may cause the decrease of treatment efficiency or even stop of the WWTP. In this case, large amount of untreated wastewater will have to be directly discharged through bypass pipelines into the receiving water bodies.

Sudden fluctuation of inlet, especially from mis-discharge of industrial sources into the sewer system, may decrease the activity of sludge or cause sludge bulking, and thus result in lower treatment efficiency and standard-exceeding discharge.

6.2.2 Water Supply Component

The main environmental concern of the water supply component during operation stage is the noise impact of the pumping stations, especially the new Airport Road Pumping Station. To minimize noise impact, the pumping station is designed as a sealed building, with adoption of noise absorption materials to reduce the noise impact. In addition, low noise equipment will be selected, and noise/vibration reduction measures will be adopted for installation of equipment. Based on modeling calculation, the noise level at the border of the pumping stations is in compliance with the applicable standard.

6.2.3 Cumulative Impacts

The key content of the project is to upgrade the wastewater treatment facility in the existing WWTPs to achieve a higher discharge standard, i.e. from Class 1B and Class 2 to Class 1A, as per *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant (GB 18918-2002)*. Therefore, upgrading and renovation will result in net reduction of total pollution load discharged over the long term. According to estimation, upon project completion, the total pollution load discharged into Lijiang River system will be reduced by

1270.5t/a of COD, BOD₅ and SS respectively, 381.15t/a of NH₃-N, 635.25t/a of TN and 63.53 t/a of TP.

7. PUBLIC CONSULTATION AND DISCLOSURE

Public consultation and information disclosure have been conducted following the national laws and regulations, as well as World Bank *OP4.01 Environmental Assessment*. Two rounds of consultation and information disclosure were carried out during January – March 2014 through a combination of public meetings, field interview and questionnaire survey in the project affected communities.

In total about 460 project affected people participated in the consultation. The project received a broad support from the public consulted who expressed strong wishes to speed up this environmental improvement project. The key environmental concerns by the public are mainly related to dust and noise impact, and construction site management during construction stage. These concerns have been adequately addressed in the EIA through development of mitigation measures, and will be closely supervised during construction period.



Figure 2 Public Consultation Meeting

For the sludge management component, consultations have been conducted for a proposed plant location within an existing landfill. However, there was a broad objection from the nearby villages. Therefore, the final selection of the sludge management plant site is postponed to the implementation stage. An environmental management framework is developed in the EIA to guide the environmental assessment process for the selected site.

Information disclosure has been conducted along with the consultation. A summary of information disclosure is shown in the following table.

Table 9 Summary of Information Disclosure

Date	Information Disclosed	Locations
2013.11.13	Project contents and environmental impact assessment information	Websites of Guilin Municipal Construction Bureau and Guilin Development and Reform Commission
2014.1	Individual EIA reports for each component	Website of Guilin Development and Reform Commission Posters in each project affected communities
2014.2	Consolidated EIA Report	Websites of Guilin Development and Reform Commission and Guilin Drainage Company
2014.3	Environmental Management Plan	Websites of Guilin Development and Reform Commission and Guilin Drainage Company

8. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

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

8.1 Roles and Responsibilities

The main responsibilities of various stakeholders are summarized in the following table.

Table 10 Key Environmental Management Responsibilities

Stage	Stakeholder	Responsibility	Staff
Design and preparation	PMO	1. Overall implementation of EMP	2
	Project Owner	1. Implementation of environmental measures in design and preparation stage; 2. Secure fund resources for EMP implementation; 3. Liaison with relevant government authorities for environmental management related matters; 4. Hire supervision companies.	3
	Design Institute	1. Incorporate environmental measures into design and budget; 2. Incorporate mitigation measures into technical specifications of bidding documents.	2
	EIA Consultant	1. Provide environmental input to design; 2. Prepare EIA; 3. Develop EMP.	4
	Local EPB	1. Review and approve EIA, ensure EMP funding availability	2
Construction	Project owner	1. Environmental management of construction, and provide funding resources; 2. Manage and supervise the EMP implementation; 3. Track the EMP implementation progress and report to local government and the World bank; 4. Receive, investigate and handle and public complaints.	3
	Contractor	1. Implement mitigation measures as per bidding documents, contract and EMP; 2. Receive supervision and guidance from project owner, environmental supervision engineers and local governments.	2
	Supervision Engineer	1. Supervise the implementation of EMP measures by contractors as per contract requirements; 2. Support project owners to fulfill environmental management work.	4
	Environment Monitoring Institute	1. Conduct environmental monitoring according to the monitoring plan in EMP; 2. Conduct ad hoc monitoring upon request of project owners.	
	Local EPB	1. Random inspection to construction sites on implementation EMP measures; 2. Conduct environmental management according to reports of PMO and project owners; 3. Receive and handle public complaints	2

Stage	Stakeholder	Responsibility	Staff
Operation	Project Owner	<ol style="list-style-type: none"> 1. Environmental mitigation measures and monitoring plan during operation stage; 2. Ensure environmental management incorporated into routine operation management; 3. Provide environmental training to staff; 4. Prepare emergency response plan and organize drills. 	2
	Environment Monitoring Institute	<ol style="list-style-type: none"> 1. Conduct monitoring upon request of project owner. 	
	Local EPB	<ol style="list-style-type: none"> 1. Conduct final inspection for commissioning; 2. Conduct routine supervision and monitoring on the operation of WWTPs and sludge management plants. 	2
	Urban Planning Bureau	<ol style="list-style-type: none"> 1. Control the land use within safety distance designated for WWTPs and sludge management plant. 	1
	Public	Society supervision	

8.2 Mitigation Measures

Mitigation measures have been developed for each component covering the full cycle of project preparation, construction and operation stages. The development of mitigation measures follows the national laws/regulations, technical guidelines and construction norms, with references to previous similar project experiences and World Bank safeguards policies and *Environmental, Health, and Safety General Guidelines*, *Environmental, Health, and Safety Guidelines for Water and Sanitation*, and *Environmental, Health, and Safety Guidelines for Waste Management Facilities*.

The key mitigation measures are summarized in the following Table 11. For the detailed mitigation measures, please refer to the separate EMP.

Table 11 Summary of Key Mitigation Measures of EMP

Stage	Activities/Impacts	Mitigation/Prevention Measures	Implement by*	Supervisors *
Design Stage	Feasibility study (FS) site selection and layout	<ol style="list-style-type: none"> 1. Comparison of alternatives; 2. Design environment and safety facilities together with engineering facilities; 3. Include the budget of environment measures into project investment 	FS consultant	EIA Units; FS Approval Departments; Guilin City WSC;
	Bidding and contract management	<ol style="list-style-type: none"> 1. Incorporate EMP into detailed design, and bidding documents; 2. Training plan for contractor and supervision before construction; 3. Environment mitigation measures included in the contractors contract; 	Guilin City WSC, Guilin City WDC and bidding agents	Guilin City WSC and Guilin City DC
Construction Stage	Water pollution of construction activities	<ol style="list-style-type: none"> 1. Strengthen, save water and reduce generation of wastewater; 2. Sedimentation tank will be built at excavation site, recycle as much as possible; 3. Minimize living facilities to reduce sewage, random discharge is prohibited; 4. No construction garbage/waste may be dumped into nearby rivers. 	Contractor	Construction Supervisors, Local EPAs
	Air pollution from excavation, fill and exhaust gas emission of construction organizations	<ol style="list-style-type: none"> 1. Temporary fences will be installed around the excavation site; 2. Suspend construction in heavy windy days; 3. Sprinkle water regularly to suppress dust; 4. Properly handle loading and unloading of spoil and cement to minimize dust; 5. Covered vehicles used for bulk materials transportation with speed control; 6. Properly cover or fence the site such as cement storage yard; 7. Timely removal of spoil generated on the same day; 7. Properly arrange construction schedule to shorten the construction period; 8. Reuse waste soil as much as possible, or timely disposal in landfill. 	Contractor	Construction Supervisors, Local EPAs
	Solid waste pollution from earthwork, transportation and disposal of waste soil, generation of living solid waste	<ol style="list-style-type: none"> 1. Develop waste disposal and transportation plan to prevent solid waste from scattering along streets; 2. Waste building materials will be sorted and recycled as much as possible. 3. Waste building materials will be sent to designated landfills; 4. Spoil waste will be reused as backfill as much as possible, and additional waste will be sent to landfills assigned by local authorities. 	Contractor	Construction Supervisors, Local EPAs
	Noise pollution	<ol style="list-style-type: none"> 1. Use low-noise equipment will be adopted; 2. No honking during night transportation; 3. strengthen environment protection education on constructors; 4. Properly arrange schedule of construction to minimize noise impact on sensitive receptors; 5. No noise construction during school hours and exam times near schools; 	Contractor	Construction Supervisors, Local EPAs

Stage	Activities/Impacts	Mitigation/Prevention Measures	Implement by*	Supervisors *
		5. No nighttime constructions adjacent to hospitals/residential areas; 6. Measures such such as elastic cushions, acoustic shields etc.		
	Soil erosion	1. Avoid large-scale earth excavation and backfill in rainy seasons; 2. Recover temporary land occupation in a timely manner. 3. Timely clear and transport waste spoil. 4. Proper construction process and temporary erosion control measures.	Contractor	Construction Supervisors, Local EPAs
	Population health	1. Carry out disinfection and simple sedimentation treatment regarding sanitary wastewater and faeces generated by constructors; 2. Carry out deinsectization, mosquito eradication and other environment health work, and implement individual labor protection; 3. Workers in strong noise construction sections should wear earplugs to reduce noise nuisance.	Contractor	Construction Supervisors, Local EPAs
	Social impact	1. Properly arrange construction to minimize traffic disturbance; 2. Temporary access roads secured for public; 3. Avoid transporting materials in peak traffic hours to reduce traffic impact; 4. Set up bulletin boards in construction sites with information of project contents, time of construction, contact persons and complaint hotline, etc.; 4. Coordinate with police for diversion plan; 5. Strengthen construction management and training on contractors; 6. If any cultural relic is found, the construction must be suspended, the site must be preserved, local cultural relics preservation departments must be timely informed, and the excavation may not be resumed before the completion of cultural relic identification and protection.	Contractor	Supervision engineers, city management unit of Guilin, local EPAs, local cultural relics departments and police
Operation Stage	Operation of water supply pipelines	1. Periodically flush water supply pipelines to clear away sediments; 2. Work out detailed risk prevention and emergency plans;	Guilin City WSC	Local EPAs and surrounding communities
	Maintenance of water drainage pipelines	1. Regularly clean sewer lines to remove grease, coarse sand and other debris; 2. Regularly check conditions for repair or maintenance; 3. Emergency preparedness measures to prevent wastewater from entering into the storm drain-off system.	Guilin City Water Draining Company	Local EPAs and surrounding communities
	Effluent compliance of WWTPS	1. Develop and enforce complete WWTP operational procedures; 2. On-line monitoring of effluent discharge and real-time transmission to EPB	Guilin City Draining Company	Local EPAs
	Odor and air pollution from WWTPs	1. Timely transport sludge after dewatering and reduce the stock of sludge; 2. Strengthen control of the fermentation of sludge in concentration tanks; 3 Spray deodorant over source of pollution to suppress odor;	Guilin City DC	Local EPAs, surrounding communities,

Stage	Activities/Impacts	Mitigation/Prevention Measures	Implement by*	Supervisors *
		4. Strengthen afforestation, cultivate protection forests along plant boundaries; 5. Coordinate with planning department to restrict residential buildings within the protection distance.		
	Treatment of sediment, precipitated sand and sludge in plants	1. Sludge will be sent to the sludge disposal center for disposal; 2. Rain roof and seepage-proof ground be used for temporary sludge storage sheds, with cofferdams, drainage ditches and collection wells; 3. Closed tank trucks should be adopted for outward transportation of sludge;	Guilin City DC	Local EPAs,
	Noise of WWTPs operation	1. Use low-noise equipment and noise-insulation buildings; 2. Green belt plantation around WWTPs and pumping stations; 3. Regular noise monitoring at boundaries	Guilin City DC	Local EPAs surrounding communities
	Health and safety of WWTP operation	1. Develop and enforce operation procedures for health and safety measures; 2. Develop emergency response plan and conduct regular drills 3. Enforce health and safety training programs;	Guilin City DC	Local EPAs, safety supervisory department of Guilin

*For the table above and tables below, WSC=Water Supply Company; DC=Drainage Company; EPAs=environment protection agencies.

8.3 Environmental Monitoring Plan

Environmental monitoring plan has been developed to monitor the ambient environmental quality and pollution discharges during construction and operation stages. Project owners will hire licensed environmental monitoring institute to conduct monitoring, and provide the monitoring results to local EPBs and the World Bank.

The monitoring plans for three components are summarized in Table 12- Table 13. For more details, please refer to the separate EMP document.

Table 12 Monitoring Plan for Water Supply Component

Stage	Item	Locations	Parameters	Frequency	Budget (RMB yuan)
Construction (2 years)	Air	13 sensitive sites along pipelines	TSP	4times/year, 2d/time, once per day	12,480
	Noise	13 sensitive sites along pipelines	Leq dB (A)	4times/year, 1d/time, twice per day (day and night)	12,480
Operation (3years)	Noise	Tangjia Village and Yaohe Rongyu Community	Leq dB (A)	4times/year, 1d/time, twice per day (day and night)	2,880
Total (RMB)					27,840

Table 13 Monitoring Plan for Wastewater Management Component

Facility	Stage	Item	Locations	Parameters	Frequency	Budget (RMB yuan)
WWTPs	Construction (2 years)	Air	Boundary of WWTPs, and sensitive sites	TSP	4times/year, 2d/time, once per day	48,960
		Noise	Boundary of WWTPs, and sensitive sites	Leq dB (A)	4times/year, 1d/time, twice per day (day and night)	
	Operation (3years)	Air	Boundary of WWTPs, and sensitive sites	H ₂ S, NH ₃ , and odor	4times/year, 1d/time, four samples per day	988,770
		Water	Discharge outlet of each WWTP	pH, DO, COD, BOD ₅ , NH ₃ -N, TP, TN, SS, Oil, Petroleum, color,	4times/year, 2d/time, once per day, except COD (on-line)	

				coliform		
		Noise	Boundary of WWTPs, and sensitive sites listed in Table 4.	Leq dB (A)	4times/year, 1d/time, twice per day (day and night)	
		Sludge	Sludge tank	As, Hg, Pb, Cr, Cd, Cu	2 times/year, 1d/time, once a day	
Pump Stations	Construction (2 years)	Noise	Boundary of 20 pump stations	Leq dB (A)	4times/year, 1d/time, twice per day (day and night)	38,600
	Operation (3years)	Air	Qingfeng, Mantoushan and Pingshan stations	H ₂ S, NH ₃ , and odor	4times/year, 1d/time, four samples per day	152,640
		Noise	Boundary of 20 pump stations	Leq dB (A)	4times/year, 1d/time, twice per day (day and night)	
Total (RMB)						1,228,970

8.4 Environmental Training Plan

Environmental capacity training is part of technical assistance of the project, which will be provided to environmental management and supervision staff in PMO, project owners, contractors, supervision engineers. An environmental training plan has been developed in EMP as shown in Table 14.

Table 14 Environmental Training Plan

Target Group	Content	Persons	Duration (days)	Budget (RMB)
Contractors	Environmental protection laws/regulations/guidelines; Mitigation measures in the EMP; EHS Guidelines;	2 persons per construction team	4	300,000
	Self-monitoring of EMP implementation;	2 persons per construction team	1	
Supervision Engineer	Environmental protection laws/regulations/guidelines; Mitigation measures in the EMP; EHS Guidelines; Detailed rules of environmental	1-2Persons per supervision team	1	80,000

	supervision			
	Monitoring technology and methods	1-2Persons per supervision team	1	
PMO/Project Owners/ Operational Companies	Environmental protection laws/regulations/guidelines; EMP measures for operation; Monitoring plan; Emergency responses plan; Reporting requirements	TBD	3	720,000
Total		/	10	1,100,000

8.5 Environmental Reporting

Contractors, operators, monitoring institutes, supervision engineers and PMO shall prepare environmental reports concerning the project progress, EMP implementation, environmental monitoring results and report to relevant government authorities and the World Bank. The purpose of such reporting is to ensure the effective implementation of EMP mitigation measures, identify any inadequacy or problems at early stage in order to implement timely remedial action, and learn experiences/lessons to guide future works.

The main reporting requirements are as follows:

- 1) Project environmental supervision engineers will provide weekly and monthly report to project owners and PMO on the EMP implementation. The reports shall include actual implementation environmental protection measures by the contractors and environmental monitoring results;
- 2) Contractors/operators will report their own project progress and EMP implementation status and report to project owners/PMO, copied to local EPB;
- 3) Monitoring institute will provide reports on environmental monitoring to project owners/operators and supervision engineers;
- 4) Project owners/operators shall provide environmental monitoring reports to PMO and Guilin EPB in a timely manner;
- 5) In case major violation of environmental protection laws/regulations, the supervision engineers and PMO shall report to Guilin EPB or even higher authority if necessary;
- 6) PMO shall submit semi-annual environmental progress report to the World Bank, which shall include (but not limited to):
 - a) Project progress;
 - b) Actual implementation of EMP mitigation measures, any problems and remedial actions or plans; Implementation of environmental monitoring plan and key results;
 - c) Any public complaints (records, resolution and public feedback);
 - d) Implementation of training
 - e) Implementation plan for next half year

9. ENVIRONMENTAL AND SOCIAL FRAMEWORK FOR SLUDGE MANAGEMENT PLANT

9.1 EIA Framework for the Sludge Management Plant

As the location of the newly proposed sludge management plant will be determined during the project implementation stage, site specific environmental impact assessment can only be started once the final site is confirmed.

According to *Catalogue of EIA Classification for Construction Project (MEP No.2)* and *OP4.01 Environmental Assessment*, full environmental impact assessment shall be conducted for this new sludge management plant (a Category A project as per OP4.01), and approved by both national authority and the World Bank.

To ensure environmental and social safeguards issues related to the new sludge management plant to be fully addressed, the following EIA framework is developed and to be followed for the site selection and subsequent environmental impact assessment for the plant.

Site Selection Criteria

The site selection for the proposed sludge management plant shall be subject to the following criteria:

- (1) The site is not within any level of protected area, i.e. drinking water source protection area, nature reserve, scenic area, ecological function protection area, basic farmland protection area, key area of soil erosion control, forest park, geological park, world heritage site, protected cultural property etc.;
- (2) The site location is in compliance with *Guilin Urban Master Plan (2010-2020)*, *Guilin Land Use Master Plan (2013-2020)*, and *Master Plan for Lijiang Scenic Area (2006-2025)*;
- (3) The site is not in area of severe water shortage, habitats of rare wildlife, spawning sites fish resources, important wetland, natural fishery waters;
- (4) The site is far away from dense populated area, cultural and education area, area with dense institutions, recreational area and hospital etc.;
- (5) Preferably with utility infrastructure, e.g. water supply and sewage networks;
- (6) It shall not locate in the area that local communities express broad disagreements as part of public consultation process.

EIA Procedures

The preparation, approval and implementation of the EIA shall follow the following framework procedures:

Table 15 Framework Procedures for EIA of Sludge Management Plant

EIA Procedures	
Step 1:	PMO shall engage experienced EA consultant to develop EIA/EMP report as per national laws/regulations and World Bank safeguards policy requirements; As an integral part of EA preparation, public consultation and information disclosure will be conducted following the OP4.01 requirements for Category A project.
Step 2:	The EIA/EMP report shall be reviewed and commented by environmental specialist of the World Bank task team;
Step 3:	The EIA/EMP report shall be reviewed and approved by Guilin EPB;
Step 4:	The EIA/EMP (in both English and Chinese) shall be submitted to the World Bank for clearance;
Step 5:	Implementation of EMP.

Implementation and supervision of EMP for the sludge management plant will be under the overall environmental management system of the whole World Bank project, i.e. Guilin Drainage Company is directly responsible for EMP implementation under the management and supervision of PMO. The implementation, supervision and reporting will be consistent with the main project.

9.2 Resettlement Policy Framework

Given the un-determined location of the new sludge management plant, and possible changes of water supply and sewer pipelines, a Resettlement Policy Framework (RPF) has been developed to guide the preparation of Resettlement Action Plan where it is deemed necessary.

The RPF is developed based on requirements of World Bank OP4.12. It specifies detailed procedures requirements for resettlement action plan preparation, implementation procedures, budgeting, consultation and information disclosure, grievance mechanisms and monitoring.

For details, please refer to the separate document of *Resettlement Policy Framework*.