

**Environmental Impact Assessment Report**

**For**

**Changzhi Sustainable Urban Transport Project**

**E2858 v3**

**Shanxi Academy of Environmental Sciences**

**Sept, 2011**

# TABLE OF CONTENT

<b>1. GENERAL .....</b>	
1.1 PROJECT BACKGROUND .....	1
1.2 BASIS FOR ASSESSMENT .....	2
1.3 PURPOSE OF ASSESSMENT AND GUIDELINES .....	4
1.4 PROJECT CLASSIFICATION .....	5
1.5 ASSESSMENT CLASS AND COVERAGE .....	6
1.6 IDENTIFICATION OF MAJOR ENVIRONMENTAL ISSUE AND ENVIRONMENTAL FACTORS.....	8
1.7 ASSESSMENT FOCUS .....	1
1.8 APPLICABLE ASSESSMENT STANDARD .....	1
1.9 POLLUTION CONTROL AND ENVIRONMENTAL PROTECTION TARGETS .....	5
<b>2. ENVIRONMENTAL BASELINE .....</b>	
2.1 NATURAL ENVIRONMENT.....	3
2.2 SOCIAL ENVIRONMENT .....	13
2.3 URBAN TRANSPORTATION .....	16
2.4 RELEVANT TRANSPORTATION PLANS .....	18
<b>3 PROJECT DESCRIPTIONS.....</b>	
3.1 PROJECT DESCRIPTION .....	23
3.2 MAJOR PROJECT COMPONENTS .....	23
3.3 INTEGRATED CORRIDOR IMPROVEMENT .....	24
3.4 PUBLIC TRANSIT SUPPORTING INFRASTRUCTURE.....	51
3.5 INTELLIGENT URBAN TRANSPORT MANAGEMENT SYSTEM .....	56
3.6 INSTITUTIONAL CAPACITY DEVELOPMENT.....	56
3.7 SCHEDULES OF PROJECT CONSTRUCTION .....	57
3.8 TRAFFIC VOLUME PROJECTION .....	57
<b>4 COMPARISON OF ALTERNATIVES.....</b>	
4.1 COMPARISON OF “WITH” AND “WITHOUT” PROJECT SCENARIO .....	66
4.2 ANALYSIS OF SITE SELECTION FOR PARKING LOT AND BUS DEPOTS .....	68
4.3 COMPARISON OF BUS LANE ALTERNATIVES.....	69
4.4 COMPARISON OF FUEL AT GAS STATION .....	72
4.5 COMPARISON OF ROAD SELECTION .....	72
<b>5 ENVIRONMENTAL IMPACT AND ITS MITIGATION AND CONTROL</b>	
<b>MEASURE .....</b>	
5.1 DESIGN PHASE.....	74
5.2 ENVIRONMENTAL IMPACT MITIGATION MEASURE DURING CONSTRUCTION PHASE .....	74

5.3 ENVIRONMENT IMPACT AND POLLUTION CONTROL MEASURE DURING OPERATION PHASE .....	87
---	----

**6 ENVIRONMENTAL MANAGEMENT PLAN ..... 11**

6.1 OBJECTIVES .....	112
6.2 ENVIRONMENTAL MANAGEMENT INSTITUTIONS .....	112
6.3 ENVIRONMENTAL SUPERVISION PLAN .....	114
6.4 SUMMARY OF MITIGATIONS .....	115
6.5 ENVIRONMENTAL MONITORING PLAN .....	121
6.6 CAPACITY BUILDING .....	125
6.7 PUBLIC COMPLAINING PROCEDURES .....	126
6.8 REPORTING PROCEDURES .....	126
6.9 COST ESTIMATION FOR ENVIRONMENTAL MANAGEMENT .....	127

**7 PUBLIC CONSULTATION AND INFORMATION DISCLOSURE .....129**

7.1 GUIDANCE AND PRINCIPLES .....	129
7.2 OBJECTIVES .....	129
7.3 METHOD, TIMING AND CONTENT .....	129
7.4 RESULTS ANALYSIS OF PUBLIC CONSULTATION .....	135
7.5 INFORMATION DISCLOSURE .....	137
7.6 CONCLUSION.....	138

**8 CONCLUSIONS AND RECOMMENDATIONS ..... 139**

8.1 BENEFIT OF THE PROJECT .....	139
8.2 ENVIRONMENTAL QAULTY CONDITION .....	139
8.3 ENVIRONMENTAL IMPACT ANALYSIS DURING CONSTRUCTION PHASE.....	139
8.4 ENVIRONMENTAL IMPACT ANALYSIS DURING THE OPERATION PHASE.....	140
8.5 ENVIRONMENTAL MANAGEMENT AND MONITORING .....	140
8.6 PUBLIC CONSULTATION .....	140
8.7 CONCLUSION.....	141
8.8 SUGGESTION .....	141

**APPENDIX 1 NEWSPAPER ADVERTISEMENT FOR INFORMATION**

**DISCLOSURE .....**

# **1. General**

## **1.1 Project background**

### **1.1.1 Project background**

Changzhi is located in the southeast part of Shanxi Province. It is surrounded by Taihang Mountain, and Changzhi is acknowledged as a gifted place. In recent years, rapid development has seen in its social, economic and cultural aspects, the urban development of Changzhi has also accomplished. In 2004, Changzhi was named one of the Ten Charming Cities in China; later in 2006, it was named National Garden City. As the first city awarded such titles in Shanxi Province, it is also leading in integrated city management and 'green' development. However, the private vehicle ownership in Changzhi is growing rapidly, leading to severe emissions, safety, congestion and other negative impacts.

It has been well recognized that the roadway capacity expansion can not catch up with the growing private vehicle demand, the Municipal Government of Changzhi (MGC) has established "Suggestions of urban development master plan and integrated transportation master plan for Changzhi", "Plan of public transport development for Changzhi", "Study of traffic safety and its management and monitoring for Changzhi" under the aid from GEF China Urban Transport Partnership Project. This project is proposed based on the GEF project, and financially supported by World Bank. The successful completion of this project could improve the efficiency of transportation in the city, improve the public travel method, and promote traffic safety and green idea into the city development. Overall, it is very important for the sustainable development of Changzhi.

### **1.1.2 Objective of EA**

Based on the requirement from "The environment protection law of the people's republic of China", "Law of the People's Republic of China on Environmental Impact Assessment" and "Ordinance on administration for environmental protection of construction projects", the project impact on the environment need to be assessed and the environmental impact assessment report needs to be prepared. In July 2011, Changzhi project management office engaged Shanxi Academy of Environment Sciences (SAES hereafter) for carrying out the environmental impact assessment of this project. After receiving engagement, the SAES primarily organized relevant staff to conduct field investigation and collection of relevant information. Public consultation and information disclosure were also conducted. The SAES also communicates with related units and departments on the feasibility study of this project. In accordance with related national policy, instruction and regulations, approved by Changzhi Environmental Protection Bureau about the applicable standards on environment quality and pollution control, the SAES finished the draft for 'Environment Impact Assessment Report for the Changzhi Sustainable Urban Transport Project' and the Environmental Management Plan.

## **1.2 Basis for assessment**

### **1.2.1 Major basis**

(1) Engagement for “Environmental assessment impact report for Changzhi Sustainable Urban Transport Project”, Project management office, July 20th, 2011.

(2) Standards for “Environmental impact assessment for Changzhi Sustainable Urban Transport Project”, Environment protection Bureau of Changzhi city, # 480, 2011.

### **1.2.2 Laws, policies and regulations**

- (1) “Law of the People’s Republic of China on Environmental Protection”, December 1989.
- (2) “Law of the People’s Republic of China on Environmental Impact Assessment”, September 2003.
- (3) “Law of the People’s Republic of China on Land Management”, August 2004.
- (4) “Law of the People’s Republic of China on Environmental Protection from Atmospheric Contamination”, April, 2000.
- (5) “Law of the People’s Republic of China on Environmental Protection from Water Contamination”, 28 February 2008.
- (6) “Enforcement Regulations for Law on Prevention of water Pollution of the People's Republic of China”, March, 2000.
- (7) “Law of the People’s Republic of China on Environmental Protection from Noise Contamination”, 1 March 1997.
- (8) “Law of the People’s Republic of China on Environmental Protection from Contamination by Solid Wastes”, 1 April 2005
- (9) “Law of the People's Republic of China on Conserving Energy”, Oct, 2007
- (10) “Law of the People's Republic of China on the Protection of Cultural Relics”, Oct, 2002.
- (11) “The Law of the People’s Republic of China on Soil and Water Conservation”, 29 June 1991.
- (12) “Implementation of the Law of the People's Republic of Soil and Water Conservation”, Aug 1<sup>st</sup>, 1993.
- (13) Administration of Construction Project Environmental Impact Assessment by Means of Classification Catalogue, Sept 2<sup>nd</sup>, 2008.
- (14) “Management Regulations on Environmental Protection of Construction Project”, 253# [1998] Decree of the State Council.
- (15) Regulations on “Grading Approval for Environmental Impact Assessment Documents of Construction Project”, Nov 1<sup>st</sup>, 2002.
- (16) “Temporary Method of Public Participating in Environmental Impact Assessment”, the Ministry of Environmental Protection, 14 February 2006.
- (17) “Management Method of Environmental Protection of Traffic Construction Project”, 2003, 5# Decree of Minister of Transport.
- (18) “Program of National Ecological and Environmental Protection”, 38# November 2000.

- (19) Decision of the State Council on “Several Issues Concerning Environmental Protection”, Aug 1996.
- (20) Notice on “Enhancing management of land use for protection of cultivated land” , # 11, 1997.
- (21) Notice on implementation of “Decision of the State Council on Several Issues Concerning Environmental Protection” for Shanxi Province, 1997 #1, Shanxi.
- (22) Notice on implementation of “Opinions on outlines for ecological and environmental protection” , Provincial government of Shanxi, # 45, Shanxi Province, Dec 2001.
- (23) “Environmental Protection Regulation of Shanxi Province”, July 1997.
- (24) “Protection and Control Regulation for Atmospheric Contamination of Shanxi Province”, 3 December 1996.
- (25) “Management plan of surface watershed for Shanxi Province”, May 2005.
- (26) Notice on disclosure of “Environmental protection management plan for construction project” and its appendix, Environmental protection agency of Shanxi Province, #193, 2002.
- (27) “Implementation methods of Public Participation for Environmental Impact Assessment, State agency for Environmental Protection” , Feb 14<sup>th</sup>, 2006.
- (28) “Opinions on Environmental noise protection and improve the environmental acoustic quality of cities”, 144#, Minister of environmental protection, 2010.
- (29) Notice on disclosure of “Management plan of urban flying Particle pollution for Changzhi”, #29, city government of Changzhi, 2009.
- (30) Notice on “Enhancing the environmental impact assessment for international financial institute loan construction project” , State agency of Environmental Protection, #324, 1993.
- (31) Regulations on the Administration of Transportation Project Environmental Protection, 17# Decree of Minister of Transport, 1990.

### **1.2.3 Requirement from the World Bank**

- (1) Safeguard Policies of the World Bank
- (2) Environment, Health and Safety Guideline, International Financial Corporation.

### **1.2.4 Related city planning and environmental function zoning documents**

- (1) Master plan for City of Changzhi (2001-2020) , Municipal Government of Changzhi, Urban Planning Design and Research Institute of Tongji, Shanghai.
- (2) Specific planning of urban district of Changzhi, Urban Planning Design and Research Institute of Tongji, Shanghai cooperated with Urban Planning Design and Research Institute of Changzhi, April, 2011.

- (3) Ecology function zoning of Changzhi, Shanxi University, Environmental Protection Bureau of Changzhi, July, 2007.

### **1.2.5 Engineering Design Documents**

- (1) “Feasibility Study Report for Changzhi Sustainable Urban Transport Project”, Shanghai WSP Consulting, Ltd, Changzhi transport project management office.
- (2) Relevant technical documents.

### **1.2.6 Technical basis**

- (1) “Technical Guidelines of Environmental Impact Assessment –Generals”;
- (2) “Environmental and Surface Water Environment” □HJ/T2.1-93□□
- (3) “Technical Guidelines of Environmental Impact Assessment-Atmospheric Environment” □HJ2.2-2008□□
- (4) “Technical Guidelines of Environmental Impact Assessment-Surface Water Environment” □HJ/T2.3-93□□
- (5) “Technical Guidelines of Environmental Impact Assessment-Acoustic Environment” □HJ2.4-2009□□
- (6) “Technical Guidelines of Environmental Impact Assessment -Ecological Environment” □HJ19-2011□□
- (7) Notice on “Specification on Environmental Impact Assessment”, State agency of Environmental protection, Planning Commission of the State, #12, 2002;
- (8) Technical standards on Efficient Control of Urban Air-borne Dust Pollution, HJ/T393, 2007;
- (9) Specifications for Environment Impact Assessment of Highway (on trial), Ministry of Transport, JTJ005, 1996.

## **1.3 Purpose of assessment and guidelines**

### **1.3.1 Purpose**

- (1) We shall investigate and evaluate the social environment, ecological, atmospheric and acoustic environment situation along project route, gain comprehensive understanding of current environment situation.
- (2) We shall analyze qualitatively and quantitatively the environment impact during the construction and operation phase of the project, predicts and evaluates the range and magnitude of the impact, provide guidance for reasonable selection of project route;
- (3) We shall on basis of the magnitude and range of the impact, proposes feasible plans for environmental protection, as well as feeds back such plans to the engineering design so as to minimize the negative environmental impact due to project construction and achieve the goal of coordinated development of city and the environment.
- (4) We shall incorporate public consultation to eliminate possible oversight in environmental assessment, so that: the planning, design and management of the proposed project could be improved; environmental, social and economic benefit

can be optimized; guidelines could be provided for the stakeholders and policy makers to facilitate the project environmental management, development of economic and environmental plan of the impacted area.

### **1.3.2 Guidelines**

- (1) Regulations, standards and technical specifications for environmental impact assessment of construction project from ministry of transportation and Shanxi province.
- (2) According to the project scope, type, location and sensitivity, formulate specific contents and methods to comprehensively analyze the impact on agricultural, atmospheric, surface water, acoustic, social and economic environment.
- (3) According to the nature of the project and environment characteristics of the affected area, find out the current condition, environment requirement and its characteristics, select the major environmental factors need assessment, predict range and magnitude of the environmental impact for the affected area after project construction, recommend rational control measures, so as to minimize the negative environmental impact due to project construction.
- (4) Through careful investigation of the affected area, enhance the quality of the assessment, give clear conclusion about the feasibility of project construction from environment protection perspective, provides basis for project construction and environment management.
- (5) Collect necessary information through comparison, analysis and on-site survey based on the characteristics of road construction. Use existing materials and results to reduce time consumption and maximize the benefit in environment assessment.
- (6) Make sure that the result of assessment is objective, accurate and equitable.

## **1.4 Project Classification**

### **1.4.1 Classification of the project**

According to classifications of environmental assessment of the World Bank (OP4.01), select the major environmental impact factors. The environmental impact of this project is limited, not irreversible and not involve ecological or cultural sensitive areas. Therefore, the environmental impact assessment of the project is classified into category B.

### **1.4.2 Screening of safeguard policies of World Bank**

The World Bank's safeguard policies includes 10 policies as following:

1. Environmental assessment (OP4.01);
2. Forests (OP4.36);
3. Natural habitat (OP4.04);
4. Safety of Dams (OP4.37);
5. Pest management (OP4.09);
6. Involuntary resettlement (OP4.12);
7. Indigenous peoples (OD4.20);
8. Physical cultural resources (OP4.11);

9. Disputed area (OP7.60);
10. International waterways (OP7.50).

Among these policies, this project will involve with environmental assessment policy (OP4.11) and involuntary resettlement (OP4.12) due to land acquisition. The Resettlement Action Plan has been completed by the resettlement team with the major findings included in this report.

This project does not involve Forests (OP/GP4.36), Natural habitat (OP4.04), safety of Dams (OP 4.37), Pest management (OP4.09), Indigenous peoples (OD4.20), Physical cultural resources (OP4.11), Disputed area (OP7.60) and International waterways (OP7.50).

## **1.5 Assessment Class and Coverage**

### **1.5.1 Assessment Class**

In accordance with the technical guidance of the environmental impact assessment, on basis of the situation of pollution discharge as well as the regional environmental plan and function requirement, the class of the environmental factors in this environmental impact assessment is shown in the following:

(1) Air environment

Based on regulations in 5.3.2.3.5 of Technical Guidelines for Environmental Impact Assessment---Ambient air, this project is an urban road reconstruction project, without expansion over the existing red line. In addition, the use of clean energy bus during the project operation period can reduce the emission from vehicles. Therefore, the ambient air impact assessment will follow class 3.

(2) Acoustic environment

According to Technical Guideline for Environmental Impact Assessment-Acoustic Environment, the affected area in this project has no GB3096-2008 regulated type 0 acoustic environmental functioning zone. The location for new construction of the South Parking and Maintenance Yard belongs to Class 2 acoustic environmental functioning zone. The increase of noise level in this location is less than 3dB (A) in project operation phase. All the rest are road reconstruction projects, so the acoustic environment impact is class 2.

(3) Ecology environment

According to the classifications of assessment grade in Technical Guideline for Environmental Impact Assessment-Ecological Environment, ecological environmental impact assessment is categorized by Class 1, 2 and 3. This project belongs to urban road reconstruction, there are no sensitive ecology sites in the assessment area. In addition, the impact of land occupation for construction is relatively small, so the ecological environmental impact assessment follows class 3.

(4) Surface water environment

According to Technical Guidelines for Environmental Impact Assessment---Surface Water Environment, the nature of this project is urban transportation improvement. Upon completion of the project, wastewater and rainwater are collected separately. Wastewater from domestic use is collected by the sewerage system. Rainwater is collected by storm water pipeline system. Demolition and reconstruction of 2 bridges are involved in this project. The size and elevation of these two bridges can not be determined from the feasibility study due to lack of essential information on the river channel planning and flood control. The design of the bridge will start upon the information collection. The surface water environmental impact is determined to be limited to site specific analysis.

(5) Environmental risk

The environmental risk involved in this project is the storage of diesel and natural gas at the oil and gas station in the South Parking and Maintenance Yard. The amount of storage for diesel is less than 40t (limit), and 10t (limit) for CNG, which should not be categorized as highly dangerous source. The area is not located in environmental sensitive zone, but it is involved with flammable material. According to standards in “Specifications on Environmental Risk Assessment of Construction Project” (HJ/T169-2004), the environmental risk of this project is class 2.

(6) Social environment

The Social environment impact assessment should be on basis of the requirement in Specifications for Environment Impact Assessment of Highway (on trial).

**1.5.2 Assessment Coverage**

In accordance with guidelines for environmental impact assessment, the coverage of this environmental impact assessment is shown in table 1-1.

Table 1-1 List of environmental impact assessment range

No	Environmental factor	Assessment range
1	Ambient air	Within 200m from both side of central line of road□ within 2.5km of the center of parking and maintenance yards□
2	Water environment	Receiving water body-Zhuozhang River
3	Acoustic Environment	Within 200m from both side of central line of road□ within 200m of the center of parking and maintenance yards□
4	Ecological Environment	Within 200m from the road□ within 300m from the parking and maintenance yards□
5	Social	Impacted area along the road; schools and residential

	Environment	area around the parking and maintenance yards□
--	-------------	--

## 1.6 Identification of major environmental issue and environmental factors

### 1.6.1 Major environmental issues

According to the features of this project and the environmental characteristics in the area, the major environmental issues are identified as the following table 1-2.

Table 1-2 Major environmental issues

Construction Phase	Social environment	Demolition of houses	Most of the project is reconstruction of existing roads and facilities, no demolition of houses involved. Land acquisition will pose impact on relevant population by the construction of South Parking and Maintenance Yard.
		Road construction	Temporary interruption of traffic will affect travel of people.
		Business	Due to the enclosure of the road section, the normal operation of the commercial business along the road will be affected.
		Traffic safety	Access to the hospitals and schools will be affected, the safety of people when crossing the roads will be affected; construction fleet may be a source for traffic accidents
		Demolition of pipelines	Demolition of pipelines underground will affect normal daily life of people
		Cultural relics preservation	No important cultural relics recorded by local cultural bureau along the project road
	Ecology of the city	Removal of median and isolation belt	Construction will damage or occupy the isolation grassland, reducing green area.
		Various construction activities	Operation of the machinery, land excavation, demolition and relocation of underground pipeline will damage municipal road, affecting landscaping, generating some construction wastewater.
		Earth excavation	Spoil and construction waste will occupy municipal land, affecting the ecology environment of the city, may causing soil erosion in the area.

	Air environment	Road construction, Vehicle transportation, Demolition of road surface	Excavation, filling, demolition during construction and transport of cement, clay and gravel will cause air-borne dust.
		Construction machinery	Increase of transportation vehicle and construction machinery will cause increase of pollutant emission.
	Noise	Demolition, transportation, use of various machinery	Various construction machineries like excavator, drilling and piling machine, air compressor, road roller as well as the demolition of road surface and road excavation will generate noise.
	Wastewater	Construction and workers	Domestic wastewater, construction wastewater, wastewater from washing the machinery.
	Solid waste	Construction and workers	Solid waste generated from excavation, building demolition, and workers.
Operation Phase	Social environment	Transportation	By alleviating the stress on transportation facilities and emphasizing bus priority, the project will develop sustainable transport system for the city. The benefit is the reduced time in public travel and freight transport, decreased fuel consumption and emission.
		Traffic safety	Influence caused by increased vehicle speed need to be mitigated by using the best practices for traffic safety to prevent traffic accident
	Ecology of the city	Urban greening	It can increase road landscaping in the city, bring benefit to the ecology and landscape of the city.
	Air environment	Vehicle transportation	Increasing traffic volume, emissions from vehicle include pollutants like CO, NOx, may increase the air pollution load along the road. From the perspective of the whole city, it will improve the air quality.
	Noise	Vehicle transportation	Noise level will be the same or better along the road; traffic noise will affect the sensitive receptors along the roads.

	Vibration	Vehicle transportation	Movement of vehicles will cause vibration on the road.
	Water environment	Bus station, Parking and maintenance yards, parking yards	Wastewater and rainwater will be collected separately; operation of bus station, parking and maintenance yards and parking yards will generate wastewater; wastewater from washing the bus will be generated
	Solid waste	Solid waste and dangerous waste	Solid waste will be collected and sent to landfill for further treatment; waste oil and sludge will be collected as dangerous waste and treated by qualified department.
	Land utilization	Function change	Integrated Corridor Improvement doesn't change the type of land use; Construction of the parking and maintenance yard located at south of the city will change the land use type from agriculture.
	Safety issues at oil and gas station	Risk of explosion	Operation of the oil and gas station in the South Parking and Maintenance Yard may cause serious environmental impact such as explosion and leakage.

### 1.6.2 Identification of environmental factors

According to the feature of this project and the major environmental issues identified, the environmental factors affected by this project are identified and selected as the following matrix table 1-3.

Environment al factors Item		Social environment			Ecology in the city		Natural environment				
		Transportation	Social life	Traffic Safety	Landscape	Green area	Solid waste	Water Environment	Air Environment	Noise	Vibration
Construction phase	Road demolition	-1S	+1L	-2S	-1S		-1S		-1S		
	Construction machinery			-2S				-1S	-1S	-2S	
	Pipeline demolition	-1S	-2S	-2S	-1S						
	Removal of Isolation grassland		-1S	-2S	-2S	-1S					
	Earth excavation	-1S		-2S	-1S		-1S				
	Construction staff			-2S			-1S	-1S			
Operation phase	Vehicle running	+2L	+1L	-2S					+1L	-2L	-1L
	Greening			-2S	+1L	+1L					

Table 1-3 Identified environmental factors Note □ “□”denotes positive impact □ “□”denotes negative impact □ “1” denotes limited impact □ “2” denotes medium impact □ “3” denotes large impact □ “S” denotes temporary impact □ “L” denotes long-term impact.

### 1.7 Assessment focus

Based on the identification and selection of the environmental issues and impact factors, the focus of this assessment is the ambient air impact, acoustic environmental impact, traffic safety impact, and social impact during the project construction and operation phase. In addition, the assessment should recommend rational mitigation measures for the negative environmental impact during the project construction and operation phase.

### 1.8 Applicable assessment standard

#### 1.8.1 Environmental Quality Standard

##### (1) Ambient air

TSP、PM<sub>10</sub>、SO<sub>2</sub>、CO shall be applicable to criteria grade-II of “Ambient air quality standard” (GB3095-1996); NO<sub>2</sub> shall be applicable to criteria grade-II of “Ambient air quality standard” (GB3095-1996) modified (Jan, 2000); There is no environmental quality standard for NMHC, so 2 mg/m<sup>3</sup> is used as the standard based on the explanations in page 243 of “Standards for Air pollutant emission”. Detailed standard is shown in table 1-4.

Table 1-4 ambient air quality standards

item	TSP	PM <sub>10</sub>	SO <sub>2</sub>	NO <sub>2</sub>	CO	NMHC
Annual average	0.20	0.10	0.06	0.08	/	/
Daily average	0.30	0.15	0.15	0.12	4.00	/
Hourly average	/	/	0.50	0.24	10.00	2

##### (2) Surface water

The involved roads in this project are all located in the city. The major Rivers in the city area are Heishui River and Shizi River. Heishui River is the major branch of Shizi River. Heishui River originates from Liing village, Handian town, Changzhi district. It enters urban Changzhi passing villages of Liulin, Linyi, Sima, Ancheng, Beiguo from south to north. Then it continues flow in the west of the urban to the north through villages of Zhenzhang, Xinanguan, Zhangzimen, finally it reaches Shizi River in the southeast part of Zifang village in the city. The entire stretch of the River is 15.1 Km, with an average slope of 3.6‰, the drainage area is 108.45 km<sup>2</sup>. Currently in Heishui River, the water flow volume is small and the water quality is poor.

Shizi River is the major branch of South Zhuozhang River□the entire stretch of Shizi River is 46km, the drainage area is 385.33km<sup>2</sup>. It originates from east of Panmachi village, Shipo xiang, Huguan district, continues to flow northwest through villages of Beizhuang, Xiqili, Jinzhuang, Dongchongxian, Zhuangtou dam, Dujiahe, Jidian and enters urban changzhi. Flowing through villages of Shiqiao, Hukou, Taoyuan, it passes through the north part of

urban Changzhi, continues to flow north through villages of Zifang, Qiucun and Jiangcun, reaches to South Zhuozhang River at western Beizhai village. Shizi River passes through urban Changzhi, is the major landscape waterway, part of it has no water flow.

According to “surface watershed environment management function zoning of Shanxi Province”, the River from the outlet of Shizi River dam to Baomaduan is subject to environmental monitoring. Its current and major planning function is agricultural water supply. The type of functioning zone is protective water supply River, which is applicable to type-1 standard of environmental monitoring. The rest part of the River is applicable to type-V standard of Surface water environment quality standard (GB3838-2002). The standard is shown in table 1-5. Heishui River finally reaches to Shizhi River, so there is function zoning, the surface water quality standard is adopted from that of the Shizi River from the outlet of Shizi River dam to Baomaduan.

In addition, the west part of the project is close to Zhuozhang River. According to “surface watershed environment management function zoning of Shanxi Province”, the River upstream of Zezhang dam is subject to environmental monitoring. Its Current function is industrial and domestic water supply. The planned function is agricultural water supply. The type of functioning zone is protective water supply River, which is applicable to type-1 standard of environmental monitoring. The rest part of the River is applicable to type-V standard of Surface water environment quality standard (GB3838-2002).

Table 1-5 Environmental quality standards of Heishui River from outlet of Shizihe dam and Baomaduan. Unit:mg/l

Pollutant	BOD5	CODcr	NH <sub>3</sub> -N	Total salt content
Standard□mg/l□	≤20	≤60	≤5.0	≤1000
Pollutant	BaP	Oil	PH	
Standard□mg/l□	≤0.00003	≤1.0	6-9	

Table 1-6 Environmental quality standards of Shizi River upstream of Zezhang dam Unit:mg/l

Pollutant	BOD <sub>5</sub>	CODcr	NH <sub>3</sub> -N	Total salt content
Standard□mg/l□	≤20	≤60	≤5.0	≤1000
Pollutant	BaP	Oil	PH	
Standard□mg/l□	≤0.00003	≤1.0	6-9	

### (3) Groundwater

The groundwater of the project location is mainly used for domestic water supply, agricultural and industrial consumption, belongs to type-III function zoning, is applicable to type-III standard of groundwater environment quality standard (GB/T14848-93), which is shown in table 1-7.

Table 1-7 Groundwater environment quality standards

No	Pollutant	Standard	No	Pollutant	Standard
1	PH	6.5□8.5	13	ammonia nitrogen (mg/L)	≤0.2
2	total hardness (mg/L)	≤450	14	volatile phenol (mg/L)	≤0.002
3	Dissolved solid(mg/L)	≤1000	15	Cyanide (mg/L)	≤0.05
4	As(mg/L)	≤0.05	16	Nitrate(mg/L)	≤20
5	Hg(mg/L)	≤0.001	17	Nitrite (mg/L)	≤0.02
6	Pb(mg/L)	≤0.05	18	Permanganate Index (mg/L)	≤3.0
7	Cd(mg/L)	≤0.01	19	Sulfate(mg/L)	≤250
8	Cr+6(mg/L)	≤0.05	20	Chloride(mg/L)	≤250
9	Fe(mg/L)	≤0.3	21	Fluoride (mg/L)	≤1.0
10	Mn(mg/L)	≤0.1	22	total bacteria (No./ml)	≤100
11	Cu(mg/L)	≤1.0	23	total coliforms (no/L)	≤3.0
12	Zn(mg/L)	≤1.0			

Note □pH has no unit □unit for total bacteria is number/ml □for total coliforms is number/L □rest are mg/L.

(4) Acoustic environment

The involved roads in this project are all located in the city. Therefore, for buildings more than three (including three) stories, the first row of the building facing the road will adopt Class 4a of “Acoustic environmental quality standard”(GB3096-2008) for assessment. If the buildings adjacent to road has less than three stories (including open area), the Class 1 area within 40m of the redline of road, Class 2 area within 30m of the redline of road, Class 3 area within 20m of the redline of road will adopt Class 4a standard for assessment, area outside should be applicable to standards corresponding to its functioning zone. The standards are shown in table 1-8.

Table 1-8 Acoustic environmental quality standards. Unit: dB□A□

Time Classification	Day	Night
Class 1	55	45
Class 2	60	50
Class 3	65	55
Class 4a	70	55

(5) Vibration

The vibration generated by this project is applicable to “Urban regional environment vibration standard” □GB10070-88□, which is shown in table 1-9.

Table 1-9 Vibration standards

Applicable area	Day□dB□	Night(dB)
Special residential area	65	65
Residential, school and cultural area	70	67
Area mixed with residence, commerce and industry	75	72
Industrial area	75	72
Areas along the main road	75	72

### 1.8.2 Pollution discharge standard

#### (1) Air pollutant

Emissions from motor vehicles: motor vehicles based on different type are applicable to the following standards: “Light weight vehicle emission limit and measurement (□,□ level)” (GB18352.3-2005), “Compression ignition engine emission limit and measurement” (GB3847-2005), “Ignition engine emission limit and measurement” (GB18285-2005), “Motorcycle and scoter emission limit and measurement” (GB19758-2005), etc.

#### (2) Water pollutant

The roads in this project are all located in the city. The waste water generated during the construction period is discharged to the municipal sewage network. The water quality standard is applicable to Class 3 of “Comprehensive standards for wastewater discharge” (GB8978-1996). Detailed information is shown in table 1-10.

Table 1-10: Water quality standard

Item	pH	SS	BOD5	COD
Standard	6-9	400	300	500
Item	NH3-N	Animal and vegetable oils	Oil	Anionic surfactant
Standard	---	100	20	20

#### (3) Construction noise

During construction period, the noise shall be controlled in accordance with “Limits of noise of construction sites boundaries” (GB12523-90), shown in Table 1-11.

Table 1-11 Limits for noise of construction sites boundaries

Construction phase	Major noise source	Standard value (dB)	
		Day	Night

Excavation	Dozer, excavator and loader	75	55
Piling	Piling machine	85	Construction is banned
Structure	Concrete mixer, vibrator and electric saw	70	55
Decoration	Crane and lift	65	55

(4) Noise from bus depots

The boundary noise of bus depots shall be applicable to Class 2 of “Boundary noise standard of industry enterprises” (GB12348-90), which is 60dB(A) in daytime and 50dB(A) at night.

(5) Solid waste

Construction spoil, domestic solid waste shall be applicable to standards of “Pollutant control standard of industrial solid waste storage and treatment” (GB18599-2001); domestic sold waste during the operation phase is collected and treated by the municipal sanitation department. According to EHS Guidelines, for the waste generated after adoption of prevention, minimization, reuse, recycle and recovery measures, proper disposal is needed. Final waste shall be sent to dedicated, licensed facility for disposal. Small amount of hazardous waste will be stored, transported and managed according to relevant regulations, and disposed of by licensed facility.

## 1.9 Pollution control and environmental protection targets

(1) Pollution control targets

- i. Control pollutants from motor vehicle emissions, protect the ambient air quality of urban district in Changzhi.
- ii. Control noise generated from motor vehicles, protect centralized residential area, hospitals, schools, kindergartens, parks and temples along the road from noise impact.
- iii. Protect grass lawn, roadside trees along the road from damage by project construction.
- iv. Make sure the social life of the communities along road not affected by project construction.
- v. Protect the water quality of Shizi River and Heihe River.

(2) Environmental protection targets

Environmental protection targets denote the targets in the area to be affected by the project construction, in another word, the receptors sensitive to the environmental impact, called sensitive receptor. The selection of environmental protection targets are based on the following criteria:

- a. Located along the project roads;
- b. Mainly focuses on the first row of building, which could be school, hospital and beadhouse.

Based on field investigation, there are 11 environmental protection objectives along the

project roads, as shown in table 1-12 and figure 1-1.

Table 1-12 Environmental protection objectives

Name \ Type	Hospital		School		Beadhouse	Toil
	Number	# of beds	Number	# of people	Number	
Yingxiong Road	/	/	3	1450	/	3
Taihang Street	1	500	3	6600	/	4
Fuhou Street	/	/	1	2500	/	1
Chengxi Road	1	120	2	3400	/	3
Parking and maintenance yard in bus company	/	/	/	/	/	0
South Parking and maintenance yard	/	/	/	/	/	0
Total	2	620	9	13950/	/	11

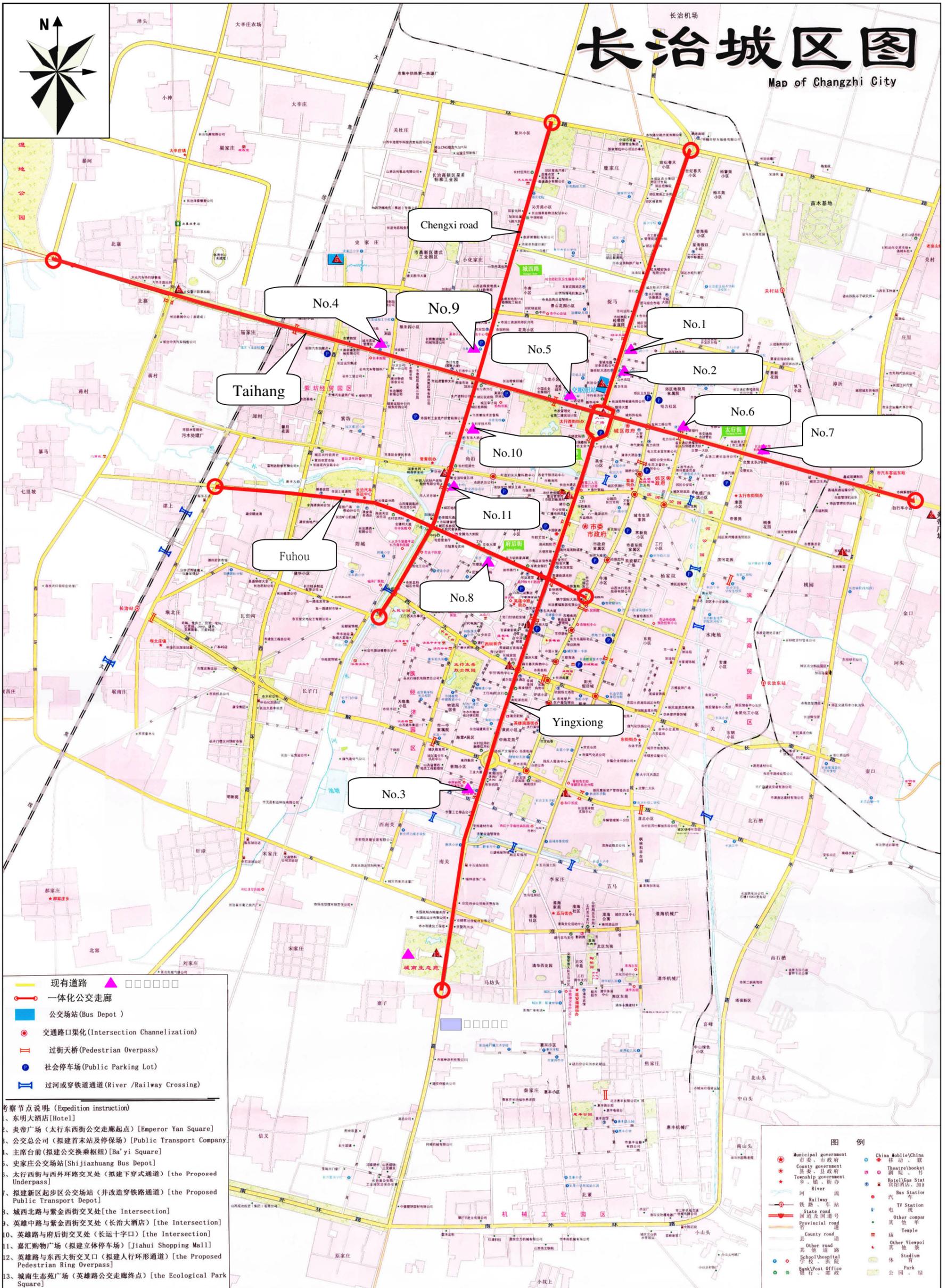


Figure 1-1: Environmental protection objectives for this project.

Note: Number in the map is corresponding to the objectives in table 1-13.

Table 1-13: Environmental protection targets along the project roads

Name	No	Targets	Distance to center of the road (m)	# of first row building	# of floor	# of student/bed	# of windows facing road
Yingxiong Road	1	Yingxiong Road elementary school	58	3	2-5	400	36
	2	Xiaolingtong kindergarten	46	1	2	300	12
	3	Xianan Street elementary school	58	1	2-5	750	20
Taihang Street	4	Huoju middle school	96	2	3-4	2800	60
	5	No.12 middle school	69	2	2-5	1800	74
	6	Jiandong Road elementary school	44	1	4	2000	88
	7	Heji hospital	63	3	2-4	500	glass curtain wall
Fuhou Street	8	No.2 middle school	85	/	/	2500	/
Chengxi Road	9	Changzhi Academy of Education	23	2	2-3	400	30
	10	Maternal and Child Care Service Center	47.8	3	3-6	120	45
	11	No.7 middle school	99	3	4-8	3000	/

## **2. Environmental Baseline**

### **2.1 Natural Environment**

#### **2.1.1 Geographical Location**

Changzhi is located in southeast of Shanxi Province, with its east in the Taihang Mountain and adjacent to Hebei and Henan province; and in the west, contiguous to Taiyue Mountain, it is connected with Linfen area; Jinzhong and Jincheng are located in its north and south. The longest distance in its east-west direction is 150km and 140km wide for its south-north direction, the total area is 13896km<sup>2</sup>. The urban district of Changzhi is in the eastern part of Shangdang basin, which is contiguous to Taihang Mountain and Zhanghe River. Located in the center of the triangle area constructed by Taiyuan, Handan and Zhengzhou, with Taijiao Railway, Changhan Highway and State Highway 207 passing through, the urban district is the political, economic, cultural, technology, information and transportation center of Changzhi city. total area of the urban area is 55.6 km<sup>2</sup>.

The project consists of Integrated Corridor Improvement, Intelligent Urban Transport Management System, Public Transit Supporting Infrastructure and Institutional Capacity Development. All the four components are located in the urban district, the project involved are Taihang Street, Yingxiong Road, Chengxi Road, Fuhou Street, Baiyi Square transit hub and underground parking lot, public bus terminal station, parking and maintenance yards. The location of involved area is shown in figure 2-1.

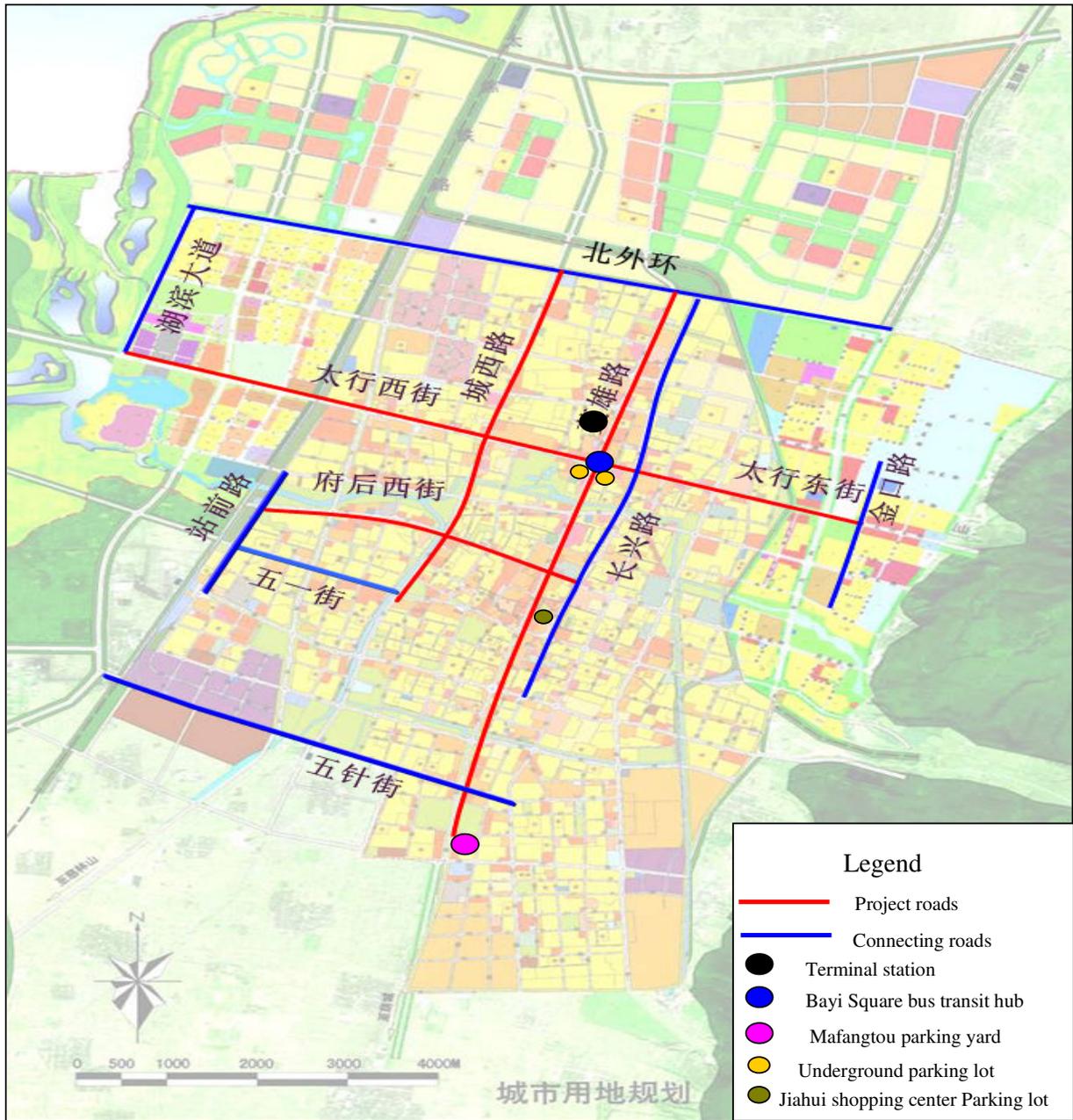


Figure 2-1: Project location

### 2.1.2 Topography

The topography of urban Changzhi is high in the southeast and low in the northwest. The highest point is the ridge of Song Mountain, which has an elevation of 1180.3m, the lowest point is the estuary of Shizi River, with the elevation of 908.00m. The type of the

topography mainly include: Dong Mountain is located in the east with north-south direction, the topography fluctuates a lot; On top of Dong Mountain is rocky area, under the mountain is Loess Hilly-gullied Region with mild slope, mainly for terrace. In the west, the topography is mainly alluvial plain, which is flat and is the major agricultural and industrial area. In the urban area, hilly-gullied region and rocky region accounts for 14km<sup>2</sup>, the flat plain accounts for 41km<sup>2</sup>. The project is located in the west plain area.

### **2.1.3 Geological structure**

The geology of Changzhi is complex. Which is a mixture of the weathered bedrock and alluvial areas. This project is located within the urban area of Changzhi where the geology is stable.

### **2.1.4 Climate condition**

Changzhi City is located in the continental warm temperate zone with semi-dry monsoon climate. It has four distinct seasons with cold and little precipitation/snow in the winter season; windy in the spring season; hot in the summer season and precipitation is concentrated; sunny and cool in the fall season. The long term annual precipitation in Changzhi is 599.0mm, the maximum daily precipitation is 145.8mm, the annual number of precipitation day is 92.8. The precipitation seasonality is in June, July, August and September, which accounts for 73.94% of the total precipitation. The largest precipitation month is July, with average precipitation of 167.6mm. Winter precipitation is little and only accounts for 2.75% of the total annual precipitation.

The long term average temperature is 9.1℃, average temperature for the coldest month (Jan) is -6.9℃, for the hottest month (Jul) is 22.8℃. The historical extreme high temperature is 37.16℃ and -29.3℃ for the extreme low temperature. the annual average air pressure is 91.08kPa, air pressure in the winter is 91.58kPa and 90.38kPa in the summer.

The seasonality of wind direction is obvious, calm wind accounts for 36% of the annual wind, followed by S wind, which is 8% in frequency. The dominant wind direction for Jan, Mar, April, May, June, Oct and Nov is S wind; for Feb and Jul is SSW wind; for Aug and Sept is NE wind and SSE wind for Dec. The annual average wind speed is 1.6m/s, with the highest wind speed of 2.3m/s in April, the average wind speed in Sept and Dec is relatively low (1.2m/s), the maximum wind speed is 20.0m/s.

The annual average evaporation is 1551.1mm, which is 2.51 times of the annual average precipitation. The evaporation is consistent with the temperature change, with the maximum evaporation between May and June. The annual average relative humidity is 65% and 77% in the hottest month (Jul). The maximum snow thickness is 18cm; the maximum depth of the frozen soil is 0.73m; the annual number of day without frost is 152, the beginning of frost period is in Oct and the end of the frost period is in May next year.

### 2.1.5 Ambient air quality

Monitoring data from three stations (Auditing bureau □ Monitoring station, Aoruite) and “2010 announcement bulletin of Environment quality for Changzhi City” are used for



Figure 2-2: Locations of three monitoring stations

The ambient air quality assessment. among these stations, Auditing bureau and Monitoring station are located within the urban area, Aoruite is located in northeast of urban area, as shown in figure2-2. The monitoring pollutants are  $SO_2$  □  $NO_2$  □  $PM_{10}$ .

According to “2010 announcement bulletin of environment quality for Changzhi City”, the ambient air pollutant is mainly PM<sub>10</sub>, then SO<sub>2</sub> and NO<sub>2</sub>. The largest loading of the pollutants is PM<sub>10</sub>, which accounts for 51.9%, followed by SO<sub>2</sub>, which accounts for 28.1%; and then NO<sub>2</sub>, which accounts for 20.0%, the percentage of pollutant is shown in figure 2-3.

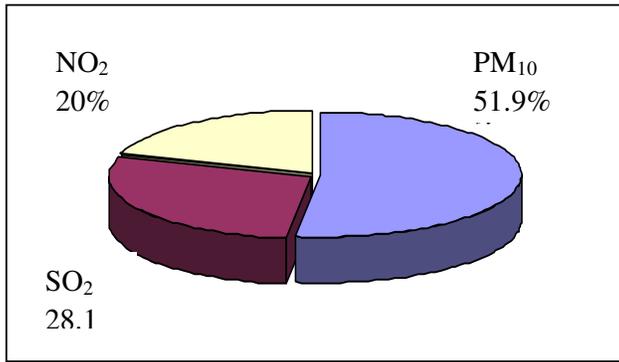


Figure 2-3: Air pollutant loading. In urban area of Changzhi, 2010

The monitoring statistics of ambient air quality for Changzhi in 2010 is shown in Table 2-1

Table 2-1 Daily average concentration of SO<sub>2</sub>、NO<sub>2</sub>、PM<sub>10</sub> at the monitoring stations in Changzhi.

No	Air pollutant	Standard	Concentration range	# of sample	# of sample exceeding the limit	Exceedance Probability (%)	Percentage of Maximum Loading □%□
Monitoring Station	SO <sub>2</sub>	0.15	0.016□0.045	365	0	0	30
	NO <sub>2</sub>	0.12	0.015□0.033	365	0	0	27.5
	PM <sub>10</sub>	0.15	0.065□0.115	365	0	0	76.7
Auditing Bureau	SO <sub>2</sub>	0.15	0.013□0.048	365	0	0	32
	NO <sub>2</sub>	0.12	0.018□0.042	365	0	0	35
	PM <sub>10</sub>	0.15	0.062□0.109	365	0	0	72.7
Aoruite	SO <sub>2</sub>	0.15	0.023□0.053	365	0	0	35.3
	NO <sub>2</sub>	0.12	0.017□0.035	365	0	0	29.2
	PM <sub>10</sub>	0.15	0.065□0.104	365	0	0	69.3

From the monitoring result of the three stations, we can see that all the air pollutant concentration meet grade 2 of “Ambient air quality standards” (GB3095-1996). Therefore, the ambient air quality in Changzhi city is good.

## **2.1.6 Surface water quality**

### **2.1.6.1 Surface water system**

Changzhi is crossing Haihe River basin and Yellow River basin. The boundary of the basin is defined by Taihang mountain and Taiyue mountain, with Haihe River basin located in the east, which belongs to South Zhangwei Canal , the major rivers in this area are Zhuozhang River, Qingzhang River and Wei River; Yellow River is located in the west, the major River is Qin River.

The major rivers in urban area of Changzhi are: Heshui River, Shizi River and South Zhuozhang River, which are all seasonally storm-typed river. Heshui River originates from Liing village, Handian town, Changzhi county. It enters urban Changzhi passing villages of Liulin, Linyi, Sima, Ancheng, Beiguo from south to north. Then it continues flow in the west of the urban to the north through villages of Zhenzhang, Xinanguan, Zhangzimen, finally it reaches Shizi River in the southeast part of Zifang village in the city. The entire stretch of the River is 15.1 km, with an average slope of 3.6‰, the drainage area is 108.45 km<sup>2</sup>. The water flow in Heshui River is small, and water quality is poor. Shizi River is the major branch of South Zhuozhang River—it originates from east of Panmachi village, Shipoxiang, Huguan county, continues to flow northwest through villages of Beizhuang, Xiqili, Jinzhuang, Dongchongxian, Zhuangtou dam, Dujiahe, Jidian and enters urban changzhi. Flowing through villages of Shiqiao, Hukou, Taoyuan, it passes through the north part of urban Changzhi, continues to flow north through villages of Zifang, Qiucun and Jiangcun, reaches to South Zhuozhang River at western Beizhai village. The drainage area is 385.33km<sup>2</sup> and the main channel of Shizi River is 49km. The river channel upstream of Shizi River is rocky or earth-rock area. It is normally dry and empty, runoff only generates during storm events. The width of the upstream of Shizi River is over 50m, the average slope is 12.1‰, which poses a high risk during flood condition. The width of downstream Shizi River is between 10m and 25m, with an average slope of 2.52‰. The River section within urban Changzhi is collected to serve as landscaping purpose. South Zhuozhang River is one of the three major branches (South Zhuozhang River, West Zhuozhang River and North Zhuozhang River) of Zhuozhang River, which belongs to Hai River basin and South Zhuowei Cannal water system. South Zhuozhang River originates from Fajiu mountain in Zhangzi county, flows through Changzhi county, urban and suburban area of Changzhi city, enters Lucheng city at north Huangnian and flows out at Xishan village, Shiku town in Lucheng, it reaches west Zhuozhang River at Gan village in Xiangyuan county and finally enters Hai River and Bohai Sea. The length of major south Zhuozhang River is 104km, with drainage area of 3522km<sup>2</sup>, the long term average annual stream flow is 0.265 billion m<sup>3</sup>. The seasonality is distinct, during flood condition, the maximum stream flow is 3780m<sup>3</sup>/s, during drought condition, part of the River dries up with no flowing water.

The Bayi bridge on Yingxiong Road crosses Shizi River, the major section of the bridge is built in 1960 for motor vehicle transportation and the auxiliary section is built in 1980 for non-motor vehicle use; The Qiyi bridge at Chengxi Road also crosses Shizi River, it is built in 1970. Both bridges are old and lack of maintenance, in addition, the cross-section of these bridges does not meet the requirement for bus priority lane. Therefore, it is suggested by related department that both bridges should be demolished and reconstructed.

The river system of Changzhi City is shown in figure 2-4.

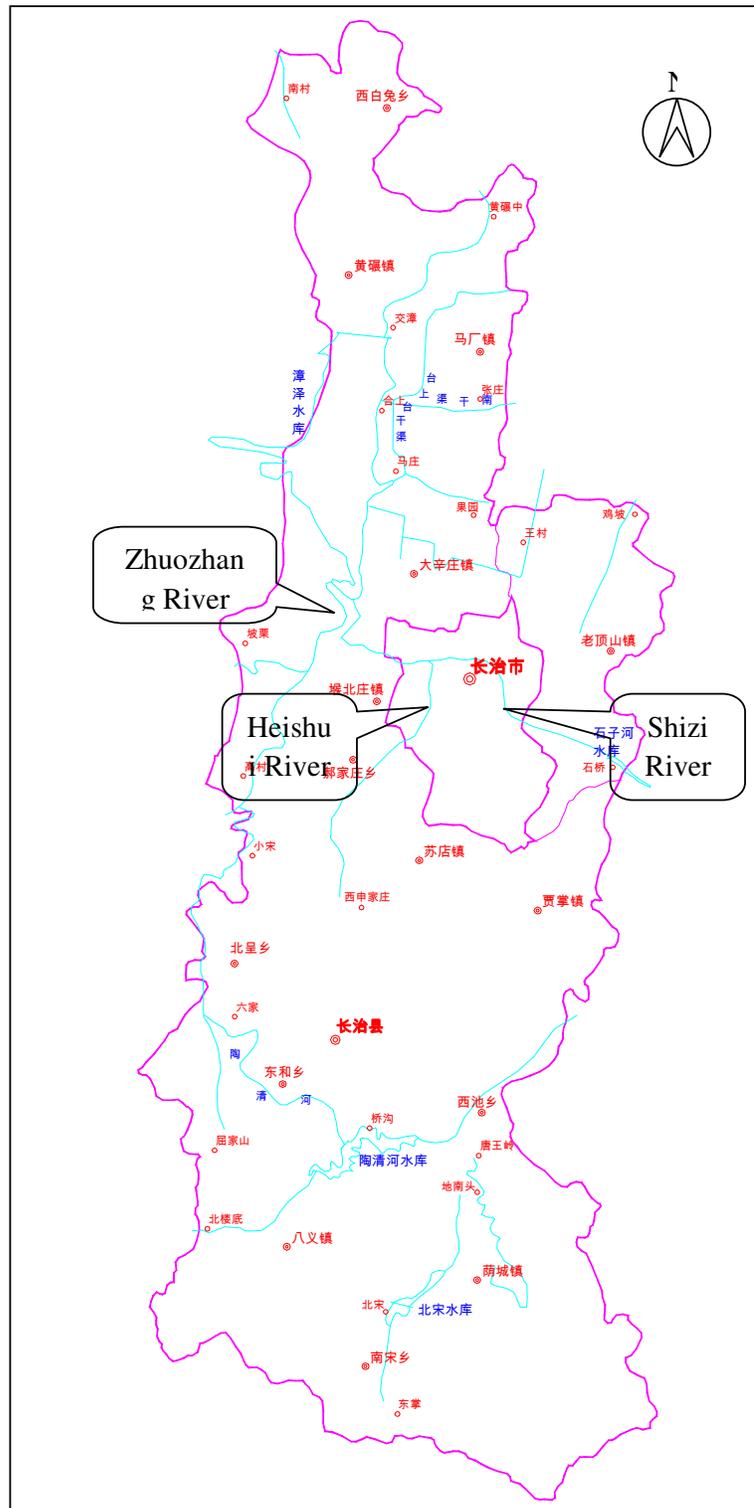


Figure 2-4: Surface water system of Changzhi area.

### 2.1.6.2 Surface water quality

The surface water quality assessment is finished based on the monitoring data of the River section of Baoma at Zhuozhang River in 2010. The monitoring pollutants are pH、COD、BOD<sub>5</sub>、Ammonia Nitrogen, oil, sulfide, fluoride, cyanide and phenol compounds. Among these, pH、COD、BOD<sub>5</sub>、Ammonia Nitrogen, oil are selected for assessment.

According to the indexes provided above, the average concentrations of the pollutants in the river cross-section are calculated and evaluated, as shown in table 2-2.

Table 2-2: Surface water quality environmental assessment result

Item	pH	Ammonia Nitrogen	COD <sub>cr</sub>	BOD <sub>5</sub>	Oil
Mean	6.9-8.53	2.46	48	22.3	0.052
Standard Deviation	-	0.49	0.80	1.11	0.05
Meets standard (Y/N)	Y	Y	Y	N	Y
Exceedance index	-	-	-	0.11	-

At the monitoring section at Baoma, the BOD<sub>5</sub> is exceeding the Class 1 standard a little (0.11 times), ammonia Nitrogen and COD meet the type 1 standard, the rests meet the type V standard of “Surface water quality standard” (GB3838-2002).

### 2.1.7 Acoustic environment quality

#### (1) Regional environmental noise

According to “2010 announcement bulletin of Environment quality for Changzhi”, there are 202 effective grid used to monitor the regional noise, the equivalent sound level for the noise is 52.4dB. Based on “Acoustic environment quality standard” (GB3096□2008), 189 grids meet the standard, which accounts for 93.6% of the total grids. Among the grids, 85 grids belong to type I region, in which 75 grids (88.2%) meet the standard; 66 grids belong to type II region, in which 63 grids (95.5%) meet the standard; 51 grids belong to type III region, in which all grids (100%) meet the standard.

#### (2) Functioning zone noise

The city is divided by four functioning zones (class 1□4) to monitor environmental noise, each zone has 2 monitoring points, the total number is 8. The monitoring work is done once every season for consecutive 24 hours. The monitoring results are: The average equivalent should level for class 1 is 53.2dB(A) during daytime and 46.0dB(A) at night; the average equivalent should level for class 2 is 59.3dB(A) during daytime and 49.9dB(A) at night; the average equivalent should level for class 3 is 56.0dB(A) during daytime and 49.5dB(A) at night; the average equivalent should level for class 4 is 63.6dB(A) during daytime and 56.9dB(A) at night. The noise in class 1 and 4 at night exceeds the limit, the rests meet the standard.

(3) Traffic noise in urban area

According to the environmental monitoring station in Changzhi, monitoring program has been done for 14 main roads and 73 sections in 2010, including Taihang Street, Yingixaong Road, Fuhou Street and Chengxi Road, the total distance of road under monitoring is 51.9km. The equivalent sound level for traffic noise of the city is 67.9dB(A), which is increased by 0.1dB from 2009. In urban area, except for road sections at hydraulic station, Physical Culture and Sports Commission, New Huaibei Community, oil company□city 1<sup>st</sup> coach station, bureau of health where the noise level exceed the class 4a standard (70dB) of “Acoustic environment quality standard” (GB3096□2008), the rest sections all meet the class 4a standard.

10 monitoring points are located along Taihang Street, the range of the sound level is 64.1□70.1dB, one of the ten points (10%) exceeds the standard by 0.1dB; 5 monitoring points are located along Fuhou Street, the range of the sound level is 66.9□70.3dB, one of the five points (20%) exceeds the standard by 0.3dB; 7 monitoring points are located along Yingxiong Road, the range of the sound level is 64.4□72.2dB, one of the seven points (14%) exceeds the standard by 2.2dB; 4 monitoring points are located along Chengxi Road, the range of the sound level is 67.4□68.6dB, noise level at all the points exceed the standard.

(4) Noise at sensitive receptors

According to the monitoring results, the noise at sensitive receptors is shown in table 2-3. From the result, it is shown that the noise level at sensitive receptors meets the class 2 standard of “Acoustic environment quality standard” (GB3096□2008), the acoustic environment meets the standard.

Table 2-3 Results of monitoring for sensitive receptors

Road name	Objective	Period	Sound level				Standard
			L <sub>10</sub>	L <sub>50</sub>	L <sub>90</sub>	Leq	
Yingxiong Road	Yingxiong road elementary school	daytime	57.6	52	50.3	53.8	60
		night	44.6	42.2	41	43.6	50
	Xiaolingtong kindergarten	daytime	58.1	54	51.4	55.4	60
		night	48.6	43.6	40	45.7	50
	Xianan Street elementary	daytime	52.3	51.5	44.0	50.2	55

Road name	Objective school	Period	Sound level				Standard	
			L <sub>10</sub>	L <sub>50</sub>	L <sub>90</sub>	Leq		
Taihang Street	Huoju middle school	daytime	53.5	52	51.1	52.3	60	
		night	42.4	42.1	41.9	42.3	50	
	No.12 middle school	daytime	56.3	54.8	53	55	60	
		night	48.4	40	37.3	44.3	50	
	Jiandong Road elementary school	daytime	59.2	55.5	50.3	56.6	60	
		night	46.8	43.4	41.9	44.1	50	
	Heji hospital	daytime	56.4	54.3	52.9	54.7	60	
		night	43.8	42.8	41.8	42.9	50	
	Fuhou Street	No. 2 middle school	daytime	55.8	47.9	44.8	51.8	55
			night	43.3	40.7	38.1	41.4	45
	Chengxi Road	Changzhi academy of education	daytime	56.4	54.3	52.9	54.7	60
			night	43.8	42.8	41.8	42.9	50
Maternal and Child Care Service Center		daytime	56.4	54.3	52.9	54.7	60	
		night	43.8	42.8	41.8	42.9	50	
No.7 middle school		daytime	54.8	51.4	48.3	52.4	55	
		night	42.8	41.5	40.3	41.7	45	
Parking and maintenance yard	Mafangtou	daytime	49.5	45.0	42.8	47.7	55	
		night	35.6	33.8	32.5	35.2	45	

### 2.1.8 Groundwater

The groundwater resource within Changzhi area is 0.664 billion m<sup>3</sup>, the resource within urban area is 5 million m<sup>3</sup>. Xinai spring within Changzhi is the second largest spring in Shanxi Province, the outlet is located at the 16km long valley of Zhuozhang River between Xiliu village in Lucheng city and Beidanche village in Pingshun. The boundaries of the spring are: surface water of Zhuozhang River and Qinhe River is the northern boundary; the border of Qin county and Qinyuan county serves as the western boundary; surface water divide between Zhuozhang River, Qinhe River and Danhe River is the southern boundary; surface water divide between Zhuozhang River and Qingzhang River and Niangziguan spring is the eastern boundary.

Xiliu source is located at the Zhuozhang River beach in Xiliu village, Lucheng city. It is 36km away from urban Changzhi and is the major source for domestic water supply.

### **2.1.9 Mineral resources**

The mineral resources detected in Changzhi area are coal, iron, manganese, aluminum, sulfur, limestone, plaster, quartz and marble etc. Among these 40 mineral resources, more than 20 of them have good mining economics, especially for coal, which has 90.6 billion ton reserve as predicted, 34.6 billion ton are detected, which accounts for 12% of total detected coal reserve in China. The type of coal in the area is diverse and the quality is good, it is buried shallow and easy for mining. There are reserves for sulfurous iron ore, evasive, bauxite, Quartz, refractory clay, marble, oil, rocks, clay, etc, which are all has potential for mining.

The mineral resources in urban are are limestone, refractory clay.

### **2.1.10 Earthquake**

According to national standards for seismic fortification intensity, design basic acceleration of ground motion and designed seismic category for major city area, the project construction area is degree 7 for the seismic fortification intensity and group 2 for the designed category.

## **2.2 Social environment**

### **2.2.1 Administrative divisions and population**

Changzhi has over 10 counties, 2 districts and 1 county-level city, these are: Changzhi County, Zhangzi county, Tunliu County, Huguan County, Licheng County, Pingshun county, Xiangyuan County, Wuxiang County, Qinxian county, Qinyuan county and Lucheng city. There are 247 towns within this administrative area and the total area of land is about 13896km<sup>2</sup>, total population is around 329.91 million.

The urban area is the political, economic, cultural, information and bussiness center, where the government agencies, such as city government of Changzhi and city committee of Changzhi, are located It has 10 subdistrict offices, which are: East street office, South Yingxiong road office, West street office, Middle Yingxiong road office, Zijin street office, Changqing street office, South Yanan street office, Mawu street office, Taidong street office, Taixi street office. Moreover, it has 49 communities, 28 grocery markets and more than 1600 institutions, military units, schools and enterprises. Population in urban area is 0.4162 million, with a density of 7376 people/km<sup>2</sup>. There are ten ethnic groups, which are: Han, Hui, Man, Mogolia, Miao, Bai, Chaoxian, Tujia and Naxi, etc.

### **2.2.2 Regional economic situation**

The GDP of Changzhi city in 2009 is 77.53 billion yuan, which is increased by 10% from 2008. The GDP of the primary industry is 3.52 billion yuan, which is decreased by 3.5%; the GDP of the secondary industry is 48.67 billion yuan, which is increased by 11.7%; the GDP of the tertiary industry is 25.34 billion yuan, which is increased by 9.5%. The ratio of

the three industries is adjusted from 4.8: 63.4: 31.8 to 4.5: 62.8: 32.7. GDP per capita is 23,558 yuan, which is increased by 9.5% from 2008.

The consumer price index (CPI) of 2009 is increased by 0.3%, among which the food price is increased by 2.5%, price of commercial product is decreased by 6.4% and price of Raw materials, fuel and power is decreased by 6.7%.

The total population with employment at the end of 2009 is about 1.5 million, which is increased by 21,900. Among these, the population in the primary industry is 0.65 million, which is decreased by 6,000; the population in the secondary industry is about 0.41 million, which is increased by 5,500; the population in the tertiary industry is about 0.48 million, which is increased by 22,400. The total number of increased jobs across the year is 39,000 and the unemployment rate is 2.16%, which is increased by 0.11% from last year.

The total gross financial revenue is 17.79 billion yuan, which is increased by 11.5% from last year. Among these, general budget revenue accounts for 6.96 billion, which is increased by 11.1%. The net financial revenue is 16.91 billion yuan and the general budget revenue accounts for 6.08 billion yuan, which are increased by 10.3% and 7.9% respectively. The general budget expenditure is 11.24 billion yuan, increased by 15.7% from last year. Among these, expenditures for social security and employment increased 9.8%, medical and health expenditures increased 21.3%, technology, education and agriculture expenditures increased 20.7%, 18.9 and 19.3% respectively.

### **2.2.3 Quality of life**

The population in the city in 2009 is 3.29 million, increased by 16,300 from last year. The birth rate and death is 11.12‰ and 6.18‰, the population increase rate is 4.94‰. Urban population accounts for 41.04%, which is increased by 0.59%. The sex ratio is 105.73 (female=100).

The annual net income for rural population per capita is 5,357 yuan, which is increased by 8.0%; in urban area, the per capita disposable income is 15,494.4 yuan, which is increased by 8.5%. The average per capita wage is 28,773 yuan, which is increased by 2,250 yuan (increased 8.4% ).

The average per capita house area in 2009 is 32m<sup>2</sup>, for rural resident, the average per capita housing area is 36.5 m<sup>2</sup>. Urban population with basic endowment insurance is 334,100, which is increased by 21,200. Among these, staffs account for 252,700, retirees account for 815,000. Staffs with basic health insurance are 449,600, which is increased by 465,000; staffs with unemployment insurance are 246,100, people with unemployment insurance

paid are 10525. There are 173 various social welfare institutions, which is increased by 27; number of beds are 9,473, which accommodates 304 people. 95 community service facilities are constructed. Amount of social welfare lotteries sold is 112.92 million yuan, donations from the society is 7.55 million yuan. Urban population with minimum standard of living are 55,419, rural population with minimum standard of living are 123,746.

#### 2.2.4 Land use

The land area in urban area of Changzhi is 55km<sup>2</sup>, which accounts for 17.1% of the total land area. Among these, the planting area of corps is 6626mu, the planting area of vegetable is 5634mu. Other types of land use such as industry, business, house and road account for 4557.5mu, which is 82.9% of the total land area.

The land use at different suburban office is shown in table 2-4.

Table 2-4 Land use condition at different xiang/town

Xiang/town/suburban office	area □km <sup>2</sup> □	percentage total %	cultivated land (ha□	Other(ha□	percentage road %
East street office	4.97	8.94	0	497	100
South Yingxiong street office	4.35	7.82	0	435	100
West street office	4.09	7.36	0	409	100
Middle Yingxiong street office	4.21	7.57	0	421	100
Zijing street office	4.94	8.88	0	494	100
Changqing street office	7.23	13	452.4	270.6	37.4
South Yanan street office	5.95	10.7	0	595	100
Wuma street office	6.55	11.8	490.1	164.9	25.2
Taidong street office	6.81	12.2	0	681	100
Taixi street office	6.50	11.73	0	650	100

#### 2.2.5 Physical cultural resources

There are 5 provincial level cultural sites within Changzhi area. Among these, 2 sites are key cultural relic under the State-level protection: Luanfu Temple and Guanyin Temple ; 3 sites are key cultural relic under the province-level protection: relic of Bitou, Chongjiao Temple and Shangdang Gate.

Verified by the Municipal Bureau of Culture in Changzhi city, there is no important cultural relic sites at any level protection within the assessment area of the project. Based on field survey, there are two PCR near Yingxiong Roads, i.e. a West Mosque and Huayan Temple. While these two sites are outside the right-of-way of the road, and will not be subject to direct impact from the project activity.

### **2.2.6 City construction**

Changzhi is awarded “one of the ten charming cities in China”, “national garden city”, “National Sanitary City” and “Provincial Model City for Environmental Protection”. In 2009, the constructed urban area is 45.3 million m<sup>2</sup>, urban building area is 53.56 million m<sup>2</sup>, which is increased by 14.1% from last year. Urban green coverage of the constructed area is 47.8%, which is increased by 1%. There are 557 operational vehicles for urban transportation and 1800 taxis. There are 4 parks within in the urban area, the total area is 127ha.

In 2009, the total water supply is 84.58 million ton, daily average domestic water per capita use is 160L. The total supply for LPG□Liquefied Petroleum Gas□ is 53.1 million ton and 15.92 million m<sup>3</sup> for that of natural gas. The total supply for coal gas is 110 million m<sup>3</sup> and 40.86 million m<sup>3</sup> of these are for domestic use. Popularization rate of gas is 82.81%, which is improved by 12.53%. The area for centralized heat supply is increased from 13.74 million m<sup>2</sup> to 18.54 million m<sup>2</sup>. Among these, 14.81 million m<sup>2</sup> are for residence use, which is increased by 3.83 million m<sup>2</sup>. The sewage plant in the city has the capacity of 140,000 ton/day, the total amount of waste water treated are 51.13 million ton. Total amount of solid waste collected are 220,000 ton, the safety disposal rate is 100%.

This project includes four main roads in urban area of Changzhi. Most of the roadside units are business, residential buildings, administration, medical and health department. The drainage system was built long time ago. Combined system is prevailing.

The current drainage pipelines and channels under the four roads have two types: single pipeline and double pipeline. Part of the narrow road sections uses single pipeline, with diameter of d500□1100×2000.

This project mainly focuses on replacing the non motor vehicle lane with bus priority lane or auxiliary road for mixed motor vehicle and non motor vehicle. The surface of road where the section is damaged by poor maintenance will be removed and repaved. The pipelines under the bus priority lane and the auxiliary road need to be protected.

## **2.3 Urban transportation**

### **2.3.1 Road network**

- (1) Connection between cities: Urban area of Changzhi has 4 highway entrances/exits. These are Taichang Highway (G208) entrance/exit in the west, Taichang Highway

(S326) entrance/exit in the south, Changhan Highway (S103) entrance/exit at Anyang, Changhan Highway (G207) entrance/exit at Xicun.

- (2) Road in the city: the layout of the road network of urban Changzhi is grid network, the main roads are in south-north direction and east-west direction. The Yixiong road is the vertical axis of south-north direction, the Taihang Street is the horizontal axis of east-west direction, which together constitute the road frame horizontally and vertically. The roads to outside urban are outer ring road, West Taihang street, west section of 1<sup>st</sup> ring road, South Yingxiong road, East Jiefang street, etc. The total distance of the road network in the urban area is 215.8km, the density of road network is 3.88km/ km<sup>2</sup>, urban road area ratio is 8.6%, average road area per capita is 7.87 m<sup>2</sup>. Ratio of major, branch and secondary road is 1:0.27:1.72, in which the ratio of branch and secondary road are too small compared with the standard 1:1.2:3.
- (3) In conclusion, the density of the road network within urban area is relatively low, the road area is relatively small and the ratio of road mixture is not proper. In addition, the scale of motor vehicle lane in the major roads is small, which is difficult for road expansion; the entrance of the building along the route direct connects with the major road, which makes the traffic efficiency low in the major road; the connectivity of the roads is not enough, where dead ends are common, which makes the traffic capacity low for the entire major roads.

### **2.3.2 Urban transportation infrastructure**

First of all, there is no bus priority lane in Changzhi, the public transit system is not complete. Currently, the bus company in Changzhi has 621 buses and the total area for bus parking is 73,000 m<sup>2</sup>, which can only satisfy the basic need for bus parking and maintenance. The number of bus terminal stations within the urban area is 40. Among there, 11 terminal stations has more than 2 bus routes. Bus stops are located along the major road including Yingxiong Road, Jiefang Street, Yanan Road, Changxing Road and Chengdong Road, usually they are harbor-typed stops with a total number of 50.

In addition, included in the current intelligent urban transport management system, signal facilities (all single point signal control), e-police, CCTV monitoring, Traffic Guidance using VMS, License Plate Recognition System and traffic guidance screen have been installed for some of the road section. However, these facilities are not well maintained and the coverage is not large enough. Moreover, most of these facilities are not functioning.

Third, parking facilities in the urban area are limited especially in the central area. Parking without permit and occupation of road shoulder disturbs the normal traffic flow, which could potentially cause safety issues.

### **2.3.3 Traffic condition**

The major way of transportation for the resident is on foot, which accounts for 4.3%, bicycle for 27%, public transportation for 12%, scooters for 8% and private vehicles for 8%. The traffic rush hour in the morning is 7:30-8:30 and 17:30-18:30 in the evening. According to the observation, the traffic volume at south-north direction of Chengxi Road, Yingxiong Road, Changxing Road, Yanan Road and the east-west direction of Taihang Street, Zijin Street, South West Street, central area of Jiefang Road are relatively high. Traffic volume for the section from West Jiefang Road to Bayi Square at Yingxiong Road is especially high. Currently, the urban transportation at Changzhi is showing congestion especially during morning and evening hours.

### **2.3.4 Traffic safety**

Every year in Changzhi, injury and death from traffic accident are high. The average number of death from each accident is 0.47, which is 1.68 time of the national average. Compared with other cities of similar size, this number is high for Changzhi, denoting that it faces serious problem in traffic safety.

Studies of traffic accident from the past 3 years show that 5 roads in Changzhi have high risk of accident: West outer ring, East outer ring, Taihang Road, Yingxiong Road and Wuzhen Street.

## **2.4 Relevant transportation plans**

### **2.4.1 Relevant plans**

#### **(1) Urban master plan of Changzhi**

From the master plan, it is determined that the city should develop toward the north. Based on this strategy, planning of various infrastructures and facilities are finished. Moreover, planning of an integrated transportation system including railway, road and airport is determined. The overall layout of the urban road network shows south-north direction.

According to the urban master plan of Changzhi (2001-2020), the structure of the road network should form “grided road network with ring road circulated from inside and outside and radiated development ” based on existing situation. These are: grided road within the urban central area; four inner and outer ring roads. The major road network for the central urban area should be “vertically six and horizontally seven”, which means: vertically layout for six roads, including West outer ring road, Luze Street, Chengxi Road, Yanan Road, Chengdong Road, East outer ring road; horizontally layout for seven roads, including North outer ring road, North 1<sup>st</sup> ring road, Chengbei Street, East and West Taihang Street, Wuzhen Street, South outer ring road.

## (2) Master plan of central urban area of Changzhi

Objective of the plan: lead the urban development, provide guideline and regulation for strategically arrangement of the land use, transportation and public municipal facilities.

This plan further implement the requirement form the city master plan. It provides plans for the land use, building density, floor-area ratio, greening rate, building height, parking spots and related facilities within the 49.59 km<sup>2</sup> urban area; it also sets guideline and standards for other urban design contents.

According to “Master plan of central urban area of Changzhi □2011-2020□”, the road network of urban Changzhi should be “vertical nine and horizontal nine”, which means: vertically layout for nine roads, including East ring road, Chengdong Road, Yanan Road, Changxing Road, Yingxiong Road, Chengxi Road, West ring road, Zhanqian road and West outer ring road; horizontally layout for nine roads, including North ring road, Chengbei Street, Taihang Street, Zijin Street, Fuhou Street, East West Street, Jiefang Street, Heping Street and Chengnan Street.

## (3) Strategy development of “1+6” metropolitan area

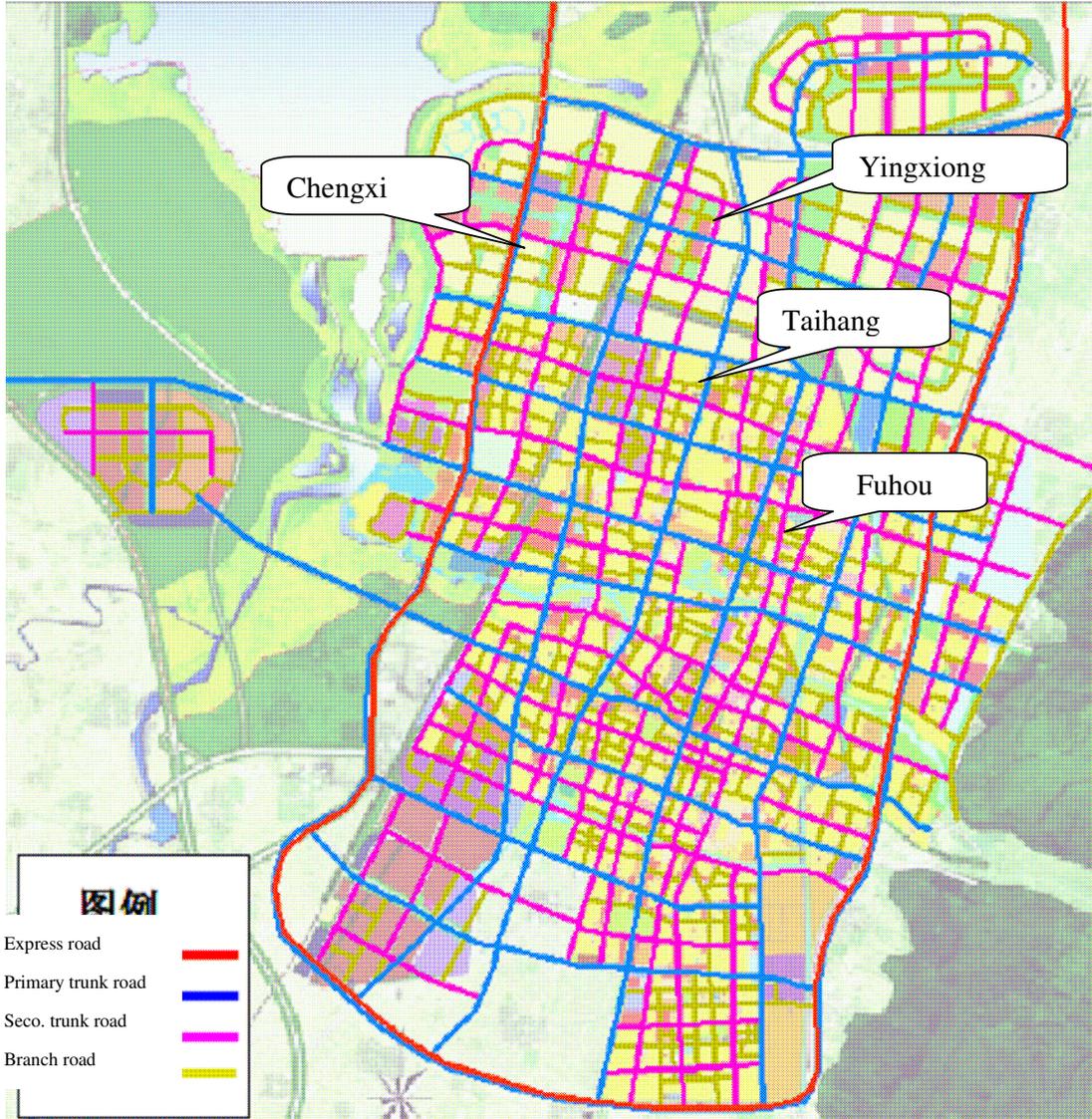
Objective: Through development, make Changzhi a hub for the economic development of southeast Shanxi. Enhance the connections and cooperation with the adjacent cities so that capital, technology, information and talent can flow and communicate within the area.

The plan lays down various development objectives for the “1+6” metropolitan area, proposes plans and strategies for industrial development, municipal and countryside development, environment protection, policy enhancement, regional development and supportive basic infrastructure development.

According to “Strategy and guidance for development of “1+6” metropolitan area” (2008-2030), urban transportation of Changzhi will have the capability to reach between urban area and adjacent counties and towns via the rapid transport system within 20 minutes. According to the planning for road network of urban area of Changzhi and inter-city connection roads, the major roads connecting with the inter-city connection roads are Tianwanji Road (toward south), Fuhou Street (toward east), Chengdong Road (toward north), Taihang Street and West Street (toward west).

## (4) Integrated transportation master plan

According to the integrated transportation planning from GEF project, the road network of urban area of Changzhi is shown in figure 2-5. For the four transport corridors, only Fuhou Street is the secondary main road and the other three are primary main roads.



#### 2.4.2.1 Relationship between the transport corridors and the transport master plan

According to the introduction from the master plan, Yingxiong Road, Taihang Street, Chengxi Road and Fuhou Road in this project are the main road in the city. In accordance with different plan contents, Fuhou Street and Taihang Street are connected with the inter-city route. The functioning definitions of the four corridors are:

- (1) Yingxiong Road

Planned as the main road; its service function for south of the city will be reduced in the future due to the construction of inter-city rapid route between Tianwanji Road and Changzhi county; as the business corridor in the old city district, the axle function will be reduced due to the development, but the business and recreational function will be maintained considering the exist of Bayi Square; The design of bus route can support the business and recreational function.

(2) Taihang Street

Planned as the main road; Served as the axle for the development in east-west direction; the development of new city district will be to its west; it is connected with Laoding Mountain in the east, so it is the key axle for supporting the city development. In the west, it is connected with the inter-city rapid route to Tunliu district. Before the construction of West outer ring road, it also serves as the transportation axles for the traffic outside the city, with the construction of the rapid transit road, this function will be weakened, which will enhance its function as the bus corridor.

(3) Chengxi Road

Planned as the main road; the development of new city district toward the south will make this corridor the most important axle in the south-north direction. The bus passenger volume will increase in the future. For the time being, it is the center bus route in the west part of the city and rapid transit will be added in the plan in the future. Its main function will be serving as a bus axle in the future because it is not connected with the inter-city rapid route according to the master transportation plan.

(4) Fuhou Street

Planned as the secondary main road; will begin the construction of inter-city rapid route recently, with the reconstruction of its eastern section in the meantime, the function as the bus corridor will be enhanced; it is connected with the coach station and foreign trade business market, the coach station will be also served as tourist coach station with its bus depot function enhanced; it is also a bus corridor crossing the old city district.

(5) Analysis and conclusion

The existing integrated transportation master plan provides a reasonable objective, which mainly includes bus improvement strategy in the future. The integrated corridor improvement in this project is the major component and it will improve the bus transportation ratio by enhancing the bus transportation attraction, in the meantime, it is of great importance for accomplishment of environment-friendly transportation in the city.

Taihang Street is the axle in the east-west direction of the city, which plays a key role in supporting the development of the new city district and Laoding mountain area; Yingxiong Road is the most important axle in the south-north direction in the current road system; Chengxi Road is the axle in the future of the city; Fuhou Street is the important axle in the future for the east-west direction. The implementation of these integrated corridors and bus priority lane will not only improve the transportation in the city, but also enhance and lead the development along the corridors and the new city district, achieve the planning objectives of the city.

#### **2.4.2.2 Relationship between public transportation infrastructure and relevant city planning**

The number of bus in urban Changzhi is not enough and part of the buses are in a poor operation condition; the parking space of buses is very limited; the location and type of the bus station is not proper ; the auxiliary facilities is old. Therefore, the construction of the bus terminal stations and the parking and maintenance yard will improve the bus operation condition and provide basis and support for the bus prior development in Changzhi.

The number of parking facilities is too limited, in addition, the lack of comprehensive planning and management is the main reason causing this problem. Currently, there is no specific planning for parking yard in Changzhi, the construction of parking yard is not under guidance. The available parking space cannot meet the requirement and the layout of the parking yard is not proper. The facilities and management of the parking yard is poor, the auxiliary facilities are not complete and have no safety guarantee. Therefore, comprehensive planning and management of parking space and facilities requires integrated parking management.

### 3 Project Descriptions

#### 3.1 Project description

Objective of the project is to improve transport mobility in the central city of Changzhi in a safe, sustainable, and efficient manner for all users.

Implementing department: Changzhi Urban Transport Project Management Office

Project location: Urban area of Changzhi

Construction period: 2012-2015

#### 3.2 Major project components

Changzhi Sustainable Urban Transport Project has four components, they are: Integrated Corridor Improvement; Intelligent Urban Transport Management System; Public Transit Supporting Infrastructure; and Institutional Capacity Development.

The total investment for this project is about 1.29 billion yuan, about 0.2 billion dolar, among which, 0.1 billion will be from the World Bank loan, the rest is from the counterpart funding of the city.

The main project construction contents are shown in table 3-1.

Table 3-1: Project Components

No	Project components	Construction Contents	Amount investment (10,000 yuan)	Percentage (%)
1	Integrated Corridor Improvement	Bus priority lane	90302.69	69.9
		Road reconstruction		
		Bridge works		
		Water supply and drainage pipeline		
		Transportation facilities		
		“Green” area relocation and renovation		
		Parking improvement		

2	Intelligent Urban Transport Management System	Urban transport database platform	21007.47	11.6
		Intelligent Traffic Management and Control System		
		Intelligent bus operation and service platform		
		Traffic Management Auxiliary System		
3	Public Transit Supporting Infrastructure	Bus Depot at Bayi Square	14973.8	16.3
		Bus Terminal Station		
		Park and Maintenance Yard		
4	Institutional Capacity Development	Institutional investigation, training, research and workshop, related technical consulting and related technical facilities and materials	2832.4	2.2
5	Project Front-End Fee	-	159.75	0.1
Total			129276.11	

### 3.3 Integrated Corridor Improvement

Integrated Corridor Improvement is one of the important components for this project. The goal is to establish an integrated fast transport system of public transit, pedestrians and bicycles. The involved corridors are Taihang Street, Yingxiong Road, Chengxi Road and Fuhou Street. The start and end location as well as the distance for the reconstruction of the four corridors are shown in table 3-2, the detailed location is shown in figure 2-1.

Table 3-2: Start location, end location and distance

Road Name	Start and End Location	Pile No.	Distance(km)
Taihang Street	Hubin Street□Jinkou Road	K0+068.609□K8+708.693	8.64
Yingxiong Road	West Outer Ring Road□Mafangtou	K0+300□K9+049.634	8.75
Chengxi Road	West Outer Ring Road□Wuyi Street	K0+190.02□K5+215.797	5.03

Fuhou Street.	Zhanqian Road □ Middle Changxing Road	K0+194.127 □ K3+885.682	3.69
Total			26.1

### 3.3.1 Major engineering criteria

(1) Road construction technical criteria

The main indexes are shown in table 3-3.

Table 3-3: Main technical standards for road construction

Item		Criteria
Road type, class		Main road □ Secondary main road for Fuhou Street □
Number of Lanes		Two ways six lines □ two ways four motor vehicle lanes + two ways two bus priority lanes □
Designed pavement structure life(year)		15
Designed running speed(km □ h)		40 □ 60
Designed road load		BZZ □ 100 standard car
Line width(m)	Road section	3.25 □ 3.75
	Intersection	3 □ 3.25
	Bay-typed bus stop	2.5 □ 3
Latitudinal slope	Motor vehicle lane	2%
	Pedestrian lane	Inverse 2%
Height(m)	Motor vehicle	≥5.0
	Non motor vehicle and pedestrian	≥2.5
Distance between bus stop		500 □ 800
Min. radius(m)		1000
Min. length of horizontal curve (m)		50
stopping sight distance (m)		70
Max. longitudinal slope		2.6%
Min. distance of longitudinal slope (m)		110
min. radius of vertical curve (m)		1800(convex) □ 1500(concave)
min. length of vertical curve		40

(m)	
-----	--

(2) Tunnel engineering technical criteria

Tunnel is constructed for entry/exit of the underground parking yard under the platform of Baiyi Square, it is the ramp of the parking lot. The maximum slope is 12%, the width is 7m, degree 7 for the seismic fortification intensity.

(3) Rainwater drainage engineering technical criteria

The drainage system for city of Changzhi is a combination of rainwater and sewage water, which is collected together by the drainage pipeline. Collection time:  $t_1=10\text{min}$ ; designed storm return period:  $P=1$  year; runoff coefficient: 0.9 for road, green area for 0.15, weighted average is 0.6; based on the precipitation condition recently, recommend to use larger runoff coefficient.

(4) Lighting technical criteria

Criteria for the road: Average illuminance  $30(1x)$  ; average brightness  $2.0(\text{cd}\cdot\text{m}^2)$ .

**3.3.2 General plan**

(1) General layout plan

Taihang Street and Fuhou Street are designed for bus running at both sides of the bus priority lane, Yingxiong Road and Chengxi Road are designed for bus running at the middle of the bus priority lane.

The layout of the bus route is adjusted based on the integrated transportation master plan, the current locations of bus stops are mostly remained, bus stops close to intersections are designed to integrate with the intersections, the type of the bus stop is changed to bay-typed. The general layout plan is shown in table 3-4.

(2) Major layout factors for the bus priority lane

a. Length of mixing section

Non- parking zone of 50m-100m long should be used in proximity of the intersection to ensure the smooth running of the vehicle.

b. Transition section

No transition between the normal road and bus priority lane, using signal to ensure the bus priority.

c. Bus priority lane at the interaction

d. Bus stop design

There are three types of bust stops: bay-typed, dot-painted bay-type and junction integrated type.

dot-painted bay-type:  $2\cdot 3$  depots, platform needs to be  $30\text{m}\cdot 45\text{m}$ .

Bay-typed: 65m for two depots, platform is 30m; 80m for three spots, platform is 45m.

intersection integrated type: consistent with the design of integrated intersection.

Table 3-4: Integrated corridors master plan

No	Name	Designed speed (km/h)	Redline Width (m)	Priority lane type	Entry/exit management	Junction	Number of Intersection Channelization	Bus route and the adjustment	
								Current	Plannin
1	Taihang Street	60	40□60	Side	Right turn	Plain Junction	11	16 bus stops along the road side, route 1, 2, 5, 13, 14, 313	Add 3 typed□ west di side pa stop ch 1□2□3 branch station 6□9□1 all need Heji ho
2	Yingxiong Road	40,60 (south of ecology garden)	40□60	Middle			6	18 bus stops, 5 bay-type, rest along road side, route tong1□2□3□6□8□10 red□10 blue□12□13□14□16□16 branch□19□20□313	Add 1 to bay-type; cl renova reconst South e north d institut route to blue□1 1□20□ airport

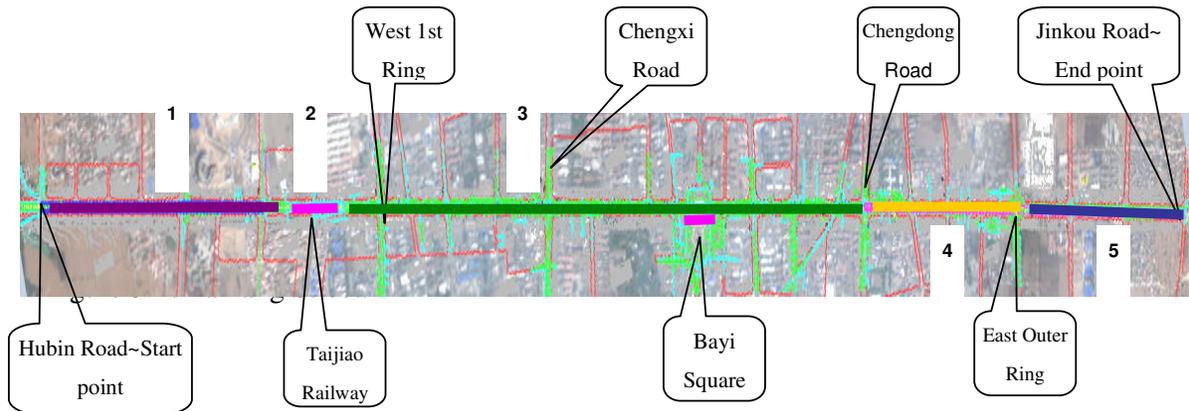
3	Chengxi Road	40	40□60	Middle			6	12 bus stops along the road side, route 3□5□7□13□14□18□302□303□307□310	8 chang type, re tong18
4	Fuhou Street	40	50	Side			3	7 bus stops along the road side, route, tong13□17□2□7□5□6□8□16□21□302□303□307□310	2 chang 2 chang tong2□ and rec directio

### 3.3.3 Road construction

In order to fully utilize the existing facilities and minimize the influence on urban transportation, the center of the horizontal curve should be maintained with existing condition on basis of meeting the design requirement. The road profile should be aligned based on the center of the current road, the shape and height of the profile should keep consistent with current design so that it can be connected smoothly with other roads, entrance/exit of department and residential area.

#### 3.3.3.1 Profile for Taihang Street

According to different type of profiles, Taihang Street is divided by 5 sections, which are shown in figure 3-1.



#### 1. Hubin Road ~ Taiyu Road

The isolation belt between motor vehicle lane and non motor vehicle lane is kept the same, the 6m non motor vehicle lane is changed to 4m bus priority lane, the rest 2m, together with the current pedestrian lane are changed to pedestrian and non- motor vehicle integrated lane, the width is 6.5m. The trees beside the road should be maintained.

This section of road is 2.2km long, the current and designed profiles are shown in figure 3-2 and 3-3.

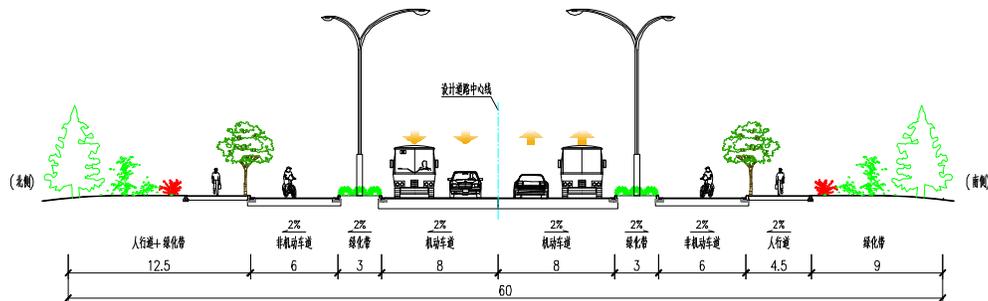


Figure 3-2 Current profile for Hubin Road ~ Taijiao railway

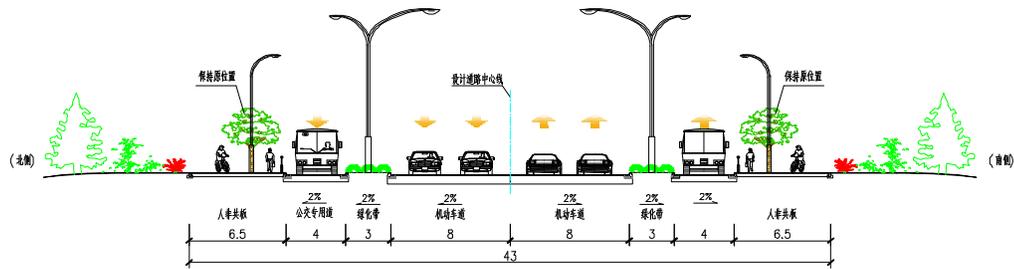


Figure 3-3 Profile design for Hubin Road~Tajjiao railway

## 2. Tajjiao Railway

This section of the road is 0.6km, the current profile is maintained, there is no bus priority lane here, but bus priority signals are used. The current profile is shown in figure 3-4.

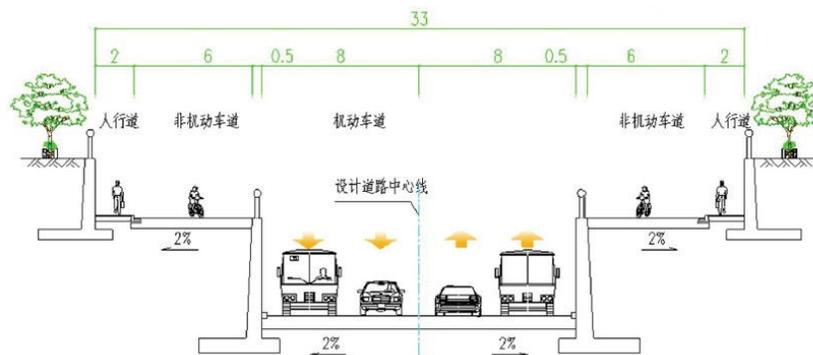


Figure 3-4: Current profile for the tunnel under Tajjiao railway

## 3. West 1<sup>st</sup> ring Chengdong Road

The isolation belt between motor vehicle lane and non motor vehicle lane will be maintained. The 7m wide non motor vehicle lane is changed to 4m wide bus priority lane and 3m wide non motor vehicle lane as pedestrian and non-motor vehicle integrated lane, the green belt and pedestrian lane are kept the unchanged. The profile design of the section in Bayi Square is shown in the figure for the junction design of Bayi Square. This section of the road is 4km, the current and designed profile are shown in figure 3-5 and figure 3-6.

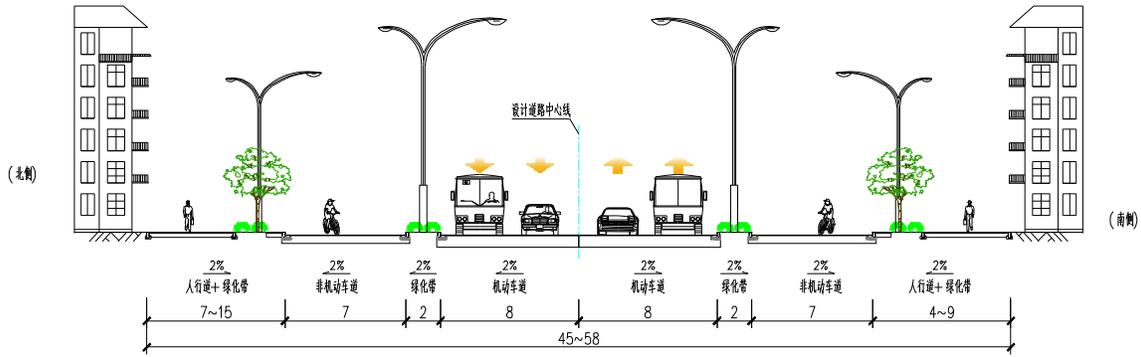


Figure 3-5: Current profile for West 1<sup>st</sup> Ring Road ~ Chengdong Road

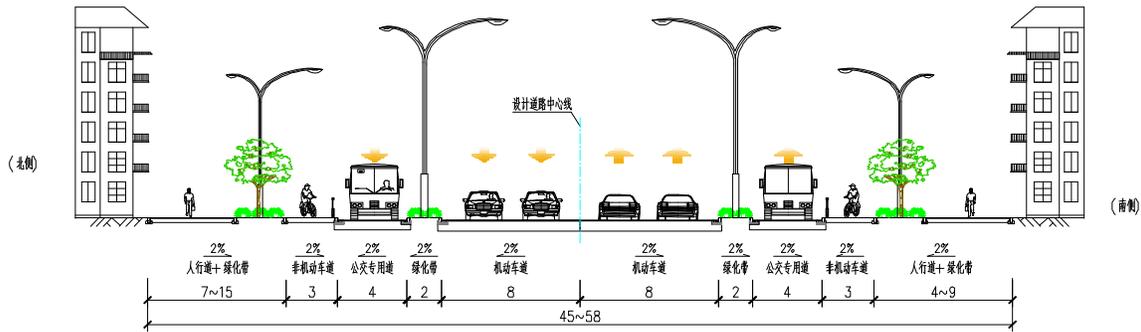


Figure 3-6: Profile design for West 1<sup>st</sup> Ring Road ~ Chengdong Road

#### 4. Chengdong Road □ East Outer Ring Road

The motor vehicle lane will be maintained, the 6m wide non motor vehicle lane is changed to 4m wide bus priority lane, the rest 2m, together with the pedestrian lane or green belt are changed to 3m non motor vehicle lane as pedestrian and non-motor vehicle integrated lane. This section of the road is 1.3km, the current and designed profile is shown in figure 3-7 and figure 3-8.

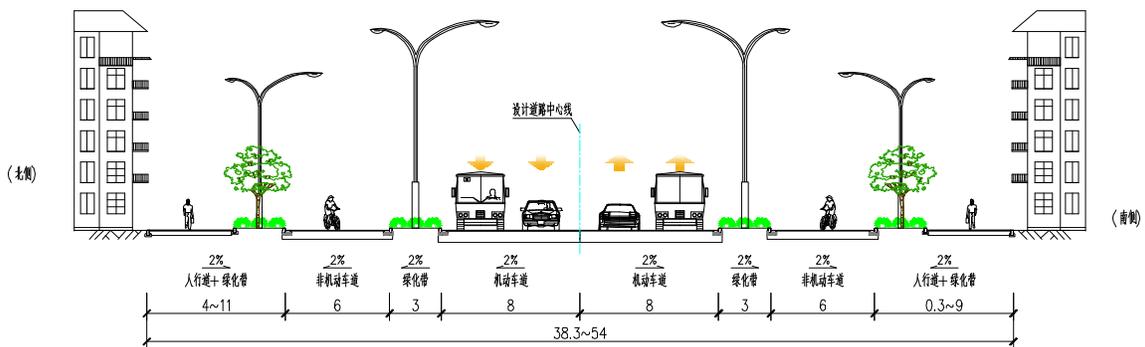


Figure 3-7: Current profile for Chengdong Road □ East Outer Ring Road

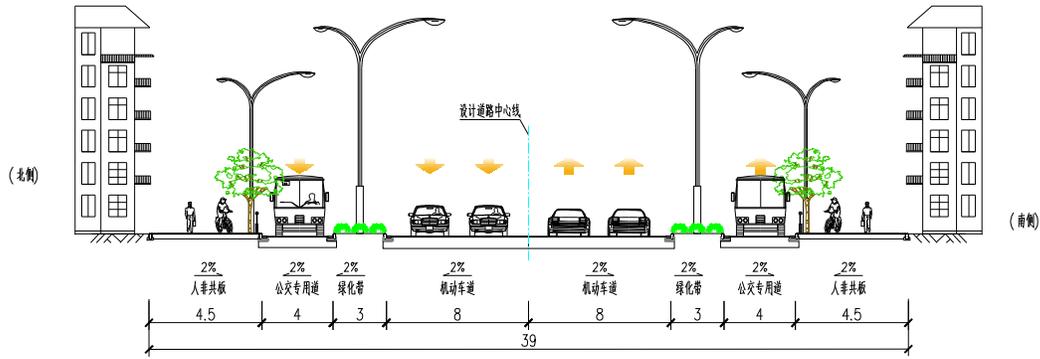


Figure 3-8: Profile design for Chengdong Road at East Outer Ring Road

### 5. East Outer Ring Road at Jinkou Village

The current profile will be maintained and bus priority is denoted using painting on the road. This section of the road is 0.5km, the current profile is shown in figure 3-9.

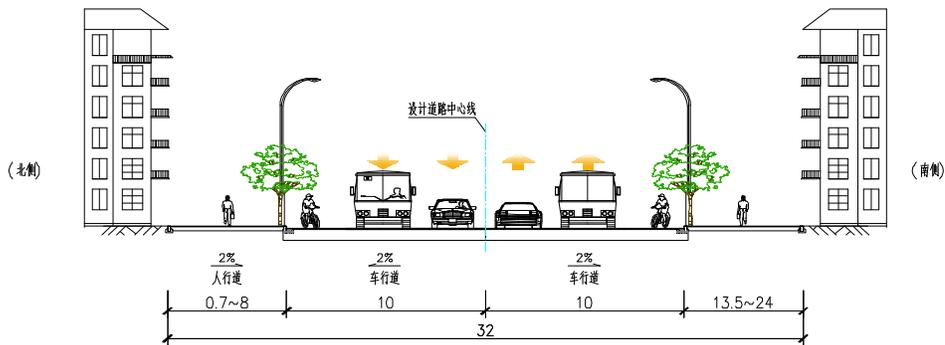


Figure 3-9: Profile design for East Outer Ring Road at Jinkou Village

### 3.3.3.2 Yingxiong Road

According to different type of profiles, Yingxiong Road is divided by 7 sections, which are shown in figure 3-10.

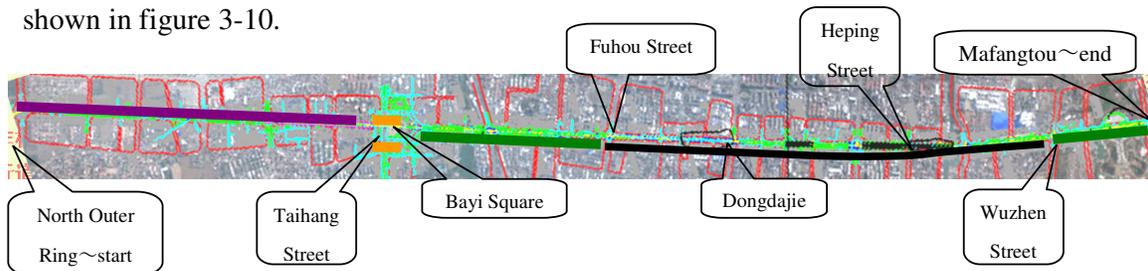


Figure 3-10: Yingxiong Road profile

#### 1. North Outer Ring Road at Taihang Street

The motor vehicle lane will be maintained; for the road section from West Street to Taihang Street, the non motor vehicle lane (5.5m) and green belt (3m) are changed to green belt

(2.5m)+ auxiliary road (6m), the pedestrian lane, green belt outside and other road section is kept the same with current design.

This section of the road is 2.7km, the current and designed profiles are shown in figure 3-11 and 3-12.

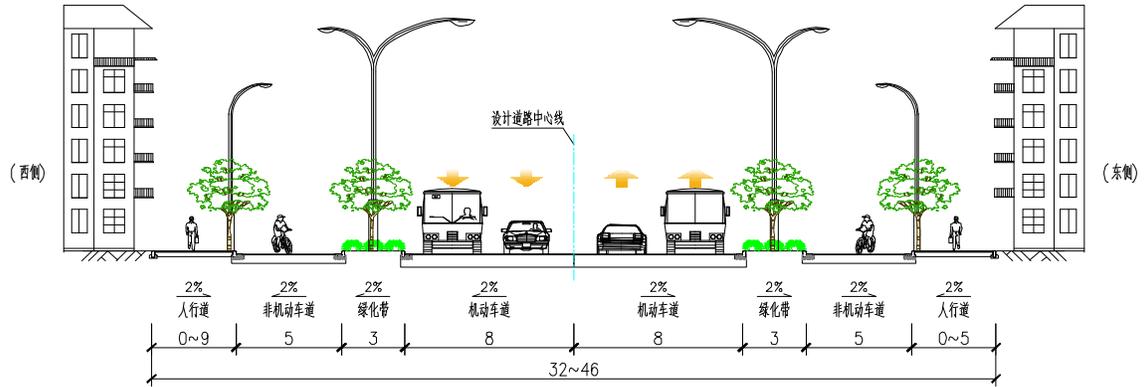


Figure 3-11: Current profile for North Outer Ring Road □ Taihang Street

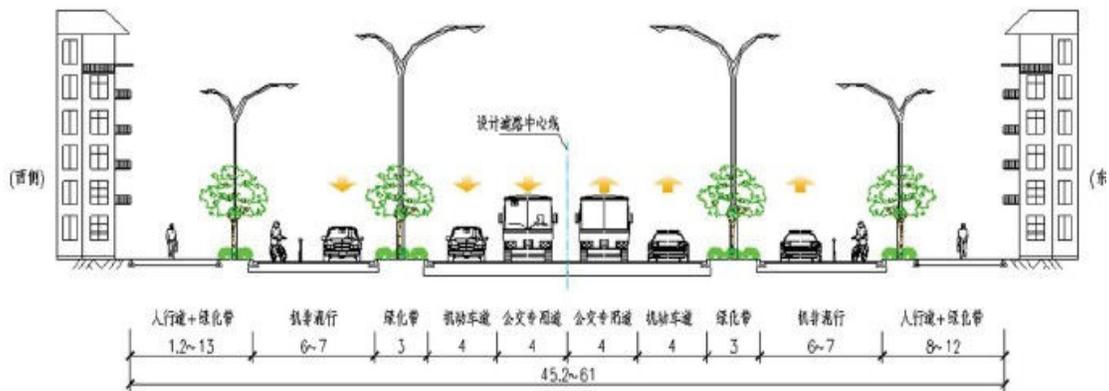


Figure 3-12: Profile design for North Outer Ring Road □ Taihang Street

## 2. Taihang Street □ Fuhou Street

The motor vehicle lane and green belt will be maintained, the 5m wide non motor vehicle lane will be expanded to 6m as an auxiliary road. The profile for Bayi Square is kept the same with the current design, one bus priority lane is added, the detailed design is shown in Bayi Square junction design figure.

This section of the road is 1.7km, the current and designed profiles are shown in figure 3-13 and 3-14.

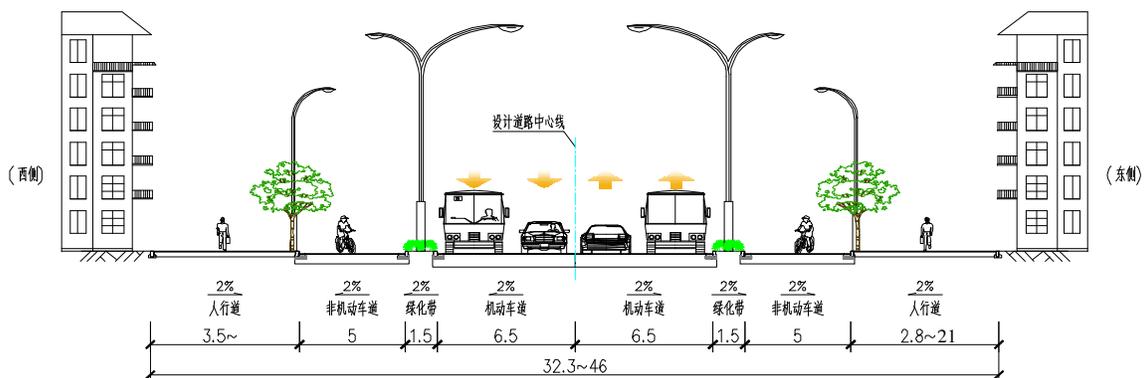


Figure 3-13: Current profile for Taihang Street □ Fuhou Street

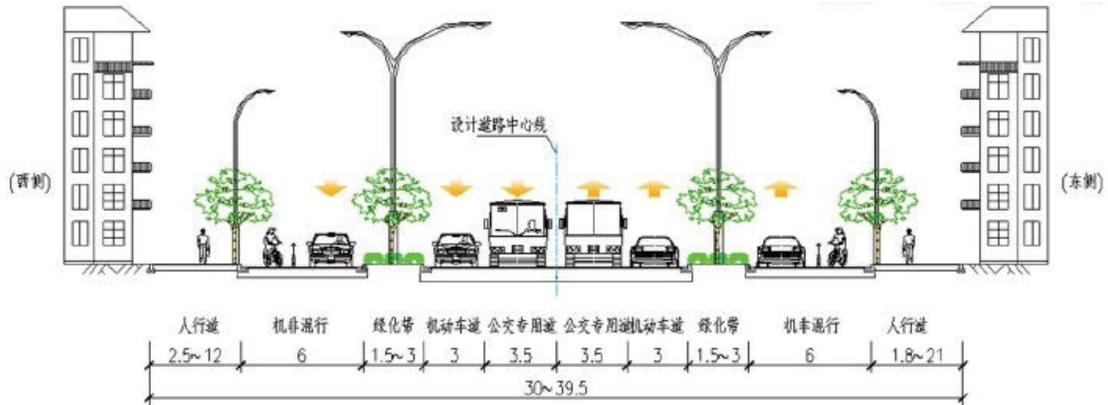


Figure 3-14: Profile design for Taihang Street □ Fuhou Street

### 3. Fuhou Street □ Dongdajie

The current design is one slab, the width will be maintained. For the road section from Xinshi Street to Dongdajie, the current mixed traffic line (13m) is changed to motor vehicle lane of the same width, with four lines in two ways. The pedestrian line outside will be changed to 4.5m wide pedestrian and non-mechanical-vehicle integrated slab. This section of the road is 0.9km, the current profile is shown in figure 3-15.

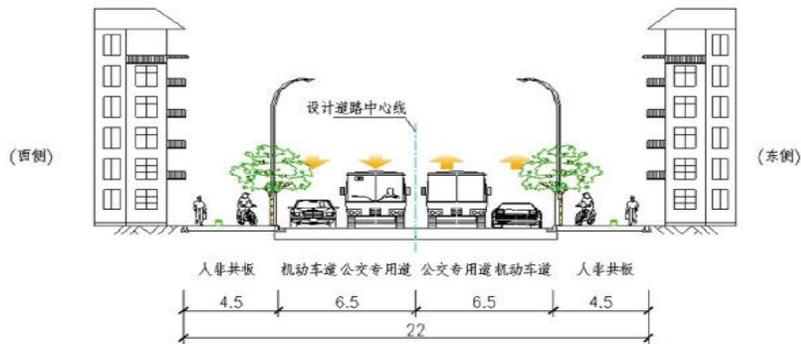


Figure 3-15: Current profile for Fuhou Street □ Dongdajie

### 4. Dongdajie □ Heping Street

This section of the road is 1.3km and the profile will be maintained, the 6m wide non motor vehicle lane is changed to auxiliary road. The current and designed profiles are shown in figure 3-16 and figure 3-17.

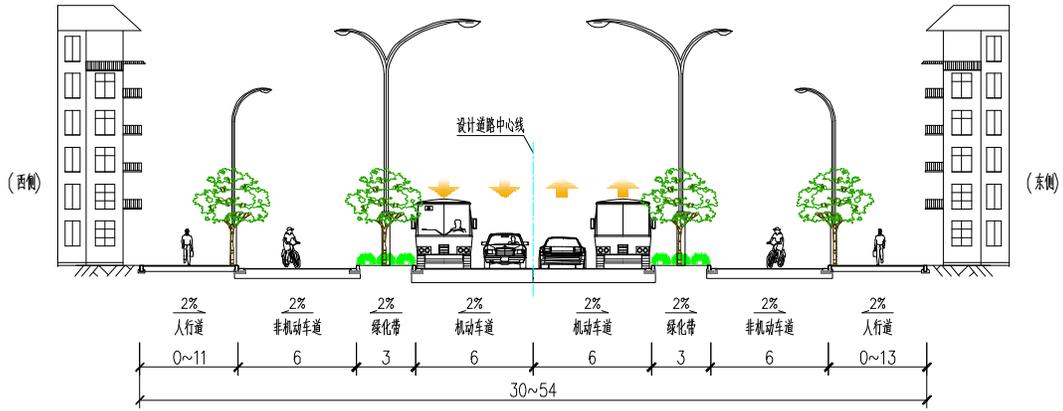


Figure 3-16: Current profile for Dongdajie Heping Street



Figure 3-17: Profile design for Dongdajie Heping Street

### 5. Heping Street Wuzhen Street

The current profile is motor vehicle lane (16m) + side isolation belt (6m) + non motor vehicle lane (8m) = 30m, the surrounding building is around 0-2.5m away from the edge of the non motor vehicle lane. This section of the road is 1.1km and will be changed to one lane, as shown in figure 3-18.

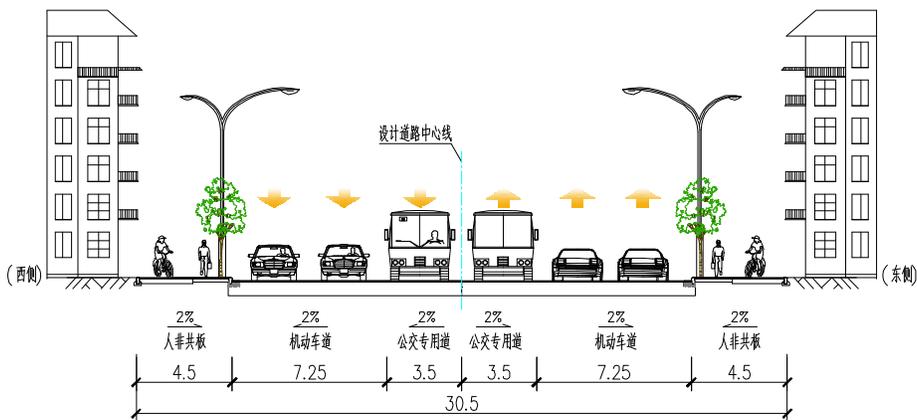


Figure 3-18: Current profile for Heping Street □ Wuzhen Street

6. Wuzhen Street □ 25th Wei Road

The current profile will be maintained, the motor vehicle lane in the center will be changed to bus priority lane + motor vehicle lane.

This section of the road is 0.7km, the current and designed profiles are shown in figure 3-19 and figure 3-20.

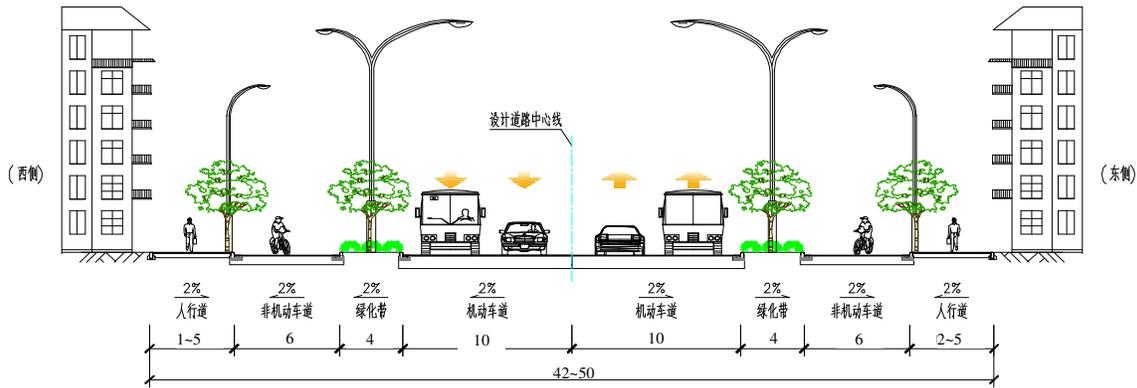


Figure 3-19: Current profile for Wuzhen Street □ 25th Wei Road

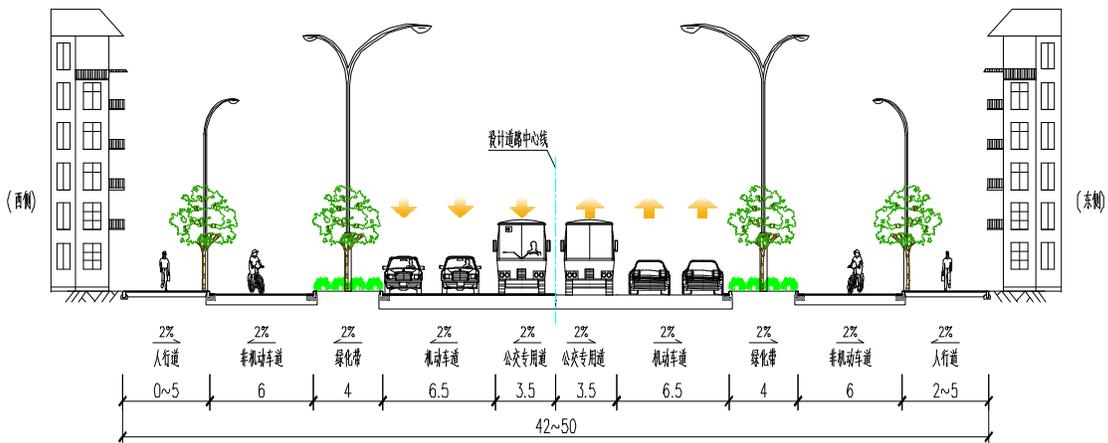


Figure 3-20: Profile design for Wuzhen Street □ 25th Wei Road

7. 25th Wei Road □ Mafangtou

The current profile is a 20m wide road, which will be maintained with no bus priority lane. This section of the road is 0.7km, the current profile is shown in figure 3-21.

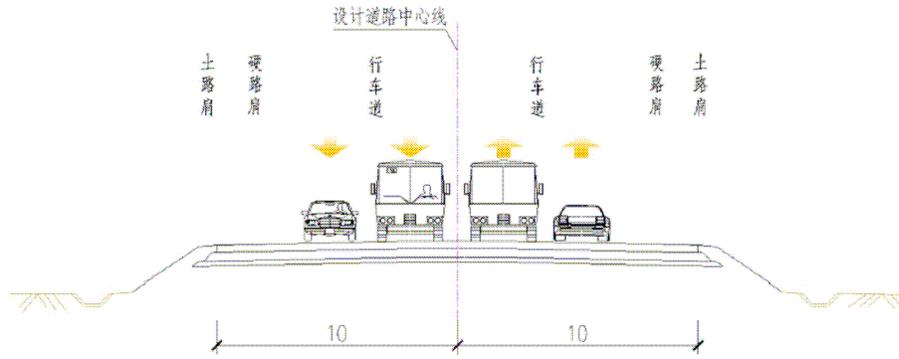


Figure 3-21: Current profile for 25th Wei Road □ Mafangtou

### 3.3.3.3 Chengxi Road

According to different types of profile, Chenxi Road is divided by 2 sections, as shown in figure 3-22.

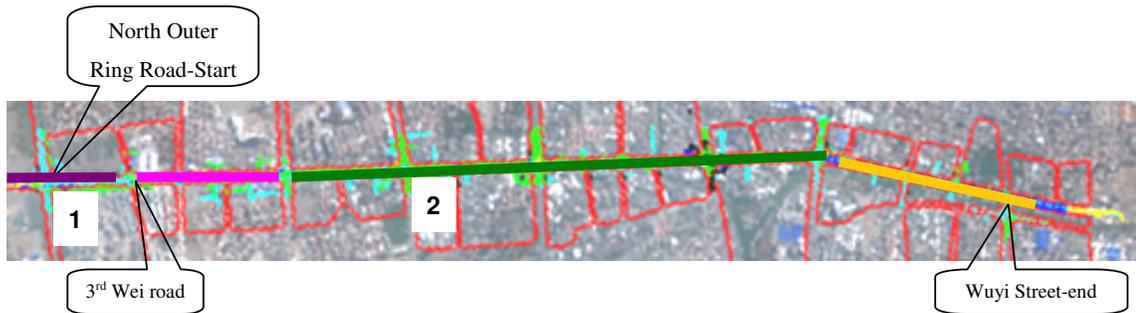


Figure 3-22 Chengxi Road profile

#### 1. North Outer Ring Road □ 3<sup>rd</sup> Wei Road

The motor vehicle lane will be maintained, the pedestrian lane will be changed to motor vehicle lane (3.5m) and a non motor vehicle lane (2.5m) with pedestrian and non-motor vehicle integrated. The road side trees should be maintained.

This section of the road is 0.4km, the current and designed profiles are shown in figure 3-23 and 3-24.

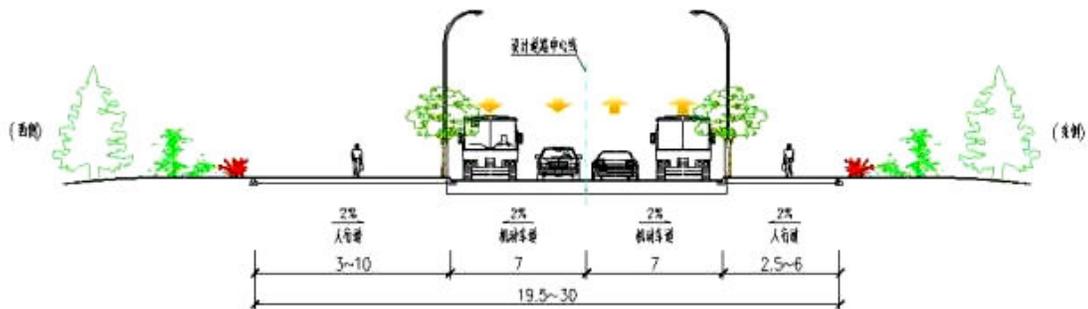


Figure 3-23: Current profile for North Outer Ring Road □ 3<sup>rd</sup> Wei Road

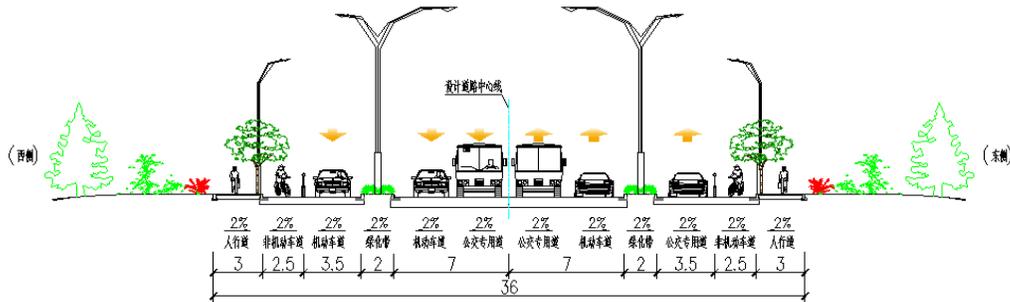


Figure 3-24: Profile design for North Outer Ring Road □ 3<sup>rd</sup> Wei Road

### 2. 3<sup>rd</sup> Wei Road □ Wuyi Street

The motor vehicle lane and the isolation belt will be maintained, the non motor vehicle lane (5-6m) will be changed to motor vehicle lane (3.5m) and non motor vehicle lane (2.5m) with pedestrian and non- motor vehicle lane integrated, extra width required will be satisfied by expanding to pedestrian lane to replace the green belt.

This section of the road is 4.6km, the current and designed profiles are shown in figure 3-25 and 3-26.

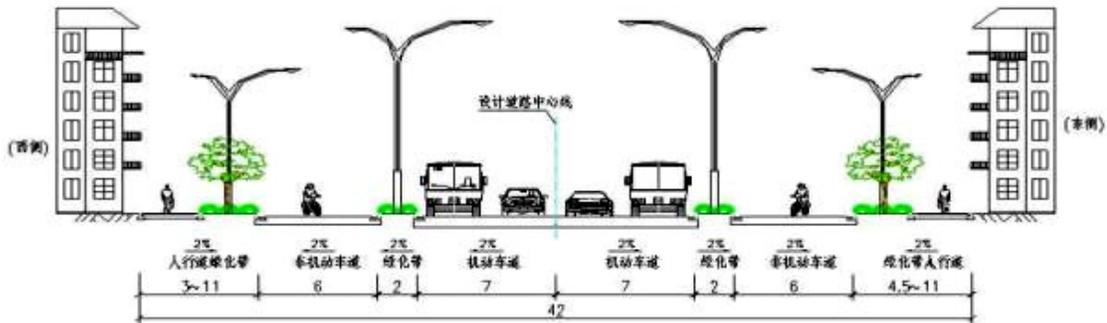


Figure 3-25: Current profile for 3<sup>rd</sup> Wei Road □ Wuyi Street

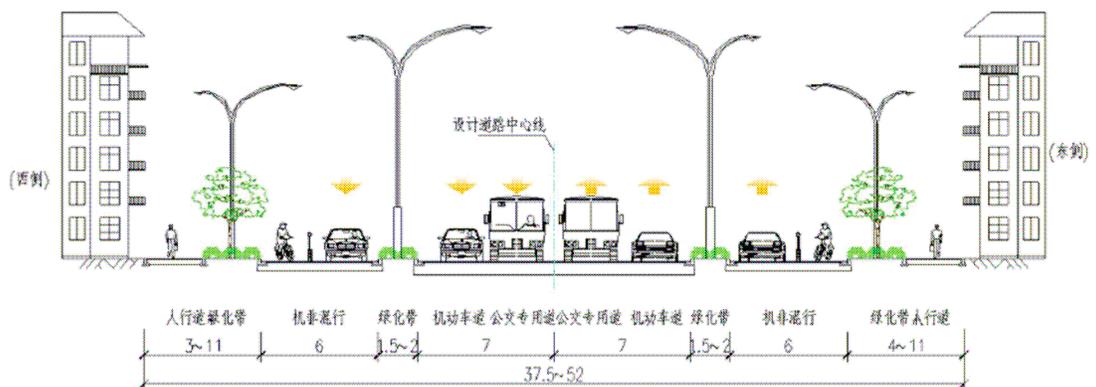


Figure 3-26: Profile design for 3<sup>rd</sup> Wei Road □ Wuyi Street

### 3.3.3.4 Fuhou Street

The profile will be maintained except for the section from Zhangqian Road to Changxing Road (the width is different), as shown in figure 3-28



Figure 3-28: Fuhou Street profile

The current 16m wide motor vehicle lane, the outside pedestrian lane and the green belt are changed to 21.5m wide motor vehicle lane + 9m pedestrian and non- motor vehicle integrated section.

The current and designed profiles are shown in figure 3-29 and figure 3-30.

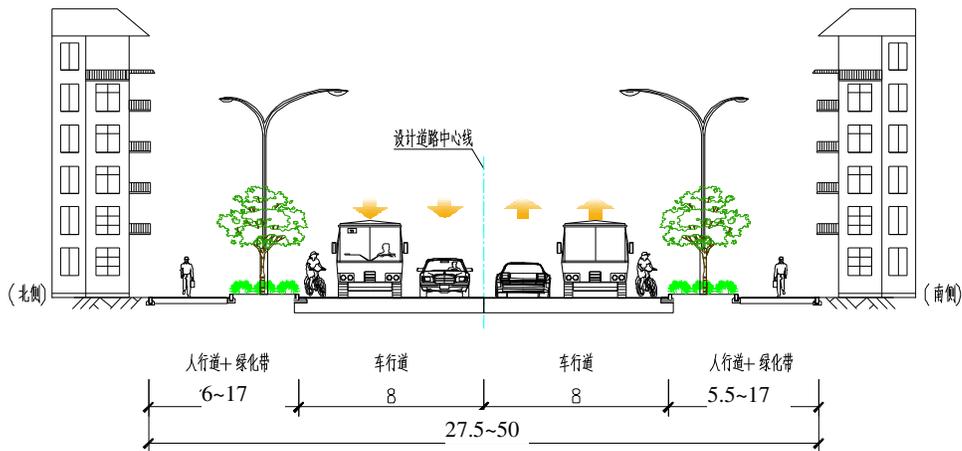


Figure 3-29: Current profile for Zhangqian Road □ Changxing Road

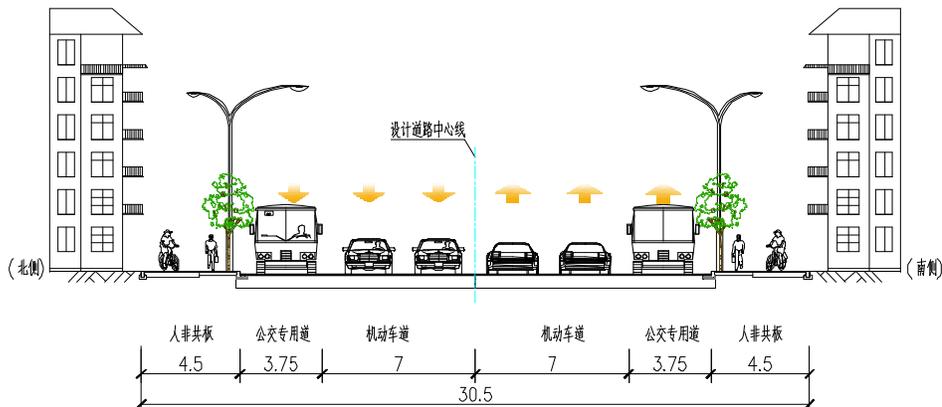


Figure 3-30: Profile design for Zhangqian Road□Changxing Road

### 3.3.3.5 South 1<sup>st</sup> Ring Road (Connected with South parking and maintenance yard)

The South 1<sup>st</sup> Ring Road, a new road, is 180m long and located at the south area of Changzhi, 500m from the Ecology garden, currently it is agricultural land. This road is a service functioning road for the parking and maintenance yard and will not be funded by this project. The profile is shown in figure 3-31.

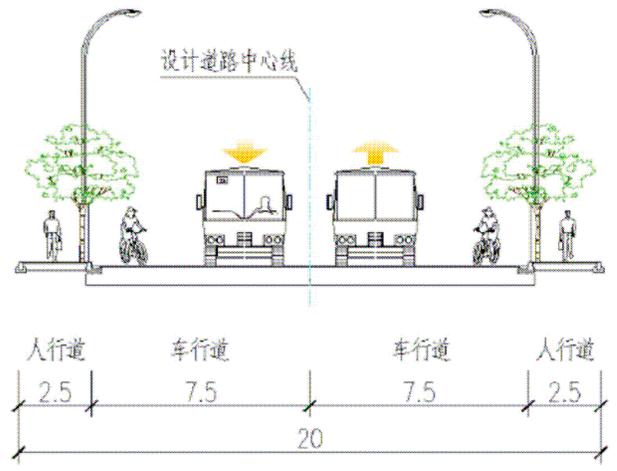


Figure 3-31: Designed profile for South 1<sup>st</sup> Ring Road (Connected with Parking and Maintenance Yard)

The environmental impact assessment report for the construction of South 1<sup>st</sup> Ring Road has been submitted by Shanxi Academy of Environmental Sciences for review of the City environmental protection agency. According to the progress, construction of South 1<sup>st</sup> Ring Road starts on July, 2011 and will complete on Dec, 2011. The operation of Parking and Maintenance Yard will be satisfied upon completion of the South 1<sup>st</sup> Ring Road.

### 3.3.3.6 Roadbed design

In order to reduce the roadbed settlement and improve the driving condition of vehicles, the project use different layers of soil filling above the roadbed. Before the filing, the original soil should be leveled and rolled.

In order to prevent the uneven settlement and crack, the road pavement at 2m around the junction place will be removed. Geogrid of 2m wide will be used between the roadbed surface and the bottom of the pavement, so as to integrate the new pavement with the old roadbed.

### **3.3.3.7 Pavement structure design**

Pavement structure design is shown in table 3-5.

### **3.3.3.8 Other designs**

#### **(1) Bus station**

The type of the bus station will influence the traffic capacity and delay time. The design of bus station will be determined by the type of the road section for bus priority lane, bus traffic volume and passenger volume.

The plan of bus station is shown in table 3-6 and the design is shown in figure 3-32~3-35.

Table 3-5: Design for road structure

Type	New bus priority lane	Planning and covering for colored bus priority lane	Planning and covering for motor vehicle lane	New, reconstructed motor vehicle lane	Reconstructed auxiliary road (Mixed slab for MV and NMV)	New motor vehicle lane	New pedestrian line
Parameter for design materials	<p>4cm Color <a href="#">asphalt mastic</a> (SMA-13, SBS modified asphalt) ; 6cm medium grained asphalt concrete (AC-20C, SBS modified) ;</p> <p>8cm coarse grained asphalt concrete□AC-25C□;</p> <p>1cm <a href="#">Asphalt surface treatment</a>;</p> <p>18cm <a href="#">cement stabilized macadam</a> (4.0MPa) ;</p> <p>18cm <a href="#">cement stabilized macadam</a> (3.0MPa) ;</p> <p>20cm <a href="#">cement stabilized</a></p>	<p>□4cm Color <a href="#">asphalt mastic</a>□SMA-13□SBS modified asphalt□;</p> <p>6cm medium grained asphalt concrete□AC-20C, SBS modified□;</p> <p>Gross Layer thickness 10cm</p> <p>□4cm Color <a href="#">asphalt mastic</a>□SMA-13□SBS modified asphalt□;</p> <p>6cm medium grained asphalt concrete□AC-20C, SBS modified□;</p> <p>8cm coarse grained asphalt concrete□AC-25C□;</p> <p>1cm <a href="#">Asphalt surface treatment</a>;</p> <p>Gross Layer thickness</p>	<p>4cm Color <a href="#">asphalt mastic</a>□SMA-13□SBS modified asphalt□;</p> <p>6cm medium grained asphalt concrete□AC-20C, SBS modified□;</p> <p>Gross Layer thickness 10cm.</p> <p>Used for Bus priority lane at Yingxiong Road with good condition(North Outer Ring~Mafangtou);</p> <p>4cm <a href="#">asphalt mastic</a>□SMA-13□SBS modified asphalt□;</p> <p>6cm medium grained asphalt concrete□AC-20C, SBS modified□;</p> <p>8cm coarse grained asphalt concrete□AC-25C□;</p> <p>1cm <a href="#">Asphalt surface treatment</a>;</p> <p>Gross Layer thickness 19cm.</p>	<p>4cm Color <a href="#">asphalt mastic</a>□SMA-13□SBS modified asphalt□;</p> <p>6cm medium grained asphalt concrete□AC-20C, SBS modified□;</p> <p>8cm coarse grained asphalt concrete□AC-25C□;</p> <p>1cm <a href="#">Asphalt surface treatment</a>;</p> <p>18cm <a href="#">cement stabilized macadam</a> □4.0MPa□;</p> <p>18cm <a href="#">cement stabilized macadam</a> □3.0MPa□;</p> <p>20cm <a href="#">cement stabilized soil</a>□12□□;</p> <p>Gross Layer thickness 75cm.</p>	<p>4cm Color <a href="#">asphalt mastic</a>□SMA-13□SBS modified asphalt□;</p> <p>8cm coarse grained concrete□AC-25C□;</p> <p>1cm <a href="#">asphalt surface treatment</a>;</p> <p>18cm <a href="#">cement stabilized macadam</a> □4.0MPa□;</p> <p>18cm <a href="#">cement stabilized macadam</a> □3.0MPa□;</p> <p>20cm <a href="#">cement stabilized soil</a>□12□□;</p> <p>Gross Layer thickness 69cm.</p>	<p>4cm fine grained asphalt concrete□AC-13C□;</p> <p>6cm medium grained asphalt concrete□AC-20C, SBS modified□;</p> <p>1cm <a href="#">aphalt surface treatment</a>;</p> <p>18cm <a href="#">cement stabilized macadam</a> □2.5MPa□;</p> <p>20cm <a href="#">cement stabilized soil</a>□12□□;</p> <p>Gross Layer thickness 49cm</p>	<p>6cm <a href="#">granite tile</a>;</p> <p>3cm M10 cement mortar;</p> <p>15cm <a href="#">cement stabilized macadam</a> □2.5%);</p> <p>15cm <a href="#">cement stabilized soil</a>□12□□;</p> <p>Gross Layer thickness 39cm</p>

	soil (12%) ; Gross Layer thickness 75cm	19cm					
Road section	Taihang Street (Hubin Road~East Outer Ring); Bus priority lane and Fuhou Street (Zhangqian Road~Chengxi Road); expanded MV line	☑Bus priority lane at  Yingxiong Road with good condition(North Outer Ring~Mafangtou)  ☑Chengxi Road with  poor condition (North Outer Ring~Wuyi Road, Fuhou Street (Zhanqian Road~Changxing Road) Bus priority lane in the middle and along side.	Chengxi Road with poor condition (North Outer Ring~Wuyi Road, Fuhou Street (Zhanqian Road~Changxing Road) MV line in the middle	Road around Bayi Square	Yingxiong Road☐North Outer Ring~Wuzhen Street☐ Reconstructed side road of Chengxi Road☐North Outer Ring~Wuyi Road☐	—	—

Table 3-6: Reconstruction design for bus stop

Location of Bus Priority lane	Type	Design parameter	Applicable situation
At side	Single	1 □ Bay-type □ transition section 15—25m □ platform length 45m □ width 2.5m □ 3 parking spots 2 □ Non bay-type □ platform length 45m □ width 2.5m □ 3 parking spots	1. Less incoming bus, enough traffic capacity 2. No enough traffic capacity
	Double	transition section 25—30m □ platform length 30m □ width 2.5m □ 2 parking spots for each platform, totally 4	1. More incoming bus, traffic capacity is limited 2. Wider space for the platform
In the middle	Stops at junction exit	1 □ Bay-type □ transition section 30m □ platform length 45m □ width 2.5m □ 3 parking spots 2 □ Non bay-type □ platform length 45m □ width 2.5m □ 3 parking spots	1. Land development along the corridor is intense 2. Enough road width
	Stops in the middle of the road	1 □ Bay-type □ transition section 12—20m □ bump section 15m □ acceleration section 25m □ platform length 45m □ width 2.5m □ 3 parking spots 2. Non bay-type □ transition section 25m □ platform length 45m □ width 2.5m □ 3 parking spots	1. Long road section 2. High traffic attraction point along road.



Figure 3-32: Road side single stop

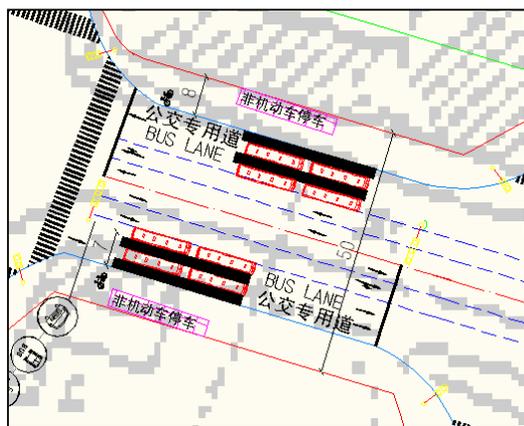


Figure 3-33: Road side double stop

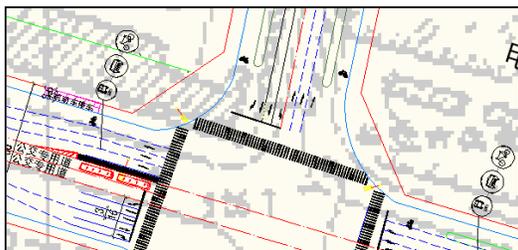


Figure 3-34: Single stop in the middle

Figure 3-35: Double stop in the middle

### (2) Intersection Channelization

The entrance lanes will be expanded to 3-4 lanes where there are 2 lines; the entrance lines will be expanded to 4-5 lanes where there are 3 lines. Length of the Channelization section: 20-30m for gradual change section and 50-60m for the expansion section, as shown in figure 3-36 and 3-37.

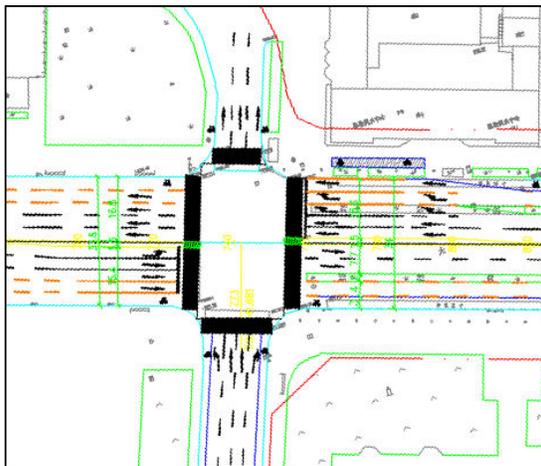


Figure 3-36: Intersection Channelization (Taihang Street and Yingxiong Road)

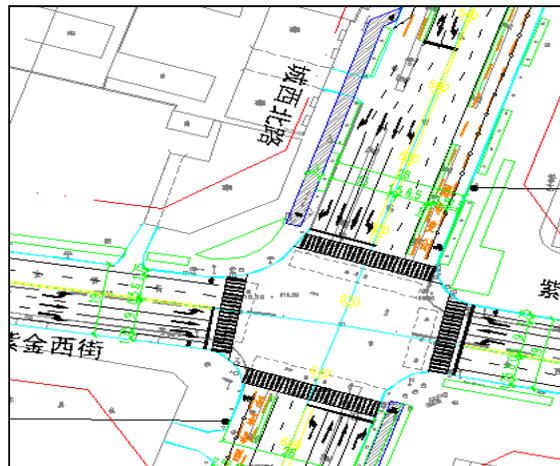


Figure 3-37: intersection Channelization (Chengxi Road and Zijin Street)

### (3) Exit along the road

Along the road there are a lot of entrance and exits for residential buildings, enterprises and businesses. Construction on such sections needs to be well organized to reduce the disturbance and interruption to the people and commercial activities and improve traffic safety.

Through the use of signals, right turn policy, the design and organization of these entrances will be improved so that the traffic capacity and safety is enhanced.

When using right turn policy, left turn should be allowed at proper location in order to reduce the travel distance of the vehicles, the distance between two entrances allowing left turn is set to be around 300m.

The plan for the entrance is shown in table 3-7, the design of the entrance is shown in figure 3-38~40.

Table 3-7 Planning of the entrance

Type	Applicable situation
□1□right turn, giving way to buses	1.applicable to the lines in the middle 2.traffic volume is limited around the building aside the road
□2□left and right turn without signal control , giving way to buses	1. Medium traffic volume around the building aside the road 2. Medium requirement for straight-going traffic 3. In the middle of the road
□3□signal controlled left turn	1. High traffic volume 2. High traffic volume around the building aside the road

(4) Side belt entrance design

The road profiles of Taihang Street, Yingxiong Street and Chengxi Road have main and auxiliary (bus priority lane) lanes isolated with side belt. In order for traffic exchange between the main road and the auxiliary road, and for ease of maintenance and emergency, the distance between each two entrances of the side belt is to be 200-300m.

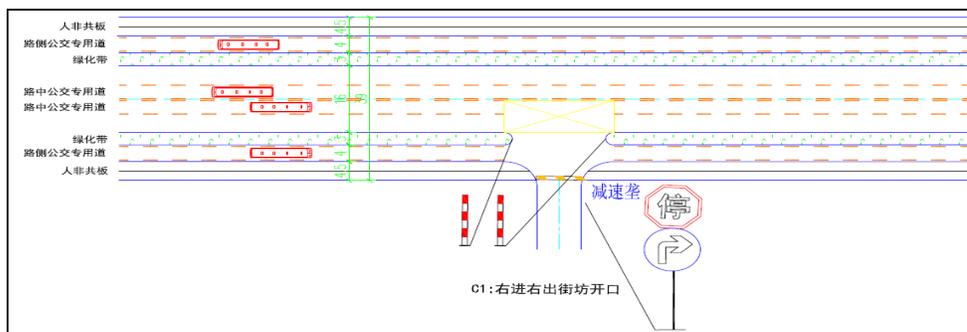


Figure 3-38: Plan (1) Entrance/exit design

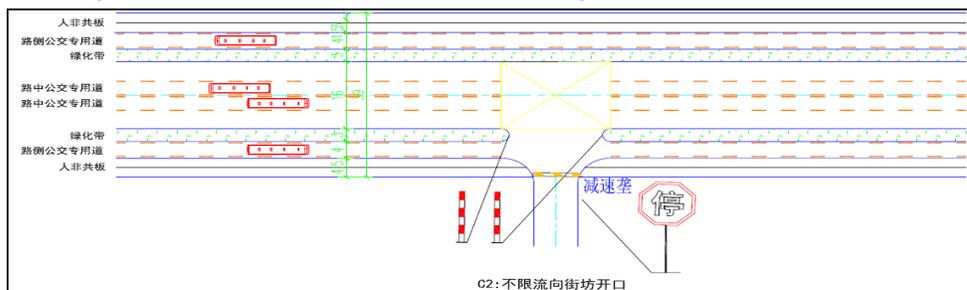


Figure 3-39: Plan (2) Entrance/exit design

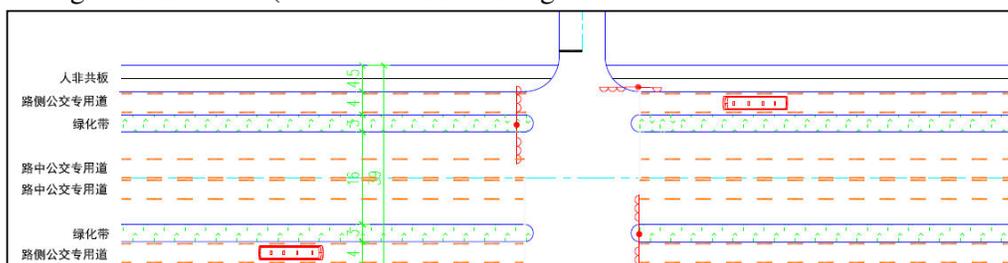


Figure 3-40: Plan (3) Entrance/exit design

(5) Slow traffic

Plan for slow traffic is shown in table 3-8, the design of slow traffic is shown in figure 3-41~3-43.

Table 3-8 Plan for slow traffic

Details	Applicable situations
(1) Pedestrian cross for bus stops in transition area: with signal control	1.Applicable to entrance to areas with high density of people (administration□school□transportation depot) 2. Applicable to areas with medium traffic flow.
(2) Pedestrian cross for bus stops: without signal control	1. Applicable to road with limited traffic volume and flows smooth. 2.Applicable to corridors with slow traffic
(3) Pedestrian cross in the road section□with signal control	1. Applicable to entrance to areas with high density of people 2. Applicable to junctions with frequent traffic accident

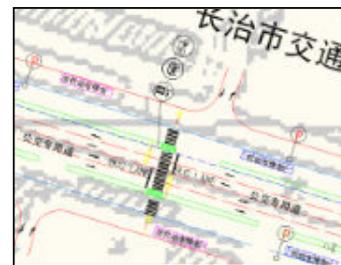
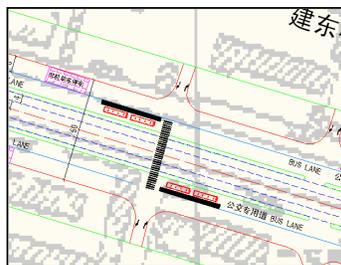
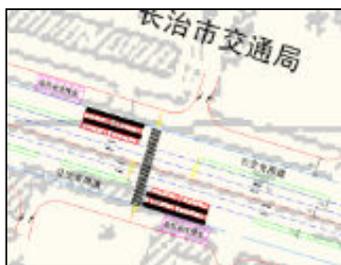


Figure 3-41 Plan 1 design    Figure 3-42 Plan 2 design    Figure 3-43 Plan 3 design

(6) Speed bump

Speed bump is widely used in foreign countries, it is designed in this project to lower the traffic speed so that the safety of pedestrian and non motor vehicle is enhanced.

(7) Signal controlled bus priority

Signals before the inter sections can improve the traffic capacity and efficiency of the bus, especially for the roads without right turn policy.

**3.3.4 Bridge works**

Bayi Bridge at Yingxiong Road is over Shizi River, the main section is built for motor vehicle in 1960, the auxiliary section is built for non motor vehicle in 1970; Qiyi Bridge at Chengxi Road is on Shizi River, it is built in 1970; the profile of both bridges does not meet the design requirement for bus priority lane, in addition, the bridges are old and poorly maintained, therefore, it is suggested by related department that the two bridges be demolished and rebuilt to the new standard.

There are no information (planned blue line and flood control standard) available for the river channel, therefore the size and height of the bridge can not be determined in current stage. Design will be finished based on completion of information collection.

During the preparation of feasibility study report, experts suggest that a Pedestrian Bridge be added at the junction of Yingxiong Road and Zijin Road due to high volume of motor vehicles and pedestrians. The initial design for the pedestrian bridge is 5m in width.

**3.3.5 Drainage system**

New pipelines will be constructed under the four corridors. Rainwater and sewage water will be collected separately, the existing pipeline will be used for sewage water only. The planning for sewerage system is that the separate system will be phases in urban area. The initial design of the rainwater pipeline is to install along the sides of the corridors, with pipeline diameter 1000mm. Spaces for connecting pipes and rainwater inception well are reserved on both side of the corridor.

For the road section (720m) from Fuhou Street to Xidajie at Chengxi Road, the diameter of the drainage pipeline is 600mm and depth is 1.88m. It is suggested that the pipeline be replaced with diameter of 1000mm.

**3.3.6 Water supply**

Through communication with relevant department, water supply network will be added in the four corridors, the plan for each of the corridor is show in table 3-9.

Table 3-9 Plans for water supply network

Corridors name	Start and end location	Length (m)	Depth (m)	Radius (mm)	Type
Taihang Street(Hubin Road-Jinkou Village)	East Outer Ring-Jinkou Village	450	1.5	400	Replacement
	Hubin Road-	2260	1.5	500	New building

Fuhou Street (Zhanqian Road- Changxing Road)	Zhanqian Road- Changxing Road	3670	1.5	400	Replacement
Yingxiong Road (North Outer Ring- Mafangtou)	North Outer Ring- Zhuoma	1240	1.5	300	New building
	Bayi Square- Chengnan Road	2950	1.5	400	Replacement
Chengxi Road (North Outer Ring- Wuyi Bridge)	North Outer Ring- Wuyi Bridge	5030	1.5	500	Replacement
Total		15600			

### 3.3.7 Transportation

This project involves transportation signs, signals and isolation facilities. The installation of the facilities are in accordance with the regulations in “Traffic Signals and Signs” <GB5768—2009>.

Isolation facility: Considering the traffic safety, isolation facilities will be placed near the auxiliary road and the intersections.

### 3.3.8 Greening work

Range: side belt for Taihang Street, Yingxiong Road, Chengxi Road and Fuhou Street and the green belt besides the pedestrian line.

Normally, evergreen flowers and shrubs are selected for the road side, flower can be seen all the season; focus on the important landscape section, which should form a unique green belt; planting arbor should not be used because it will shelter the landscape along road; island inside the channelized junction should highlight the local cultural characteristic.

Design of greening and landscaping should focus on “quality” and “quantity”, especially for the isolation green belt, which should mainly use flower, shrub and lawn, large arbor should be used for the upper layer, trees with low branch and large crown is not proper for use; should guarantee the safety sight distance, which is controlled in 80~100m, side belt should use [Bauhinia variegata](#), cassia surattensis, Oleander Allemanda and decorated with yellow plum blossom; Trees along the road should use banyan; away from the road, the [Bauhinia variegata](#), goldenrain tree and purple plum blossom should be used.

This project involves relocation of 746 trees and replanting of 17897.021m<sup>2</sup> green area.

### 3.3.9 Integrated Corridor Improvement

#### (1) Current parking situation

Currently, many on-road parking spots exist on both sides of the four corridors, the integrated corridor improvement will require removal of these on-road parking spots, which

will pose certain negative effects on the functioning area along the corridor. Therefore, the parking issue with the integrated corridor improvement needs to be investigated more.

Currently, a lot of residential and public buildings are located along both sides of the corridors, including community, government agency, school, hospital, business building and facility, transportation hub, square, super-market and entertaining facilities. These facilities will attract large amount of people and the corresponding parking needs.

The parking spots along the four corridors are in serious shortage, the construction of public parking yard is slow. Currently, a lot of parking spots are placed along the side of the corridors to satisfy the parking needs generated along the corridor, most of them are on the non motor vehicle lane.

The parking situation along the corridor is shown in table 3-10.

Table 3-10 Parking condition along the corridor

Road name	Length for parking section □km□	Number of spot	Number of spots every 10m
Taihang Street□Taijiao Railway□East Outer Ring□	5.5	1056	1.92
Yingxiong Road□Old Yingxiong Road□South city Ecology garden□	7	586	0.84
Chengxi Road□North 1 <sup>st</sup> Ring Road□15 <sup>th</sup> Wei Road□	3.2	146	0.46
Fuhou Street□West 1 <sup>st</sup> Ring Road□Changxing Road□	2.9	468	1.61
Total	18.6	2256	1.21

## (2) Parking strategy

After removal of the on-road parking spots along the corridor, ways to solve the parking issue by:

- a. Promoting three-dimension parking for the units along the corridor, open to public with parking fee. Currently, there are around 2900 parking spots on ground for the units along the corridors, half of them can be designed as two floor parking lot, which can increase around 1400 parking spots. These parking spots can be placed at market and business building along Taihang Street, Chengxi Road and Fuhou Street.
- b. Building a public parking lot for Huijia shopping market at Yingxiong Road, which can increase 230 parking spots. The parking lot can be built as a four-story building to meet the parking needs around the business center.
- c. Building an underground parking lot integrated with the renovation of Bayi Square, which can add 400 public parking spots.

- d. Providing temporary parking spots during non-rush hour along some of the branch roads.
- e. Providing parking facilities for non motor vehicles at important sections.

The increased parking spots at Jiahui shopping market and Bayi Square are public parking lots, which are included in this project. The city government will be responsible for the cost of construction, the revenue will be used for public transit fund in Changzhi.

(3) Plan for underground parking lot at Bayi Square

The underground parking lot is a medium size parking facility, which is 9m in length, 2.5m in width and 3.2m in height; the area of each parking spot is 25 m<sup>2</sup>.

Two underground parking lots area designed, which can totally provide 400 parking spots. Each underground parking lot at the east and west of the square is 2500 m<sup>2</sup> respectively and provides 200 parking spots (two layer machinery parking). The design is shown in figure 3-44 and 3-45.

The access lane to the underground parking lot is 4m wide; the minimum slope is 8% and the maximum slope can reach 12%.

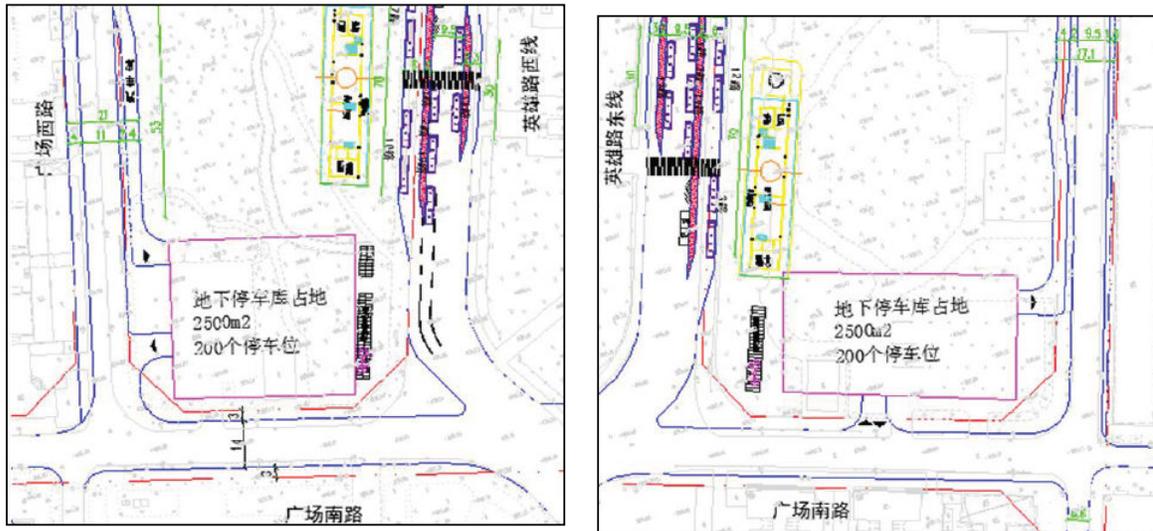


Figure 3-44 Parking lot at West of Bayi Square Figure 3-45 East of Bayi Square.

**3.4 Public Transit Supporting Infrastructure**

These include: Bayi Square bus depot, Bus terminal stations and parking and maintenance yard.

**3.4.1 Bayi Square bus depot**

Suggested plan for Bayi Square bus depot: integrated bus station with two ways traffic flow.

(1) Layout plan

The south part of the square is cone shaped and will be connected in the east-west direction at the Y-shape junction; bus stops will be placed in east-west direction on both side of the square, these are route 10 and route 7 terminal station; bus stops along Taihang Road will be moved to the both side of Baiyi Square, where passengers can change bus route 1, 2, 13 and 19; add taxi waiting area and non motor vehicle parking space for bus terminal station at Yingxiong Road beside the square; the entrance/exit of the underground parking lot in the west is located at West Square Road; the entrance/exit of the underground parking lot in the west is located at South Square Road and East Square Road. The details are shown in figure 3-46.

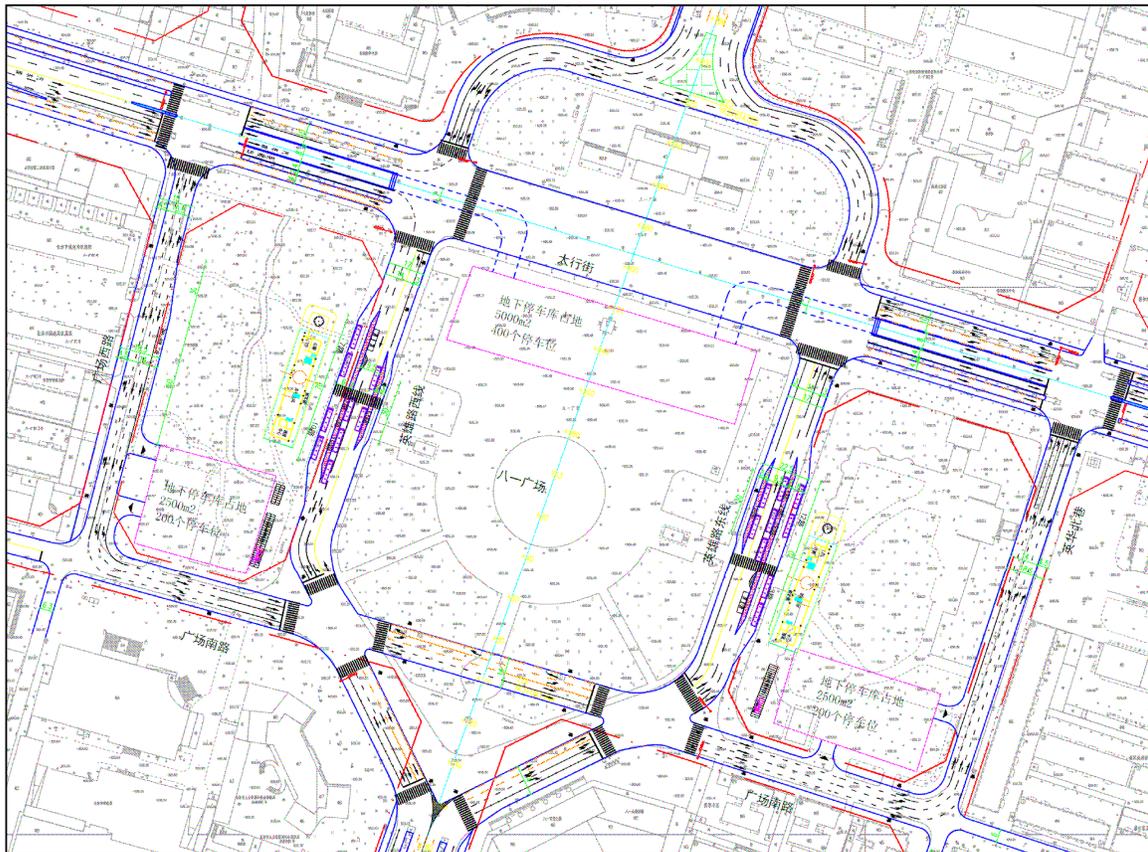


Figure 3-46: Design for Baiyi Square

(2) Slow traffic

Channelization of key junctions and installation of pedestrian crossing facilities; parking for non motor vehicles are located around the bus depot, which is convenient for parking and transfer.

(3) Control of motor vehicles

Place signal control for 6 junctions that have traffic conflict; Yingxiong Road at both side of the square is for bus use only; the traffic going straight at Taihang Road use detour of the road besides the underground parking lot, and is controlled by the signal at the junction of Taihang Road.

(4) Organization of bus route

Bus terminal stations of route 3 and 12 are placed at the east side of the square, the buses are running beside the square counter clockwise; bus terminal stations of route 10 and 7 are placed at the west side of the square, the buses are running beside the square counter clockwise; bus stops for route 13 in east-west direction run beside the square clockwise.

The design of bus depot at Bayi Square is shown in table 3-11.

Table 3-11 Design standards for bus depot at Bayi Square.

	Station parameters	Area □m <sup>2</sup> □	Area and green area occupied □m <sup>2</sup> □	Note
West side	Terminal station of route 7 and 10, 4 parking spots; bus stops of route 1, 2 and 13, 5 parking spots	3000	800	Area for auxiliary facilities 840m <sup>2</sup> □ area for road construction 21560m <sup>2</sup>
East side	Terminal station of route 3 and 12, 4 parking spots; bus stops of route 1, 2, 13 and 19, 5 parking spots	3000	800	Area for auxiliary facilities 840m <sup>2</sup> □ area for road construction 21560m <sup>2</sup>
		6000	1600	Area for rental 280m <sup>2</sup>

The bus stations at the east and west side of Bayi Square is designed as figure 3-47 and 3-48.

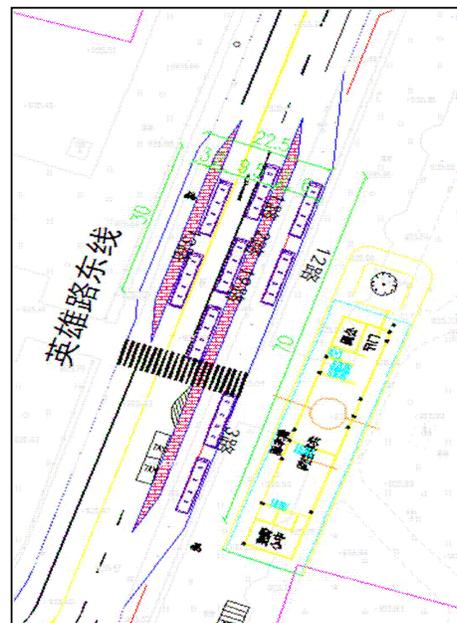
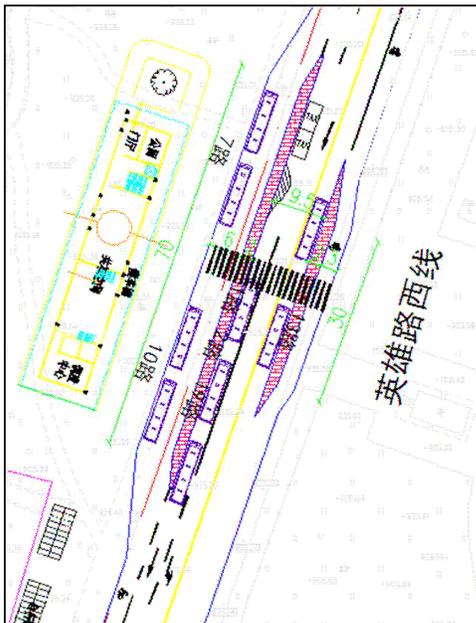


Figure 3-47 Bus stations in the west      Figure 3-48 Bus stations in the east

### 3.4.2 Bus terminal stations in the bus company

The bus terminal stations are located in the bus company at North Yingxiong Road, the planned area is 1.7ha, which is shown in table 3-12. The plan view of the bus stations in bus company are shown in figure 3-49.

Table 3-12: Area of buildings for the bus terminal stations

Building name	Area□m <sup>2</sup> □	Note
Bus parking yard	4000	40 spots
Integrated administrative building	1200	
Business building along street	1200	
Administrative building	1400	
Facilities for Business building along street	2800	
Parking yard for staff	600	
Maintenance yard	1200	2
Other auxiliary building	1000	Staff apartment, restroom
Bus platform and terminal station	2000	2 route in service

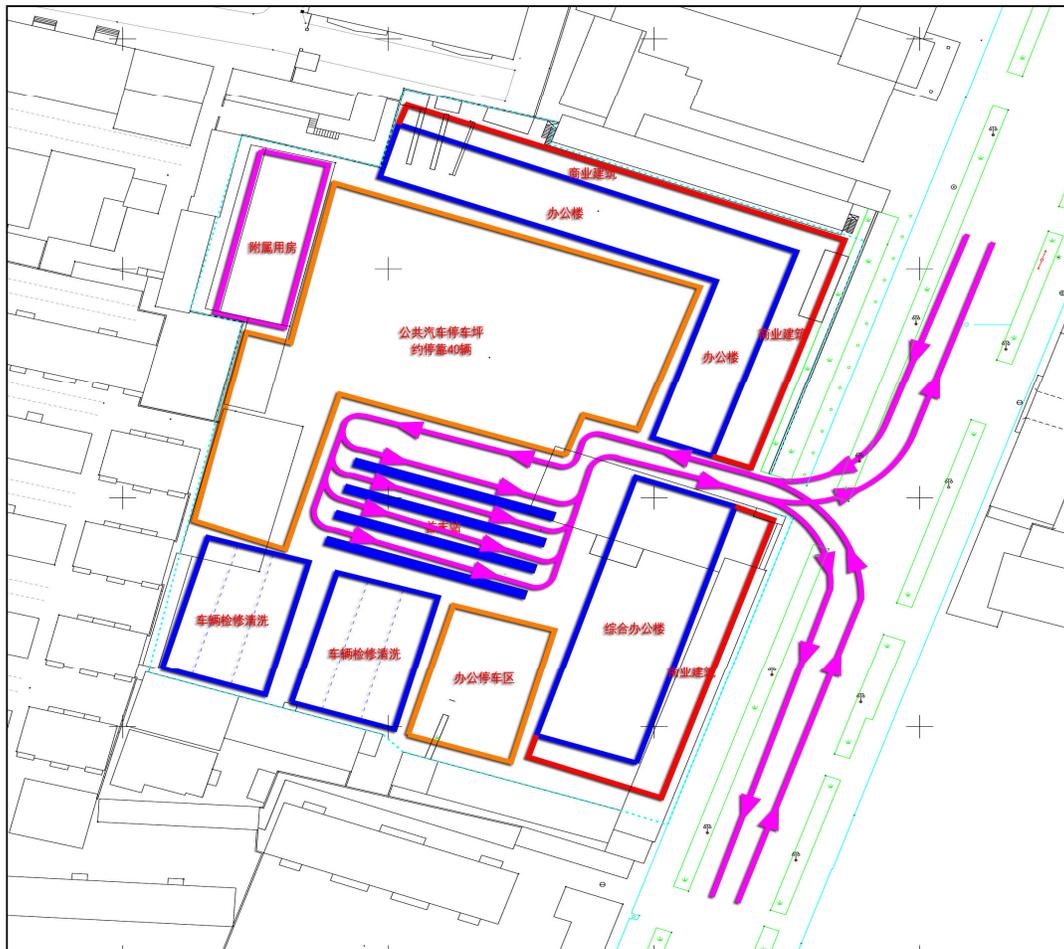


Figure 3-49: Plan view of the terminal stations in the bus company.

Currently, there are 6 arranged service route for the urban area: route 3, route 8, route 10, route 12, route 14 and route 16, number of buses in service is 80, the terminal stations of route 12 and 16 are located here. In 2015, there will be 7 arranged service route for the urban area: route 12, route 16, route 19, route 3, route N3, route N\_air2 and route N\_air3. In 2030, there will be 6 arranged service route for the urban area: route 12, route 16, route 19, route N3, route N10 and route N25. The area of terminal stations is 2000 m<sup>2</sup>, 2 bus routes are in service currently.

### 3.4.3 South parking and maintenance yard

The South parking and maintenance yard is located at the south of Mafangtou Village in the sub-urban district of Changzhi, it is adjacent to Changhan Highway. The planned area is 1.3ha, as shown in table 3-13. The plan view of the parking and maintenance yard is shown in figure 3-50.

Table 3-13: Building area of the South parking and maintenance yard at Mafangtou

Building name	Area□m <sup>2</sup> □	Note
Integrated administrative building	800	
Repair and maintenance building	600	
Auxiliary building and staff apartment	500	
Oil and gas station	600	
Reception house	30	
Parking yard	6000	60 parking spots
Terminal station	3000	

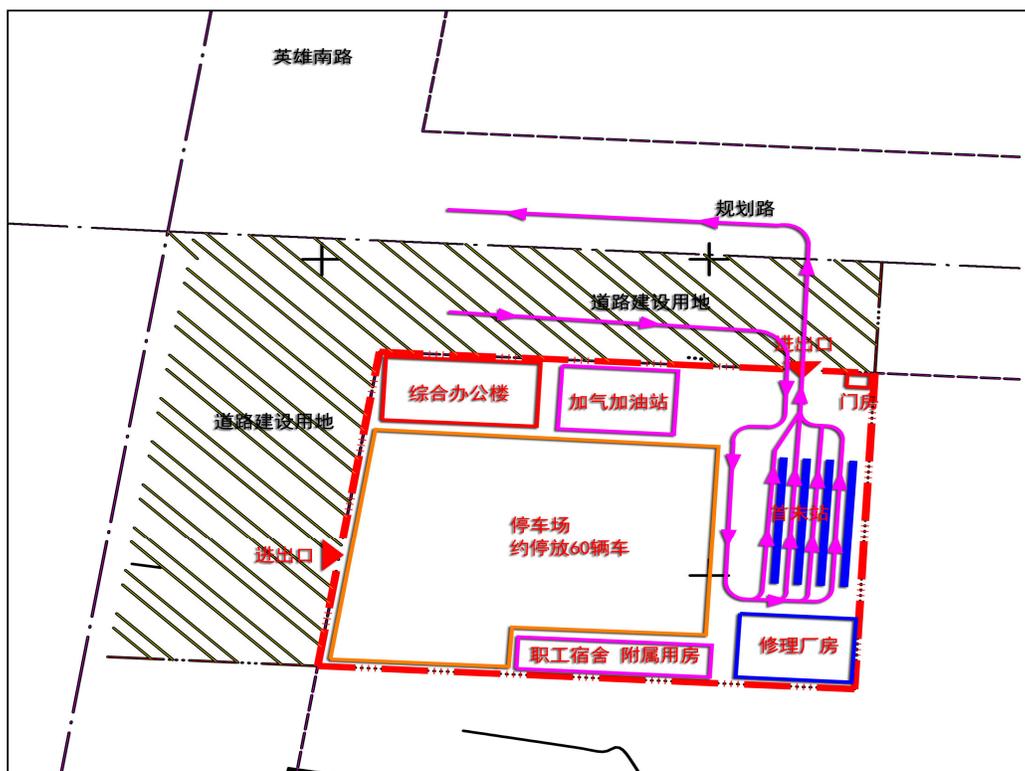


Figure 3-50: Plan view of the parking and maintenance yard

The designed parking capacity is 100 standard buses, 6 terminal station are planned, these are route 1, route 2, route 18, route N1, route N6 and route N18, 3 routes are in service currently, 6 routes will be in service in the future.

### 3.5 Intelligent Urban Transport Management System

The major components are: Urban transport database platform, Intelligent Traffic Management and Control System, Intelligent bus operation and service platform, integrated transport management and decision making system, Traffic Management Auxiliary System.

The structure of this constitute is shown in figure 3-51.



Figure 3-51: Structure of Intelligent Urban Transport Management System

### 3.6 Institutional Capacity Development

Mainly include: Plans and evolutions for Institutional Capacity Development, field trip in both China and foreign countries, professional training, expert consultancy, workshop discussion, institutional operation development, etc.

### 3.7 Schedules of project construction

The schedule for Integrated Corridor Improvement and Public Transit Supporting Infrastructure are shown in table 3-14.

Table 3-14 Project construction schedule

Project content	Construction period	Note
Chengxi Road	May-Oct,2012	Two construction sections working simultaneously at different section
Taihang Street	May-Oct,2013	Two construction sections working simultaneously at different section
Yingxiong Road	May-Oct,2014	Two construction sections working simultaneously at different section
Fuhou Street	May-Oct,2015	Two construction sections working simultaneously at different section
Parking and maintenance yard	2012	
Bus depot at Bayi Square	2013	
Bus terminal stations	2014	

### 3.8 Traffic volume projection

#### (1) Taihang Street

According to the project feasibility study, the traffic volume of Taihang Street in 2015 and 2030 are predicted as shown in table 3-16 and 3-17.

#### (2) Yingxiong Road

According to the project feasibility study, the traffic volume of Yingxiong Road in 2015 and 2030 are predicted as shown in table 3-18 and 3-19.

#### (3) Chengxi Road

According to the project feasibility study, the traffic volume of Chengxi Road in 2015 and 2030 are predicted as shown in table 3-20 and 3-21.

#### (4) Fuhou Street

According to the project feasibility study, the traffic volume of Fuhou Street in 2015 and 2030 are predicted as shown in table 3-22 and 3-23.

Table 3-16: Light weight vehicles and buses traffic volume projection at different sections of Chengxi Road in 2015

Road section	Length (Km)	Time Period	Length (Km)	Prt Speed	# of Light weight vehicle		# of Passengers on bus		# of Taxies	
					East-West	West-East	East-West	West-East	East-West	West-East
East Taihang Street (Yanshan Road~East Outer Ring)	1.405	10.053								
East Taihang Street (East Outer Ring ~North Chengdong Road)	1.241	28.058								
East Taihang Street (North Chengdong Road ~Mid. Yanan Road)	0.586	14.121								
East Taihang Street (Mid. Yanan Road ~Mid. Changxing Road)	0.335	5.848								
East Taihang Street ( Mid. Changxing Road ~Mid. Yingxiong Road )	0.353	12.754								
West Taihang Street ( Mid. Yingxiong Road ~Gongyixiang )	0.8	37.658								
West Taihang Street ( Gongyixiang ~Chengxi Road )	0.343	14.394								
West Taihang Street ( Chengxi Road ~South Taihang Road )	0.852	32.505								
West Taihang Street ( South Taihang Road ~West 1 <sup>st</sup> Ring Road )	0.539	24.189								
West Taihang Street ( West 1 <sup>st</sup> Ring Road ~West Outer Ring Road )	1.208	48.649								
G208 ( West Outer Ring Road~Hubin Road)	1.224	22.24								

Table 3-17: Light weight vehicles and buses traffic volume projection at different sections of Chengix Road in 2030

Road section	Length (Km)	Time Period	Length (Km)	Prt Speed	# of Light weight vehicle		# of Passegeners on bus		# of Taxies	
					East-West	West-East	East-West	West-East	East-West	West-East
East Taihang Street (Yanshan Road~East Outer Ring)										
East Taihang Street (East Outer Ring ~North Chengdong Road)										
East Taihang Street (North Chengdong Road ~Mid. Yanan Road)										
East Taihang Street (Mid. Yanan Road ~Mid. Changxing Road)										
East Taihang Street ( Mid. Changxing Road ~Mid. Yingxiong Road )										
West Taihang Street ( Mid. Yingxiong Road ~Gongyixiang )										
West Taihang Street ( Gongyixiang ~Chengxi Road )										
West Taihang Street ( Chengxi Road ~South Taihang Road )										
West Taihang Street ( South Taihang Road ~West 1 <sup>st</sup> Ring Road )										
West Taihang Street ( West 1 <sup>st</sup> Ring Road ~West Outer Ring Road )										
G208 ( West Outer Ring Road~Hubin Road)										

Table 3-18: Light weight vehicles and buses traffic volume projection at different sections of Yingxiong Road in 2015

Road section	Length (Km)	Time Period	Length (Km)	Prt Speed	# of Light weight vehicle		# of Passegeners on bus		# of Taxies	
					East-West	West-East	East-West	West-East	East-West	West-East
North Yingxiong Road (North Outer Ring~North 2 <sup>nd</sup> Ring)										
North Yingxiong Road ( North 2 <sup>nd</sup> Ring ~North 1 <sup>st</sup> Ring)										
North Yingxiong Road ( North 1 <sup>st</sup> Ring ~East Chengbei Street)										
North Yingxiong Road ( East Chengbei Street ~East Taihang Street)										
Mid. Yingxiong Road ( East Taihang Street ~East Zijin Street)										
Mid. Yingxiong Road ( East Zijin Street ~East Fuhou Street)										
Mid. Yingxiong Road ( East Fuhou Street ~Dongdajie)										
Mid. Yingxiong Road ( Dongdajie ~West Jiefang Road)										
South Yingxiong Road ( West Jiefang Road ~Chengnan Road)										
South Yingxiong Road ( Chengnan Road ~Wuzhen Road)										
South Yingxiong Road ( Wuzhen Road ~Sourth 1 <sup>st</sup> Ring Road)										
South Yingxiong Road (Sourth 1 <sup>st</sup> Ring Road ~Sourth Outer Ring)										

Table 3-19: Light weight vehicles and buses traffic volume projection at different sections of Yingxiong Road in 2030

Road section	Length (Km)	Time Period	Length (Km)	Prt Speed	# of Light weight vehicle		# of Passegeners on bus		# of Taxies	
					East-West	West-East	East-West	West-East	East-West	West-East
North Yingxiong Road (North Outer Ring~North 2 <sup>nd</sup> Ring)										
North Yingxiong Road ( North 2 <sup>nd</sup> Ring ~North 1 <sup>st</sup> Ring)										
North Yingxiong Road ( North 1 <sup>st</sup> Ring ~East Chengbei Street)										
North Yingxiong Road ( East Chengbei Street ~East Taihang Street)										
Mid. Yingxiong Road ( East Taihang Street ~East Zijin Street)										
Mid. Yingxiong Road ( East Zijin Street ~East Fuhou Street)										
Mid. Yingxiong Road ( East Fuhou Street ~Dongdajie)										
Mid. Yingxiong Road ( Dongdajie ~West Jiefang Road)										
South Yingxiong Road ( West Jiefang Road ~Chengnan Road)										
South Yingxiong Road ( Chengnan Road ~Wuzhen Road)										
South Yingxiong Road ( Wuzhen Road ~Sourth 1 <sup>st</sup> Ring Road)										
South Yingxiong Road (Sourth 1 <sup>st</sup> Ring Road ~Sourth Outer Ring)										

Table 3-20: Light weight vehicles and buses traffic volume projection at different sections of Chengxi Road in 2015

Road section	Length (Km)	Time Period	Length (Km)	Prt Speed	# of Light weight vehicle		# of Passegens on bus		# of Taxies	
					East-West	West-East	East-West	West-East	East-West	West-East
Chengxi Road (North Outer Ring~North 2 <sup>nd</sup> Ring)										
Chengxi Road ( North 2 <sup>nd</sup> Ring ~North 1 <sup>st</sup> Ring)										
Chengxi Road ( North 1 <sup>st</sup> Ring ~West Chengbei Street)										
Chengxi Road ( West Chengbei Street ~ West Taihang Street)										
Chengxi Road ( West Taihang Street ~ West Zijin Street)										
Chengxi Road ( West Zijin Street ~ West Fuhou Street)										
Chengxi Road ( West Fuhou Street ~Wuyi Street)										

Table 3-21: Light weight vehicles and buses traffic volume projection at different sections of Chengxi Road in 2030

Road section	Length (Km)	Time Period	Length (Km)	Prt Speed	# of Light weight vehicle		# of Passegeners on bus		# of Taxies	
					East-West	West-East	East-West	West-East	East-West	West-East
Chengxi Road (North Outer Ring~North 2 <sup>nd</sup> Ring)										
Chengxi Road ( North 2 <sup>nd</sup> Ring ~North 1 <sup>st</sup> Ring)										
Chengxi Road ( North 1 <sup>st</sup> Ring ~West Chengbei Street)										
Chengxi Road ( West Chengbei Street ~ West Taihang Street)										
Chengxi Road ( West Taihang Street ~ West Zijin Street)										
Chengxi Road ( West Zijin Street ~ West Fuhou Street)										
Chengxi Road ( West Fuhou Street ~Wuyi Street)										

Table 3-22: Light weight vehicles and buses traffic volume projection at different sections of Fuhou Street in 2015

Road section	Length (Km)	Time Period	Length (Km)	Prt Speed	# of Light weight vehicle		# of Passegeners on bus		# of Taxies	
					East-West	West-East	East-West	West-East	East-West	West-East
East Fuhou Street (East Outer Ring~Chengdong Road)										
East Fuhou Street ( Chengdong Road ~Mid. Yanan Road)										
East Fuhou Street (Mid. Yanan Road ~Mid. Changxing Road)										
East Fuhou Street ( Mid. Changxing Road ~ Mid. Yingxiong Road )										
Fuhou Street ( Mid. Yingxiong Road ~ Fuxi Road)										
Fuhou Street ( Fuxi Road ~ Chengxi Road)										
West Fuhou Street ( Chengxi Road ~South Taihang Road)										
West Fuhou Street ( South Taihang Road ~West 1st Road)										
West Fuhou Street ( West 1st Road ~Tiedong Road)										

Table 3-22: Light weight vehicles and buses traffic volume projection at different sections of Fuhou Street in 2030

					# of Light weight vehicle		# of Passegeners on bus		# of Taxies	
Road section	Length (Km)	Time Period	Length (Km)	Prt Speed	East-West	West-East	East-West	West-East	East-West	West-East
East Fuhou Street (East Outer Ring~Chengdong Road)										
East Fuhou Street ( Chengdong Road ~Mid. Yanan Road)										
East Fuhou Street (Mid. Yanan Road ~Mid. Changxing Road)										
East Fuhou Street ( Mid. Changxing Road ~ Mid. Yingxiong Road )										
Fuhou Street ( Mid. Yingxiong Road ~ Fuxi Road)										
Fuhou Street ( Fuxi Road ~ Chengxi Road)										
West Fuhou Street ( Chengxi Road ~South Taihang Road)										
West Fuhou Street ( South Taihang Road ~West 1st Road)										
West Fuhou Street ( West 1st Road ~Tiedong Road)										

## 4 Comparison of Alternatives

### 4.1 Comparison of “With” and “Without” Project Scenario

“Without project” means remaining the current status of the road conditions in the project area. Under the context of “without project” development, with population growth, economic development, infrastructure development, and evaluations of the social, economic and environmental impact are the main analysis in this comparison.

#### 4.1.1 Analysis of social impact

##### (1) Traffic flow, traffic safety and residents traveling

In recent years, the economic development of Changzhi is fast. Accomplishment has been achieved in many aspects, especially in urban construction. It was named one of the ten charming cities in China in 2004 and national-level garden city by the Ministry of Construction in 2006. However, with the rapid growth of private vehicle ownership, the traffic congestion is a growing issue. Intensive vehicle traveling has caused air pollution, safety and traffic congestion and other negative effects. Implementation of this project will help alleviate local traffic congestion and parking difficulties. It can also improve the satisfaction of the residents travel demand and meet the travel requirements of residents.

##### (2) Social services function

Based on the implementation of this project, increasing requirements for social services function will be met in the area. However, the “without project” has no improvement to the regional social service, thus it cannot meet the growing demand.

##### (3) Production resource

For the impact on the production resource, as the scenario of “without project” will not cause land occupation and resident relocation, “without project” will not impact the production resource. While the “with project” will occupy some of the farm land and thus reduce the production resource of the people.

##### (4) Cultural resources and scenic spots

In the respect of cultural relics and scenic spots protection, the “without project” does not require land acquisition, relocation and other large-scale civil works. In this way, the “without project” has the benefit in local cultural relics and scenic protection. The “with project” does not pass any cultural sites or scenic spots, thus the implementation of the project will not affect it.

#### 4.1.2 Analysis of economic impact

Although “without project” requires no additional investment, the current status of traffic conditions is poor and will not be improved in future. It is clear that “without project” cannot meet the needs of regional public transport and local social development and thus confining the economic development in the future. Implementation of this project will greatly improve the local traffic environmental and public transport. It can also provide solid foundation for economic development of Changzhi.

#### 4.1.3 Analysis of environmental impact

##### (1) Atmosphere

With the increasing trend of regional traffic volume, “without project” will cause increase of vehicle emission and transportation dust. With the development of Changzhi, “without project” obviously cannot meet the requirement of the regional and public transportation demand. It can even cause more serious traffic congestion, which will result in longer time of vehicle idling, thereby increasing vehicle emission. It can be seen that “without project” cannot reduce the pollution source intensity thus it is not capable of improving the local air quality.

##### (2) Acoustic environment

The percentage of transportation land is relatively small compared with the construction land in the area. Thus it cannot meet the future demand for transport development and causing traffic congestion. With the natural increase of regional traffic volume, noise impact on the environment will increase. Thus, “without project” does not offer any advantages in controlling the noise from overall perspective. By improving the road condition and diverting majority of traffic flow into bus priority transport system, the “with project” alternative will improve the acoustic environment quality, compared with the “without project” alternative, in the project area.

##### (3) Water environment

The drainage system is relatively complete and covers wastewater collection and treatment facilities. “without project” does not affect much the regional water environment. Establishment of “with project” can further improve the drainage system in the project area. Wastewater along the route will be collected through the municipal sewage pipeline network and discharged after treatment by municipal wastewater treatment system. Storm water will be collected through rainwater pipeline network. “with project” can have a favorable impact on the water environment. In addition, “with project” will help complete the drainage planning of the city by constructing separate system in urban area.

##### (4) Environmental risks

“Without project” cannot meet the requirement for regional public transportation in Changzhi, further may lead to traffic congestion, resulting in longer time of vehicle idling, thereby increasing the regional environmental risk. For the sake of this reason, “without project” is not conducive to control the environmental risk in the area.

##### (5) Analysis of environment impact

“Without project” does not need additional land acquisition and relocation, so it will not change the land use nature. Therefore, “without project” will not pose obvious impact on land utilization. The parking and maintenance yard in “with project” needs land occupation, and it will change the land use. However, “with project” will add more public green space through greening.

“Without project” and “with project” have their own advantages in social, economic and environmental impact, the comparison is shown in Table 4-1.

Table 4-1 Comparison of “without project” and “with project”

No.	Factors	“Without project”	“with project”
1	Traffic volume	It cannot meet future development demand of traffic.	Improve the quality of current roads and thus supporting regional transport development.
2	Traffic safety	As the regional transport development has lagged behind, it will lead to regional traffic congestion and traffic safety problems.	Help improve regional traffic safety.
3	Satisfaction of the residents traveling	Cannot meet the requirements of residents’ traveling.	Improve traffic quality, improve transport facilities and improve residents travel satisfaction.
4	Social services function	Cannot meet the growing demand for social services.	Infrastructure construction will improve the quality of the region social services.
5	Production resource	Do not occupy land, no relocation of residents, will not affect production resource.	Will change some production resource, but very minor impact
6	Cultural relics and scenic spots	There are not any important cultural relics or scenic spots in the project area.	There are not any important cultural relics or scenic spots in the project area.
7	public transport	Cannot meet development demand.	Will improve the capacity and quality of regional traffic.
8	Economic development	It will limit future economic development.	Conducive to investment environment and economic development.
9	Atmosphere	Poor transportation and automobile exhaust emissions will adversely affect the air environment.	The use of clean energy and smooth flow of traffic will help improve air quality in Changzhi.
10	Noise	Increasing noise can not be controlled in the project area.	Beneficial in controlling the environmental noise of the project area.
11	Water	No significant effect.	Improve the regional sewerage facilities. It is supportive to water environment protection in the planned new city district.
12	Land use	No land acquisition or relocation requirement. No significant effect.	Parking and maintenance yard in south of city will occupy some farm land. No house demolition.
13	Animals and plants	No significant effect.	No significant effect.
14	Habitats	no effect on natural habitats.	All land occupation of this program located in the city, no effect on natural habitats.
15	Soil erosion	Has benefit in soil and water conservation.	Planning to take protective measures such as slope protection works and green compensation.

#### 4.2 Analysis of site selection for parking lot and bus depots

Integrated corridor improvement is all located in the urban area on existing roads. No site selection is required. Only analysis needs to be done is the comparison of site alternatives for parking and maintenance yard and bus depot.

#### (1) Bayi Square bus depot

Bayi Square is located in the central area of urban area of Changzhi. It is an important hub at the intersection of Yingxiong Road (south-north axle) and Taihang Street (east-west axle). It is also the important hub connecting the urban area with the airport and external traffic.

The transportation network coverage is very high in Bayi Square area. All roads have bus lines except West Square road and East Square road. Each road has at least three bus routes. There are 7 bus routes in Yingxiong Road and 5 in Taihang Street.

As an important transportation hub, Bayi Square is capable of controlling the traffic. Construction of parking and transfer facility can meet the requirement for fast traffic and bus transfer. Development of the surrounding land, especially the use of underground space could also be an important part of the transportation hub. The establishment of commercial and financial center in this area as required by the master plan, makes the hub really play an important role in urban development. Therefore, construction of bus depot at Bayi Square is necessary.

#### (2) Public Transport Company terminal depot

Construction of bus terminal station is located in the bus company at North Yingxiong Road. This site is identified as public transport facility sites by the urban development master plan. Besides, this is a reconstruction of existing bus terminals, so there is no alternative comparison.

#### (3) South parking and maintenance yard at south of city

The South Parking and Maintenance Yard is located at Mafangtou Village in the south of Changzhi. In 2006, city government decided to build a bus parking lot in Mafangtou Village to improve the public transportation infrastructure. The Shanxi Province Land Bureau issued the land quota in December 2006 and completed the initial site selection, construction land use permission. Development and Reform Commission of Changzhi approved the project in 2008. This project is the extension of the existing parking project, so there is no need for site selection and no sensitive points are located within 300m around the site.

### **4.3 Comparison of bus lane alternatives**

According to the location of bus priority lane in the road profile, two options are available for selection, these are central bus priority lane and side bus priority lane.

Option One: central bus priority lane

- The central of the road is designated as the bus priority lane; platform in the side of bus priority lane, bus door on the right side; expand both side of the road section with bus stop; pedestrian lane is provided.
- According to the location of the median line for bus priority lane, there are two type of layout for the priority lane: on both sides of the median line or between the

median line.

Option Two: road side bus priority lane

Bus priority lane is located on both road sides. Taking the three lanes road as example, three layout options are available due to the use of bus lines:

a. bus priority lanes located along the MV line on the left side of the barrier between MV and NMV line

Bus priority lane is located on the left side of the motor vehicle lines, the platform, based on the location of the bus door, and could be located at the barrier between MV and NMV or at the pedestrian line.

b. bus priority lanes located along the NMV line on the left side of the pedestrian line

c. bus priority lanes located along the NMV line on right left side of the barrier between MV and NMV line

See the detail on table 4-2 about comparison of alternatives.

Table 4-2 Comparison of bus lane alternatives

Alternatives	Option One	Option Two		
		a	b	c
Advantage	Safe and reliable; facilitate future upgrades to high-capacity transit system to provide sufficient road space, reflecting sustainable development. The right door do not require new bus model; after compression of a motor vehicle lane, an exit lane is obtained on NMVs lane or isolated zone, which improves the exit passing capacity. Because the vehicle can be integrated inside or outside the system, it is suitable for open systems, trunk-branch system or a combination of escort-service approach, it is more flexible.	Less profile change, simple design; similar to current bus operation, passengers do not need to re-understand the system; bay-typed stop is more convenient for bus to run over stops. But it is less significance for too many bus routes.	This option separates the bus from the motor vehicle and does not change the status of motor vehicle lanes, which means it improves the driving conditions on MV lines. Continue to use existing bus priority lanes, does not need much reconstruction, only require an isolated zone between bus priority lane and NMVs lane. Cost is low	similar to current bus operation, passengers do not need to re-understand the system; bay-typed stop is convenient for buses to skip stop and turn right. Non-motor vehicle does not affect the bus operation. Less reconstruction of existing roads, only require an isolated zone between bus priority lane and NMVs lane, cost is low. After the isolation of bus priority lane, operation of NMVs doesn't change much, only squeezed the NMVs width. The NMVs driving changes a little at the bus stop.
Disadvantage	The turn left traffic and bus traffic conflicts; bus turn right is more difficult; passenger transfer for opposite direction requires to cross at least one lane; with no passing lanes, it is easy for buses to stay long at the bus station,	Turn right traffic and bus traffic conflicts; NMVs disturbs bus operation at stops; bay-typed stop will take up some sidewalk space; with no isolation, only one motor vehicle lane is left inside. In rush hour, traffic have to use bus lane to pass, which is similar to the current condition	Turn right traffic and bus traffic conflicts; NMVs disturbs bus operation at stops; bay-typed stop will take up some sidewalk space. Affect the degree of freedom for NMV, but not affecting its normal running. With isolation for bus priority lane, the NMVs are pushed into the isolation facilities and isolated zone. Make it unable to move to both sides of the corridor, and lose its advantage of and easily produce more disturb; with no isolation, NMVs move can affect the traffic speed for buses.	Turn right traffic and bus traffic conflicts; bus right turn is difficult; bay-typed stop take some sidewalk space; passengers in and out of platform conflicts with NMVs.
Applicable Conditions	applicable for the corridor intersects with the branch road, main road NMVs lane is narrow, left turn at the intersection is prohibited	suitable for wide slow traffic line, or small bicycle traffic line, right turn traffic is small.	suitable for road section with large bicycle traffic and the barrier is wide, small right turn traffic.	suitable for road section with large bicycle traffic and the barrier is wide, small right turn traffic

According to the actual situation, Taihang Street and Fuhou Street select road side bus priority lane; Yingxiong Road and Chengxi Road select central bus priority lane.

#### 4.4 Comparison of fuel at gas station

A CNG and diesel station will be built within the South Parking and Maintenance Yard in south of the city, see below the comparison between CNG and other fuels, in table 4-3:

**Table 4-3 Comparison of CNG, LNG, LPG**

Items	CNG	LNG	LPG	#93 gasoline	#0 diesel
Resource of gas	Good	Very bad	Fair		
Emission reduction	Good	Good	Fair		
Price stability	Stable	Stable	Not stable		
Price (Yuan)	3.7/Nm <sup>3</sup>	4.5/Nm <sup>3</sup>	3.75/L	5.12	5.12
gas consumption per 100 km for taxi	10 Nm <sup>3</sup>	9.5 Nm <sup>3</sup>	12.5L	10L	8L
cost per 100 km for taxi (Yuan)	37	42.75	42.5	51.2	40.96
gas consumption per 100 km for bus	52	50	65	52	40
gas cost per 100 km for bus(Yuan)	192.4	225	243.75	266.24	204.8
Pressure (MPa)	20	1.6	0.1		
Technology maturity	Mature	Pilot phase	Mature		
National Standards	Complete	Not set yet	Complete		
Facilities at gas station	Domestic good	Parts abroad	Domestic good		
Percentage share of the domestic gas vehicles	60% (Increasing rapidly)	Pilot phase	40%		

After the analysis, we see that CNG vehicle has more advantages in the environmental, economic and safety aspects than gasoline, diesel and LPG vehicles. In addition, compared with LPG vehicles, the technology is more mature for CNG vehicles. Although the storage advantage is obvious for LPG, the price is high and the gas source is limited, so it is still not suitable for promotion in current stage. Overall, it is necessary and urgent to promote the use of CNG vehicle in Changzhi.

#### 4.5 Comparison of road selection

The existing city road pavement material include: ordinary asphalt pavement, concrete pavement and road noise reduction pavement, etc. The project selects the plan by comparing these types of materials, as table 4-4 shows.

Table 4-4: Comparison of materials

Materials Comparison	Asphalt pavement	Concrete pavement	Noise reduced pavement
Environmental impact	Maintenance with high frequency, likely to cause secondary pollution	Normal operating conditions demand less maintenance, hard to cause secondary pollution	Less maintenance frequency than asphalt pavement, not easy to cause secondary pollution
Impact during construction phase	Asphalt paving process produces smoke, pollution of the	Produce wastewater, construction period is long, affect the normal	Asphalt paving process produces smoke, pollution of the

	environment	life of residents.	environment
Noise sound level	Flat and smooth, ride comfort, low noise	High noise	Pavement containing noise absorption material, reduce noise 2-3 dB compared with asphalt road
Compressive strength and flexural strength	Good	Fair	Good
Applicability of the temperature	asphalt melts at high temperature, easily damaged	High heat resistance	Fair
Yield value	Fair	Bad, easy cracks	Better scalability
Pavement quality	Fair	Wear-resistant, but prone to cracks; easy for surface wear; small holes easy to appear	half thinner than ordinary asphalt and life can be doubled
Features of anti-slip and waterproof	Good	Fair	Icy on surface in winter
Investment	Initial investment is low, but higher cost of repair and maintenance	One-time investment is large, a relatively small repair and maintenance	Due to the use of sound-absorbing material, investment is the largest

Based on this comparative analysis, it is clear that:

- Asphalt pavement has a low initial investment, smooth surface, low noise, anti-slip and waterproof performance. Disadvantages are high frequency of maintenance; high frequency and cost for maintenance, produces asphalt smoke (secondary pollution).
- Concrete pavement has the advantage of less frequent maintenance requirements, low cost, but has a larger initial investment, construction period is long and need for maintenance after construction (resulting in wastewater). In addition, high and low temperature flexibility for the cement pavement is poor, easy to cracks and other damage. Compressive strength and tensile strength is poor, anti-slip and waterproof less effective and noise is high.
- Noise reduction pavement has the advantage of good quality, long life, low maintenance frequency, construction and maintenance process produces less pollution, good scalability, has good resistance to deformation. Since it contains acoustic materials, road noises reduce 2-3 dB than ordinary asphalt pavement. However, it is easy to freeze in winter, and large initial investment makes it hard to build.
- Based on considerations from initial investment, maintenance, pavement quality, environmental pollution and other aspects, asphalt pavement has relatively low investment costs, it is smoothness, resistance to deformation, waterproof, anti-slip, cause less environmental pollution. Therefore, this project selects asphalt as the pavement material.

## **5 Environmental impact and its mitigation and control measure**

### **5.1 Design phase**

#### **5.1.1 Environmental impact during design phase**

This is a transportation improvement project, several aspects should be given consideration during the design phase in order to avoid, minimize or mitigate adverse environmental impacts:

This project involves reconstruction of Bayi Bridge and Qiyi Bridge, construction of pedestrian bridge at the junction of Yingxiong Road and Zijin Street as well as the reestablishment of green belt along the transport corridors. Therefore, the landscape design should be kept consistent with surrounding area;

Design of traffic safety facilities should be well finished during construction phase and operation phase;

Ensuring reasonable selection of routes for transport corridors, the route should be kept away from the environmental sensitive receptors as much as possible, and it should also reduce the demolition and land acquisition.

#### **5.1.2 Mitigation measures at the design stage**

During feasibility study, EIA team and feasibility study team should conduct a brief analysis on the environmental impact based on the environmental characteristics of the area and consultation from the local environmental protection agency.

Project management office should engage qualified institute for drafting the environmental impact assessment report.

During preliminary design and construction drawing design, environmental protection should be included as a chapter based on the environmental impact assessment report and the EMP. This can serve as basis for environment management and can guide the project construction.

### **5.2 Environmental impact mitigation measure during construction phase**

#### **5.2.1 Social impact and mitigation measure**

The major construction content in this project include Integrated Corridor Improvement, new building and reconstruction of parking and maintenance yard, reconstruction of bus depot, etc. The construction contents are all located in urban area of Changzhi. Along the construction route, a lot of business enterprise, community, hospital, school, administrative institute and some city parks are distributed. According to investigation, 66% of the total urban population, 77% of the total employment, 81% of the total business opportunities and 70% of the total student are concentrated in this area which only accounts for 55% of the urban land. It is the business, residential, job market and education center of Changzhi. The construction period is relatively long, several aspect of impact could be considered on the social environment, as the following:

##### **5.2.1.1 Impact on transportation and traffic safety**

- (1) The project corridors (Taihang Street, Yingxiong Road, Chengxi Road and Fuhou Street) are all major roads in urban area of Changzhi, the traffic volume is large especially for the business area crossed by Yingxiong Road, where the traffic of pedestrian and motor vehicle are mixed together. During the construction phase, construction work will be carried out section by section to expedite the construction progress and mitigate the safety risk. Along the above road section, traffic congestion and blocking will happen during the rush hour.
- (2) A lot of construction and transportation machinery are used during construction phase, which will increase the traffic volume in the area and disturb the normal

traffic, or even cause traffic safety problem where the pedestrians interact with construction vehicles .

#### 5.2.1.2 Impact on resident life

- (1) Business operation: A lot of commercial businesses are active along the transport corridors. The roadside commercial businesses would be affected by the road construction by blocking the access to the businesses. Construction work should be confined within the redline by the fence. Temporary access roads should be provided during the construction of this section so that the entrance/exit of the consumers will not be blocked and the impact is limited and temporary and will disappear once the completion of the construction.
- (2) Resident communities: Urban transportation is disturbed during the construction phase, which will cause traffic congestion and blocking. Bus route will be adjusted at places where traffic separation and detour are used, this will cause inconvenience for the commuters, work and life of the resident.
- (3) Administration work: A lot of administrative institutes are along the route, like the city government, police station, tax department and city court, etc. In order to reduce the impact on normal administrative work, announcement should be provided before construction.
- (4) Normal life: The above and underground facilities like water supply, drainage system, electricity, telecommunication, heating pipeline system need to be relocated , but normal usage will not be paused for the resident.

#### 5.2.1.3 Social impact mitigation measure

- (1) Preparation work should be finished before construction, detailed investigation on the construction contents such as road, electricity, and telecommunication should be conducted and relocation plan should be determined by cooperation with relevant department. Emergency plan should be provided for the construction contents to facilitate the normal social life.
- (2) Traffic separation should be planned during construction phase in order to prevent traffic congestion and reduce the impact on urban transportation and resident life. Cooperation with police, traffic control department should be provided and announced using radio, TV and newspaper when necessary to ensure the smooth of the traffic flow.
- (3) Announcement plate should be installed at the construction site, explaining the contents, construction period, petition for public understanding and providing contact and complaint method.
- (4) Large amount of electricity and water will be used during construction, the construction unit should contact relevant department to determine plan for pipeline connection of electricity and water and prepare for connection work, for the area with limited regional capacity, reconstruction of the pipeline should be finished to prevent temporary pause of water and electricity use along the route.

- (5) Temporary pedestrian bridge should be installed at sensitive road section such as school, hospital, home for the aged, business building to ensure the safety of pedestrian.
- (6) Construction at night is prohibited.
- (7) Minimizing pedestrian interaction with construction vehicles.
- (8) Using locally sourced materials, whenever possible, to minimize transport distance. Locating associated facilities such as worker bus transport to minimizing external traffic.

## 5.2.2 Noise impact and mitigation measures

### 5.2.2.1 Noise source and its characteristic

Noise from road construction is mainly from the operation of construction and transportation machinery, which can generate very high noise and can not be predicted, its impact on the environment is temporary and will disappear with the completion of construction. However, the sound level for the noise generated from the machinery is very high, which can pose large impact on the sensitive receptors like surrounding village, school, and hospital if it is poorly controlled. According to investigation, the major machinery used for road construction are loading machine, excavator, leveler, road roller and pavers, etc, with their corresponding sound level shown in table 5-1.

Table 5-1: Road construction machinery noise sound level.

No	Type	Distance to construction machinery(m)	L <sub>max</sub> (dB)
1	Wheel loading machine	5	90
2	Road leveler	5	90
3	Vibration road roller	5	86
4	Wheel road roller	5	76
5	Bulldozer	5	86
6	Excavator	5	84
7	Pavers	5	82

Road construction is different with other construction, the noise generated has the following characteristics:

- (1) Various kind of machinery at different construction stage, the number of machinery used at the same construction stage is different, which makes the noise hard to predict.
- (2) Noise characteristic of different machinery is different, some of the noise are vibrated and intermediate, which has great impact; some of the machinery () has low frequency, but lasts long. The sound level of all the noise is relatively high, but the difference between them is also big, some of the noise could reach above 90dB.
- (3) Noise from road construction is not usual, both fixed source and moving source are expected. This will increased the range of area affected by noise during this time period. But compared with moving sources, the construction noise is still regionally limited.

- (4) Construction machinery has a small range of impact and it can be defined as point source.
- (5) For specific road section, construction noise only happens within certain period. Most of the machinery used for construction are moving sources, which is not fixed and intermediate. The transportation machinery has a large range of impact and the bulldozer have limited moving range, which is different with the transportation machinery. Therefore, it is obvious that the impact is time limited.

#### 5.2.2.2 Noise impact analysis and prediction

The construction noise of this project is using the standards in “Noise sound standard for construction site” (GB12523-90). The noise from the construction machinery are treated as point source, of which the range of impact will be calculated in order for the construction team to control the noise based on actual situation. The model used for noise prediction is as follows:

- a. Distance of noise attenuation equation:

$$L(r)=L(r_0)-20Lg(r/r_0)$$

in which,

r is the distance from the prediction point to noise source;

r<sub>0</sub> is the distance from the reference location to noise source;

L(r) is the sound level for the point with distance r;

L(r<sub>0</sub>) is the sound level for the point with distance r<sub>0</sub>;

Additional attenuation generated by barrier, vegetation and air are not considered.

- b. Noise superposition

For impact generated by multiple machineries, noise superposition should be considered, as the following equation:

$$L=10Lg(10^{0.1L_1}+10^{0.1L_2}+.....+10^{0.1L_n})$$

in which,

L is the total sound level;

L<sub>1</sub>.....L<sub>n</sub> are the sound levels for noise sources of 1, 2 ,...,n.

#### 5.2.2.3 Range calculation for construction noise

According to the above model, by only considering the distance attenuation, the noise sound level for different machineries with different distance is predicted as table 5-2.

Table 5-2: Construction noise sound level prediction. Unit Leq(dB(A))

Type	Distance from construction(m)							Standard dB(A)		Distance meet standard (m)	
	5	10	20	40	60	80	100	daytime	night	daytime	night
Loading machine	90	84	78	71.9	68.4	65.9	64	75	55	28	281
Leveler	90	84	78	71.9	68.4	65.9	64	75	55	28	281

Vibration roller	86	80	74	67.9	64.4	61.9	60	70	55	32	177
Wheel roller	76	70	64	58	54.4	52	50	70	55	10	56
Excavator	86	80	74	67.9	64.4	61.9	60	75	55	18	177
Hydraulic excavator	84	78	72	66	62.4	60	58	75	55	14	141
Pavers	82	76	70	64	60	58	56	70	55	20	112
Percussive drill	87	81	75	69	65	63	61	85	—	6	—

#### 5.2.2.4 Construction noise environmental impact analysis

- (1) From table 5-2, based on the standards in “Noise sound level standard for construction site” (GB12523-90), if a single machinery has a sound level of 90dB(A), the area within 35m from the construction will exceed 75 dB(A) during daytime, the within 281m from the construction will exceed 55 dB(A) at night. For actual construction, multiple machineries are used at the same time, the affected range will be larger, especially at night. However, the noise is intermediate and within a short time period, it will disappear with the completion of construction, which is normally acceptable for the resident. The contractor should use proper noise management and control measure, to reduce its impact on the environment so that the normal life of the resident along route will be maintained.

According to investigation, the major noise sensitive receptors along route are : Yingxiong Road elementary school, Xiaolingtong Kindergarten, Xianan Street elementary school, Huoju middle school, No.12 middle, Jiandong Road elementary school, Heji hospital, No.2 middle school, Changzhi academy of education, Maternal and Child Care Service Centre and No.7 middle school. Except for these, resident building and administrative agency are located along the road and will be affected during construction to some extent.

- (2) From table 5-2, the noise level for is normally above 80dB(A), some of which will reach 90dB(A), this will damage the health of the construction staff especially for the machinery operator.

#### 5.2.2.5 Construction noise control measure

- (1) The construction team should strictly executed “Measures for construction noise management”, during the construction period, and keep the fixed machinery away from the sensitive receptors.
- (2) Use low noise machinery, keep good maintenance of the machinery.
- (3) Choose proper construction time period on sensitive road sections.
- (4) Enhance the management of construction and transportation machinery, slow down when entering the vicinity of sensitive area, reduce or prohibit horn.
- (5) Construction at night (22:00~6:00) is prohibited.
- (6) Should keep the machinery well maintained to minimize the noise level.
- (7) Should rotate the operators of the machinery to reduce the time exposure to high noise; should protect construction staff working long near noise source by using ear plug.

- (8) Construction near school should be arranged during the weekend or holiday, transportation of materials should also be kept away from school.
- (9) Prohibit the operation of high noise, high vibration machinery during the rest time in the noon.

### 5.2.3 Vibration impact and its mitigation measure

#### 5.2.3.1 Vibration level

The vibration source in this project is mainly from drill, heavy-duty transporter, compressor, airpick, pile driver, excavator, bulldozer, road roller, etc. The vibration level of these machineries is shown in table 5-3.

No	Type		Vibration level 10m away (DB)
1	drill-grouter		63
2	heavy-duty transporter		74-76
3	compressor		81
4	airpick		83-85
5	Vibration pile driver		79
6	Concrete pile driver		50-67
7	excavator	caterpillar	72-80
		wheel	65-70
8	Vibration roller	Vibration moving	71
		Non-vibration moving	55
9	bulldozer	running	78
		operating	70

#### 5.2.3.2 Vibration impact analysis

##### (1) Prediction model

Prediction of vibration could use the following equation:

$$VL_z = VL_{z_0} - 20 \log\left(\frac{r}{r_0}\right) - \Delta L_z$$

in which,

$VL_z$  is the vibration level at  $r$  m away from the machinery, dB

$VL_{z_0}$  is the vibration level at  $r_0$  m away from the machinery dB

$r$  is the distance between the prediction point and the machinery, m

$r_0$  is the reference distance to the machinery, m

$\Delta L_z$  is the additional damping adjustment factor, dB

##### (2) Prediction result

The result of the damping distance for vibrations from construction machinery is shown in table 5-4.

Table 5-4: Vibration level for typical construction machinery

No	Type		Distance to vibration source □m□									
			10	20	30	40	50	60	70	80	90	100
1	drill-grouter		63	56.98	53.46	50.96	49.02	47.44	46.10	44.94	43.92	43
2	heavy-duty transporter		76	69.98	66.46	63.96	62.02	60.44	59.1	57.94	56.92	56
3	compressor		81	74.98	71.46	68.96	67.02	65.44	64.10	62.94	61.92	61
4	airpick		85	78.98	75.46	72.96	71.02	69.44	68.10	66.94	65.92	65
5	Vibration pile driver		79	72.98	69.46	66.96	65.02	63.44	62.10	60.94	59.92	59
6	Concrete pile driver		67	60.98	57.46	54.96	53.02	51.44	50.10	48.94	47.92	47
7	excavator	caterpillar	80	73.98	70.46	67.96	66.02	64.44	63.10	61.94	60.92	60
		wheel	70	63.98	60.46	57.96	56.02	54.44	53.10	51.94	50.92	50
8	Vibration roller	Vibration moving	71	64.98	61.46	58.96	57.02	55.44	54.10	52.94	51.92	51
		Non-vibration moving	55	48.98	45.46	42.96	41.02	39.44	38.10	36.94	35.92	35
9	bulldozer	running	78	71.98	68.46	65.96	64.02	62.44	61.10	59.94	58.92	58
		operating	70	63.98	60.46	57.96	56.02	54.44	53.10	51.94	50.92	50

### (3) Impact analysis

From table 5-4, the area 40□50m away from the vibration source will reach 75 dB(A), in another words, the project construction will pose obvious impact for areas within 50m of the vibration source. Residents are located within 50□240m away from the construction machinery, therefore the vibration will affect the resident in this range of area to different magnitude.

#### 5.2.3.3 Vibration impact mitigation and control measure

- (1) Proper planning should be given to machinery with high vibration level according to the actual condition.
- (2) Construction activities with high vibration should be prohibited at night and noon.
- (3) Enhance construction management, reduce the vibration impact on surrounding environment as much as possible.

#### 5.2.4 Air pollutant impact and mitigation measure.

##### 5.2.4.1 Ambient air impact analysis

The air pollutant sources during the construction may include: excavation; material loading/unloading and transportation; flying dust from machinery operation, earth piling; emissions from construction and transportation equipment. This project will purchase commercial asphalt product for road pavement, which could prevent generating pollutant when melting the asphalt. The only impact will be from little air pollutant produced from

the asphalt pavement, the temperature of the asphalt mixture is controlled between 135°C and 165°C, the pavement is one-step forming, of which the impact on the atmospheric environment is limited. The materials used during construction such as lime, cement and stone are already processed; solid waste generated from the construction site will be collected in a timely manner; no temporary construction station is used in this project.

The major impact during construction period on atmospheric environment is dust. Excavation and drilling of the ground will generate dust, some of the dust will suspend in the air, some of the dust will land on the ground and building in vicinity; dust will generate from the earth pile during large wind; dust can generate during material load/unload; earth contained in the rainwater when dried will generate dust though vehicle moving or wind; excavation and filling will generate a lot of dust.

The pollution from dust during construction period should not be ignored. Once inhaled by the construction staff or the resident, it can cause respiratory disease. In addition, suspended dust can reduce the invisibility and cause traffic accident. Dust on building and tree can influence landscape. Therefore, construction unit should enforce strict management and measures to prevent dust generation during construction.

#### 5.2.4.2 Ambient air pollution mitigation measures

In order to reduce the impact on surrounding environment, construction units should enforce the regulations in “Notice on implementation of (Measures for dust control and management in Changzhi)” and adopt the following measures:

- (1) Street water sprinkling should be applied for the sensitive section such as hospital and school along the corridor, especially before and after school; the surface of the road should be maintained clean.
- (2) Construction of the parking and maintenance yard at south of city should prepare construction road to prevent the generation of dust from transportation vehicle on earth ground. Before earth excavation, solidification of the door, fence, ground at construction site, entrance/exit should be done. Washing facilities should be provided for the vehicle.
- (3) During excavation, the site should be sprayed with water to maintain certain humidity, especially for the loose surface soil at construction site; during filling, the site should also be sprayed to prevent the flying of dust.
- (4) Enhance the management of temporary storage of the materials, sprinkle water or cover the materials prone to air-borne dust; spoil, construction waste should be collected as soon as possible.
- (5) The transportation vehicle should be covered and not loaded too much to prevent leakage from the vehicle; make specific plan of the route and schedule for the transportation vehicle, prevent the vehicle running at central area, large traffic area and resident area; for road section that needs strict standard, transportation should be done at night according to the actual condition. The leakage of soil from the transportation should be cleaned up as soon as possible to reduce dust.

- (6) Steel fence higher than 2.5m should be used at construction site, the height should be higher than 3m for road section with sensitive receptors.

## 5.2.5 Construction wastewater impact and mitigation measure

### 5.2.5.1 Source of construction wastewater and its intensity

This project is located at the urban area, no construction station is built during construction period, wastewater from the construction staff does not exist. The major source of wastewater is construction wastewater and wastewater from washing the machinery. The main pollutant in the wastewater is SS, which is settled and collected by the drainage system and does not affect the surface water environment much.

### 5.2.5.2 Environmental impact analysis and mitigation measures

During construction period, contractors should organize facilities for the discharge of wastewater, as the following measures:

- (1) Construction wastewater contains a lot of SS and is prohibited to discharge directly. Proper settlement should be applied to the wastewater.
- (2) Shizi River is a human controlled landscaping river, most of the time it is dry according to investigation. The bridge construction can carry out during the dry period. Construction waste soil should be cleaned up from the river channel, the transportation and storage of the waste soil should be supervised by people, it is prohibited to throw the waste soil.

## 5.2.6 Solid waste impact and the mitigation measure.

### 5.2.6.1 Solid waste impact

Solid waste during construction period is mainly from road pavement reconstruction, underground parking lot excavation, construction and domestic solid waste.

The road surface reconstruction will generate 7830m<sup>3</sup> waste, spoil from the underground parking lot construction is 23320m<sup>3</sup>, construction waste is 6820m<sup>3</sup>, waste from the construction staff is 2.7t (May to Oct).

Domestic solid waste during construction period can pollute the environment and affect landscaping and traffic if not properly disposed; other construction waste will cause dust pollutant and silt during windy and rainy days. The running of cleaning vehicles on urban road will increase the traffic volume and more importantly the lose of soil from it can influence the environmental health of the city.

### 5.2.6.2 Solid waste pollution control measure

Following measures are suggested in order to reduce the impact of solid waste on environment:

- (1) Domestic solid waste: contractors should set up solid waste collection tank, and engage relevant department for disposal.
- (2) Construction spoil: contractors should have plans for spoil disposal before construction and keep balance of the soil inside the project. Spoil should be reused

as much as possible, if not, it should be disposed at the construction waste landfill located at Shuangqiaozhuang Village through payment of related fees. The environmental sanitation department will be in charge of recovering the ecological environment for this landfill.

- (3) Construction waste: all disposed to the construction landfill located at Shuangqiaozhuang Village through payment of related fees. The environmental health department will be in charge of recovering the ecological environment for this landfill.
- (4) Construction unit should enforce the management standards established by relevant responsible administrative institute and control the construction waste and soil from its source.
- (5) Clean up as soon as possible, covered transportation to prevent lose.
- (6) Construction waste and soil should be transported by qualified department with covering capability.
- (7) Transportation vehicle for construction waste and soil should run and dispose according to regulated time, route and location.
- (8) Transportation vehicle for materials should avoid rush hours at sensitive receptors. Transportation should be confined within regulated time period and route. Cover should be provided for transportation of loose material and waste, wash from outside before transportation.

## 5.2.7 Urban ecology impact and mitigation measures

### 5.2.7.1 Urban ecology impact analysis

This project involves the construction of 4 integrated corridors, 2 parking and maintenance yard and 1 traffic depot, the urban ecology impact during the construction period is mainly from the green belt excavation and renovation, spoil, construction waste and transportation vehicle.

#### (1) Vegetation removal and replanting

Table 5-5: Impact on the vegetation within the green belt

No	Corridor	Increased green area □m <sup>2</sup> □	number of trees to be relocated
1	Taihang Street	17897	746
2	Yingxiong Road	18374	530
3	Chengxi Road	12475	140
4	Fuhou Street	19740	805
Total		68486	2221

From table 5-5, the construction of this project will not damage the green belt along the route, in opposition, it will increase the vegetation area in the green belt along route. During the construction period, the traffic volume is large, which will greatly influence or even demolish the vegetation around the construction site if construction is not properly managed.

(2) Construction spoiled soil will occupy cultivated land, which can reduce the per capita cultivated area. In the meantime, due to the increase of population and consumption level, increased pressure has been added for the cultivated land, which will cause conflict between human and land as well as causing environment ecological issues. All construction spoil will be disposed to the construction landfill located at Shuangqiaozhuang Village through payment of related fees. The environmental health department will be in charge of recovering the ecological environment for this landfill. Therefore the spoil is not affecting the land use much.

(3) The major construction contents are located in the flat urban area with little high filling or deep excavation, so erosion is hardly seen. However, the temporary storage of construction materials and waste materials such as soil, cement and clay will cause impact on the ecological environment of the city. Especially for the spoil, if not well protected, it will be flushed by rainwater into the drainage pipeline and cause congestion.

(4) During construction period, the transportation of construction materials will cause a lot of dust if poorly managed, which will cause dust impact on the ground, green belt and resident along the road. The environmental health of the city is also affected to some extent.

#### 5.2.7.2 Analysis of impact on city landscaping

The following aspects of impact on the city landscaping are considered:

- (1) Pipeline demolition and relocation will affect the landscape within limited range, but this impact is temporary, will diminish upon the completion of the project. On other hand, the landscaping will be enhanced through road greening.
- (2) The storage of excavated soil and construction material, especially the spoil and construction waste will affect landscaping and environmental sanitation of the city.
- (3) The temporary building and parking of machinery will also affect landscaping.
- (4) The use of isolation fence and cover will affect landscaping to some extent.
- (5) Noise, dust, emission, construction waste and waste water generated from the construction period will cause pollution; the business unit and administrative institute beside the reconstruction road will be affected.

#### 5.2.7.3 Mitigation measure during construction period

The following aspects should be given consideration in order to protect the landscaping along route:

- (1) The vegetation and trees in the middle or at side of the road should be protected and then relocated, rather than replanting after demolition. The trees and green area near the construction site should be protected.
- (2) The construction should be confined within the redline range, storage of the soil and material should not occupy the land near the site.

- (3) Plan ahead the management of excavation and filling, protection should be given to the temporary spoil. Avoid excavation and filling activities when it is raining so that there will be no erosion, pollution and congestion happening.
- (4) Should enact contract with the soil usage department about recovery of the ecology for spoil on sale.
- (5) Should minimize the land occupation as much as possible and make proper arrangement on the construction progress. Clean the construction site after completion of construction, retreat from the occupied land, recover previous road and greening.

## 5.2.8 Cultural resources impact and the mitigation measure

### 5.2.8.1 Cultural resources

There are no important cultural sites at any protection levels as recorded in local cultural bureau. According to field investigation, there is a “West mosque” to the north of the junction at Yingxiong Road and West Heping Street, this mosque was built in 1947, it is the normal worship place for people believe in Islamism in Changzhi. There are 5 worships everyday (5:00, 13:00, 17:30, 19:30, 20:30) with 50 people attending each time. The important dates for Islamism are Mohammed's Birthday (March 12<sup>th</sup> in Islamism calendar), Fast-Breaking Ceremony (Oct 1<sup>st</sup> in Islamism calendar) and Corban Festival (Dec 12<sup>th</sup> in Islamism calendar). During these dates, devotees will gather in the mosque to celebrate, the number of people is around 100-300. “West Mosque” is along the road side of Yingxiong Road and is outside the redline.

Huayan Temple is located to the south of West Taihang Street, 730m away from east of Hubin Road and 54m from Taihang Street. It is used for Buddhism worship and was built in 2001, the area is 300m<sup>2</sup>. Inside the temple, there is “Sansheng” palace hall with statures inside. There are no important events during normal days. Worship activities will happen during the 1<sup>st</sup> and 15<sup>th</sup> day of each month in Buddhism calendar.

The “West Mosque” is close to Yingxiong Road. Construction should be carefully scheduled to avoid the above mentioned dates. Announcement and information plate should be available before construction on such sections to ensure the arrangement by the host of the temple and the mosque. For construction in this section, temporary road should be made available to the mosque, good construction management should be enforced. Huayan temple is away from West Taihang Street and there is 30m green barrier in between. In addition, it is a small temple and the worship activities are not frequent, therefore the impact on this temple during construction period is minor.

### 5.2.8.2 Measures for cultural relics during construction (Chance Find)

In accordance with regulations and laws from” Law of the People's Republic of China on the Protection of Cultural Relics”, “Rules for the implementation of Law of the People's Republic of China on the Protection of Cultural Relics”, and “Implementation of 〈Law of the People's Republic of China on the Protection of Cultural Relics〉 in Shanxi Province”, following procedures should be used when cultural relics are found during construction period:

- (1) Any unit or personnel when find cultural relics during construction should protect the site and report to the local cultural administrative institute. Upon receiving the report, the cultural administrative institute should arrive at the site within 24 hours and provide protection opinion within 7 days. The cultural administrative institute can report to the police department and ask for protection of the site; if important cultural relics are found, it should be reported to the state cultural administrative institute, which should provide protection opinion within 15 days. Construction should be paused before the completion of the relic excavation.
- (2) The cultural relics found should be preserved by the public museum, library or other public units designated by the cultural administrative institute of the city, province or state. Permission should be obtained from the cultural administrative institute of the city, province or state in order to keep a sample of the cultural relics found.
- (3) The cultural relic found belongs to the state, any unit or personnel should not keep it privately.

#### 5.2.9 Traffic safety

Four main roads in urban Changzhi are involved during construction period. Since the construction is section by section, the section without construction will be used normally. The settle of construction vehicle and staff will increase the pedestrian and vehicle traffic in very short time, this will bring traffic safety issue. During construction period, all the project staff entering or leaving the construction site as well as operating the machinery on road should maintain traffic safety. Safety measures preventing and controlling injury and death from accident should focus on the project staff and pedestrians, including these prone to be harmed by traffic. The safety measures should include following contents according to the size and characteristic of the activity:

- (1) Underscore safety regulations for the driver;
- (2) Improve driving technique and use licensed driver;
- (3) Limit driving time, rotate drivers;
- (4) Avoid dangerous road and time, minimize the chance of traffic accident;
- (5) Install speed control system on the truck and supervise the driver;
- (6) Maintenance in a timely manner using parts from the dealer, prevent accident happening due to out of order for the parts;
- (7) Minimize situations that pedestrian and construction vehicle use the road at the same time;
- (8) Improve the visibility of the signal to enhance overall traffic safety;
- (9) Education on traffic safety and pedestrian safety should be provided at communities near school;
- (10) Cooperate with the emergency responding staff to provide proper first aid when accident happens; purchase local materials as much as possible to minimize transportation; use large vans around construction site to reduce the traffic volume; adoption of traffic safety control measure, use traffic signal and staff to remind the pedestrian and vehicle of dangerous situation.

### **5.3 Environment impact and pollution control measure during operation phase**

#### **5.3.1 Social environmental impact analysis**

##### **(1) Improving traffic condition and organization**

The operation of this project will pose new requirement for the facilities related to buses, logistics and parking lots. Upon finishing of this project, resident travel will be more convenient due to improved public transportation and good management of parking for private vehicles. In addition, the improvement of the traffic condition and road network will enhance the people and goods transportation with vicinity area.

This project is World Bank loan project, which will help improve the transportation development. The determination of “green city and green transportation” as well as promoting bus priority can improve the public transport system comprehensively, which will solve the traffic congestion issue.

##### **(2) Reducing vehicle emission and traffic noise**

Through green transport system of “bus+bicycle+pedestrian”, traffic within the urban area will be smoother. In addition, vehicle running speed on the road will increase to some extent due to enhanced management of traffic. The traffic distribution in space will be more even, which will reduce traffic congestion and keep the vehicle running at a constant speed so that frequent idling and honking will be reduced significantly. The emission discharge from the vehicle is the smallest when running at a constant speed, therefore the emission and noise will also be reduced, which is vital in improving the ambient air quality and acoustic environment. In the meantime, the green transport system in the project can also reduce the emission discharge significantly.

##### **(3) Improving city landscaping**

The proposed green isolation belt and new green area during the construction phase will improve the ecological environment and landscape. In the meantime, demolition and reconstruction along the route as well as reconstructions for municipal water supply, thermal, gas, electricity, drainage system can greatly improve the city landscaping.

##### **(4) Improving the life standard**

Real estate industry is one of the industries that will be influenced by transportation, it also requires a lot on transportation. The improvement of transportation will change the evaluation standard for the valuation and social function of the community. Generally, the community with accessible transportation and related facilities will have high value. Therefore, upon the improvement of transportation condition, the valuation of the community along the route will increase, which will improve the life quality of the resident.

##### **(5) Impact on vulnerable groups**

For transportation system, people with non motor vehicle is the vulnerable group compared with that with the motor vehicle, pedestrian is the vulnerable group compared with vehicle, disabled people is the vulnerable group compared with healthy people, bus is the focused group compared with other vehicles. While improving the transportation condition,

considerations should be given to the vulnerable group and focused group. The design of sidewalk for the blind has been considered during the plan and design of pedestrian lane. Moreover, during actual design and construction, care should be given to the pedestrian, older people, blind people and disabled people by incorporating the design of pedestrian, sidewalk for the blind and cross street tunnel. The improved public transport system and policy subsidy can provide better service for low income people, which is important for enhancing the harmony society.

Overall, upon completion of the project, the transportation infrastructure of urban Changzhi is better and the traffic capacity of the road network is enhanced; the city landscape is better and the commute time is less for the city resident; the valuation of the land along route will increase; economic development could be promoted through the development of industry, real estate, business, service, information technology; investment environment and tourist industry can also be enhanced.

### 5.3.2 Noise impact and mitigation measures

#### 5.3.2.1 Traffic volume

The short term and long term traffic volume projection is shown in table 5-6 according to the feasibility study.

Table 5-6: short term and long term hourly traffic volume project for sensitive receptors.

Unit: vehicle per hour

Road name	No	receptors name	Traffic volume	
			2015	2030
Yingxiong Road	1	Yingxiong Road elementary school	1850	2143
	2	Xiaolingtong Kindergarten	1850	2143
	3	Xianan Street elementary school	1253	1858
Taihang Street	4	Huoju middle school	2335	3028
	5	No.12 middle school	2442	2616
	6	Jiandong Road elementary school	918	1224
	7	Heji hospital	1268	2273
Fuhou Street	8	No.2 middle school	1009	1005
Chengxi Road	9	Changzhi academy of education	3112	3125
	10	Maternal and Child Care Service Centre	2689	2772
	11	No.7 middle school	1881	1940

#### 5.3.2.2 Noise level

CADNA/A method is used in this report to calculate the environment noise impact, the result is shown in table 5-7.

Table 5-7: Noise level for single vehicle during operation phase

Road name	No	Objective name	Short term single vehicle sound level		Long term single vehicle sound level	
			daytime	night	daytime	night
Yingxiong Road	1	Yingxiong Road elementary school	60.8	53.4	61.5	54.1
	2	Xiaolingtong Kindergarten	60.8	53.4	61.5	54.1
	3	Xianan Street elementary school	59.1	50.4	60.8	52.1
Taihang Street	4	Huoju middle school	64.4	55.6	65.5	56.8
	5	No.12 middle school	64.6	55.8	64.9	56.1
	6	Jiandong Road elementary school	60.3	51.6	61.6	52.8
	7	Heji hospital	61.7	53	64.3	55.5
Fuhou Street	8	No.2 middle school	58.2	49.2	58.3	49.4
Chengxi Road	9	Changzhi academy of education	63.1	54.3	63.2	54.4
	10	Maternal and Child Care Service Centre	62.4	53.7	62.6	53.8
	11	No.7 middle school	60.9	52.1	61	52.3

### 5.3.2.3 Projection model and parameter

Based on the characteristic of proposed project and its environmental feature along route, RLS90 projection method from Germany is used in CADNA/A software. The model is simulated for the buildings within 200m from the road side, which can reflect the use of building as a barrier for blocking the noise.

(1) Calculation model for road sound level

Noise  $L_{m,E}$  generated by the vehicle is defined as:

$$L_{m,E} = L_m^{(25)} + D_v + D_{surf} + D_{slope} \dots \dots \dots (1)$$

$$L_m^{(25)} = 37.3 + 10 \lg [M(1 + 0.082p)] \dots \dots \dots (2)$$

$$D_v = L_{car} - 37.3 + 10 \lg \left[ 100 + \frac{10(L_{truck} - L_{car}) - 1}{(100 + 8.23p)} p \right] \dots \dots \dots (3)$$

$$L_{car} = 27.7 + 10 \lg [1 + (0.02V_{car})^3] \dots \dots \dots (4)$$

$$L_{truck} = 23.1 + 12.5 \lg (V_{truck}) \dots \dots \dots (5)$$

in which,

$M$  is the mean traffic volume for single line;

$p$  is the ratio of large vehicles which is more than 2.8 t;

$V_{car}$  and  $V_{truck}$  are speed limit for small vehicle and truck, km/h;

$D_{slope}$  is 0 when slope  $G \leq 5\%$ ,  $D_{slope} = 60G - 3$  when  $G > 5\%$

(2) Calculation for the traffic noise level of the projection point

Divide the vehicle line into  $i$  sections, the noise sources are located at 0.5m above the center of each section, the length of each section  $l_i$  should not be greater than half the distance between the noise source and the projection point, the noise sound level  $L_m$  at the projection point is the superposition of the mean sound level  $L_{m,i}$  at each section,  $L_{m,i}$  is calculated by adjustment of section length  $D_{l,i}$ , atmospheric absorption and distance damp  $D_{s,i}$ , ground absorption and climate influence  $D_{Bm,i}$ , reflections between the parallel plains aside the road  $D_{refl,i}$ , noise reduction by barrier  $D_{bar,i}$ .

$$L_m = 10 \lg \sum_i 10^{0.1(L_{m,E} + D_{l,i} + D_{s,i} + D_{Bm,i} + D_{refl,i} - D_{bar,i})}$$

$$D_{l,i} = 10 \lg(l_i)$$

$$D_{s,i} = 11.2 - 20 \lg(S_i) - S_i / 200$$

$$D_{Bm,i} = (h / S_i)(34 + 600 / S_i) - 4.8 \leq 0$$

$$D_{refl,i} = \begin{cases} 4h_{build,i} / w_i \leq 3.2 \text{ reflection} \\ 2h_{build,i} / w_i \leq 1.6 \text{ absorption} \end{cases}$$

$$D_{bar,i} = 10 \lg \left[ 3 + 80 \delta_i e^{\left[ \frac{-1}{2000} \frac{A_i B_i S_i}{2 \delta_i} \right]} \right]$$

In which □

$S_i$  is the distance from  $i^{\text{th}}$  section to the projection point □

$h$  is the height for the projection point □

$h_{build,i}$  is the height for the reflection plain of the  $i^{\text{th}}$  section □

$w_i$  is the distance between the reflection plain of the  $i^{\text{th}}$  section □

$A_i$  is the distance from  $i^{\text{th}}$  section to the top of the sound barrier □

$B_i$  is the distance from projection point to the top of the sound barrier □

$\delta_i$  is the difference between the sound distance,  $\delta_i = A_i + B_i - S_i$  □

For road with multiple lines, the noise sound level  $L_m$  of the projection point is calculated by superposition of the sound level for the closest line  $L_{m,n}$  and the farrest line  $L_{m,f}$ .

(3) Parameter determination

A. single vehicle

The average sound level for single vehicle of different type during operation phase is shown in table 3-11.

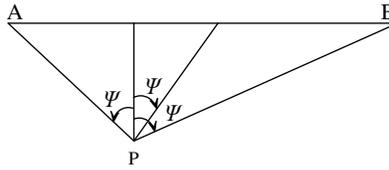
B. Adjustment for road section with curve and limited length

$$\Delta L_1 = 10 \lg \left[ \frac{\Phi_a(\Psi_1, \Psi_2)}{\Phi_a(\Psi_1, \Psi_2)} \right]$$

$$\Phi_a(\Psi_1, \Psi_2) = \int_{\Psi_1}^{\Psi_2} (\cos \Psi)^a d\Psi$$

In which □ □  $-\frac{\pi}{2} \leq \Psi \leq \frac{\pi}{2}$

$\Phi_a$  — adjustment function for road with limited length  $\Psi_1$   $\Psi_2$  are the angle for the limited length, as shown in figure 5-1.



In the figure  $\square$  AB is the road section  $\square$  P is the projection point

Figure 5-1: Section with limited length

C. Adjustment for barriers in between  $\Delta L_{barrier}$

$$\Delta L_{barrier} = \Delta L_{forest} + \Delta L_{house} + \Delta L_{shadowarea}$$

a.  $L_{forest}$  is the damping amount caused by forest  $\square$  which is normally calculated by  $\square$

$$\Delta L_{\text{树林}} = k \cdot b$$

In which  $\square$   $k$  — damping index for the forest  $\square$  use  $k = \square 0.1 \text{ dB/m}$   $\square$

$b$  — width of the forest  $\square$  m  $\square$

The amount damp caused by forest has little difference among areas, which is usually less than 10dB. For example, density of forest in the north is small, damp amount is low.

b.  $L_{house}$  is the damping amount from village house.

The distribution of village house is scatter, the projection point usually is located in front of the window for the first row of house, sound level of the rest house is calculated based on table 7-18 and figure 7-19.

c.  $\square$   $L$  is the damping amount caused by the sound shadow due to the levee side.

When projection point is outside the shadow area,  $\square$   $L = 0$

When projection point is inside the shadow area,  $\square$   $L = 0$  is determined by  $\delta$ ,

$N_{max}$  is defined as:

$$N_{max} = \frac{2\delta}{\lambda}$$

In which

$N_{max}$  — Fresnel Number;

$\lambda$  — wave length of the sound, m;

$\delta$  — ACOUSTIC-PATH DIFFERENCE, m; calculated by figure 8-4,  $\delta = a + b - c$ .

a — distance from the source to the road side, m;

b — distance from the projection point to the road side, m;

c — distance between the source and projection point, m.

Table 5-8: noise damping from building

Building condition	Damping amount $\Delta L$	note
Area of the first row accounts for 40~60%	-3 dB	The area of the building is calculated by figure8-3
Area of the first row accounts for 70~90%	-5 dB	
One more row of building	-1.5 dB, maximum $\leq 10\text{dB}$	

Note : this table is only applicable to buildings aside the plain road embankment.

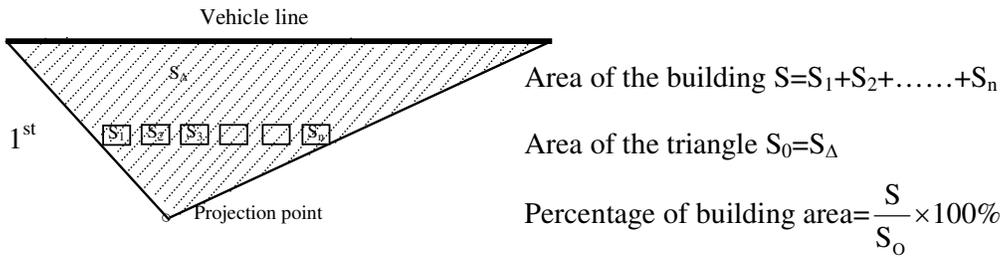
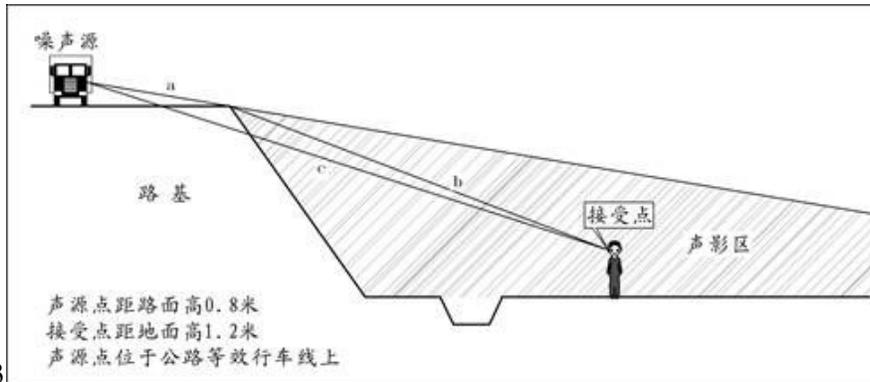


Figure 5-2: calculation of the area for 1<sup>st</sup> row building.



Calculation of damping from the shadow area is as following equation:

$$\Delta L_{shadow} = \begin{cases} -10 \times \lg\left(\frac{3 \times \pi \times \sqrt{(1-t^2)}}{4 \times \tan^{-1} \frac{\sqrt{(1-t)}}{\sqrt{(1+t)}}}\right) & (t \leq 1) \\ -10 \times \lg\left(\frac{3 \times \pi \times \sqrt{(t^2-1)}}{2 \times \ln(t + \sqrt{(t^2-1)})}\right) & (t > 1) \end{cases}$$

In which  $t=20 \times N_{max}/3$ .

#### 5.3.2.4 Projection result

Based on the selected model and parameter, the sound level of noise at sensitive receptors during the operation period (short term: 2015; long term:2030) are calculated as table 5-9 and figure 5-4.

According to table 5-9, only the short term and long term noise sound level at Changzhi academy of education exceed the standard.

#### 5.3.2.5 Noise pollution control measure

During the operation period, in order to minimize the traffic noise impact on Changzhi academy of education, the buildings along the route will be installed noise-isolation window, which can reduce the noise by more than10dB(A), and the impact will be limited after that.

Table 5-9: Noise projection for environmental protection objectives (Meets standard? Y/N)

Road name	No	Objective name	Distance to center of line□m□	Short term projection □2015□						Long term projection □2030□					
				daytime	standard	Y/N	night	standard	Y/N	daytime	standard	Y/N	night	standard	Y/N
Yingxiong Road	1	Yingxiong Road elementary school	58	55	60	Y	47.6	50	Y	55.7	60	Y	48.3	50	Y
	2	Xiaolingtong Kindergarten	46	56.8	60	Y	49.5	50	Y	57.5	60	Y	50.1	50	Y
	3	Xianan Street elementary school	58	53.2	55	Y	44.4	45	Y	54.9	55	Y	46.1	45	Y
Taihang Street	4	Huoju middle school	96	55	60	Y	46.2	50	Y	56.1	60	Y	47.4	50	Y
	5	No.12 middle school	69	57.3	60	Y	48.6	50	Y	57.6	60	Y	48.9	50	Y
	6	Jiandong Road elementary school	44	56.8	60	Y	48.1	50	Y	58.1	60	Y	49.3	50	Y
	7	Heji hospital	63	55.2	60	Y	46.5	50	Y	57.8	60	Y	49	50	Y
Fuhou Street	8	No.2 middle school	85	49.6	55	Y	40.9	45	Y	49.5	55	Y	40.8	45	Y
Chengxi Road	9	Changzhi academy of education	23	64.1	60	N	55.3	50	N	64.2	60	N	55.4	50	N
	10	Maternal and Child Care Service Centre	47.8	57.7	60	Y	49	50	Y	57.9	60	Y	49.1	50	Y
	11	No.7 middle school	99	50.7	55	Y	42	45	Y	50.9	55	Y	42.1	45	Y

### 5.3.3 Ambient air impact and mitigation measures

#### 5.3.3.1 Air pollution impact analysis

The major air pollution source during the operation phase is the vehicle emission, in addition, dust from vehicle running will also affect the ambient air.

##### (1) Emission impact on atmospheric environmental

The major pollutants for vehicle emission is CO and NO<sub>x</sub>, which is scattered and moving non-point source, the height of the emission source is low and the range of emission is small. The pollution in daytime is usually higher than at night due to the traffic volume change, the pollution down the wind is higher than the windward, the pollution during no wind days will be higher than heavy wind days. The pollution load is determined by fuel type, vehicle type and fuel consumption, normally large size vehicle is higher than medium and small vehicle. Emission of CO and hydrocarbon for gasoline vehicles is higher while emission of SO<sub>2</sub> and PM for diesel vehicles is higher.

With the increase of traffic volume, the pollutant discharge will also increase, as a consequence, the pollution for atmospheric environment along the route will increase. The pollutant discharge along the route during the operation period is low and the impact range is limited within 50m based on the investigation result on existing environmental assessment for other projects. In addition, with the increase of state emission standards, the pollutant discharge will also decrease. Percentage of vehicles with high fuel consumption and pollution will be phased out by higher fuel price and the range of impact on the ambient air along route will be reduced, therefore the overall impact is limited.

##### (2) Dust from vehicle running

Vehicle running on the road will cause flying of dust, the involved corridors are all urban road, the occurrence of dust is not serious based on the routinely sprinkle and clean. Therefore, the dust impact is light if proper environmental health work is enhanced.

#### 5.3.3.2 Air pollution mitigation measure

The impact of traffic on ambient air will be more serious with the development of the motor vehicle industry. According to prediction, upon completion of the project, the vehicle emission discharge will increase year by year due to the increase of traffic volume, hence, following measures should be considered to mitigate the impact:

##### (1) Control measure for the pollutant source

The air pollution source in this project is the vehicle running on the road. This is a moving pollution source, which make it difficult and not efficient to control only on one or several roads. According to experience in foreign countries, the control of motor vehicle emission should be conducted systematically within a city or an area. Therefore, the emission control of this project is closely related to the regulations and policies from the city government, Shanxi province or even the national level. The management unit in this project should enforce the regulations and polices

strictly and use proper measures to mitigate and control the emission discharge. Overall, several measures are suggested as follows:

- a. Prohibit the running of vehicle exceeding the emission standard  
In April 16<sup>th</sup>, 2001, Limits and measurement methods for emissions of pollutants from light-duty vehicles(I) (GB 18352.1-2001) is enacted from the state level; following this Limits and measurement methods for emissions of pollutants from light-duty vehicles□II□(GB 18352.2-2001) is enacted and with the first being replaced. Currently, annual inspection for emission discharge from motor vehicles is conducted in Changzhi. In order to reduce the emission discharge, the vehicles exceeding the standard can be prohibited on the road in this project, this could to some extent mitigate the ambient air pollution for this project.  
More strict standards should be enforced to reduce the pollution caused by motor vehicle emission. Examples from foreign countries show that ambient air quality could be maintained or not decreased by reducing the emission discharge for a single vehicle through more strict standards.
- b. Carry out Inspection and Maintenance system for in-use vehicles (I/M) vehicle  
Typically, the amount pollution caused by motor vehicle emission is highly related to the working condition of the engine. It is possible that the vehicle exceeds the standard due to poor maintenance and repair. Thus, routinely maintenance and repair work should be done to keep good working conditions for the engine, this can help reduce the emission discharge.  
The pollutant discharge standard in Changzhi will be more strictly, various control measures will be used. To ensure the effectiveness of these measures and control the emission discharge, the vehicle maintenance and repair work in Changzhi should be enhanced and proper inspection method should be placed on agenda.
- c. Reduce dust on road  
This can reduce pollutant source because it comes from the particles on road.
- d. Support and cooperate with local government for emission control  
Control of motor vehicle emission should be conducted systematically within a city or area. Therefore, the road management unit should cooperate with the local government and environmental protection agency to better control the emission discharge.
- e. Promote the use of clean fuel  
Currently, natural gas station has been constructed in Changzhi, part of the vehicle have started using liquid gas as fuel. It would further reduce emission discharge if more motor vehicles are using clean fuel. Therefore, government should support and give subsidy for the use of clean fuel; or enact law of policy for the use of clean fuel in order to reduce the emission discharge.

(2) Keep new sensitive receptors away from the road

This could reduce the impact of emission pollution. Based on investigation, the concentration of the pollutant for the receptors will be directly affected by the distance to the pollutant source. Therefore, by increasing the distance between the sensitive receptors and the road, pollutant could be diluted during transport and the concentration of the pollutant at the receptor will be reduced. Hence, it is suggested that sensitive receptors should not be added within 50m of the road side. The sensitive receptors should be relocated or reconstructed to isolated building such as business center, building or warehouse, the first row of building should be settled back from the road, this could reduce the negative impact of vehicle emission and dust.

(3) Utilize vegetation to clean the air

According to experiment, vegetations along the road side have certain capability of dust control and pollutant clean, thus the greening along route in this project could be utilized for cleaning of the atmosphere.

(4) Use bus priority lane and increase green area

Bus priority lane could attract more resident due to its convenience, it can also reduce the use of private vehicle and related maintenance cost, thereby reduce emission from its source; in the meantime, increase the green area along road side could improve the air quality to some extent.

#### 5.3.4 Water environmental impact and mitigation measures:

##### 5.3.4.1 Water pollutants

During the projection operation phase, wastewater is mainly generated from the parking and maintenance yard and bus washing.

Domestic wastewater goes into the municipal sewage pipe network after pre-digestion by septic tank. Bus wash water goes into the municipal sewage pipe after grease separator and goes to Changzhi wastewater treatment plant together with domestic wastewater. All the wastewater discharges into the Zhuozhang South source after meeting the standard.

##### 5.3.4.2 Water pollution control measures

(1) Domestic wastewater: all the domestic wastewater during the project operation phase access to Changzhi wastewater treatment plant. Changzhi wastewater treatment plant is located at Qiu Village, west of the city. The treatment capacity is 100,000m<sup>3</sup> wastewater per day, which can process all domestic water of the city. It uses nitrogen and phosphorus removal A<sup>2</sup>/O plant and can reach the Class A standard of the national “Standards for integrated wastewater discharge”. The project has passed environmental impact assessment and environmental inspection.

Discharge from the parking and maintenance yard is small. The existing wastewater treatment plants have the ability to accept all the wastewater from project construction. Construction departments should make sure that the project wastewater discharges to municipal sewage pipe, underscore the management of water during the project operation period, and emphasize water conservation and water reuse, avoiding lose of water. In this way, it can be ensured that all the domestic wastewater get collected and treated to reach the standard.

(2) Treatment measures for wastewater from bus washing: install a washing water circulation deposit tank in the park and maintenance yard, and use grease water separator to separate the waste grease. The bus wash water will entry municipal sewage pipe network and discharge after reach the standard.

### 5.3.5 Solid waste impact and reduce measures:

#### 5.3.5.1 Statistics of source of solid waste

Solid waste generated from this project mainly include waste from staff at park and maintenance yard, transit hub garbage and the waste grease and sludge from grease water separator. The garbage from bus station and passengers at square are managed by the municipal solid water management department.

- (1) Garbage: the garbage generated during the period of the project operation is about 535.5kg and 195.5t annually. All of them are collected by local sanitation department and sent to Changzhi solid waste treatment plant.
- (2) Hazardous waste: the waste grease and sludge from grease water separator about 1.0 t/a, belongs to HW08 hazardous waste.

#### 5.3.5.2 Solid waste disposal and related facilities

- (1) Garbage: construction unit will set garbage collection point with necessary collection bins to prevent the dumping of garbage at park and maintenance yard. Collected garbage will send to Changzhi solid waste treatment plant for treatment and disposal by municipal department of environmental health management. Currently, there is one solid waste treatment and disposal facility in Changzhi. Construction started in 2006 and finished in 2008. The daily process capacity is 500t. Now daily process is about 400t, which it have a certain margin to make sure process the garbage during the period of project operation.
- (2) Hazardous waste: The hazardous waste generated by the project is mainly grease water separator sludge. The park and maintenance yard entrust qualified units to process.

For hazardous waste, the operation department must pay special attention to the collection, storage, transportation and disposal. It must be operated according to the national regulations and measures to collection, storage, transportation and disposal. First of all, based on the nature of hazardous waste, use different

containers which reach the standard and difficult to damage, deformation, aging and can avoid leakage and proliferation effectively. And label on container with details about name, weight, composition, characteristics, and leakage, spread of pollution incident emergency measures. In addition, hazardous waste should be stored in special room, designated people should be in charge of the management work. Prohibit dumping outdoors to prevent infiltration of pollutant generated from runoff in the case of rain and snow. By taking above preventive measures, solid waste from planning project has little effect on the environment.

### 5.3.6 Traffic safety

#### 5.3.6.1 Impact analysis

During the project operation phase, due to increase in traffic volume and speed, it will directly result in increase of traffic safety risk. On the one hand, risk of crossing roads is increased, especial for area with intense residential, commercial, school, hospitals and other activities closely related with people's lives. Due to pedestrian crossing roads, the traffic status will become more complex and risk factor will increase. It is necessary to consider the traffic lights, pedestrian crossing, pedestrian overpasses and other settings in these areas. Especially schools, the school time will cause congestion on the walkway, resulting in safety risks. On the other hand, in driving along the roads, between vehicles, between vehicles and pedestrians, there are also traffic risks. Due to speed difference and traffic requirement difference between motor vehicles, non-motorized vehicles and buses, increased traffic risk will happen if these factors are not considered in the road planning and design. According to the city actual traffic demand, traffic risk could be avoided though the following measures: separate the fast lane and slow lane, bus lane and other motor vehicle lane, motor vehicle lane and non-motorized vehicle lane as well as planning of non-motorized vehicle lane and sidewalks with reasonable traffic volume.

In addition, the entrance and exit of the parking and maintenance yards, bus depots and terminals have large traffic volume due to increase bus fleet, it is necessary to be rational planning to ensure safety.

#### 5.3.6.2 Measures for traffic safety in operation phase

- Emphasizing safety aspects among drivers;
- Improving driving skills and requiring licensing of drivers;
- Adopting limits for trip duration and arranging driver rosters to avoid overtiredness;
- Use of speed control devices on trucks, and remote monitoring of driver actions;
- Regular maintenance of vehicles and use of manufacturer approved parts to minimize potentially serious accidents caused by equipment malfunction or premature failure;
- Collaborating with local communities on education about traffic and pedestrian safety. Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents;

- Employing safe traffic control measures, including road signs and flag persons to warn of dangerous conditions.

### 5.3.7 Safety assessment and emergency response measures for gas and diesel station

There is a 600m<sup>2</sup> gas station in the South Parking and Maintenance Yard at south of city.

The capacity and capability is not determined yet. It requires risk assessment and proposes emergency response measures.

#### 5.3.7.1 Risk assessment and safety measures of gas station

##### (1) Feature of fuels

The fuels stored in this project are diesel and CNG. Hazardous properties and their physical and chemical properties are shown in Table 5-9, Table 5-10 respectively.

Table 5-9 Hazardous properties, physical and chemical properties of fuel

Part one: Hazards			
Category:	Class 3.1 low flash point flammable liquid.	Blasting risk:	Flammable
Intake:	Inhaled, ingested, absorption by skin	Hazardous combustion products:	CO, CO <sub>2</sub>
Health hazards:	Major act on central nervous system. Symptoms of acute poisoning are dizziness, headache, nausea, vomiting, unsteady gait, and ataxia.		
Environmental hazards:	It is hazardous for environment. Pay attention to surface water, soil, air and drinking water pollution.		
Part two: physical and chemical properties			
Appearance and character	Colorless or light yellow volatile liquid with special odor		
Melting point (°C)	<-60	Relative density (water=1)	0.70~0.79
Flash point(°C)	-50	Relative density (air=1)	3.5
Ignition temperature(°C)	415~530	Explosion upper limit%(V/V)	6.0
Boiling point(°C)	40~200	Explosion lower limit% (V/V)	1.3
Solubility:	Insoluble in water, soluble in benzene, carbon disulfide, alcohol and fat		
Main purpose	Mainly used for gasoline engine, used in rubber, footwear, printing, tanning, etc.		
Part three: stability and chemical activity			

Stability	Stable	Avoid conditions	Fire, high temperature
Avoid materials	Strong oxidants	Polymerization hazardous	Not aggregate
Decomposition products	CO, CO <sub>2</sub>		
Part four: toxicological information			
Acute toxicity	LD50 67,000mg/kg (mice), (120 solvent naphtha) LC50 103,000mg/m <sup>3</sup> , 2 hours (120 solvent naphtha)		
Acute poisoning:	Inhalation of high concentrations of toxic encephalopathy. Inhalation of high concentrations lead to sudden loss of consciousness, stop breathing reflex and chemical pneumonia. Can cause corneal ulceration, perforation and even blindness. Acute skin contact dermatitis or allergic contact dermatitis. Acute oral poisoning caused by acute gastroenteritis; severe acute inhalation poisoning symptoms appear similar.		
Chronic poisoning:	Neurasthenic syndrome, peripheral neuropathy, skin lesions		
Irritation:	Human eye: 140ppm (8 hours), a mild irritant		
Maximum allowable concentration	300mg/m <sup>3</sup>		

Table 5-10 Hazardous properties, physical and chemical properties of diesel

Part one: Hazards			
Category:	Class 3.3 high flash point flammable liquid.	Blasting risk:	Flammable
Intake:	Inhaled, ingested, absorption by skin	Hazardous combustion products:	CO, CO <sub>2</sub>
Environmental hazards:	It is hazardous for environment. Pay attention to surface water, soil, air and drinking water pollution.		
Part two: physical and chemical properties			
Appearance and character	Slightly viscous brown liquid	Main purpose	Mainly use for diesel engine, etc.
Flash point(°C)	44-55	Relative density (water=1)	0.87~0.9
Boiling point(°C)	200~350	Explosion upper limit%(V/V)	4.5
Ignition point(°C)	257	Explosion lower limit% (V/V)	1.0
Solubility:	Insoluble in water, soluble in benzene, carbon disulfide, alcohol		

	and fat		
Main purpose	Mainly used for gasoline engine, used in rubber, footwear, printing, tanning, etc.		
Part three: stability and chemical activity			
Stability	Stable	Avoid conditions	Fire, high temperature
Avoid materials	Strong oxidants, halogen	Polymerization hazardous	Not aggregate
Decomposition products	CO, CO <sub>2</sub>		
Part four: toxicological information			
Acute toxicity	LD50 LC50		
Acute poisoning:	Skin contact may cause contact dermatitis, oil acne, inhalation may cause aspiration pneumonia. Can into fetus by blood through the placenta		
Chronic poisoning:	Diesel exhaust can cause eye, nose irritation, headaches		
Irritation:	Stimulus		
Maximum allowable concentration	No standard currently		

## (2) Analysis of accident classification

The station's main function is to store fuel and fuel buses. The process includes vehicle unloading, storage and oil distribution. According to the characteristics and accident types, the project can be divided into fire and explosion, spill and leak two categories.

### A. Fire and explosion

Data shows that when fueling, due to the drop of liquid surface, the increasing of air space in tank makes the tank gas pressure lower than atmospheric pressure, a lot of air added into the tank. Once meeting the explosion limit, it will explode with fire. Meanwhile, the oil outlet make the negative pressure in tank, the burning flame will be sucked inside the tank and make tank explode. According to national statistics, tank fire probability is much lower than  $3.1 \times 10^{-5}$  times/year.

### B. Spill and leakage

Tanks are easier to leak or spill. Therefore, the leakage and spill of storage tanks and pipelines cannot be ignored. According to statistics, the reasons tank overflow are as follows: a. tank measuring instrument failure, resulting in the process of filling the tank filled with overflow; b. for the tank during refueling, the gas barrier because of air resistance, resulting in oil spill ; c. in the refueling process, due to the different interfaces, convergence is not tight, causing oil spill.

The possible reasons for tank leak are as follows: a. pipeline corrosion resulting in oil spills; b. damage due to construction structures on pipeline; c. in the process of sending and

receiving the oil, due to operational errors, resulting in oil spills; d. all pipe joints loose, resulting in run, emit, drip.

A large area spill accident is not happen in China, but small spill happened before. Spills and leaks pollute surface water, ground water and also potential for adverse effects on regional water resources. Once contaminated, it will be difficult to eliminate, and will also cause fire and explosion hazards.

#### C. Accident risk identification

Analysis from above paragraph shows that the first kind of accident has a low possibility to occur, but it is more dangerous, because the damage can be completed instantly and is very difficult for rescue and emergency response. The project proposed to set horizontal tank buried. According to GB50156-2002 “vehicle refueling stations design and construction standards (specific explanation)”, it will be safer by setting horizontal underground oil tank. From abroad and our country’s survey statistics, the chance of fire of underground tank is very low. Even if the tank caught, it is easy to put out the fire.

The second kind accident occurs frequency is higher than first. It occurs with significant randomness and chance. Such accident will impact the environment for some time and cause serious consequences. The pipelines and tanks of this project should design and construct according to the specifications, and take effective leak detection facilities. The probability of such accident will be small, as long as operation in practices.

#### (3) Environment impact of accident

According to “accident risk identification”, “Class I oil (i.e., gasoline) has no possibility of fire as long as stored in the underground tank. Therefore, this EIA will focus on the second accident.

##### A. Pollution of surface water

Once leakage or seepage of oil into the river, it will cause pollution of surface water. As the volume of the project tank is small, ditches are set near the tank, and the nearest river Shizi River is 2.1km away, once leakage or seepage happened, the oil will accumulate in the tank area. There is neither possible overflow area nor entering the surface water.

##### B. Pollution of groundwater

Groundwater pollution by leakage and seepage from storage tanks and pipelines are more serious. Once the groundwater polluted by oil, the water would have serious odor and is teratogenic and carcinogenic, which is completely undrinkable. According to survey, surrounded villages’ drinking water is supplied by municipal distribution network, not from the groundwater directly. In the meantime, the project proposed using FRP corrosion anti-seepage technology. Once leakage and seepage happened, because of protection from the impermeable layer, it will accumulate in the reservoir area. Therefore, leaks or seepage will not affect groundwater.

##### C. Pollution of atmosphere

According to the researches in our country and abroad, for unexpected accidents oil spill, oil distribute on the surface irregularly. The evaporation rate of oil depends on oil vapor pressure, on-site wind speed, the oil spill area and the average heavy oil vapor molecules. This project uses buried storage tank technology, once leakage or overflow accident happened, testing facilities such as anti-leakage inspection hole can find the tank leakage in time. Because of the anti-leakage technology and small amount of leaking oil, the leakage will accumulate in the storage area. Storage area surface is hardened by concrete, which is more closed. Oil will primarily volatilize through the ventilator and manhole, and will not cause large area spread. So it has small impact to atmosphere.

#### D. Impact on the surrounding sensitive points

The nearest sensitive point of the project is Manfangtou Village which is 350m away to the north. Once leakage and spill accident, the sphere of influence can be controlled in project site area. To prevent leakage and overflow resulting fire, explosion to affect the villagers, the project construction department should strengthen management and prepare control measures.

### 5.3.7.2 The risk management and emergency response plan for gas station

#### (1) Management requirements

To prevent accidents, the project should be strictly comply with GB50156-2002 “vehicle fueling station design and construction standard” for design and construction. The preventive measures include:

- a. General layout should follow the requirements of design, control the security distance between every building.
- b. Design the effective fire protection system;
- c. Choose quality products for process equipments, transport facilities and process system. Selection, design, installation and maintenance of electrical equipment of gas station should comply with GB50058-82 “explosive fire danger design specifications of electrical equipment installation” and GB13955-92 “leakage protection and management”.
- d. Set combustible gas alarm device in possible leakage position and accumulation of volatile gas places.
- e. Set up anti-static charge and lightning grounding device at the beginning, end and branch of the oil pipelines.
- f. Adopt higher safety factor for anti-seismic in design of the station.
- g. Install low level alarms for tanks. Reduce line interface. Use metal hose connections at the import and export of pipe.

#### (2) Emergency response plan for gas station

- a. When parts of the gas station are in fire, the people should immediately put the fire out using nearest equipment such as fire extinguisher. And report to the fire department for support.
- b. Loading, unloading and measurement operators should stop operating and close all valves.

- c. The staff who are not on duty hear the fire signal should rush to the fire site and put the fire out by using fire fighting equipment such as fire extinguisher,.
  - d. Logistics and communications defense group are responsible for all materials and equipment protection in the fire site, and call “119” asking for help.
- (3) Anti-leakage emergency measures
- a. Responded staff should collect oil by emergency supplies, explosion-proof equipment.
  - b. When leakage happened, stop fueling vehicles and loading oil.
  - c. Trained fireman rush to the site to prevent accidents
  - d. Clear the remaining oil, repair equipment, make sure no hazardous material remains when it happens in tank area or fueling site. Continue operations after that.
- (4) Measures doe loading and unloading of fuel
- a. Metering operator should shut down valve immediately. Report to leaders (emergency group leader), and make the site of the safe.
  - b. Site leader should organize rescue according to the emergency plan.
  - c. All the emergency responders should follow the same order collecting oil by aluminum cone, aluminum dustpan and cotton yarn. The collected oil fills to the reserve barrels for recycle
  - d. Site security staff and trained fireman should strengthen on-site monitoring to avoid fire accidents.
- (5) Emergency plan for pipeline spillage
- Staff of divisions of labor and safety are required to follow the same command, to collect remaining oil, using cork and roof screen plugging, and clearing site, then repair pipelines.
- (6) Plan for tank leakage
- a. Relevant team members in charge of tank oiling, should collect and transport the leaked oil immediately to other container (tank).
  - b. When diesel storage tank leaks, personnel need to take safety measures.
  - c. Divert oil to other stations.
  - d. According to the situation, load water to the bottom of the tank.
  - e. Record the leaking tank and report to the head of the monitoring team.
  - f. When tank leakage occurs, the personnel should seriously and promptly report, in accordance with relevant regulations.
- (7) Emergency plan for power failure
- Store enough fuel for power generators. If the power does not start normally, report to the electricity sector and ask for help in order to make sure gas station safety.
- (8) Station emergency evacuation plan
- a. Immediately cut off all electrical power to prevent accidents.
  - b. Firefighters catch a favorable position as soon as possible, and keep putting out the fire to prevent the spread of fire.
  - c. Measurement operator should shut down all the valves.
  - d. Maintenance staff will do their best to remove the equipment as many as possible to safe areas.

- e. If there is tanker in unloading area, promptly notify the driver to drive out the station.
- f. Evacuating fueling vehicles and related person to ensure that access road open.

### 5.3.7.3 Risk assessment and measures of gas stations

The parking and maintenance yard at south of city gas station is CNG gas station. Major risk factors are: fire, deflagration, choking poisoning, mechanical damage, electrical damage, accident, etc. One of the most damaging and the main hazards is detonation, which also makes greatest losses. The evaluation focused on the fire, explosion hazard.

#### (1) Hazardous material identification

The station mainly involves transporting flammable, explosive methane in a closed-system. The mainly risks are leakage, fire and explosion. According to “material risk standard” in “Construction Project Environmental Risk Assessment Technical Guidelines” HJ/T169-2004, hazardous material is identified during the project operation period. The composition feature of CNG is similar as natural gas. The main properties of natural gas in Table 5-11

Table 5-11 Hazardous identification of natural gas

Name	Density	Boiling point°C	Flash point°C	Explosion limit	Hazard classification	Risk identification
Natural gas	0.72	-160	-188	5%-15%	Class 2.1 flammable gases	Combustible gases

Note: 1. “hazard classification” is based on the “List of hazardous Chemicals (2002 edition)”

2. “Risk identification” is based on “Construction Project Environmental Risk Assessment Technical Guidelines”.

Table 1 shows that the proposed project involved material-CNG meet the “material risk standard” in “inflammable substances 1-flammable gas”, can be regarded as dangerous substances prone to fire and explosion.

#### (2) Process risk identification

The process includes: regulating, storage, pipeline transportation, car fueling. Involved dangerous substances are CNG; potential accident is leakage from damaged equipment and pipeline system. CNG leaks fast and explosion with fire. Process risk factors identified in Table 5-12.

Table 5-12 Identification of process risk factors

Class	Type	Risk items
The risk of filling process	Design and construction	Regulator, metering facilities and related facilities such as pressure equipment. Effect from outside, design, construction and manufacturing defects may cause the physical burst in pipeline and equipment.

	Equipment	<input type="checkbox"/> production equipment, pipelines, valves, flanges, etc. due to corrosion, caused by lightning or leak close to a fire source (such as static electricity, fire, etc.) leading to combustion, explosion. <input type="checkbox"/> pressure gauge, valves, accessories and other equipment operating under pressure loss, faulty equipment or operation error will cause the explosion.
	Operation	<input type="checkbox"/> facility failure caused by improper operation overpressure of valve, the process is not smooth, such as the safety valve interlock alarm system failure, resulting in burning up a lot of gas. <input type="checkbox"/> process replacement, maintenance, emergency handling, cut-off valve interlock, etc. when the gas is mixed with air, fire or explosion will occur. <input type="checkbox"/> during the process of system operation, repair of leaking pipes, flanges and various valve devices, explosion may occur. The case of fire or shock, static electricity, electrical sparks caused by gas and other explosive hazards.

(3) Accident with max. reliability and the probability of occurrence

The compression system in gas station has a high filling pressure and changes frequently. It is prone to leakage and fire explosion. Combined with the result of the same type project, the most possible accident is compressor room methane leakage leading to fire explosion.

Analog of gas engineering accident statistics, after leaked natural gas is ignited and the probability is  $2.5 \times 10^{-4}$ . Except for the compressor room, CNG pipelines, control valves, fittings and flanges and similar storage can also have the likelihood of accidents.

(4) Fire, explosion accident consequence analysis

Fire, explosion, gas filling stations is the most serious accidents. CNG leak is caused by explosive combustion of the main stations. Possible CNG impact by leakage accident:

- a. Methane leakage accident, when the methane concentration in the air up to 25% - 30%, it will cause human discomfort, or even suffocation.
- b. When the concentration of methane reaches explosive limit, it will under heat, or fire. Fire thermal radiation will result in burns or death. CNG explosion will affect an area in a radius of 100m. The nearest village Mafangtou Village is 350m away, which is out of the influence radius.
- c. Where the leaked gas is directly ignited, a jet of flame will be caused. Jet flame radiation can cause burns or death. Assuming the thermal radiation intensity being  $12.5 \text{KW/m}^2$  as a standard to calculate the effects of the radiation intensity, within 10 seconds it will make the human body burned, there will be 1 minute 1% mortality.
- d. If the CNG is not directly ignited, the release of gas may form explosive clouds. When this cloud is ignited, it will produce a steam explosion smoke, or the

formation of flash fire. If the flickering flame is within the people, they will be burned to death or serious injured. When the resulting steam explosion smoke presents, its shock waves can harm a person other than smoke.

(5) Environmental impact of associated accident with explosion

When the leaked gas explodes on fire, burning hydrocarbons will produce carbon dioxide, carbon monoxide and water. Among them, carbon monoxide is toxic, which is harmful to human health. Inhalation of high concentrations of carbon monoxide also causes poison, or even death. Incomplete combustion of hydrocarbons will produce carbon monoxide and its generation is generally between 1% to 10%. As the height of the CNG flame is high, with high temperature, a large amount of pollutants are lift to high-altitude. Therefore, ground CO concentration is low and will not reach the lethal concentrations. Main components of leaking CNG is methane, while a small amount of hydrocarbons, are non-toxic gases. However, accident caused by fire usually lasts long, thus the pollutants will still cause relatively large impact on the surrounding environment.

5.3.7.4 Gas station risk management and emergency plan

(1) Risk management

- a. Strictly following “” for design and construction;
- b. Install various regulations and guidance, such as fire control in responsibility, safety operation guideline, routine inspection, etc; visible sign should be provided at the entrance of the station, “no smoking” warning should be proved on the wall or at the entrance;
- c. Enact emergency operation guideline, explaining the operation procedures during pipeline accident, regulate the repair progress, control the accident into a limited impact, safety problems of the operation staff should also be explained;
- d. Education should be provided in a weekly basis for the operation staff, improve the awareness of safety issue and understanding of the control measures before and after the accident happens;
- e. Inspection and maintenance method should be provided for the important facilities; inspect and maintain routinely; all documents on file;
- f. Accident emergency response plan should be provided for the staff with related equipment and facilities; the response plan should be on file in the safety supervision unit.

(2) Emergency response plan

The content of the response plan is shown in table 5-13.

Table 5-13: content of the response plan

No	item	Content and requirement
1	Response region	Dangerous target □ storage and fill area of the station
2	Response institute, staff	Gas station, regional emergency institute and staff
3	Conditions of	Enact the level of the plan and its response procedure

	response level	
4	emergency rescue security	Emergency facility, equipment
5	Reporting, communication method	Reporting, communication method and transportation security under emergency response
6	Emergency environmental monitoring, rescue, and control measure	Monitoring by professional team, evaluate the type, index and result of the accident, provide basis for decision making
7	Emergency inspection, control measure, leaking prevention measure and facility	On site, vicinity and nearby area, fire control region, control and removal measure with related facility
8	Staff repatriation, evacuation	On site, vicinity and nearby area, fire control region, staff evacuation plan, medical rescue and public health
9	Emergency rescue close procedure and recover measure	Termination under emergency Follow up work and recovering measure Clear of warning in the vicinity and recovering measure
10	Emergency training	After plan enacted, proved training and practice
11	Public education and information	Public education in the vicinity and information disclosure

Major risk control measures:

- a. Stop valve should be provided at gas entrance to prevent leaking under unusual condition. The installation location should be easy to access;
- b. Provide concentration warning system for flammable gas, so that control measure could be enforced before reaching the explosion limit;
- c. Gathering facility should be provided so that temporary storage can be provided during over pressure and pipeline inspection. In the meantime, fire blocking equipment should be placed at the end of the pipeline in the releasing system so that releasing safety can be ensured;
- d. Storage tank should install pressure releasing facility, which should have enough capacity.

The releasing gas should meet the following regulations:

- A. If the releasing flow is small, such as the gas releasing from the safety valve and releasing valve, pipeline should be connected to safety area or releasing pipeline.
- B. If the releasing flow is greater than 2m<sup>3</sup> and releasing frequency higher than 2□3 per hour, recycling tank should be provided.

- C. If the releasing flow is greater than 500m<sup>3</sup> (high pressure), such as gas releasing from the storage tank, fire accident or emergency facility inspection, should release to empty in half an hour using the releasing pipeline.
- e. Gas released from the gas dispenser should toward the safe direction, prevent the risk when releasing the high pressure gas;
  - Emptying of the gas should meet the following requirement:
    - A. Emptying system of different pressure level should be placed at different location so that each releasing pipeline can operate safely.
    - B. Gas released from the safety valve can be discharged into the atmosphere, the pipeline should be in vertical direction and should be at least 2m higher than the facility platform and 5m higher than ground;
    - C. Emptying pipeline should be placed outside the building and should be kept away from the operation area, the height of it should be at least 2m higher than the near building and infrastructure and the total height should not exceed 10m.

(3) Risk control measure during transportation

- a. CNG transportation vehicle must satisfy “guidelines for dangerous freight transportation” enacted by the state council of transportation. Prevent heat, vibration and fire during transportation.
- b. The transportation vehicle should have warning sign painted or installed, with communication equipment, staff facility and first aid equipment. The exhaust system for the vehicle should install fire blocking equipment.
- c. The transportation vehicle, tank should have obvious dangerous sign.
- d. The transportation vehicle should keep safe distance and speed, speeding and overtaking is prohibited, entering into the prohibited zone is not allowed.
- e. When unusual condition happens during transportation, should report to the local police department. Should strictly follow the arranged time and path when crossing the urban area, no stop in the middle and at resident area, market, school, administrative agency, landscaping area.
- f. When leaking happens during transportation, should report immediately to the local police department, all possible warning measure should be applied.
- g. Enhance the training and education of the staff, improve their awareness and skills.

In conclusion, the risk of accident can be minimized based on effective control measure and emergency response plan enacted.

### 5.3.8 Environmental benefit

(1) Improve traffic environment, cut the resource use, and mitigate air pollution

According to “Urban motor vehicle emission control”, the concentration of the air pollutant from the vehicle is closely related to the running condition of the vehicle. During morning and evening rush hours the vehicle speed is slow and is about 5km/h. Based on comparison, the average oil consumption at 5km/h is 0.02L/min. Currently, the morning rush hour in Changzhi is 7:30-8:30 and evening rush hour is 17:30-18:30. During the project operation phase, traffic condition will be greatly improved during the morning and

evening rush hour, the idling of vehicle will be decreased. The traffic volume during rush hour in Changzhi and the emission volume reduced is shown in table 5-14 and 5-15.

Table 5-14: Rush hour traffic volume and the oil consumption

Road	Traffic volume during rush hour private vehicle #/hour	Oil consumption L
Taihang Street	2945	3534
Yingxiong Road	3872	4645
Chengxi Road	2464	2957
West Fuhou Street	1615	1938

The annual oil consumption during morning and evening rush hour for the motor vehicle is 13074L/h.

According to the emission index in data handbook of practical environmental protection, the emission discharge volume reduced during morning and evening rush hours is shown in table 5-15.

Table 5-15: Motor vehicle emission index and discharge volume reduced

Pollutant	Emission index (g/L)	Discharge volume (t/h)	Discharge volume (t/a)
CO	169	4.4190	1612.94
NO <sub>x</sub>	21.1	0.5517	201.38
SO <sub>2</sub>	0.295	0.0077	2.82
HC	33.3	0.8707	317.82

We can see that the completion of this project could effectively reduce the emission pollutant from motor vehicles, the amount reduced are: CO, 1612.94t/a; NO<sub>x</sub>, 201.38t/a; SO<sub>2</sub>, 2.82t/a; HC, 317.82t/a . The environmental benefit obtained from this project is obvious.

(2) Use clean fuel and reduce pollutant discharge

During the operation phase, the use of CNG bus will greatly reduce the emission. Based on the initial planning, CNG bus accounts for 50% of the total bus, the discharge concentration and volume for NO<sub>x</sub> CO PM<sub>10</sub> CO<sub>2</sub> are greatly reduced. In the same time, the CO<sub>2</sub> emission from CNG bus is reduced a lot, which could contribute to controlling the greenhouse gas emission. In addition, combustion for CNG bus is sufficient, emission of CO and SO<sub>2</sub> are a lot less than the gasoline bus, which could reduce the opportunity of acid rain. During accident, leaking fuel will be diluted in the air quickly; no pollution will be caused for surface water and soil.

(3) Reduce noise pollution

During the operation phase, low noise modified asphalt is used for road pavement. Friction could be reduced on flat road surface. Indicating signs for no honking and slow traffic are installed at sensitive road sections such as school and hospital, this could effectively reduce traffic noise and improve the acoustic environment in the city.

## 6 Environmental Management Plan

### 6.1 Objectives

This project will have certain negative impacts on the surrounding social and natural environment in both the construction stage and operation stage. It is necessary to establish environmental management and monitoring plans for construction and operation period to implement effectively mitigation measures for the adverse impacts.

### 6.2 Environmental Management Institutions

In order to protect the environment along the proposed alignment, and ensure the successful implementation of the mitigation plan, the institutional arrangements should be clearly established. Each of the institutions below will play its role respect to the project environmental management and impact mitigation.

#### 6.2.1 Environmental Management in Construction Stage

##### 6.2.1.1 Institutional arrangement

The framework of environmental management institutions for Changzhi Sustainable Urban Transport Project is illustrated in Figure 6-1.

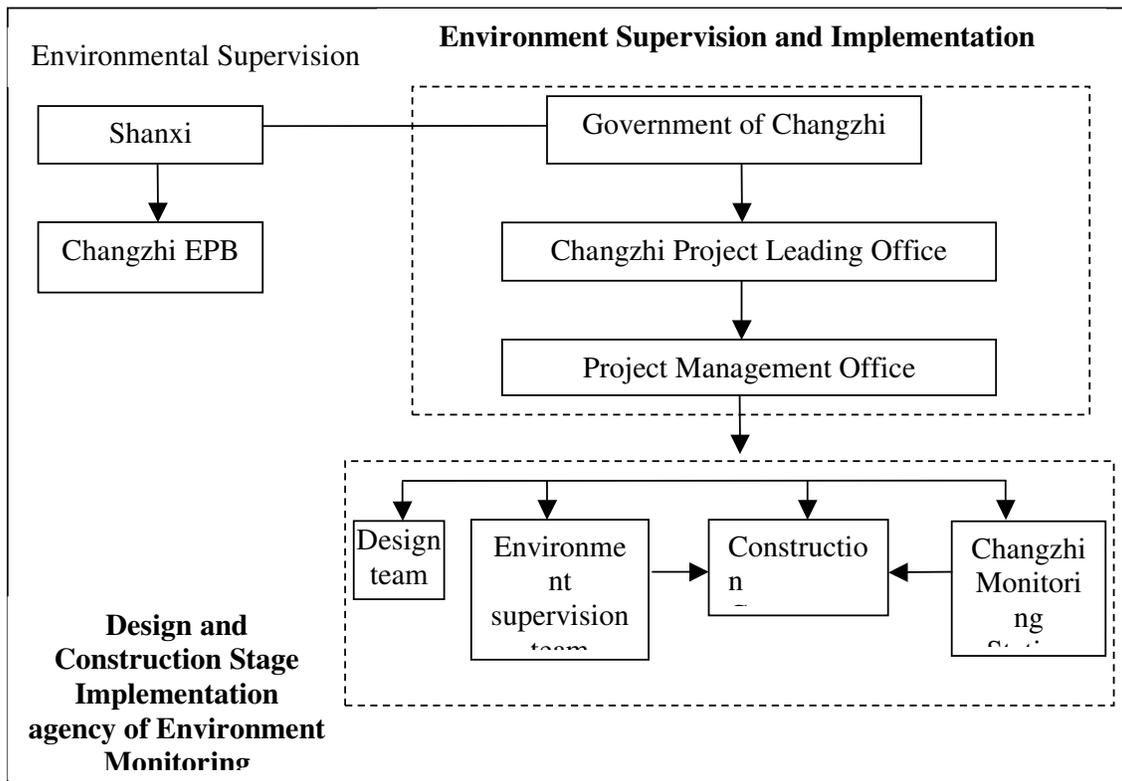


Figure 6-1: Framework of Environmental Management Institutions in Construction Stage

#### 6.2.1.2 Major Responsibility of Institutions

The responsibility of environmental management institutions for the proposed project is introduced as follows.

- Report the implementation of environmental management to the World Bank, Changzhi government and Shanxi Province EPA, as well as to be supervised by those institutions.
- Supervise the implementation of environmental protection measures on the construction site.
- Organize and coordinate the air, noise and vibration monitoring during the construction and operation stage.
- Analyze and recommend pollution control measures to resolve raised environmental issues during the construction and operation stage.
- Investigate and resolve the issues that disturb residents. Comments or suggestion on the environmental protection measures and management plan should be considered and resolved properly.

#### 6.2.1.3 Major Content of Environmental Management

In order to effectively control the environmental pollution in construction of the project, it is required to manage not only the construction quality and progress but also the good practice of the construction, the implementation condition of environmental impact mitigation measures, as well as to supervise and check the execution of contract clauses in terms of environmental protection.

- The project management office should ensure that the total project contract include the environmental mitigation measures in construction in the Contract document and require the contractors to strictly implement the measures.
- The contractors shall organize the construction in accordance with the requirements in the project contract, and various laws and regulations on environmental protection and sanitation stipulated by the nation and the local government, meanwhile, carry out civilized construction as per the environmental control measures and suggestions in the Environmental Assessment Statement so as to protect the environment.
- The contractors shall assign fulltime (part-time) environmental management personnel on each construction sites to carry out on-spot supervision of mitigation measures implementation. It is particularly important to control the construction time of high-noise, and high-vibration construction equipment.
- Carry out publicizing. Because of limitation of technological facilities and construction environment, even if associated control measures are taken, environmental pollution along with the construction is unavoidable. Therefore, it is

necessary to publicize the project to citizens along the line and in affected areas so as to enhance their bearing capacity of bad impacts and gain their understanding in temporarily conquering the difficulty and in coordinating with the construction unit to complete the project construction.

- The administration departments and the construction unit shall set up office of calls and letters in particular, and install a special telephone line for complaints to receive the complaints from the public and immediately assign persons to solve the problems within a time limit. It is required to properly handle the complaints from the citizens.

## 6.2.2 Environmental Management in Operation Stage

### (1) Institutional arrangement

The framework of environmental management institutions in the operation stage is illustrated in Figure 6-2.

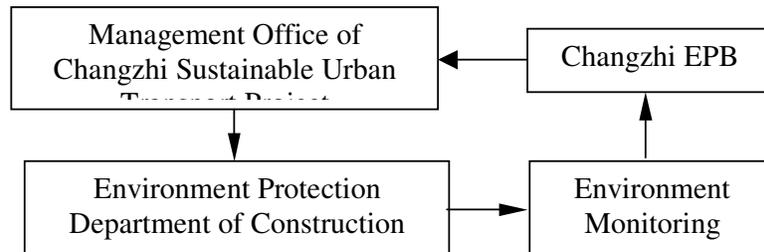


Figure 6-2: Framework of Environmental Management Institutions in Operation Stage

### (2) Responsibility and Content

In order to control the potential pollution impacts raised in the operation, environment management institution should be established to be responsible for the following aspects.

- Environment related law and regulations should be well enforced.
- Environment management procedures should be well followed and implemented.
- Periodically review, repair and maintain the roads to make sure the transportation is functioning properly.
- Environment monitoring should be conducted by professionals and documented properly.
- Investigate and resolve any pollution accident or resident complaints related to the proposed project.
- Periodically provide training programs to related personnel to develop capacity and improve the environment management.

## 6.3 Environmental Supervision Plan

The institutional arrangement for environmental supervision are summarized in Table 6-1.

Table 6-1 Summary of Environmental Supervision Plan

Phase	Supervision Institution	Supervision Content	Supervision Objectives
Feasibility study and preliminary design	Shanxi Province EPA and Changzhi EPA	1. Review EIA report	1. Make sure the EIA report is prepared properly; 2. Make sure the potential impacts on the environment are properly identified and analyzed; 3. Make sure the control measures for environmental impacts are properly planned and implemented.
Construction stage	Shanxi Province EPA and Changzhi EPA	1. Check if the investment is implemented. 2. Check if the vegetation and related ecological environment is restored during the construction stage. 3. Check if municipal and construction wastewater is properly treated and discharged. 4. Check the control measures for dust and noise and decide the construction time slot accordingly. 5. Check the project progress and make sure it will be completed in time. 6. Check if the environmental protection equipment is functioning properly.	1. Make sure the investment is implemented on the environmental protection. 2. Make sure the surface water is not polluted. 3. Make sure the construction wastewater meets the related standard before discharge. 4. Make sure the ecological nature along the routes will be stored. 5. Make sure the related environmental regulations and standards are implemented properly to reduce the negative impacts. 6. Make sure the environmental protection facilities are functioning properly.
Operation stage	Shanxi Province EPA and Changzhi EPA	1. Review the implementation of monitoring plan. 2. Review if any further control is needed to resolve any issue that is unexpected. 3. Review if the environmental quality of sensitive areas meets the related quality standard. 4. Check the solid waste is disposed properly.	1. Implement the monitoring plan. 2. Protect the environment 3. Enhance the environmental management and protect the public health

## 6.4 Summary of Mitigations

## Environmental impact and the mitigation measures

Table 6-2

Type	Potential impact	mitigation measure	implementation institute	Cost estimation (10,000 yuan )	Source of investment	Supervision institute	Supervision standard	frequency
<b>A.design stage</b>								
route selection	Ecological environment would be affected by land acquisition	1) further compare alternatives for route selection, avoid community and resident area, reducing land acquisition 2) cooperate with people affected in the area in design and implementation of the resettlement plan	Resettlement research center of Hehai University	project provision	Changzhi PMO	Municipal leading committee for world bank loan sustainable urban transport project	①engineering design for the route ② 《World Bank OP/ BP 4.12 (involuntary resettlement) 》	before construction
route design	Landscape would be damaged	1) specific design for green belt along bridge, road 2) need detailed plan for greening	design institute	project provision	Changzhi PMO	Municipal leading committee for world bank loan sustainable urban transport project	①greening design	before construction
	Inconvenient for pedestrian crossing; traffic safety risk; difficult of disabled person to cross street	1) specific design (6 pedestrian bridge, signal and 40 pedestrian crossing)for high pedestrian density area such as school and community 2) design for sidewalk and crossing facility for disabled people	design institute	project provision	Changzhi PMO	Municipal leading committee for world bank loan sustainable urban transport project	Design for crossing facility	before construction
<b>B. construction stage</b>								
Spoil and waste	Dust, soil erosion, landscaping, land occupation	1) Agreement has to be obtained for disposal of spoil (sent to construction waste land fill at Shuangqiao Village) 2) enhance the management of storage of soil that is to be compacted, covered and sprinkled periodically; spoil and construction waste should be transported out of sites quickly. 3) Construction should be limited within the redline, storage of soil and material should not occupy land out of the red line.	Construction contractor (design institute is responsible for including it in the contract document)	75.0	investment included in the contract	Municipal leading committee for world bank loan sustainable urban transport project; Environmental monitoring unit at Changzhi EPA	Spoiled soil、 TSP ( see details in table 4.3-1 )	Monitoring: everyday

Type	Potential impact	mitigation measure	implementation institute	Cost estimation (10,000 yuan )	Source of investment	Supervision institute	Supervision standard	frequency
Bayi bridge, Qiyi bridge	Construction wastewater and solid waste would cause pollution in the river	1) construction wastewater containing a lot of soil and grease, should be sedimented before discharge into municipal pipeline, prohibiting direct discharge into surface water	Construction contractor (design party is responsible for including it in the contract document)	15.0	investment included in the contract	Municipal leading committee for world bank loan sustainable urban transport project; Environmental monitoring unit at Changzhi EPA; Environmental monitoring station	① Wastewater should be discharged after sedimentation ② SS	Monitoring: everyday
road	construction site	1) install bulletin and safety fence 2) solidify the ground at the construction site 3) during excavation, drill, demolition and refill, water should be sprinkled to prevent flying dust 4) should restore the vegetation and green area after construction	Construction contractor (design party is responsible for including it in the contract document)	35.0	investment included in the contract	Municipal leading committee for world bank loan sustainable urban transport project; Environmental monitoring unit at Changzhi EPA;	①public complain	Monitoring: everyday
	construction noise	5) prohibit the operation of machinery with high noise and vibration during the noon, use machinery with low noise or adopt noise barrier methods like isolation and fence whereas possible.. 6) proper arrangement for construction time and location, for high noise construction, keep away from the sensitive receptors 7) noise monitoring should be enforced at sensitive receptors.. 8) following measures should be taken when night construction is needed: send application to Changzhi EPB and announce at surrounding communities and use noise barriers if necessary	Construction contractor (design party is responsible for including it in the contract document)	20.0	investment included in the contract	Municipal leading committee for world bank loan sustainable loan transport project; Environmental monitoring unit at Changzhi EPA; Environmental monitoring station	Construction noise and noise at sensitive receptors are shown in table 4.3-1	Monitoring: everyday

Type	Potential impact	mitigation measure	implementation institute	Cost estimation (10,000 yuan )	Source of investment	Supervision institute	Supervision standard	frequency
construction	Air-borne dust	9) sprinkle water on the transportation road, reducing dust as much as possible 10) prevent dust pollution by fencing the site during construction period, plan ahead the route and time for transportation, avoid running in sensitive area such as business area and resident area. 11) construction waste is prohibited to use as fuel for heating.	Construction contractor (design party is responsible for including it in the contract document)	23.0	investment included in the contract	Municipal leading committee for world bank loan sustainable urban transport project; Environmental monitoring unit at Changzhi EPA; Environmental monitoring station	sensitive receptors TSP, detail shown in table 4.3-1	Monitoring: everyday
	ecological environment	1) affected trees in the middle and along the road side should be relocated, vegetation and green area around the project route should be protected during construction 2) construction should be well managed to keep landscape clean 3) minimize land occupation, properly plan for the construction progress. Clean the site, restore green area after construction completes	Construction contractor (design party is responsible for including it in the contract document)	20.0	investment included in the contract	Municipal leading committee for world bank loan sustainable urban transport project; Environmental monitoring unit at Changzhi EPA;	①# of relocated tree ②increased green area and tree ③erosion	Monitoring: everyday
	Cultural relics	1) stop construction if cultural relics are found and report immediately to the local cultural bureau; 2) the site should be protected; 3) construction should be paused before permits from the local cultural bureau is granted. 4) communication with the hosts of the West Mosque and the Huayan Temple should be maintained during the construction on the section. The temporary access roads should be provided. Construction should be carefully scheduled to avoid the important event of the mosque and temple. Education for construction workers should be provided to avoid disturbance on the temple and mosque.	Contractor			Municipal leading committee for world bank loan sustainable urban transport project;		

Type	Potential impact	mitigation measure	implementation institute	Cost estimation (10,000 yuan )	Source of investment	Supervision institute	Supervision standard	frequency
	social environment	1) make plans for traffic diversion and temporary access roads, set up enough TV and newspaper pipeline connection (electricity and water) plans should be determined through cooperation with relevant units before construction. 2) height and direction of the lighting facility should not affect resident at night. 3) collaboration with local communities and responsible authorities to improve signage, visibility and overall safety of roads, particularly along stretches located near schools or other locations where children may be present	Construction contractor (design institute is responsible for including it in the contract document)	15.0	investment included in the contract	Municipal leading committee for world bank loan sustainable urban transport project; Environmental monitoring unit at Changzhi EPA;	①public complain	Monitoring: everyday
<b>C.operation stage</b>								
traffic on ground	noise	1) use low noise modified asphalt pavement, install noise isolation window to reduce the noise impact, details are shown in table2-2 2) use modified asphalt for repair work	Changzhi PMO	454.8	investment included in the contract	Shanxi province EPA; Changzhi EPA; Changzhi monitoring station	Situation for noise control monitoring value at sensitive receptors	before operation

Type	Potential impact	mitigation measure	implementation institute	Cost estimation (10,000 yuan )	Source of investment	Supervision institute	Supervision standard	frequency
	traffic safety	3) use pedestrian bridge and pedestrian crossing according to design 4) maintenance should be done regularly during operation stage 5) improve transportation management, traffic diversion should be properly used to ensure smooth traffic flow. 6) emphasizing safety aspects among drivers 1) improving driving skills and requiring licensing of drivers 2) adopting limits for trip duration and arranging driver rosters to avoid overtiredness 3) avoiding dangerous routes and times of day to reduce the risk of accidents 4) use of speed control devices (governors) on trucks, and 5) remote monitoring of driver actions 6) regular maintenance of vehicles and use of manufacturer approved parts to minimize potentially serious accidents caused by equipment malfunction or premature failure.	Changzhi PMO Changzhi Bus Company	-	-	Traffic Police department in Changzhi	traffic safety	every day
	air pollution	1) improve the management of motor vehicles, make sure the emission meets standard 2) complete the construction of green belt according to design and routinely maintenance should be provided	Changzhi PMO	11.7	investment included in the contract	Shanxi province EPA; Changzhi EPA; Changzhi monitoring station	vehicle emission (NO <sub>2</sub> , PM <sub>10</sub> )	before operation

Table 6-3 Control measures for sensitive receptors along Taihang Street, Yingxiong Road, Chengxi Road, West Fuhou Street

Road name	No	Objective name	meets standard Y/N (short term)	meets standard Y/N (long term)	cost estimation □10,000 yuan□	control measures
Yingxiong Road	1	Yingxiong Road elementary school	Y	Y	-	Use low noise modified asphalt pavement
	2	Xiaolingtong Kindergarden	Y	Y	-	Use low noise modified asphalt pavement
	3	Xianan Street elementary school	Y	Y	-	Use low noise modified asphalt pavement
Taihang Street	4	Huoju middle school	Y	Y	-	Use low noise modified asphalt pavement
	5	No.12 middle school	Y	Y	-	Use low noise modified asphalt pavement
	6	Jiandong Road elementary school	Y	Y	-	Use low noise modified asphalt pavement
	7	Heji hosptial	Y	Y	-	Use low noise modified asphalt pavement
Fuhou Street	8	No.2 middle school	Y	Y	-	Use low noise modified asphalt pavement
Chengxi Road	9	Changzhi academy of eduction	N	N	24	Use low noise modified asphalt pavement+noise isolation window
	10	Maternal and Child Care Service Centre	Y	Y	-	Use low noise modified asphalt pavement
	11	No.7 middle school	Y	Y	-	Use low noise modified asphalt pavement

## 6.5 Environmental Monitoring Plan

### 6.5.1 Objectives and Principles

The purpose of environmental monitoring is to understand the status of pollutant discharge and the impact during the construction and operation period to ensure that

the mitigation measures be taken and the impact would be mitigated. The principles to prepare the monitoring plan should be focusing on major impacts on the environment in both the construction and operation stage.

### 6.5.2 Monitoring Items

During the construction period, the monitoring items include TSP and PM<sub>10</sub>; during the operation period, the items include noise, CO and NO<sub>x</sub>.

### 6.5.3 Monitoring Plan

The monitoring plans for construction and operation stage are shown in Table 6-4.

Table 6-4 Monitoring Plan during Construction and Operation Stages

Category	Item		Phased Monitoring Scheme	
			Construction Phase	Operation Phase
Air	Pollutant Source		Construction dust	Vehicle emissions
	Monitoring parameters		TSP□PM10	CO□NOX□PM10
	Standard	Quality standard	“Quality standard of ambient air” □GB3095-1996□	“Quality standard of ambient air” □GB3095-1996□
		Emission standard	-	“Limit and measurement methods for emissions from light-duty vehicles” □GB18352.3-2005□
	Monitoring point		Yingxiong Road elementary school□Xiaolingtong kindergarten□Xianan Street elementary school□Huoju middle school□No.12 middle school□Jiandong Road elementary school□Heji hospital□No.2 middle school□Changzhi Academy of education□Maternal and Child Care Service Centre□No.7 middle school	□No.7 middle school □Jiandong Road elementary school □Changzhi Academy of education □Maternal and Child Care Service Centre
	Monitoring frequency		2 day per month, both in the morning and afternoon	Once (1~2 days) in both the summer and winter
	Execution institution		Changzhi monitoring station	Changzhi monitoring station
	Supervision institution		Construction contractor	Construction contractor
Noise	Pollutant Source		Construction equipment noise	Traffic noise
	Monitoring parameters		LAeq(dB)	LAeq(dB)
	Standard	Quality standard	Urban Acoustic Environment Standard (GB3096-2008)	Urban Acoustic Environment Standard (GB3096-2008)
		Emission standard	Boundary noise limit for construction site □GB12523-90□	Emission standard for industrial enterprises noise at boundary (GB12348-2008)

	Monitoring standard	Urban Acoustic Environment Standard (GB3096-2008)	Urban Acoustic Environment Standard (GB3096-2008)
Monitoring point		Yingxiong Road elementary school <input type="checkbox"/> No.12 middle school <input type="checkbox"/> Heji hospital <input type="checkbox"/> No.2 middle school <input type="checkbox"/> Changzhi Academy of education	<input type="checkbox"/> No.7 middle school <input type="checkbox"/> Changzhi Academy of education <input type="checkbox"/> Maternal and Child Care Service Centre Xiaolingtong kindergarten
Monitoring frequency		1 day/month, both in the morning and night	Twice/year, both in the morning and night
Execution institution		Changzhi monitoring station	Changzhi monitoring station
Supervision institution		Construction contractor	Construction contractor
Monitoring institution		Changzhi EPA	Changzhi EPA

In addition to the monitoring activities, a periodical environmental monitoring program should also be carried out by construction contractors during the construction, as well as by project owners in operation phase. This program is mainly designed to reduce or mitigate the negative impacts on the environment.

#### 6.5.4 Monitoring Procedures

The environment monitoring procedures should be prepared in accordance with the characteristics of the project and the requirement of environmental management system (ISO14001). The environment monitoring procedures should include the following aspects.

- (1) The environment management system should be established to management the requirement of funding and personnel.
- (2) Environment management procedures, monitoring plan, training program and protection measures should be prepared as a part of the construction plan and the EIA report.
- (3) The training program should be implemented as planned.
- (4) Regular environment management should be implemented as planned to timely monitor the impacts on the environment.
- (5) The information share channel should be well established to respond any public complaint.
- (6) The monitoring plan should be periodically implemented as planned. The monitoring results need to be submitted to related agencies timely.
- (7) Any violation or issue that disturb nearby public during the construction and operation stage should be timely corrected. If necessary, related management plan should be revised accordingly.
- (8) The monitoring reports, public complaints and other documents should be well documented.
- (9) The environmental supervision should be reviewed and reported periodically to regulatory agencies. The environment management plan

should be revised to improve the management in response to the comments from regulatory agencies.

#### 6.5.5 Monitoring Reporting

##### (1) Environmental monitoring report in construction stage

The construction of this project will take about 4 years. The environmental monitoring station should compile “progress report of environmental monitoring” (twice every year) according to the national environmental management codes of construction project and the requirement of World Bank, in order to ensure that the environmental mitigation measures are being taken as given in the approved environmental monitoring plan.

The “Progress report of environment monitoring” should include: Setup of environmental management institutions, engineering progress, main constructing contents and methods, implementation of training program and mitigation measures, and the implementation and results of environmental monitoring plan. The establishment of public complaints response mechanism and response should also be included in the report.

Except for the above monitoring report, the contractor should compile daily and monthly reports, submitting it to superior department in charge and local environmental protection department.

##### (2) Environmental monitoring report in operation stage

After this project being put into operation, the environmental monitoring station will compile “Environmental monitoring report” regularly (once a year). It should mainly include: setup of environmental management institutions and the project operation status, the implementation status of comments of the environmental protection department on previous report, the monitoring system (including timing, frequency, points and used instruments and devices, applicable standard), statistical analysis result of monitored data, and further mitigation measures to be taken.

#### 6.5.6 Monitoring Cost

The monitoring cost for one year in both the construction and operation stage is shown in Table 6-5

Table 6-5 Monitoring Cost during Construction and Operation Stages, Unit: 104 Yuan/year

Description	Monitoring Items	Air	Noise	Total
Transport project	Construction phase	26.4	3.2	29.6
	Operation phase	12.0	1.6	13.6

Total	
-------	--

## 6.6 Capacity Building

### 6.5.1 Personnel Training Plan

Personnel training on the environmental protection knowledge and skills will be provided in different stages of project implementation. Domestic and overseas training programs will be offered for personnel at different working positions, which are shown in Table 6-6 for more details.

Table 6-6 Personnel Training Plan

Personnel	Training Content	Mode	Number	Time (day)	Cost(10,000 Yuan)
Construction environmental protection personnel	Basic theory of environment and monitoring method, writing monitoring report, position training	Domestic training	2 for each construction section	3	8.4
Environmental protection supervision engineers, environmental management engineers form construction party	Relevant environmental regulations, policies, standards and programs	Domestic training	1-2 for each construction section; 2-4 from construction party	3	8.4
	Control and monitoring knowledge and skills for air and noise	Domestic	6	4	
Senior environmental management personnel and environment engineers	Abroad advantage experience in transportation management and noise control	Overseas	4	15	10
Gasoline and natural gas urgent management personnel	Gas and diesel station safety operation training	Domestic	4	3	2.4
Total				28	29.2

### 6.6.2 Equipment Procurement Plan

In order to facilitate the environmental monitoring and management during the construction and operation stages, it is necessary to purchase the regular equipment, chemicals and supplies, as shown in Table 6-7.

Table 6-7. Equipment Procurement Plan and Cost Estimate

No.	Instrument Name	Unit	Cost (10,000 Yuan)
-----	-----------------	------	--------------------

1	Portable noise measurement meter	3	1.80
2	Air sampler	1	3.00
3	Analytical balance	1	1.00
4	Other experimental chemicals and supplies	--	3.00
	Total		8.8

### **6.7 Public Complaining Procedures**

It is necessary to carry out the public consultation and communications throughout the project construction stage. The objective is to inform the public of construction activities to gain their understanding and support, and to resolve any concerns they may have and suggestions for mitigation.

The hotline of the administration office of Changzhi sustainable urban transport project will be announced to the public via local media such as website and newspaper, as well as the bulletin on construction sites. The administration office will record and document the complaints properly. A full-time staff in the project management office will be designated for recording, documenting and replying any public complaints, and report to the leaders of the PMO by whom the relevant regulatory agency will be informed.

Any person affected by the project is provided the opportunity via oral or written to complain to the management office, which should be resolved within two weeks. If not satisfactory with the results, the complaint can be submitted and resolved by the local EPA, even by the local court as necessary.

### **6.8 Reporting Procedures**

Contractors, monitoring and supervision parties should be responsible to report to related regulatory institutions on the project progress, the implementation of environmental management plan and monitoring results, which include 6 components as shown below.

- (1) The environmental supervision engineers are required to record and report the implementation of EMP based on a monthly basis to the project owner and project administration office. The EMP implementation report may include the implementation of environmental protection, monitoring plan and results.
- (2) The contractors and operators are required to record and report the project progress and the implementation of EMP on a quarterly basis to the project administration office as well as local EPA.
- (3) The contractors and operators are required to record and report the project progress and the implementation of EMP on a quarterly basis to the project administration office as well as local EPA.

- (4) The local project administration office should submit the project progress report to higher project administration office, which include the implementation of EMP and monitoring results.
- (5) Any violation on environmental protection should be reported to the related environmental protection agencies.
- (6) Annual EMP implementation report should be submitted to the World Bank prior to March, 31 in the following year.

The EMP implementation report may include:

- a. implementation of training programs;
- b. progress of individual project components;
- c. implementation of environmental monitoring and control;
- d. resident's complaints and responding solutions;
- e. following year's EMP implementation requirements.

### 6.9 Cost Estimation for Environmental Management

By the preliminary estimate, 24.13 million Yuan (24,13,76) will be invested in environmental protection for the proposed project as shown in Table 6-8.

Table 6-8 Environmental Protection Cost, Unit: 10,000 Yuan

Period	Content		Investment	
			Estimation	Total
Construction stage	Social environment	Surface and ground pipeline investigation	10	44
		Media, public notice	6	
		Billboard in construction site	8	
		Bridge and safety fencing	20	
	Urban ecology	Maintenance of stocked soil	10	2114.56
		Renewing of destroyed Urban vegetation	2104.56	
	Air	Site preparation	20	69.4
		Vehicle washing	3	
		Spray	10	
		Construction site fencing	10	
		Monitoring	26.4	
	Noise	Temporary facilities for reducing noise	15	18.2
		Monitoring	3.2	
	Wastewater	Wastewater treatment	5	5
Solid waste	Disposal of used soil and construction waste	10	12	
	Disposal of MSW	2		
	Overhead	10	10	
	Total			
Operation stage	Air	Road repair and maintenance	50	62

		Monitoring (year one)	12	
	Noise	Noise isolation windows	24 (8000 Yuan per window, 30 windows total)	31.6
		Monitoring (year one)	1.6	
		Noise monitoring for deciding if installing the noise control windows	6	
	Overhead		9	9
	Total		102.6	
Training			38	38
Total			2413.76	

## **7 Public consultation and Information Disclosure**

### **7.1 Guidance and Principles**

According to the Guidelines for Environmental Protection for Construction Projects of the State Council and World Bank Safeguards Policy OP4.01, the public directly affected by the specific project is required to be involved in the preparation of the EIA. The public consultation and information disclosure was carried out throughout the EA Preparation.

### **7.2 Objectives**

Public consultation is one of the key elements in the EIA, the objective of consultation is to promote the public awareness of the project construction and reduce the risk or negative impact so that the economic, social and environmental benefit can be optimally achieved.

In addition, the public consultation will improve the public awareness of environment protection and better receive the support of the public and avoid or mitigate any potential adverse impacts.

In order to fully understand the environmental impact of this project, and enhance the rationality and effectiveness of the environmental mitigation measure, public consultation is conducted during the environmental impact assessment.

### **7.3 Method, Timing and Content**

Two rounds of public consultation were conducted for this project. The EIA information was disseminated online through the government website since September 1 through September 10, 2011, a snapshot of which was provided in Figure 7-1, to solicit the general public comments on the project. The second round of the public consultation was implemented in the form of distributing questionnaires along the proposed transport corridors and public meetings near the two parking and maintenance yards.

#### **7.3.1 Round One of Public consultation**

According to The Provisional Measures for Public Participation in Environmental Assessment in PRC, the proposed project and related EIA information was disseminated online through the government website since September 1 through September 10, 2011. The snapshot of the website was shown in Figure 7-1, in which enclose:

- a. brief description of the project;
- b. contact of the construction party;
- c. contact of the agency to implement the EIA;
- d. major concerns;
- e. options for the public to participate; and
- f. the valid time slot for the participation.

中央政府门户网站 山西省人民政府网站 市委 市人大 市政协 英文版 | 繁

**中国长治** www.changzhi.gov.cn **长治 — 国家卫生**

首页 | 政府信息公开 | 办事服务 | 政民互动 | 长治市管 | 时政动态 站内搜索

当前位置: 首页>>时政动态>>公示公告>>正文

### 世界银行贷款长治市可持续城市交通项目环境影响评价第一次公示

[2011-09-05] (点击率:585)

[字号:大 中 小]

长治市城市交通项目管理中心筹备开展“世界银行贷款长治市可持续城市交通项目”，按照《中华人民共和国环境影响评价法》，该项目已经委托山西省环境科学研究院进行环境影响评价。根据《环境影响评价公众参与暂行办法》有关规定，现将有关信息公示，如下：

一、建设项目名称及概要

建设项目名称：世界银行贷款长治市可持续城市交通项目

建设项目概要：项目计划总投资为2亿美元，约1.8亿人民币，其中世界银行提供贷款1亿美元，长治市配套资金1亿美元。项目的建设范围全部位于长治市城区，共包括五部分，分别为：

(1) 综合交通走廊改造：综合交通走廊改造确定为“两街两路”，分别为太行街（自湖滨大道至金口路总长8.64km）、府后街（站前路至长兴路总长3.67km）、英雄路（北外环至城南生态苑总长8.17km）、城西路（北外环至五一街总长5.03km），共计25.51km。改造内容包括公交专用道设置、公交车站改造、信号控制系统、交叉口一体化改造、出入口改造、慢行过街、减速改造、停车管理方案等。

(2) 智能城市交通管理系统建设：智能城市交通管理系统建设包括城市综合交通数据平台、智能交通管理与控制平台、智能公交运营与服务平台、交通管理附属系统四部分。

(3) 公共交通基础设施建设：公共交通基础设施建设包括八一广场公交枢纽站改造、公交公司停车场改造及城南停车场建设。

(4) 停车管理建设：停车管理建设包括停车策略研究、停车规范建立与执行。

(5) 机构能力建设。

二、建设项目的建设单位的名称和联系方式

建设单位的名称：世行贷款长治市城市交通项目管理中心

建设单位的联系方式：0355—2228179

三、承担评价工作的环境影响评价机构的名称和联系方式

评价机构的名称：山西省环境科学研究院

评价机构的联系方式：0351—8285926（电话/传真）

四、公示时间

公示时间从2011年9月1日—2011年9月10日，为10个工作日。

五、征求公众意见的主要事项

主要征求受工程建设影响的公众对该项目的建设所带来的环境影响的意见和建议，从环境保护的角度提出防治工程建设所造成的不利环境影响的建议，以便通过环境影响评价将公众合理可行的意见和建议反馈于工程设计中。

六、公众提出意见的主要方式

公众可以通过上述联系电话和传真，参与到建设项目环境影响评价的公众参与活动中。

长治市城市交通项目管理中心  
二〇一一年九月一日

Figure 7-1. Changzhi Government Website for Project Announcement

No public comments were received during the period of September, 1 through 10, 2011.

### 7.3.2 Round Two Public consultation

Round two public consultation was implemented on September 3, 2011, which included questionnaire distribution along the four proposed transport corridors and public meetings near two parking and maintenance yards.

The coverage of public consultation mainly includes the sensitive receptors along the four corridors. These sensitive receptors include resident, school, hospital and enterprise and business unit, temples and others. Interviews have been conducted particularly for Huayan Temple on Taihang Street and the West Mosque at Yingxiong Road. Totally 34 questionnaires were distributed along the road and all are returned. In addition, major environment issues and sensitive problems are introduced to the public before distributing the questionnaires.

The public meeting at two parking and maintenance yards is conducted with participants being the directly affected people. Meeting rooms of the bus company and the village committee of Mafangtou are the places for public meeting. The project information and related impacts were presented to the participants at both public meetings. The EIA team also responded to the public questions, comments and opinions on the project to help the participants better understand the environmental implications of the project. The public consultation questionnaires were distributed among the peoples who have already better understanding of the project. Opinions, suggestions and requests from the people are recorded by the EIA team along with the returned 28 questionnaires.

Table 7-1 through 7-3 was presented below.

Table 7-1. Public consultation Questionnaire for Changzhi Sustainable Urban Transport Project

<p>Project summary: Changzhi Sustainable Urban Transport Project has five project constituents: Integrated Corridor Improvement; Intelligent Urban Transport Management System; Public Transit Supporting Infrastructure; Comprehensive Parking Management; Institutional Capacity Development. Integrated Corridor Improvement involves four implementation corridors: Taihang Street, Yingxiong Road, Chengxi Road and Fuhou Street.</p> <p>Taihang Street (Hubin Road~Jinkou Road) is 8.64km long □ Yingxiong Road (North Outer Ring Road~Mafangtou) is 8.75km long □ Chengxi Road (North Outer Ring Road~Wuyi Street) is 8.03km long □ Fuhou street (Zhanqian Road~Middle Changxing Road) is 3.69km long □ the total length is 26.1km.</p> <p>Taihang Street, Fuhou Street are designed to have road side bus priority lane, Yingxiong Road and Chengxi Road are designed to have bus priority lane in the center of road.</p> <p><b>Project Summary:</b></p>					
Basic information for the person participated in the	Occupation	Gender	Age	Commute method	Purpose of Commute

the person participated in the survey						
Questions		General opinion on the project				
Relation to the project		Residential housing along the roads	Regular pedestrian	Others		
Your attitude on the proposed project		Agree	Disagree	Don't Care		
Your opinion on the current road situations you are working or housing		Excellent	Satisfactory	Unsatisfactory		
Current impacts of vehicle emissions to you		Serious	Not serious	Fair		
Current impacts of noise to you		Serious	Not serious	Fair		
Your knowledge on the project	Project routing	Know very well	Know little	Know nothing		
	If the routing is reasonable	Reasonable	Partially reasonable	Not known		
Positive impacts of the project on the public transportation		Very helpful	Little help	Not helpful at all		
Your attitude on the project during the construction		Acceptable	Acceptable with control measures	Not acceptable		
	Noise					
	Dust					
	Waste water					
	Inconvenience for pedestrian					
	Negative impact on traffic					
Your attitude on the project during the operation		Serious	Not serious	Acceptable		
	Vehicle emissions					
	Noise					
	Vibration					
	Others					
Economic benefits that the project brings to the local community		Is it beneficial to promote the development of other industry?	Yes	No		
		Is it beneficial to improve the local reputation?	Yes	No		

Other comments or suggestion	
------------------------------	--

Table 7-2. Public consultation Questionnaire for Public Meeting in Bus Company

Project summary: Parking and maintenance Yard located in the bus company has planned area of 1.7ha, the construction contents are listed as the following table:

Project Description: the parking lot is located

Building Name	Area □m <sup>2</sup> □	Remarks
Parking lot for buses	4000	40 Parking Spots
Comprehensive office building	1200	
Commercial buildings along the street	1200	
Office building	1400	
Commercial infrastructure along the street	2800	
Parking lot for administration	600	
Vehicle repair zone	1200	2 Zones
Other buildings	1000	Employee Housing and gas station
Bus station	2000	Two bus routes (short term), 6 bus routes in total (long term)

Basic information for the person participated in the survey		Occupation	Gender	Age	Commute method	Purpose of commute
Questions		General opinion on the project				
Relation to the project		Residential housing along the roads	Regular pedestrian	Others		
Your attitude on the proposed project		Agree	Disagree	Don't Care		
Your opinion on the current road situations you are working or housing		Excellent	Satisfactory	Unsatisfactory		
Current impacts of vehicle emissions to you		Serious	Not serious	Fair		
Current impacts of noise to you		Serious	Not serious	Fair		
Your knowledge on the project	Project routing	Know very well	Know little	Know nothing		
	If the routing is reasonable	Reasonable	Partially reasonable	Not known		
Positive impacts of the project on the public transportation		Very helpful	Little help	Not helpful at all		
Your attitude on the project		Acceptable	Acceptable with control measures	Not acceptable		

on the project during the construction	Noise			
	Dust			
	Waste water			
	Inconvenience for pedestrian			
	Negative impact on traffic due to the construction			
Your attitude on the project during the operation		Serious	Not serious	Acceptable
	Vehicle emissions			
	Noise			
	Vibration			
	Others			
Economic benefits that the project brings to the local community	Is it beneficial to promote the development of other industry?	Yes	No	
	Is it beneficial to improve the local reputation?	Yes	No	
Other comments or suggestion				

Table 7-3: Public consultation Questionnaire for Public Meeting in Bus Company

Project summary: South parking and maintenance yard is located at Mafangtou Village in south of the city. Planned construction area is 1.3ha and designed parking capacity is 100 buses, terminal stations of 6 bus routes are planned, the construction contents is listed in the following table:

Building Name	Area □m2□	Remarks
Parking lot for buses	4000	40 Parking Spots
Comprehensive office building	1200	
Commercial buildings along the street	1200	
Office building	1400	
Commercial infrastructure along the street	2800	
Parking lot for □administration	600	
Vehicle repair zone	1200	2 Zones
Other buildings	1000	Employee Housing and gas station
Bus station	2000	Two bus routes (short term), 6 bus routes in total (long term)

Basic information for the person participated in the survey	Occupation	Gender	Age	Commute method	Purpose of Commute
Questions	General opinion on the project				
Relation to the project	Residential housing along the roads	Regular pedestrian	Others		
Your attitude on the proposed project	Agree	Disagree	Don't Care		

Your opinion on the current road situations you are working or housing		Excellent	Satisfactory	Unsatisfactory
Current impacts of vehicle emissions to you		Serious	Not serious	Fair
Current impacts of noise to you		Serious	Not serious	Fair
Your knowledge on the project	Project routing	Know very well	Know little	Know nothing
	If the routing is reasonable	Reasonable	Partially reasonable	Not known
Positive impacts of the project on the public transportation		Very helpful	Little helpful	Not helpful at all
Your attitude on the project during the construction		Acceptable	Acceptable with control measures	Not acceptable
	Noise			
	Dust			
	Waste water			
	Inconvenience for pedestrian			
	Negative impact on traffic due to the construction			
Your attitude on the project during the operation		Serious	Not serious	Acceptable
	Vehicle emissions			
	Noise			
	Vibration			
	Others			
Economic benefits that the project brings to the local community		Is it beneficial to promote the development of other industry?	Yes	No
		Is it beneficial to improve the local reputation?	Yes	No
Other comments or suggestion				

#### 7.4 Results Analysis of Public Consultation

The public opinions, as expressed in the questionnaire during the public consultation, are summarized in Table 7-4 and 7-5.

Table 7-4: Demographic Statistics of Participants in Survey

Gender	Male	Female
	47%	53%

Age	Less	Between 30 and	Above 50	
	15%	52%	33%	
Occupation	Public	Teachers	Wo	Others
	32.1%	11.5%	47	9.4%
Education background	College	High school	Less educated than high	
	44%	13□	43%	

Table 7-5: Summary of Questionnaire

Questions		General opinion on the project		
Relation to the project		Residential housing along the roads	Regular pedestrian	Others
		18	39	5
Your attitude on the proposed project		Agree	Disagree	Don't Care
		60	0	2
Your opinion on the current road situations you are working or housing		Excellent	Satisfactory	Unsatisfactory
		26	26	10
Current impacts of vehicle emissions to you		Serious	Not serious	Fair
		13	23	17
Current impacts of noise to you		Serious	Not serious	Fair
		16	20	17
Your knowledge on the project	Project routing	Know very well	Know little	Know nothing
		32	26	4
	If the routing is reasonable	Reasonable	Partially reasonable	Not known
		43	13	6
Positive impacts of the project on the public transportation		Very helpful	Little helpful	Not helpful at all
		58	4	0
Your attitude on the project during the construction		Acceptable	Acceptable with control measures	Not acceptable
		Noise	20	0
		Dust	23	1
		Waste water	20	2
		Inconvenience for pedestrian	19	3
		Negative impact on traffic due to the construction	20	3
Your attitude on the project during the operation		Serious	Not serious	Acceptable
		Vehicle emissions	26	34
		Noise	28	32
		Vibration	27	34

	Others	1	28	33
Economic benefits that the project brings to the local community	Is it beneficial to promote the development of other industry?	Yes	62	No 0
		No		
	Is it beneficial to improve the local reputation?	Yes	62	No 0
		No		
Other comments or suggestion				

Comprehensive understanding of the project information has been accomplished through public consultation of the project. 34 questionnaires have been distributed and all of them are returned with effective answer. Combined with the questionnaires collected during the public meeting, 62 questionnaires are collected.

The comments and suggestion raised in the public consultation are summarized below.

- (1) The environmental mitigation measures identified and described in this EIA report should be fully implemented during the construction stage to mitigate the adverse impacts on the nearby residents.
- (2) The illuminating on construction sites should be banned to use at night to mitigate the adverse impacts on the nearby residents.
- (3) The environment regulatory agency should be responsible to supervise and make sure the environmental mitigation measures are implemented properly.
- (4) All construction waste should be removed from the site promptly to avoid the adverse impacts on the environment and nearby residents.
- (5) The construction process should be well planned and organized. The damaged roads, sidewalks, greens, and other community facilities should be given priority in repairing, or rehabilitation to mitigate the inconvenience to nearby residents.
- (6) Personal interview has been conducted particularly for Huayan Temple and West Mosque, temporary access road should be provided for visitors and priors in construction stage. Close communication should be kept with the hosts of the temple and the mosque so as to well schedule the construction to avoid the important events of the temple and the mosque.

In response to the comments and suggestion raised in the consultation process, some mitigation measures were designed and shown in chapter 5 in the EIA report.

### **7.5 Information Disclosure**

The EIA team released the project announcement on September 1, 2011 on the Changzhi government website to ask for any comments or suggestion from the public in accordance with domestic requirement. The hotline and e-mail address to receive public comments was also listed on the website.

The EIA team disclosed the full text of the EIA report and EMP from September 10, 2011. The hard copy and electronic copy of the full text of the EIA and EMP are placed in the project management office and Changzhi government website, respectively.

In addition, the advertisement for public information to access to the EIA and EMP was published in the local primary newspaper as well. The information disclosure process is summarized in Table 7-6 and the scanned advertisement is attached in Appendix 1. .

Table 7-6. Summary of Information Disclosure

Content	Date	Place
A brief project description and invitation for public opinions	September 1 through 10, 2011	Changzhi government website
Full text of EIA report and EMP	September 12, 2011	Changzhi Project Management Office and Changzhi government website at : <a href="http://www.changzhi.gov.cn/info/news/2011/nry/211315.htm">http://www.changzhi.gov.cn/info/news/2011/nry/211315.htm</a>
Newspaper advertisement	September 10, 2011	Changzhi Daily

## 7.6 Conclusion

To conclude, the project received strong public support and the majority of the public believed the project will contribute to improvement of public transport and environment. In response to the comments and suggestion raised in the consultation process, the contractors should be responsible to implement the proper mitigation measures provided in this EIA report.

## **8 Conclusions and Recommendations**

### **8.1 Benefit of the project**

The project will achieve a great net positive benefit. The successful completion of this project could improve the efficiency of transportation in the city, shifting the public travel behavior toward a more safe, efficient and environmentally friendly manner, and promoting safety and green idea in the city development. Overall, it is very important for the sustainable development of Changzhi.

### **8.2 Environmental Quality Condition**

#### **(1) Ambient Air**

Based on the monitoring results from three monitoring points (Auditing bureau, Monitoring station, Aoruite), all the air pollutants concentration in urban area of Changzhi meet grade 2 of “Ambient air quality standards” (GB3095-1996).

Therefore, the ambient air quality in Changzhi city is good.

#### **(2) Acoustic environment**

According to the monitoring of traffic noise, 10 traffic monitoring points are located along Taihang Street, the range of the sound level is 64.1~70.1dB, one of the ten points (10%) exceeds the standard by 0.1dB; 5 traffic monitoring points are located along Fuhou Street, the range of the sound level is 66.9~70.3dB, one of the five points (20%) exceeds the standard by 0.3dB; 7 traffic monitoring points are located along Yingxiong Road, the range of the sound level is 64.4~72.2dB, one of the seven points (14%) exceeds the standard by 2.2dB; 4 traffic monitoring points are located along Chengxi Road, the range of the sound level is 67.4~68.6dB, all the points meet the standard.

From the monitoring result, the noise level for environmental sensitive receptors meets the class 2 standard of “Acoustic environment quality standard” (GB3096-2008), the acoustic environment meets the standard.

#### **(3) Surface Water**

According to the monitoring result at Baoma section of Zhuozhang River, the BOD5 is exceeding the class 1 standard marginally (0.11 times), ammonia Nitrogen and COD meet the class 1 standard, the rest pollutants meet the class V standard of “Surface water quality standard” (GB3838-2002).

### **8.3 Environmental impact analysis during construction phase**

During the construction period, construction dust, noise could impose impact on the city’s social environment, ecological environment, ambient air quality, acoustic environment, and traffic safety. Hence, comprehensive mitigation measures have been

designed in this project for the construction period. Based on good management and mitigation measures, the environmental impact of construction could be reduced to minimum level. In addition, these impacts are temporary and will disappear upon the completion of the project construction.

#### **8.4 Environmental impact analysis during the operation phase**

##### **(1) Noise impact analysis**

According to the result of noise projection, traffic noise at some of the road section will be reduced upon completion of the project, which denotes that the construction of this project can bring positive impact on the acoustic environment. Traffic noise at some of the road section will be increased a little, however, the noise level is smaller in 2015 and 2030 under the “with project” alternative than that under the “without project” alternative, this is mainly due to the reason that noise reduced by improved road and traffic condition by the project.

The noise level at some environmental sensitive receptors will exceed the standard upon completion of the project, however, by taking measures like noise reduction road surface, noise isolation windows and greening, the environmental noise level could reach the standard.

##### **(2) Atmospheric environment impact analysis**

With the increase of traffic volume, the pollutant discharge will also increase, as a consequence, the pollution on atmospheric environment along the transport corridor will increase. The pollutant discharge along the route during the operation period is low and the impact range is limited to within 50m. In addition, with the increase of state emission standards, the pollutant discharge will also decrease. Percentage of vehicles with high fuel consumption and pollution will be reduced and the range of impact on the ambient air along the corridors will be reduced, therefore the overall impact is limited.

On the other hand, improved traffic condition could reduce the idling period of vehicles so as to reduce the emission. Overall, this project could improve the ambient air quality either at the road side or in the urban area.

#### **8.5 Environmental management and monitoring**

Effective environmental management and monitoring should be conducted during construction and operation phase in order to mitigate the environmental impact of this project. The environmental monitoring plan and protection measure should also be carried out with necessary training provided for related staff.

#### **8.6 Public consultation**

Public consultation have been done with the participation of the directly affected people. All the people participated in the consultation are voluntary and they consider the completion of this project a great accomplishment enhancing the economic development of the city and improving the life quality of the residents. For the

negative environmental impact during the project construction and operation phase, people along the route consider it acceptable and supportive if enhanced management and effective control measure are implemented. During operation phase, in order to mitigate the impact on acoustic environment, greening and installation of noise isolation window are widely accepted by the public.

Overall, widely public support is seen for the construction of this project.

### **8.7 Conclusion**

In conclusion, the Changzhi Sustainable Urban Transport Project is consistent with the city development master planning. It can improve the traffic condition in Changzhi and thus decrease the traffic stress. In addition, the improvement of infrastructure construction can also be beneficial for rapid development of the city.

The environmental impact on the surrounding area during construction phase in this project is temporary. Upon completion of construction, traffic flow will be smoother and emission from vehicle will be reduced so as to improve the ambient air quality. Moreover, through corresponding mitigation measure, the increased environmental noise due to increased traffic volume will be reduced to an acceptable level.

Overall, this project can bring obvious social and economic benefit to Changzhi, it is environmentally feasible in the premise that all the environmental protection measures in this report could be enforced during project construction and operation phase.

### **8.8 Suggestion**

The construction of south parking and maintenance yard in the south of city could change the acoustic function zoning of this area, therefore, it is suggested that the acoustic function zoning of this area be changed before the completion of the project through authorization by the city government.

# Appendix 1 Newspaper Advertisement for Information Disclosure

47号

长治日报

CHANGZHI RIBAO

中共长治市委机关报

2011年9月10日 星期六

(第11131期) 今日4版

山西第一报

国内统一刊号:CN34-0021

电子报: http://www.changzhi.com

## 城中村改造项目“格林小镇”开工建设

田喜荣张保李彦王云亭等出席奠基仪式

本报讯 记者魏海霞报道:9月9日上午,清华机械厂与城区黄家庄、晋峰村“格林小镇”项目正式开工建设。这是城区加快推进城中村改造、打造全国一流宜居城市的重要举措。市委、市政府高度重视,多次召开专题会议研究部署,全力推动城中村改造工作。此次“格林小镇”项目开工建设,是城区城中村改造工作的又一重要成果。市领导田喜荣、张保、李彦、王云亭、魏海霞、李国峰、李光祥、潘洪学、王梅、李东峰、王玉杰、李国峰、李书庆、桂正平、曹惠斌、许慧、魏晋发等出席了奠基仪式。市领导田喜荣、张保、李彦、王云亭、魏海霞、李国峰、李光祥、潘洪学、王梅、李东峰、王玉杰、李国峰、李书庆、桂正平、曹惠斌、许慧、魏晋发等出席了奠基仪式。

3天有小雨  
南风  
2-3级  
13℃/21℃

长治市人力资源和社会保障就业管理中心9月11

## 道一声辛苦 送一份祝福

### 市领导看望慰问一线教育工作者



田喜荣看望慰问市二中教师。本报记者 李彦 摄

张保看望慰问市实验中学教师。本报记者 梁林 摄

本报讯 记者魏海霞报道:9月9日上午,市委、市政府领导田喜荣、张保、李彦、王云亭、魏海霞、李国峰、李光祥、潘洪学、王梅、李东峰、王玉杰、李国峰、李书庆、桂正平、曹惠斌、许慧、魏晋发等,分两路看望慰问全市一线教育工作者。田喜荣、张保、李彦、王云亭、魏海霞、李国峰、李光祥、潘洪学、王梅、李东峰、王玉杰、李国峰、李书庆、桂正平、曹惠斌、许慧、魏晋发等,分两路看望慰问全市一线教育工作者。

## 田喜荣张保 会见李彦林一行

### 双方就开拓城市燃气市场等事宜 进行座谈交流

本报讯 记者魏海霞报道:9月9日上午,市委、市政府领导田喜荣、张保、李彦、王云亭、魏海霞、李国峰、李光祥、潘洪学、王梅、李东峰、王玉杰、李国峰、李书庆、桂正平、曹惠斌、许慧、魏晋发等,分两路看望慰问全市一线教育工作者。

## 我市举行台胞台属 “庆国庆、迎中秋”茶话会

本报讯 记者魏海霞报道:9月9日上午,市委、市政府领导田喜荣、张保、李彦、王云亭、魏海霞、李国峰、李光祥、潘洪学、王梅、李东峰、王玉杰、李国峰、李书庆、桂正平、曹惠斌、许慧、魏晋发等,分两路看望慰问全市一线教育工作者。

15530 地址:延安中路延东一巷1号楼

# 会警示

## 蟹

里养殖的大闸蟹... 消费者协会提醒... 大闸蟹是受国的地方专有商... 信誉可靠,是导品牌。阳澄大闸蟹相比主要

都有江苏省技... 伪标志,即“专... 印有国家地理... 标志。背面印... 个字。均佩带产地

# 公告

山西省长治市拟争取世界银行贷款建设长治城市可持续发展交通项目。按照基本建设项目审批和世行的要求,山西省环科院已经编写完成了本项目的环境影响评价报告和环境管理计划。该报告和环境管理计划的全文放置在长治市城市交通项目管理中心和长治政府网上,欢迎公众查阅并提出宝贵的意见。

长治政府网网址: <http://www.changzhi.gov.cn/info/news/2011/nry/211315.htm>

长治市城市交通项目管理中心地址: 太行东街168号永盛大厦四楼

电话: 0355-2228179

联系人: 胡楠楠

传真: 0355-2228225

2011年9月10日

五、挂牌  
18时(节假日)

# 屯留

经屯留县  
一、公开

序号	宗地
1	麟绛镇
2	麟绛镇
3	麟绛镇
4	麟绛镇
5	渔泽镇
6	渔东
7	麟绛镇
8	渔东

二、中华  
可申请参加,  
三、申请

中央政府门户网站 | 山西省人民政府网站 | 市委 | 市人大 | 市政协 | 英文版 | 繁体版 | 网上纠错 | 设为首页 | 加入收藏



中国长治  
www.changzhi.gov.cn

长治—国家卫生城市

首页 | 政府信息公开 | 办事服务 | 政民互动 | 长治市情 | 时政动态 | 站内搜索: [ ] 搜索

当前位置: 首页 > 时政动态 > 公示公告 > 正文

## 世界银行贷款长治市可持续发展城市交通项目环境影响评价第一次公示

[2011-09-05] (点击: 1013)

[字号: 大 中 小]

长治市城市交通项目管理中心筹备开展“世界银行贷款长治市可持续发展城市交通项目”,按照《中华人民共和国环境影响评价法》,该项目已经委托山西省环境科学研究院进行环境影响评价,根据《环境影响评价公众参与暂行办法》有关规定,现将有关信息公示,如下:

- 一、建设项目名称及概要  
 建设项目名称: 世界银行贷款长治市可持续发展城市交通项目  
 建设项目概要: 项目计划总投资为2亿美元,约1.9亿元人民币,其中世界银行提供贷款1亿美元,长治市配套资金1亿美元。项目的建设内容包括: 城市交通项目, 共包括五部分, 分别为:  
 (1) 综合交通走廊改造: 综合交通走廊改造确定为“两南两东”, 分别为太行街(自南内大街至金口段全长0.64km)、府后街(站前路至长兴路全长0.67km)、英雄路(北外环至城南生态岛全长0.17km)、城西路(北外环至五一南全长0.93km), 共计25.51km。改造内容包括公交专用道设置、公交车站改造、信号控制系统、交叉口一体化改造、出入口改造、慢行过街、减速改造、停车管理方案等。  
 (2) 智慧城市交通管理系统建设: 智慧城市交通管理系统建设包括城市综合交通数据平台、智能交通管理与控制中心、智能公交运营与服务平台、交通管理附属系统四部分。  
 (3) 公共交通基础设施改造: 公共交通基础设施改造包括八一场公交车枢纽改造、公交公司停车场改造及城市停保场建设。  
 (4) 停车管理建设: 停车管理建设包括停车库场研究、停车规范建立与执行。  
 (5) 机构能力建设。  
 二、建设项目的建设单位和联系方式  
 建设单位的名称: 世行贷款长治市城市交通项目管理中心  
 建设单位的联系方式: 0355-2228179  
 三、承担评价工作的环境影响评价机构的名称和联系方式  
 评价机构的名称: 山西省环境科学研究院  
 评价机构的联系方式: 0351-6285928(电话/传真)  
 四、公示时间  
 公示时间从2011年9月1日—2011年9月10日, 为10个工作日。  
 五、征求公众意见的主要事项  
 主要征求工程建设影响的公示对该项目的建设所带来的环境影响的意见和建议, 从环境保护的角度提出除工程施工建设所造成不同环境影响的建议, 以便通过环境影响评价公众参与程序的意见和建议以及用于工程设计中。  
 六、公众提出意见的主要方式  
 公众可以通过上述联系电话和传真, 参与该建设项目环境影响评价的公众参与活动中。

长治市城市交通项目管理中心  
二〇一一年九月一日

附件【环评影响报告书.doc】

### 相关链接

- 平遥县: 市交通运输局长治派驻入县检查农村街道硬化工作
- 平遥县召开迎建第五届全国新闻摄影展暨第二届摄影文化季环境整治工作会议
- 中国共产党长治市第十次代表大会代表资格审查委员会名单
- 潞城市水利局局长百安全生产大检查
- 长治市食药监局: 城区分局积极开展《食品安全法》宣讲活动



晋ICP备06005623号  
长治市人民政府主办 长治市人民政府各部门协办 长治市人民政府信息中心承办  
COPYRIGHT © 2007 CHANGZHI INFORMATION CENTER ALL RIGHTS RESERVED  
最佳浏览效果显示分辨率 1024\*768  
版权所有: 中国长治 | 网站声明 | 网站地图 | 关于我们 | 网上纠错

