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World Bank Loan Funded

Zhengzhou Urban Rail Project

In Henan, China

ENVIRONMENTAL IMPACT ASSESSMENT

Prepared by
The Environmental Protection Center of Ministry of Transport
Entrusted by:
Zhengzhou Urban Rail Group Co.

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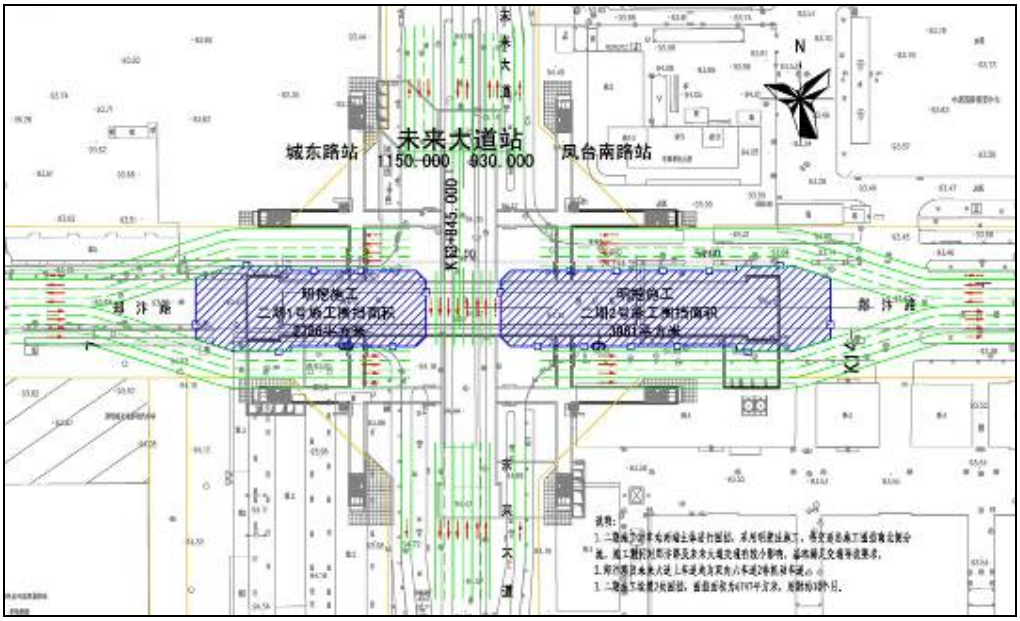

1. Based on the demand from traffic development, considering the land development mode along the subway route, the characteristics of connecting passenger flow, land condition, road network condition and the traffic condition, specific studies have been done on some topics concerning the integrated traffic plan in order to build a well-developed integration traffic network to meet the demand of resident traveling as quick as possible. Based on these results from studies, various station's accessing functions are defined and spatial arrangement of different types of connecting facilities are planned as a whole. There will be mainly five ways and means: 410

(1) Pedestrian access 410

Walk will be the final form for all accessing ways. The walk accessing system shall be first considered for all stations. A continuous, safe and comfortable pedestrian system shall be provided through squares, crossing-street facilities and foot paths based on the passenger flow to be accessed, considering road building and rebuilding. The barrier-free facilities shall be provided for and attached to the pedestrian system and be constructed together with the urban facilities. 410

(2) Cycling access 410

In view of the accessing features at difference areas along the subway route where most are residential areas, the cycling access is inevitable and planning of parking lots along the entire route shall be focused on whether it is convenient to access to residential areas. The accessing facilities shall be designed and distributed based on whether the land supply is possible and reasonable, and land will be reserved in view of the change in long/near term demand. The parking space will be reduced through parking space landscaping, sharing it with public buildings, three-dimensional parking, reducing space for a single cars. For the cycling accessing facilities, passengers will be encourage to use it more frequently. Specific bicycle parking space will be arranged to reduce the time percentage of bicycles using roads as much as possible. 410

(3) Access to bus stops 410

At the old urban areas where there are more public transports, the spatial position, the manners and the spatial size of the intermediate stops will be optimized by analyzing the bus flow route, defining the main passenger flow direction and centering arrangement of the entrance and exit of railway transit. At other areas where the public transport is developing, public transports shall be planned and developed in consideration of the subway stations along its route. Bus stops shall be optimized and adjusted to proper positions while consideration shall be given to the intersections are coordinated as a whole to meet the requirement to connect subways efficiently..... 410

(4) Taxi access 411

The regulations on design and arrangement of taxi facilities shall be complied and road and general traffic conditions at different areas shall be taken into consideration. Taxies are allowed to pull over the road around the subway route to take or drop passengers, for instant stopping and leaving. At the peripheral areas towards the south and the north, where conditions permit, taxi waiting space or taxi-beckoning stops will be set, and the passenger-waiting space will be set at the hub station, flexibly. 411

(5) Car access 411

Car access shall be planned and arranged in compliance with the criteria of "P+R" (Parking and Transfer), based on the station land condition, the road network conditions and the traffic condition, and considering the whole picture of the railway network. In the process of preparing the detailed regional planning, focus shall be on reserving parking space around the remote subway stations..... 411

The above-mentioned access space for public transport will be controlled and reserved as the accessing land by the planning bureau to avoid being used by other projects. During the project construction, the Subway planning company and the commission for communication will take the lead to organize the public transport companies and the gardening &landscaping organizations to build respective facilities to be accessed to the subway stations as per the planning. 411
Example: Erqi Square Station - the transfer station between Subways #1 and #3.....411
(1) Traffic around the station.....411
The station is located at the intersection of Jiefang Road and Zhengxing Street and arranged in transmeridional way along Jiefang Road. Passengers can transfer between Subway #1 and #3. There are totally 5 entrances/exits for Subways #1 and #3 which are distributed on four sides of the intersection between Jiefang Road and Zhengxing Street. The station stand at the center of the old urban area where it is well-developed, densely populated, the most prosperous commercially and highly-concentrated with urban functions.....411
At present, Bus Line No. 6, 603, 28, B17 have stops on Jiefang Road (stop name: Erqi Square bus stop) which are closer to the subway entrance/exit while Bus Line No. 105 (south), 806, K906, 95, 32, 21, K6, K903, 93, 517 and 906 have stops at Zhengxing Street (stop name: Erqi Square bus stop) that intersects Jiefang Road, which also are closer to the subway entrance/exit. 411
(2) Passenger flow features.....412
The passenger flow is dominantly mixed including travellers and commuters. The passengers walking to the station are distributed over the commercial space around it. Since railway transit stations concentrate there, most passengers from other stations also walk inside it and so there will be no bicycle parking space. passengers coming to it by public transports are by passing-by buses and the train station. 412
(3) Improve the integrated traffic network.....412
Consideration is mainly given to access to the station on foot, by public transport, by bicycle, taxi, and private cars.....412
The pedestrian system: Since the on-foot passenger flow comes from every direction around the station, squares are to be built around every entrance/exit of the subway and to be connected with established roads, and the established roads with footpath width less than 3 m will be rebuilt. Develop and improve sound planar crossing-street facilities and crossing-street facilities for transferring bus stops to provide a safe and comfortable on-foot system for on-foot and transferring passengers to the station.....412
The public transport facilities: 2 bue stops on the west street will be reserved. 2 bus stops on Shuncheng Street will be relocated in order to minimize the distance from new stops to the subway entrance/exit, thus reducing the transferring time.....412
The bicycle parking space: based on the demand from bicycle access and the organizational requirement, the first measure is to build more cycling roads and the second measure is to build 2 bicycle parking lots somewhere around the subway entrance/exit on the western street in order to reduce the frequency of bicycles crossing street effectively and lower traffic interference. The total area of both bicycle parking lots is 500 square meters including No.1 bicycle parking lot of 200 m2 to be located on the north side of the western street to serve the passenger flow on the north side of the station and No.2 bicycle parking lot of 300 m3 to be located on the south side of the western street to serve the passenger flow on the south side of the station; 412

1 Preface

1.1 Background of the Project

1.1.1 The brief introduction of the project

Line 3 will be an oblique radial rail backbone line from northwest to southeast in the city’s center. The north end of the Phase-1 project of Line 3 will start from Xinliu Road Station at the provincial sports center in Huiji District, and the south section will end at East Hanghai Road Station at the Economic Development Seventeenth Street in the Economic Development Zone. The length of the line will be about 25.2km, all underground, with 21 stations, one car depot and one parking lot. The line will be constructed along Changxing Road, Nanyang Road, Minggong Road, Jiefang Road, West Street, East Street, Zhengbian Road, Nandu Road and Economic Development Seventeenth Street, and will connect the Feb 7 Square’s Commercial Center, Economic Development Zone’s center and other urban functional centers. The line’s average station spacing will be 1.29km, and its length will be about 25.2km, with 21 stations, one car depot and one parking lot.

1.1.2 Project Origin

As the provincial capital of Henan Province, Zhengzhou City is located in the hinterland of the Central Plain, with "an important hub controlling advantageous positions." Zhengzhou is always one of China’s important transportation and communication hubs, an important city of the new Eurasian Continental Bridge, and a national open and historical and cultural city. Zhengzhou is an important center city of the central region, the first city in Henan province and the urban agglomeration in the Central Plain, has unique and important geographic conditions, and is Henan Province’s political, economic and cultural center.

Zhengzhou City has a long history. The Shang Dynasty had its capital here. It is the birthplace of the Chinese Civilization and one of China’s oldest cities. Its north is near the Yellow River, its southwest is hilly land, and its southeast is a vast plain. In the pattern of China’s economic development, it has an important role in linking the east and west, north and south.

Zhengzhou now has under its jurisdiction six districts, five county-level cities, one county and two state-level development zones. The city's total area is 7446.2 square

kilometers. In recent years, Zhengzhou's economic construction and development is rapid. Throughout 2011, Zhengzhou completed 491.27 billion yuan of GDP, ranking 20th among Chinese large and medium-sized cities, and the annual general budget revenue of its local fiancé was 50.23 billion yuan, ranking 17th among Chinese large and medium-sized cities.

With the rapid development of the city, Zhengzhou presents such problems as population growth, the rapid growth of its motor vehicles, traffic jams and so on. Although, in recent years, Zhengzhou has been increasing investment in the construction of its urban traffic, the increase of its traffic supply is still far less than the growth of its traffic demand and its traffic supply and demand contradiction has an intensifying momentum.

To solve the problem of metropolitan traffic congestion, the general experience of domestic and international cities is to build rapid rail transit systems and construct integrated transport systems so as to solve traffic pressure and promote cities' healthy development. To this end, in September 2000, Zhengzhou began the preparation of the planning of its urban rail transit lines and networks. In 2004, according to Zhengzhou's overall urban planning-related local adjustment program and to experts' review comments, the planning of Zhengzhou's rail lines and networks experienced a local adjustment.

In August 2005, the Henan Development and Reform Commission organized and convened an experts' review meeting on Zhengzhou City's urban rail transit construction planning. The meeting proposed an opinion of further optimizing the forward line and network solutions. In January 2006, Zhengzhou's rail transit construction plan was completed. In January 2008, in Zhengzhou, the China International Engineering Consulting Corporation (CIECC) organized and convened an evaluation meeting for "Zhengzhou City's Rapid Rail Transit Construction Plan"; in March, the CIECC completed an assessment report and submitted it to the National Development and Reform Commission.

In April 2008, in Zhengzhou, the Ministry of Environmental Protection organized and convened an experts' review meeting, comprehensively reviewing and passing in principle the "Environmental Impact Report for Zhengzhou City's Rail Transit Lines and Networks Construction Planning." In February 2009, the National Development and Reform Commission printed and issued the "Circular of the National Development and Reform Commission Regarding the Request for the Examination and Approval of the Recent Construction Plan (2008 ~ 2015) for Zhengzhou's Urban Rapid Rail Transit" (NDRC Basic Document No. [2009] 369.).

According to the construction plan, the Phase-1 project of Line 1 for rail transit started in June 2009, and the Phase-1 project of Line 2 started in December 2010.

Meanwhile, in order to coordinate the construction of Lines 1 and 2, do a good job of the

reserved projects and provide technical support, the Zhengzhou Rail Transit Office organized and carried out the preliminary study of Lines 3, 4, 5 and 6, so as to provide a technical resource guarantee for along-the-line land use control planning, urban construction and the interim construction plan.

In July 2009, the Zhengzhou Rail Transit Office entrusted relevant units to formulate and complete the pre-feasibility study report (draft for review) for Line 3 project of Zhengzhou's rail transit, which passed experts' review. According to the experts' review comments and related units' opinions, the report underwent corresponding modification. In November 2009, the pre-feasibility study report (final draft) of Line 3 project of Zhengzhou's Rail Transit was completed.

In 2010, in order to maintain the sustainability, feasibility and rationality of Zhengzhou's rail transit construction, give play to the overall efficiency of Zhengzhou's rail transit lines and networks as soon as possible, accelerate the process of building rail transit, and provide the construction basis for the follow-up projects of its rail transit, Zhengzhou started the preparation of "Zhengzhou City's Rail Transit Construction Plan" (2013 - 2020). Currently, this planning report has been basically completed, initially having the conditions for being reported to a higher body. .

Combining with the progress of the original construction plan and with Zhengzhou's recent years' development, this plan proposes that after the phase-1 projects of Line 1 and 2, the Phase-2 project of Line 1, the Phase-2 project of Line 2, the Phase-1 project of Line 3, the Phase-1 project of Line 4 and Line 5 be constructed. Among them, the project of Line 3 will be constructed in 2014 and will be completed and opened to traffic in 2016.

In October 2010, in order to coordinate the formulation of its rail transit construction plan and to carry out in advance the research work for the relevant lines, the Zhengzhou Rail Transit Office entrusted the Beijing Urban Construction Survey and Design Institute to carry out the feasibility study work for Line 3 project for Zhengzhou's rail transit. In 2012, the institute completed a first draft feasibility study report. This EIA report is based on this first draft.

The Line 3 project of Zhengzhou City's rail transit was included in the projects using the World Bank's loans in 2011, which needed preparing an EIA report, environmental impact assessment summary and environmental management plan (ESMP) and other documents in line with the World Bank's requirements. After accepting the entrustment, our unit organized experienced EIA staff members to undergo field research and collect the information and data related to the project, and completed the preparation of this report in December 2012.

1.1.3 Project Development Objectives

(1) The construction of this project will not only provide safe, efficient, fast and comfortable transport for the residents along the line and will be of great significance in promoting the rational distribution of the city, accelerating the formation of urban planning, improving transport structure, protecting the ecological environment, creating a favorable investment environment, accelerating economic development, etc. At the same time, its completion will have a strong pull effect on the project's along- the-line comprehensive development, land appreciation and so on.

(2) As the backbone line of Zhengzhou City, Line 3 of its rail transit will go through the city's east and west development axis, connect the February 7 Square's business center, Zhengzhou's southeast leisure center, the shopping mall's historical and cultural centers and other zones and municipal functional centers, and meanwhile, connect the Hi-tech Zone's business center, East University City, West University City and other districts. The building of Line 3 will promote the gathering and cultivation of the service functions of the city's east and west urban development axis region, boost urban development, and guide the rational distribution of the city.

1.1.4 Project owners

Construction unit of the project: Zhengzhou Rail Transit Co., Ltd.

1.1.5 Geographic location of the project

Zhengzhou is located in the hinterland of China and at the center of China and is ten provinces' thoroughfare. It adjoins the Yellow River in the north and the Songshan Mountain in the west. Its east and south connects the Huang-Huai Plain, and it is between east longitude 112 ° 42 '~ 114 ° 14', and north latitude 34 ° 16 '~ 34 ° 58'.

1.1.6 Environmental characteristics

The project is located in Zhengzhou City, and the scope of project primarily is the urban ecosystem.

1.2 The purpose, content and organization of the environmental impact assessment

1.2.1 Purpose of the environmental impact assessment

(1) Through carrying out environmental impact assessment for project to be constructed, the range and degree of impact of project construction on regional environmental quality is determined based on understanding and mastering the current situation of nature and social environmental quality of the area along the project, and the rationality of line scheme is demonstrated from environmental protection point which provides the basis for decision making for the implementation of this project.

(2) Carry out analysis for the feasibility and rationality for environmental protection measures suggested in the project design document, put forward environmental protection schemes and suggestions for mitigating and avoiding environmental hazards, guide and provide feedback for project design, realize synchronous implementation of project construction and environmental protection measures, minimize the adverse environmental impact, and promote harmonious development of economic benefit, environmental benefit and social benefit of project construction.

(3) Comprehensively balance the beneficial effects and adverse effects of project implementation, encourage residents to participate positively in demonstration of the project through various means including public opinion survey, publicity via newspapers and internet, public notice, telephone counseling and symposium with public participation etc, so as to make the demonstration process and evaluation conclusion more democratic and scientific, which also plays positive effect on publicizing environmental protection laws and regulations and strengthening environmental protection awareness of the masses.

1.2.2 The content of environmental impact assessment report

The evaluation made in the report is in accordance with Attachment B of OP 4.01 and laws and regulations of China concerning environmental impact assessment (for details, see Chapter 2) covering environmental and security impact, potential environmental impact, public participation etc.

Based on project features and environmental sensitivity, contents of this assessment are: acoustic environment, vibration environment, water environment, electromagnetic environment, ambient air, urban ecology, social environment, material and cultural resources, cumulative impact, alternative solution, environmental risk, public participation, ESMP, economic gains and losses of environmental impact, environmental

measures suggestions and environmental protection investment estimation etc.

1.3 Environmental impact identification and evaluation factor screening

Based on the features of pollution of this project, environmental impact evaluation factors of all evaluation elements are listed in Table 1.3-1.

Table 1.3-1 Summary table of environmental impact evaluation factors

Evaluation stage	Evaluation item		Current situation evaluation	Unit	Prediction evaluation	Unit
Construction period	Acoustic environment		Day, night equivalent sound level, LAeq	dB (A)	Day, night equivalent sound level, LAeq, sound pressure level A	dB (A)
	Vibration environment		Z vibration level in vertical direction, VLz10	dB	Z vibration level in vertical direction, VLz10	dB
	Surface water environment		pH, SS, COD, BOD5, oil	mg/L (pH excluded)	pH, SS, COD, BOD5, oil	mg/L (pH excluded)
	Ground water environment		Total hardness, sulphate, chloride, CODMn, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen	mg/L	Total hardness, sulphate, chloride, CODMn, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen	mg/L
	Atmospheric environment		PM10	mg/m³	PM10	mg/m³
Operation period	Acoustic environment		Day, night equivalent sound level, LAeq	dB	Day, night equivalent sound level, LAeq, sound pressure level A	dB
	Vibration environment		Z vibration level in vertical direction, VLz	dB	Z vibration level in vertical direction, VLz10, VLzmax	dB
					Indoor structural noise	dB (A)
					Vibration velocity	mm/s
	Electromagnetic environment		Power frequency electric field, power frequency magnetic induction, television signal strength	V/m, mT, 0.5MHzdB	Power frequency electric field, power frequency magnetic induction, television signal strength	V/m, mT, 0.5MHzdB
	Water environment	Surface water	pH, SS, COD, BOD5, oil	mg/L	Production wastewater: pH, SS, COD, BOD5, oil, LAS Domestic sewage: pH, SS, COD, BOD5, animal and vegetable oils, ammonia nitrogen	mg/L
		Ground water	pH, total hardness, chloride, nitrate, sulphate	mg/L	pH, total hardness, chloride, nitrate, sulphate	mg/L
	Atmospheric environment		Smoke and dust, SO2, NOx, PM10	mg/m³	Smoke and dust, SO2, NOx, PM10	mg/m³

1.4The focus of evaluation

1.4.1 Key evaluation subjects

The key evaluation subjects includes acoustic environment, vibration environment, urban

ecology, water environment and social impact evaluation, material and cultural resources impact evaluation, cumulative impact evaluation, alternative solution, environmental risk analysis, ESMP and public participation etc.

1.4.2 Focus of evaluation of each subject

The assessment focuses of all subjects within the range of assessment are described as below:

1.4.2.1 Focus of acoustic environmental impact assessment：

schools, hospitals and residents concentrated areas within the range of evaluation.

1.4.2.2 Focus of vibration environmental impact assessment：

historical and cultural sites under government protection, residential buildings, schools and hospitals etc along the project route.

1.4.2.3 Focus of water environmental impact assessment：

There are no surfacewater drink water source protection area and groundwater drink water source protection area near the project, sewage of this project is involved in the rationality and feasibility evaluation of municipal drainage facility.

1.4.2.4 Focus of electromagnetic environmental impact analysis：

Take the car depot and substations as the key areas of evaluation, and the focuses are impact of electromagnetic radiation generated by train movement on televiewing of residents around the ground section, Car depot and impact of power frequency electricity and magnetic field generated by main transformer station on surrounding electromagnetic environment.

1.4.2.5 Focus of ambient air impact analysis:

During construction period, the key areas for assessment are stations and car depot and the focus of assessment is analysis on impact of fugitive dust caused by construction; during operation period, the key areas for assessment are station ventilation systems and the focus of evaluation is analysis on impact of exhaust emission of this project and foreign flavor of air exhaust of ventilation systems.

1.4.2.6 Focus of solid waste assessment:

The key areas for assessment are stations and car depot and the focuses of assessment are spoils generated during construction period and domestic garbage of the staffs and passengers and domestic waste generated in comprehensive base during operation period.

1.4.2.7Focus of urban ecology assessment:

The key areas for assessment are areas influenced by surface structures including station entrance-exits, ventilation system, car depot, comprehensive base and main transformer stations;

The focuses of assessment during construction period are land occupation of the project and compatibility between the project and city planning; analysis on harmony urban landscape of surface structures including station entrance-exits and ventilation system etc; impact of the project on ecology-sensitive target.

1.4.2.8Focus of social impact assessment:

The focuses of assessment are impact of open-cut stations and semi-cover-and-cut stations on traffic, economic income of merchants around the station and residents' life, and impact of land occupation of the project on residents' income.

1.4.2.9 Focus of cumulative impact assessment:

The focuses of assessment are cumulative effect of traffic, noise, vibration, land use, ecology, environment, air and social influence.

1.4.2.10 Focus of alternative solution assessment:

The focuses of assessment are comparison of different line schemes and station schemes and comparison of different construction methods of line sections and stations.

1.4.2.11 Focus of environmental risk assessment:

The focuses of assessment are collapse and land subsidence accidents during construction period and fire, terrorist attack and machinery accidents etc during operation.

1.5 Environmental impact assessment team

The consultant team of this environmental impact assessment is mainly constituted by specially invited experts and experienced persons with work license for environmental impact assessment. Basic information of team members are listed in Table 1.5-1.

Table 1.5-1 Staffing table of environmental impact assessment for Zhengzhou rail transit line 3

Table 1.5-1 Staffing table of environmental impact assessment for Zhengzhou rail transit line 3

Serial No.	Name	Title	Specialty	Occupational qualifications	Subject
1	Yang Jianjun	Senior engineer	Environmental consultants	Environmental expert consultants	Specially invited senior consultant for environmental problems, environmental impact assessment summary
2	Cai Zhizhou	Researcher	Environmental engineering	Certified EIA engineer	Chief engineer
3	Yu Chenyu	Senior engineer	Environmental engineering	Certified EIA engineer	Project manager General remarks, line network and construction planning overview, regional environmental status investigation, analysis and assessment, environmental impact factors analysis and screening, implementation summary, analysis of planning coordination
4	Fu Zhengjun	Research associate	Environmental engineering	Certified EIA engineer	Project assistant manager analysis on Ecological environment、Public participation,、analysis on Social environment、analysis on Cumulative Impact
5	Zhang Yao	Research associate	Environmental engineering	Certified EIA engineer	analysis on EHS，analysis on ESMP、total quality control,、relocation and resettlement of residents
6	Zhang Jinfang	Assistant engineer	Environmental resource	/	vibration environmental impact analysis, ANALYSIS OF ALTERNATIVE SCHEMES、analysis on Social environment
7	Han Yanlai	Research associate	Prevention of noise and vibration	Work license for environmental impact assessment	Acoustic environmental analysis
8	Wang Yuhui	Research associate	Environmental engineering	Work license for environmental impact assessment	Electromagnetic environmental impact analysis、public participation
9	Zhang Tingliang	Assistant engineer	Environmental resource	/	analysis on water environment、analysis on EHS、analysis on Ambient air、analysis on Solid waste

1.6Train of thought and method of EIA

1.6.1 Train of thought of EIA

EIA of Zhengzhou Rail Transit Line 3 Project takes “environmental protection, people first” as the guiding ideology; through investigation on basic information including social environmental conditions, natural environmental conditions and sensitive targets, function regionalization etc, focuses on assessment of social environment, natural environment (vibration environment and acoustic environment etc), material and cultural resources; carries out analysis and predict evaluation for environmental impact caused by project construction during construction period and operation according to different environmental elements; carries out selective analysis for cumulative impact, alternative solution, risk etc generated from the project; meanwhile, analyzes environmental protection measures put forward in the project design according to relevant laws and regulations, standards and planning stipulated by the World Bank, in China, HenanProvince and Zhengzhou City, and puts forward feasible and reasonable control

measures for project activities failed to meet environmental protection requirements; provides suggestions from the point of environmental protection for schemes undetermined in the design; promptly submit assessment conclusion and suggestions to design unit, construction unit and corresponding planning department, so as to minimize the adverse impact of project construction on environment. Furthermore, based on the World Bank Project features, pay more attention to cumulative impact analysis, social impact analysis, material and cultural resources impact analysis alternative solution analysis, public participation analysis and ESMP management plan.

1.6.2 Operating methods

1. Field survey and data collection: based on the feasibility study data of this project, combining the residents relocation and resettlement report, carry out field survey for the project and for social environment and environment-sensitive targets within the affected area of the project; communicate with corresponding competent authorities and non-government organizations based on conditions of the project and collect relevant basic information.

2. Project coordination: based on conditions of the project and relevant requirements of the World Bank, promptly provide feedback to the owner on project relating problems and relevant environmental protection problems which requires governmental coordination and assist the owner to solve them.

3. Public participation: investigate the opinions and suggestions of design unit, government departments and relevant non-government organizations on project construction; through field questionnaire survey, putting up notices in communities, publicizing via internet and media, symposiums with public participation, and return visit on public's opinion, invite the public's opinion and suggestions.

4. Compilation of report: organize project personnel to compile environmental impact report according to laws and regulations and technical methods of the World Bank and China relevant to environmental impact assessment.

5. Report reviewing and submitting for approval: prepare the EIA report, ESMP and EIA summary based on the World Bank's requirements; the World Bank organizes experts to review, and if requirements met, the executive director of the World Bank will give official reply.

1.7 Types and grades of assessment

1.7.1 Acoustic environment and vibration environment assessment grades

This project belongs to large-scale newly-built municipal project, and the location of it is classified as class 1, 4a of Zhengzhou acoustic environment function zones, after completion of the project, impact of the noise around underground station ventilation system and cooling tower and at the car depot increased apparently (most of the increments are larger than 5dBA); according to grading principle stipulated in HJ2.4-2009 Technical Guidelines for Noise Impact Assessment and HJ453-2008 Technical Guidelines for Environment Impact Assessment of Urban Rail Transit, the acoustic environmental impact assessment is carried out as grade 1.

The entire line of this project is underground line, before putting into operation, most variable quantities of vibration level of sensitive building within the range of assessment are higher than 5dB; according to grading principle stipulated in HJ453-2008 Technical Guidelines for Environment Impact Assessment of Urban Rail Transit, the vibration environmental impact assessment is carried out as grade 1, and the vibration status monitoring and prediction cover all vibration environment sensitive sites.

1.7.2 Water environment assessment grade

The project will produce sewage discharge volume during the operation period,but a little, the depot Day displacement is the Maximum volume of effluent discharge,but smaller than 1000 m3/d, Sewage nature are mainly domestic sewage and washing waste，which belong to non-persistent pollutants, number of water quality parameters that require concentration prediction is less than 7, therefore, the complexity degree of water quality of sewage is “simple”, and all sewage can be carried out with centralized treatment in municipal sewage plant. According to stipulations in HT/J2.3-93 Technical Guidelines for Environmental Impact Assessment Surface Water Environment and Technical Guidelines for Environment Impact Assessment of Urban Rail Transit (HJ453-2008),the surface water environment assessment grade is grade 3.

1.7.3 Air environment assessment grade

Since the trains of this project apply electric power motor train unit, there is no locomotive exhaust emission; while the exhaust emission of the car depot is also quite little, thus only the off-flavor of exhaust emission of underground stations ventilation systems that has certain influence on living environment of the surrounding residents; according to stipulations in Guidelines for Environmental Impact Assessment · Atmospheric Environment (HJ2.2-2008) and Technical Guidelines for

Environment Impact Assessment of Urban Rail Transit (HJ453-2008), it's no need to determine grade of the air environment assessment, and only air environmental impact analysis needs to be carried out.

1.7.4 Urban ecology assessment grade

Within the scope of the project site are the Urban built-up areas and plan to be developed Urban development integration areas, which mainly is the urban ecosystem.，the line length of this project is shorter than 50km, the effects ranged from 20 km2～2km2；there is no important ecological preservation area involved, therefore, according to Technical Guideline for Environmental Impact Assessment · Ecological Impact and Technical Guidelines for Environment Impact Assessment of Urban Rail Transit (HJ453-2008),,the ecologic environmental impact assessment is determined as grade 3.

1.8 Project study and range of assessment

The range of project study involved in this assessment is main line of Line 2 project of Zhengzhou subway, stations, Car depot and the entrance-exit depot line, substations etc. The ranges of assessment of each subject are described as bellow.

1.8.1 Range of acoustic environment assessment

The range of acoustic environment assessment is the area within 50m around ventilation system of underground stations, cooling tower and main transformer station, the area within 200m outside of the the car depot and car parking.

1.8.2 Range of vibration environment assessment

the transverse range of vibration environment assessment is the area within 60m on both sides of outer rail center line; the range of noise impact assessment of indoor secondary structure noise is from vertically above the tunnel to the area within 10m from both sides of the center line of the outer rail.

1.8.3 Range of water environment assessment

Range of surface water environment assessment: sewage outlet of the stations, the car deport and the main transformer station within the range of project design,and the range that may be affected.

Range of ground water environment assessment: According to the thematic reports of the groundwater, range of ground water environment assessment is a complete

hydrogeological units,therefore, the range of ground water environment assessment is Zhengzhou,the area is 1013.3km2.（not include the Shangjie District）.

According to Technical Guidelines for Environment Impact Assessment of Urban Rail Transit (HJ453-2008), the range of ground water environment assessment is 300m away from the outer rail on both sides of the center line.

1.8.4 Range of ambient air assessment

Based on the range of influence of off-flavor gas emitted by the ventilation systems, the range of assessment of this subject is determined as the area within 50m around the ventilation systems.

1.8.5 Range of electromagnetic environment assessment

The area within 50m on both sides of the ground segment lines and 50m around the Car depot, and the range of assessment of newly-built main transformer station is the area within 50m outside the substation fence.

1.8.6 Range of solid waste assessment

Spoil generated during construction period and domestic waste and garbage of stations, car depots and comprehensive bases along the line.

1.8.7 Range of urban ecological environment

The project will all be underground line ,so there have small perturbation to the local ecological environment。In accordance with the practical situation of the project and the environment characteristics of the location of the project, the vertical range of assessment is planned to be same with the scope of design, and the horizontal range is to comprehensively take the attract range of the requested project and the land use planning of both sides of the line, and within the area of 100m outside the boundary of the parking lots and the temporary ground. During assessment, the range of assessment for factors including urban landscape, traffic and social economy etc is expanded to the area on which the project may cause obvious effect.

1.9. Environmental Protection Objectives

The project will proceed mainly along the city's main thoroughfare, with part of its sections being beneath residential areas. Both sides of Line 3 have a great number of residential buildings, schools, office buildings and other buildings, which will be more

sensitive to the vibration generated by the project. By way of shield method construction, the project will go beneath the Jinshui River, Xiong'er River, Qili River, Chao River and other rivers. The project will not involve nature reserves, scenic spots, forest parks and other ecologically sensitive areas.

The site investigation will be carried out based on the design documents. This project will involve an ecological environment and urban landscape, an acoustic environment and vibration-related environmental protection objects. See Table 1.9-1 to Table 1.9-3. The whole line of the Phase-1 project will set up a car depot, which will be away from a village. Within the scope of protection of electromagnetic radiation, there will be no sensitive points.

Table 1.9-1 The ecological environment and urban landscape protection targets

SN	Protection goals	The position relationship diagram	scope	function	influence
1	Jialu river	The north of Jialu River parking lot	River width is 50m	Ⅳwater bady	
2	Jinshui river	K8+513~573 Tunnel Underpass	River width is 50m	Ⅳwater bady	River water may can affect groundwater quality
3	Xionger river	K12+900~942 Tunnel Underpass	River width is 20m	Ⅳwater bady	
4	Qili river	K17+220~340Tunnel Underpass	River width is 50m	Ⅳwater bady	
5	Chao river	Car depot Tunnel Underpass	River width is 10m	Ⅳwater bady	
6	Ecological Greenbelt	Seize the Urban road green belts on both sides	The gateway , wind pavilion,coolingof the 21 sation,and car depot ,main substation	Urban green belts and planning of ecological green space	The ground excavation of station ,car depot and main substation

Table1.9-2 List of acoustic environment sensitive targets

Sensitive point number	Station	Wind Pavilion (cooling tower) number or car depot name	Wind Pavilion cooling tower or car depot location	Mileage	Sensitive point Name	Distance (m)				mplementation standards	picture
						Exhaust wind pavilion	New wind pavilion	The piston wind pavilion	The cooling tower		
1	Xinliu Road Station	West Wind Pavilion	Northwest side of the intersection of Sanqun Road and Changxing Road	K0+090~ K0+100	Building 1 of Yuhua ninth city	30	30	30	/	Class 1	
2	Shamen Road Station	North wind Pavilion, cooling tower	North side of northwest exit, Shamen Road Station, west side of Changxing Road	K1 +436 ~ K1 +460	Hualian family member courtyard's, Buildings 3	26	26	26	30	Class 1	
3	Shamen Road Station	North wind Pavilion, cooling tower	North side of northwest exit, Shamen Road Station, west side of Changxing Road	K1 +436 ~ K1 +460	Hualian family member courtyard's, Buildings 4	23	25	20	26	Class 4a	
4	Shamen Road Station	North wind Pavilion, cooling tower	North side of northwest exit, Shamen Road Station, west side of Changxing Road	K1 +436 ~ K1 +460	Hualian family member courtyard's, Buildings 5	20	19	23	16	Class 4a	
5	Shamen Road Station	South wind Pavilion,	North side of southwest exit, Shamen Road Station, west side of Changxing Road	K1+615~ K1+650	Cityorth Shore District, 1 #building	33	33	33	/	Class 4a	
6	Shamen Road Station	South wind Pavilion,	North side of southwest exit, Shamen Road Station, west side of Changxing Road	K1+615~ K1+650	Cityorth Shore District, 4 #building	16	19	13	/	Class1	
7	Xinglongpu Road Station	North wind Pavilion,	West side of Northwest exit, Xinglongpu Road Station	K2+787～ K2+803	City bus company, family member courtyard 2#	26	23	31	/	Class 4a	
8	Xinglongpu Road Station	South wind Pavilion, cooling tower	West side of Southwest exit, Xinglongpu Road Station	K3+070～ K3+090	Projects under construction (Chang Jian.Yufeng)	48	48	48	40	Class1	
9	Dongfeng Road Station	North wind Pavilion,	North side of Northwest exit, Dongfeng Road Station, west side of Nanyang Road	K4+405～ K4+425	Nanyang Road, No. 219 Courtyard6# Building	14	18	1	/	Class 4a	
10	Dongfeng Road Station	North wind Pavilion,	North side of Northwest exit, Dongfeng Road Station, west side of Nanyang Road	K4+405～ K4+425	Nanyang Road, No. 219 Courtyard4# Building	26	30	15	/	Class1	
11	Dongfeng Road Station	North wind Pavilion,	North side of Northwest exit, Dongfeng Road Station, west side of Nanyang Road	K4+405～ K4+425	Sunshine Holiday district, 3 #Building	6	6	6	/	Class1	

Sensitive point number	Station	Wind Pavilion (cooling tower) number or car depot name	Wind Pavilion cooling tower or car depot location	Mileage	Sensitive point Name	Distance (m)				mplementation standards	picture
						Exhaust wind pavilion	New wind pavilion	The piston wind pavilion	The cooling tower		
12	Dongfeng Road Station	North wind Pavilion,	North side of Northwest exit, Dongfeng Road Station, west side of Nanyang Road	K4+405～K4+425	Sunshine Holiday district, 2#Building	17	14	21	/	Class 4a	
13	Dongfeng Road Station	South wind Pavilion, cooling tower	South side of Southeast exit, Dongfeng Road Station, east side of Nanyang Road	K4+600～K4+637	Fun district, Southern District, fun district building 46#	30	25	39	16	Class1	
14	Dongfeng Road Station	South wind Pavilion, cooling tower	South side of Southeast exit, Dongfeng Road Station, east side of Nanyang Road	K4+600～K4+637	Fun district, Southern District, fun district building 61#	28	23	31	23	Class1	
15	Dongfeng Road Station	South wind Pavilion, cooling tower	South side of Southeast exit, Dongfeng Road Station, east side of Nanyang Road	K4+600～K4+637	Liangji, family member courtyard 2	28	28	28	35	Class1	
16	Agricultural Road Station	Northwest wind Pavilion,	Northwest exit of Dongfeng Road and Agricultural Road	K5+640～K5+660	Xincun home district, 3# Building	31	35	20	/	Class1	
17	Agricultural Road Station	Northwest wind Pavilion,	Northwest exit of Dongfeng Road and Agricultural Road	K5+640～K5+660	Ronghua home district,2#Building	12	12	12	/	Class1	
18	Agricultural Road Station	Northwest wind Pavilion,	Northwest exit of Dongfeng Road and Agricultural Road	K5+640～K5+660	Ronghua home district, 3#Building	25	21	29	/	Class1	
19	Agricultural Road Station	Southwest wind Pavilion, cooling tower	South side of Southeast exit, Agricultural Road Station	K5+816～K5+836	Small Yuzhai (Nanyang Road courtyard 266) 3 #, 5 # Building	21	15	26	16	Class 4a	
20	Agricultural Road Station	Southwest wind Pavilion, cooling tower	South side of Southeast exit, Agricultural Road Station	K5+843～K5+878	Transport company family member courtyard, (Nanyang Road No. 268 courtyard), 1 # Building	21	26	10	19	Class 4a	
21	Huanghe Road Station	North wind Pavilion, cooling tower	East side of Northeast exit, Huanghe Road Station	K7+000～K7+030	Zhengzhou Textile staff apartments, 29 # Building	4	1	9	1	Class 4a	
22	Huanghe Road Station	North wind Pavilion, cooling tower	East side of Northeast exit, Huanghe Road Station	K7+000～K7+030	Zhengzhou Textile staff apartments, 30# Building	12	16	4	25	Class 4a	

Sensitive point number	Station	Wind Pavilion (cooling tower) number or car depot name	Wind Pavilion cooling tower or car depot location	Mileage	Sensitive point Name	Distance (m)				mplementation standards	picture
						Exhaust wind pavilion	New wind pavilion	The piston wind pavilion	The cooling tower		
23	Huanghe Road Station	North wind Pavilion, cooling tower	East side of Northeast exit, Huanghe Road Station	K7+000～K7+030	Zhengzhou Textile staff apartments, 18# Building	16	16	16	11	Class 1	
24	Huanghe Road Station	North wind Pavilion, cooling tower	East side of Northeast exit, Huanghe Road Station	K7+000～K7+030	Zhengzhou Textile staff apartments, 19# Building	38	34	42	19	Class 1	
25	Huanghe Road Station	Northwest wind Pavilion	South side of Southwest exit, Huanghe Road Station	K7+240～K7+320	Garden community, 5 # building	13	11	18	/	Class 1	
26	Huanghe Road Station	Northwest wind Pavilion	South side of Southwest exit, Huanghe Road Station	K7+240～K7+320	Garden community, 6#building	37	32	42	/	Class 1	
27	Jinshui Road Station	Northeast wind Pavilion, cooling tower	East side of Northeast exit, Jinshui Road Station, east side of Nanyang Road	K8+200～K8+330	Film Bureau, family member courtyard, 6#	22	25	10	15	Class 4a	
28	Jinshui Road Station	Northeast wind Pavilion, cooling tower	East side of Northeast exit, Jinshui Road Station, east side of Nanyang Road	K8+200～K8+330	Film Bureau, family member courtyard, 5 #	45	45	45	35	Class 1	
29	Jinshui Road Station	Northeast wind Pavilion, cooling tower	East side of Northeast exit, Jinshui Road Station, east side of Nanyang Road	K8+200～K8+330	Zhengzhou City Library	32	29	41	31	Class 1	
30	Jinshui Road Station	Southeast wind Pavilion,	South side of Northeast exit, Jinshui Road Station, east side of Nanyang Road	K8+400～K8+420	Downtown Community Phase II 1# building	31	31	31	/	Class 1	
31	Jinshui Road Station	Southwest wind Pavilion	West side of Northwest exit, Jinshui Road Station, west side of Nanyang Road	K8+400～K8+420	Zhengzhou National Oil Reserve Depot, family member courtyard 1 # building	39	37	45	/	Class 1	
32	Taikang Road Station	North wind Pavilion, cooling tower	West side of Southwest exit, Taikang Road Station	K9+275～K9+315	West Cai district, (Ming Gong Road, No. 240 Courtyard), 2 #, 3 # Building	44	40	48	27	Class 4a	
33	Taikang Road Station	North wind Pavilion, cooling tower	West side of Southwest exit, Taikang Road Station	K9+340～K9+375	Courtyard No. 85 West Front Street, 1 #,2# Building (Ming Gong Road, No. 245 Courtyard)	20	17	24	4	Class 4a	

Sensitive point number	Station	Wind Pavilion (cooling tower) number or car depot name	Wind Pavilion cooling tower or car depot location	Mileage	Sensitive point Name	Distance (m)				mplementation standards	picture
						Exhaust wind pavilion	New wind pavilion	The piston wind pavilion	The cooling tower		
34	Erqi square Station	Northwest wind Pavilion	East side of Northwest exit, Erqi square Station, west side of Minzhu Road	K9+890～K9+980	Huigang New Town 3 # Building	21	25	10	/	Class 1	
35	Erqi square Station	Northwest wind Pavilion	East side of Northwest exit, Erqi square Station, west side of Minzhu Road	K10+010～K10+020	Small building mosques	41	41	41	/	Class 4a	
36	Shunchengjie Station	Southeast wind Pavilion, cooling tower	East side of Northeast exit, Shunchengjie Station	K10+915～K10+990	Hongxin Jia Yuan 1 # building	35	32	39	32	Class 4a	
37	Shunchengjie Station	Southeast wind Pavilion, cooling tower	East side of Northeast exit, Shunchengjie Station	K11+070～K11+151	Xidan apartments, 3# buildings	36	36	36	26	Class 4a	
38	Shunchengjie Station	Southeast wind Pavilion, cooling tower	East side of Northeast exit, Shunchengjie Station	K11+070～K11+151	Xidan apartments, 1# buildings	41	46	30	39	Class 4a	
39	Dongdajie Station	Southeast wind Pavilion, cooling tower	East side of Dongdajie Station,South side of Dongdajie road	K11+978～K12+105	220 East Main Street	/	/	/	5	Class 4a	
40	Dongdajie Station	Southeast wind Pavilion, cooling tower	East side of Dongdajie Station,South side of Dongdajie road	K12+110～K12+200	248 East Main Street	/	/	/	5	Class 4a	
41	Chengdong Road Station	Northwest wind Pavilion, cooling tower	Northwest exit of Chengdong Road Station, North side of Dongdajie road	K12+600～K12+650	Shangcheng Garden 1# building	60	56	53	43	Class 1	
42	Chengdong Road Station	Northeast wind Pavilion	Northeast exit of Chengdong Road Station, North side of Dongdajie road	K12+716～K12+830	Dongguandongli 96# Yard 1# building	29	32	16	/	Class 4a	
43	Chengdong Road Station	Northeast wind Pavilion	Northeast exit of Chengdong Road Station, North side of Dongdajie road	K12+716～K12+830	Dongguandongli 96# Yard 2#building	28	32	16	/	Class 1	
44	Chengdong Road Station	Northeast wind Pavilion	Northeast exit of Chengdong Road Station, North side of Dongdajie road	K12+716～K12+830	Dongguandongli 96# Yard,6# building	37	39	28	/	Class 1	

Table 1.9-3 List of vibration environment sensitive targets

SN	Target Name	Mileage	Location	Section Name	The recent distance（m）	Target Name（m）	Information of the building					executive standard	the road crossed by and red line width of the road（m）	picture
							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
1	New Hope Ao Garden, 17 #, 3 #	K0-195~ K0-472	Right	Parking lot traction line	47	14.5	House	8 floors，mixed structure		-3	about 112 househlds	Both sides of the main traffic road	Changxing road，45m	
2	Fuwa beauty area, Building 3, Building 1,	K0+843～K0+921	Left	Xinliu Road-Shamen Road Station Section	18	19.6	House	5 floors，mixed structure		-3	about 40 househlds	Both sides of the main traffic road	Changxing road，45m	
3	Taili community, Building 1,	K0+940～K0+968	Left	Xinliu Road-Shamen Road Station Section	16	19	House	19 floors，Frame structure		-10	about 171 househlds	Both sides of the main traffic road	Changxing road，45m	
4	Hongda district, 11 #, 10 #, 9 #, 5 # Buildinsg	K0+986～K1+100	Left	Xinliu Road-Shamen Road Station Section	18	18.8	House	6 floors，mixed structure	II	-3	about 144 househlds	Both sides of the main traffic road	Changxing road，45m	
5	Huiji District, Changxing Road, Street office	K1+454～K1+537	Left	Xinliu Road-Shamen Road Station Section	30	14.3	institution	4~5 floors，mixed structure	II	-3	Street agency	Both sides of the main traffic road	Changxing road，45m	
6	Changxing Road, No. 2 Courtyard	K1+476～K1+539	Left	Xinliu Road-Shamen Road Station Section	38	14.3	House	7 floors，mixed structure		-3	about 140 househlds	Both sides of the main traffic road	Changxing road，45m	
7	Yuhua ninth city, Building 1 #~ 3 #	K0+100～K0+280	Right	Xinliu Road-Shamen Road Station Section	46	14.5	House	25 floors，mixed structur		-10	about 1475 househlds e	Both sides of the main traffic road	Changxing road，45m	
8	Angel Kindergarten	K0+310～K0+320	Right	Xinliu Road-Shamen Road Station Section	18	14.4	House	2～3 floors，mixed structure		-3	About 200 pepl	Both sides of the main traffic road	Changxing road，45m	
9	Sanquan Food Co., Ltd., staff quarters	K0+644～K0+670	Right	Xinliu Road-Shamen Road Station Section	20	17.2	House	--	III	0	about 42 househlds	Both sides of the main traffic road	Changxing road，45m	
10	ChengHuang 5-rings Mansion	K1+010～K1+030	Right	Xinliu Road-Shamen Road Station Section	25	19.2	institution	10 floors，Frame structure	I	-10		Both sides of the main traffic road	Changxing road，45m	
11	Hualian family member courtyard, Buildings 2, 4, 5,	K1+362～K1+450	Right	Xinliu Road-Shamen Road Station Section	23	17	House	7 floors，mixed structure		-3	about 252 househlds	Both sides of the main traffic road	Changxing road，45m	

SN	Target Name	Mileage	Location	Section Name	The recent distance（m）	Target Name（m）	Information of the building					executive standard	the road crossed by and red line width of the road（m）	picture
							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
12	Cityorth Shore District, 1 # building	K1+450～K1+540	Right	Xinliu Road-Shamen Road Station Section	18	14.5	House	6 floors，mixed structure		-3	about 60 househlds	Both sides of the main traffic road	Changxing road，45m	
13	Phosphate fertilizer factory family member courtyard, 1 #, 2 #,6#,7# Buildings	K1+587～K1+700	Left	Shamen Road-Xinglongpu Road Station Section	17	14.7	House	6 floors，mixed structure		-3	about 190 househlds	Both sides of the main traffic road	Changxing road，45m	
14	Phosphate fertilizer factory family member courtyard, 1 #, 2 # Buildings	K2+411 ～ K2+440	Left	Shamen Road-Xinglongpu Road Station Section	17	21.6	House	6 floors，mixed structure		-3	about 72 househlds	Both sides of the main traffic road	Nanyang road，60m	
15	Huiji District’s office building of Land and Resources	K2+444～K2+495	Left	Shamen Road-Xinglongpu Road Station Section	5	21.4	institution	7 floors，mixed structure		-3	----	Both sides of the main traffic road	Nanyang road，60m	
16	Peaceful residential homes, Building 8,	K2+600～K2+619	Left	Shamen Road-Xinglongpu Road Station Section	9	18.4	House	22 floors，Frame structure	I	-10	about 132 househlds	Both sides of the main traffic road	Nanyang road，60m	
17	RCC family member courtyard (Gadameilin district)	K2+623～K2+663	Left	Shamen Road-Xinglongpu Road Station Section	0	16.0	House	17 floors，Frame structure	I	-10	about 324 househlds	Both sides of the main traffic road	Nanyang road，60m	
18	CR City Concert (Xinyu Garden) district ,1 #, 5 # Buildings	K2+800～K2+900	Left	Shamen Road-Xinglongpu Road Station Section	9	16.0	House	6 floors，mixed structure		-3	about 40 househlds	Both sides of the main traffic road	Nanyang road，60m	
19	Changxing Building	K1+650 ～ K1+790	Right	Shamen Road-Xinglongpu Road Station Section	32	16.0	House	7 floors，mixed structure		-3	about 60 househlds	Both sides of the main traffic road	Changxing road，45m	
20	Huiji District, Tumor Courtyard of Traditional Chinese Medicine	K1+801 ～ K1+871	Right	Shamen Road-Xinglongpu Road Station Section	29	17.4	Hospital	6 floors，mixed structure		-3	--	Both sides of the main traffic road	Changxing road，45m	
21	City bus company, family member courtyard	K2+800 ～ K2+910	Right	Shamen Road-Xinglongpu Road Station Section	15	14.5	House	7 floors，mixed structure		-3	about 154 househlds	Both sides of the main traffic road	Nanyang road，60m	
22	Zhongji urban spring	K3+080 ～ K3+140	Left	Xinglongpu Road-Dongfeng Road Station Section	33	14.0	House	13 floors，Frame structure	I	-10	--	Both sides of the main traffic road	Nanyang road，60m	
23	Jianye Yihao Chengbang District, 1 #, 7 #, 8 # Building	K3+144 ～ K3+266	Left	Xinglongpu Road-Dongfeng Road Station Section	33	14.0	House	5～13 floors，Frame	I	-10	about 234 househlds	Both sides of the main traffic road	Nanyang road，60m	

SN	Target Name	Mileage	Location	Section Name	The recent distance（m）	Target Name（m）	Information of the building					executive standard	the road crossed by and red line width of the road（m）	picture
							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
								structure						
24	National Food Authority's Zhengzhou Institute of Science and family member courtyard	K03+280 ～ K03+550	Left	Xinglongpu Road-Dongfeng Road Station Section	15	16.2	Research institutes	3～6 floors，mixed structure		-3		Both sides of the main traffic road	Nanyang road，60m	
24	National Food Authority's Zhengzhou Institute of Science and family member courtyard	K03+280 ～ K03+550	Left	Xinglongpu Road-Dongfeng Road Station Section	14	16.7	House	5～7 floors，mixed structure		-3	about 48 households	Both sides of the main traffic road	Nanyang road，60m	
25	Tianxiu home district, 1 # ~ 4 # Building	K3+610 ～ K3+723	Left	Xinglongpu Road-Dongfeng Road Station Section	16	19.2	House	7 floors，mixed structure		-3	about 140 households	Both sides of the main traffic road	Nanyang road，60m	
26	Zhengzhou Oriental Tumor Courtyard	K3+730 ～ K3+784	Left	Xinglongpu Road-Dongfeng Road Station Section	15	19.8	Hospital	5 floors，mixed structure		-3	--	Both sides of the main traffic road	Nanyang road，60m	
27	ICBC family member building	K3+957 ～ K3+990	Left	Xinglongpu Road-Dongfeng Road Station Section	11	20.2	House	5 floors，mixed structure		-3	about 20 households	Both sides of the main traffic road	Nanyang road，60m	
28	Zhang Zhaicun	K4+000 ～ K4+213	Left	Xinglongpu Road-Dongfeng Road Station Section	17	18.8	House	2～7 floors，mixed structure		-3	about 320 households	Both sides of the main traffic road	Nanyang road，60m	
29	Fun district, 1 #, 2 #, 3 #, 4 #, 5 # Building	K4+291 ～ K4+463	Left	Xinglongpu Road-Dongfeng Road Station Section	11	14.9	House	6～7 floors，mixed structure		-3	about 140 households	Both sides of the main traffic road	Nanyang road，60m	
29	Fun district, 6 # - 11 # building	K4+291 ～ K4+463	Left	Xinglongpu Road-Dongfeng Road Station Section	28	14.9	House	6 floors，mixed structure		-3	about 48 households	The mixed zone	Nanyang road，60m	
30	Projects under construction (Chang Jian.Yufeng)	K2+940 ～ K3+170	Right	Xinglongpu Road-Dongfeng Road Station Section	50	14.0	House	17 floors，Frame structure		-10	about 136 households	The mixed zone	Nanyang road，60m	
31	Grain transport community, Building 9, Building 10	K3+200 ～ K3+328	Right	Xinglongpu Road-Dongfeng Road Station Section	11	14.8	House	6 floors，mixed structure		-3	about 126 households	Both sides of the main traffic road	Nanyang road，60m	
31	Grain transport community, 3 #~ 8 # Building	K3+200 ～ K3+328	Right	Xinglongpu Road-Dongfeng Road Station Section	23	14.8	House	4 floors，mixed structure		-3	about 144 households	The mixed zone	Nanyang road，60m	

SN	Target Name	Mileage	Location	Section Name	The recent distance（m）	Target Name（m）	Information of the building					executive standard	the road crossed by and red line width of the road（m）	picture
							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
32	Huiji District's Board of Education family member building	K3+611 ～ K3+621	Right	Xinglongpu Road-Dongfeng Road Station Section	13	19.2	House	7 floors，mixed structure		-3	about 42 househlds	Both sides of the main traffic road	Nanyang road，60m	
33	Yuhua Wen Hui Garden District, Building 1 to 5	K3+635 ～ K3+773	Right	Xinglongpu Road-Dongfeng Road Station Section	16	19.5	House	7 floors，mixed structure		-3	about 252 househlds	Both sides of the main traffic road	Nanyang road，60m	
34	Yuhua Wen Qing Garden District Building 1 to 4	K3+917 ～ K4+049	Right	Xinglongpu Road-Dongfeng Road Station Section	13	20.2	House	7 floors，mixed structure		-3	about 30 househlds	Both sides of the main traffic road	Nanyang road，60m	
35	City Brewery, family member courtyard north courtyard Building 25,	K4+056 ～ K4+120	Right	Xinglongpu Road-Dongfeng Road Station Section	18	20.1	House	6 floors，mixed structure		-3	about 24 househlds	Both sides of the main traffic road	Nanyang road，60m	
36	Yaxin good times area, 3 to 4 Building	K4+129 ～ K4+211	Right	Xinglongpu Road-Dongfeng Road Station Section	13	18.8	House	6～8 floors，mixed structure		-3	about 116 househlds	Both sides of the main traffic road	Nanyang road，60m	
37	Chuangye Homes	K4+217 ～ K4+277	Right	Xinglongpu Road-Dongfeng Road Station Section	9	16.8	House	7 floors，mixed structure		-3	about 336 househlds	Both sides of the main traffic road	Nanyang road，60m	
38	Sunshine Holiday district, 1 #, 2 # Building	K4+286 ～ K4+500	Right	Xinglongpu Road-Dongfeng Road Station Section	10	14.9	House	7 floors，mixed structure		-3	about 80 househlds	Both sides of the main traffic road	Nanyang road，60m	
38	Sunshine Holiday district Building 3# ~ 9 #	K4+286 ～ K4+500	Right	Xinglongpu Road-Dongfeng Road Station Section	30	14.9	House	7 floors，mixed structure		-3	about 294 househlds	The mixed zone	Nanyang road，60m	
39	Nanyang Road, No. 111 Courtyard	K4+529 ～ K4+558	Left	Dongfeng Road-Agricultural Road Station Section	6	14.5	House	6 floors，mixed structure		-3	about 53 househlds	Both sides of the main traffic road	Nanyang road，60m	
39	Fun district, Southern District, fun district building 46, 61	K4+560 ～ K4+600	Left	Dongfeng Road-Agricultural Road Station Section	36	14.5	House	6 floors，mixed structure		-3	about 81 househlds	The mixed zone	Nanyang road，60m	
40	Xinyuan Garden 3 #, 4 #	K4+620 ～ K4+700	Left	Dongfeng Road-Agricultural Road Station Section	52	16.0	House	6 floors，mixed structure		-3	about 92 househlds	The mixed zone	Nanyang road，60m	
41	Nanyang Road, No. 97 Courtyard (Henan Engineering College family member courtyard), 1 #, 4 #, 5 # Building	K4+720 ～ K4+900	Left	Dongfeng Road-Agricultural Road Station Section	16	18.0	House	5 floors，mixed structure		-3	about 96 househlds	Both sides of the main traffic road	Nanyang road，60m	
42	Henan Engineering college family member courtyard's five buildings	K4+720 ～ K4+900	Left	Dongfeng Road-Agricultural Road Station Section	34	19.0	House	6 floors，mixed structure		-3	about 240 househlds	The mixed zone	Nanyang road，60m	

SN	Target Name	Mileage	Location	Section Name	The recent distance（m）	Target Name（m）	Information of the building					executive standard	the road crossed by and red line width of the road（m）	picture
							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
43	China Railway Bridge Bureau family member courtyard 1 #	K4+929 ～ K5+010	Left	Dongfeng Road-Agricultural Road Station Section	8	19.9	House	7 floors，mixed structure		-3	about 84 households	Both sides of the main traffic road	Nanyang road，60m	
44	Home world community 1 #, 2 # Building	K5+024 ～ K6+105	Left	Dongfeng Road-Agricultural Road Station Section	27	14.1	House	16 floors，Frame structure	I 类	-10	about 448 households	Both sides of the main traffic road	Nanyang road，60m	
45	Zhengzhou Boiler Factory family member courtyard 1 #, 2 #	K5+116 ～ K5+247	Left	Dongfeng Road-Agricultural Road Station Section	11	20.2	House	7 floors，mixed structure		-3	about 74 households	Both sides of the main traffic road	Nanyang road，60m	
45	Zhengzhou Boiler Factory, family member courtyard 3 # - 8 #	K5+116 ～ K5+247	Left	Dongfeng Road-Agricultural Road Station Section	27	20.2	House	7 floors，mixed structure		-3	about 336 households	The mixed zone	Nanyang road，60m	
46	Zhengrong Group Limited family member courtyard, 3 #, 6 # building	K5+268 ～ K5+318	Left	Dongfeng Road-Agricultural Road Station Section	8	20.2	House	5 floors，mixed structure		-3	about 80 households	Both sides of the main traffic road	Nanyang road，60m	
47	Home world community 1 # Building	K5+328 ～ K5+390	Left	Dongfeng Road-Agricultural Road Station Section	13	20.0	House	7 floors，mixed structure		-3	about 60 households	Both sides of the main traffic road	Nanyang road，60m	
47	Home world community 3 #, 2 # Building	K5+328 ～ K5+390	Left	Dongfeng Road-Agricultural Road Station Section	33	20.0	House	7 floors，mixed structure		-3	about 140 households	The mixed zone	Nanyang road，60m	
48	Old meat processing factory family member courtyard, 1 #, 3 #, 5 # Building	K5+392 ～ K5+456	Left	Dongfeng Road-Agricultural Road Station Section	12	17.7	House	5～6 floors，mixed structure		-3	about 136 households	Both sides of the main traffic road	Nanyang road，60m	
49	Nanyang Road 68 homes, 1 #, 2 #, 3 #, 10 #, 41 # Building	K5+480 ～ K5+679	Left	Dongfeng Road-Agricultural Road Station Section	12	14.5	House	7 floors，mixed structure		-3	about 210 households	Both sides of the main traffic road	Nanyang road，60m	
50	Fu Tian Lijing Garden District, 39 #, 40 # Building	K4+585 ～ K4+774	Right	Dongfeng Road-Agricultural Road Station Section	17	15.0	House	7 floors，mixed structure		-3	about 560 households	Both sides of the main traffic road	Nanyang road，60m	
51	Mold factory family member courtyard 1 # building	K4+785 ～ K4+833	Right	Dongfeng Road-Agricultural Road Station Section	12	17.5	House	6 floors，mixed structure		-3	about 24 households	Both sides of the main traffic road	Nanyang road，60m	
52	Vision garden, 1 # building	K4+845～ K4+900	Right	Dongfeng Road-Agricultural Road Station Section	14	19.0	House	6 floors，mixed structure		-3	about 96 households	Both sides of the main traffic road	Nanyang road，60m	

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							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
53	Nanyang Road, No. 239 Courtyard	K4+937 ～ K5+025	Right	Dongfeng Road-Agricultural Road Station Section	14	20.3	House	6 floors，mixed structure		-3	about 50 househlds	Both sides of the main traffic road	Nanyang road，60m	
53	Mineral Homeworld 2 # ~ 5 #	K4+937 ～ K5+025	Right	Dongfeng Road-Agricultural Road Station Section	37	20.3	House	6 floors，mixed structure		-3	about 96 househlds	The mixed zone	Nanyang road，60m	
54	Nanyang Road, No. 244 Courtyard # 1 (aquaculture company family member courtyard)	K5+325 ～ K5+349	Right	Dongfeng Road-Agricultural Road Station Section	16	20.0	House	5 floors，mixed structure		-3	about 45 househlds	Both sides of the main traffic road	Nanyang road，60m	
55	Ronghua community, 1 # Building	K5+390 ～ K5+441	Right	Dongfeng Road-Agricultural Road Station Section	12	18.0	House	5 floors，mixed structure		-3	about 30 househlds	Both sides of the main traffic road	Nanyang road，60m	
56	Nanyang Road 253 (food company meat branch family member building) 1 #, 3 #	K5+477 ～ K5+520	Right	Dongfeng Road-Agricultural Road Station Section	11	16.0	House	6 floors，mixed structure		-3	about 60 househlds	Both sides of the main traffic road	Nanyang road，60m	
56	Residential Community of Meat Product Branch of Food Company	K5+570 ～ K5+700	Right	Dongfeng Road-Agricultural Road Station Section	40	14.1	House	5～7 floors，mixed structure		-3	about 72 househlds	The mixed zone	Nanyang road，60m	
57	Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	K5+790 ～ K5+890	Left	Agricultural Road-Huanghe Road Station Section	10	14.6	House	5 floors，mixed structure		-3	about 60 househlds	Both sides of the main traffic road	Nanyang road，60m	
57	Zhengzhou ceramics factory family member courtyard, 2 #, 4 #, 5 #, 6 #	K5+790 ～ K5+890	Left	Agricultural Road-Huanghe Road Station Section	25	14.6	House	6 floors，mixed structure		-3	about 144 househlds	The mixed zone	Nanyang road，60m	
58	Provincial Prospecting machinery factory family member courtyard 1 #, 5 #, 6 # building	K5+900 ～ K5+965	Left	Agricultural Road-Huanghe Road Station Section	12	14.2	House	6 floors，mixed structure		-3	about 60 househlds	Both sides of the main traffic road	Nanyang road，60m	
59	Henan Geology and Mineral Resources Building	K5+986 ～ K6+032	Left	Agricultural Road-Huanghe Road Station Section	22	14.2	institution	15 floors，Frame structure		-10	—	Both sides of the main traffic road	Nanyang road，60m	
60	Nanyang Road, No. 52 (Yuhua Wen Jinyuan), three buildings	K6+043 ～ K6+082	Left	Agricultural Road-Huanghe Road Station Section	13	14.0	House	7 floors，mixed structure		-3	about 126 househlds	Both sides of the main traffic road	Nanyang road，60m	

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61	Sipo Road 9	K6+205 ～ K6+234	Left	Agricultural Road-Huanghe Road Station Section	12	14.1	House	8 floors，Frame structure		-10	about 32 households	Both sides of the main traffic road	Nanyang road，60m	
62	Nantong district, (Sipo Road 7th courtyard) 1 #	K6+250 ～ K6+350	Left	Agricultural Road-Huanghe Road Station Section	34	14.1	House	6～7 floors，mixed structure		-3	about 108 households	The mixed zone	Nanyang road，60m	 7
63	College family member courtyard 1 # 3 #	K6+364 ～ K6+406	Left	Agricultural Road-Huanghe Road Station Section	28	14.1	House	6 floors，mixed structure		-3	about 108 households	The mixed zone	Nanyang road，60m	
64	Nanyang Road, No. 46）	K6+429 ～ K6+500	Left	Agricultural Road-Huanghe Road Station Section	11	14.2	House	17 floors，Frame structure		-10	about 314 households	Both sides of the main traffic road	Nanyang road，60m	
65	Nanyang Road, No. 41 courtyard, 5 # Building	K6+517 ～ K6+548	Left	Agricultural Road-Huanghe Road Station Section	9	13.9	House	6 floors，mixed structure		-3	about 30 households	Both sides of the main traffic road	Nanyang road，60m	
66	Taiji Kindergarten, Beijia Education	K6+613～K6+679	Left	Agricultural Road-Huanghe Road Station Section	6	13.9	School	2 floors		-10	About 50 people	Both sides of the main traffic road	Nanyang road，60m	
67	Huafu Institute of Dermatology,	K6+613 ～ K6+679	Left	Agricultural Road-Huanghe Road Station Section	10	13.8	Research institutes	5～7 floors，mixed structure		-3	about 30	Both sides of the main traffic road	Nanyang road，60m	
68	City No. 71 high school	K6+690 ～ K6+762	Left	Agricultural Road-Huanghe Road Station Section	11	13.9	School	5 floors，mixed structure		-3	about 130	Both sides of the main traffic road	Nanyang road，60m	
69	The 2nd Hospital, Zhengzhou University	K6+825 ～ K6+878	Left	Agricultural Road-Huanghe Road Station Section	23	14.1	Hospital	3～7 floors，mixed structure		-3	--	Both sides of the main traffic road	Nanyang road，60m	
70	Zhengzhou Textile staff apartments, 29 #, 30 #	K6+900 ～ K7+073	Left	Agricultural Road-Huanghe Road Station Section	14	14.5	House	4 floors，mixed structure		-3	about 500	Both sides of the main traffic road	Nanyang road，60m	

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							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
	Building													
71	Zhengzhou Textile staff apartments, 18 # to 20 # buildings	K7+000 ～ K7+100	Left	Agricultural Road-Huanghe Road Station Section	37	14.5	House	7 floors，mixed structure		-3	about 126 househlds	The mixed zone	Nanyang road，60m	
72	Small Yuzhai (Nanyang Road courtyard 266--279)	K5+753 ～ K5+832	Right	Agricultural Road-Huanghe Road Station Section	15	14.4	House	6 floors，mixed structure		-3	about 114 househlds	Both sides of the main traffic road	Nanyang road，60m	
73	Pearl Factory, family member courtyard, 1 #, 2 #, 3 # Building (Nanyang Road 275), diecuiyuan courtyard	K6+100 ～ K6+180	Right	Agricultural Road-Huanghe Road Station Section	9	14.0	House	5～6 floors，mixed structure		-3	about 76 househlds	Both sides of the main traffic road	Nanyang road，60m	
74	Nanyang Road, No. 283 Courtyard	K6+260 ～ K6+305	Right	Agricultural Road-Huanghe Road Station Section	13	14.0	House	5 floors，mixed structure		-3	about 32 househlds	Both sides of the main traffic road	Nanyang road，60m	
75	Municipal Corporation family member courtyard (Nanyang Road No. 289 courtyard), 1 #, 2 #, 3 #, 4 # Building Hengtian Heavy Industry Co., Ltd family area	K6+455 ～ K6+511	Right	Agricultural Road-Huanghe Road Station Section	36	14.2	House	6 floors，mixed structure		-3	about 84 househlds	Both sides of the main traffic road	Nanyang road，60m	
76	Hengtian Heavy Industry Co., Ltd family area	K6+600 ～ K6+975	Right	Agricultural Road-Huanghe Road Station Section	14	14.1	Office、House	3～6 floors，mixed structure		-3	about 75 househlds	Both sides of the main traffic road	Nanyang road，60m	
77	Nanyang Road, No. 296 Courtyard, 1 #, 2 #, 3 #	K7+032 ～ K7+168	Right	Agricultural Road-Huanghe Road Station Section	15	13.9	House	6～12 floors，Frame structure		-5	about 312 househlds	Both sides of the main traffic road	Nanyang road，60m	
78	Zhengzhou Jianguo Medicine Institute	K07+280 ～ K07+400	Right	Huanghe Road-Jinshui Road Station Section	15	13.9	Hospital	4 floors，mixed structure	II	-3	--	Both sides of the main traffic road	Nanyang road，60m	
79	anyang Road branch of Shiyan Kindergarten, Zhengzhou	K07+280 ～ K07+400	Right	Huanghe Road-Jinshui Road Station Section	54	13.9	school	3 floors，mixed structure	II	-3	--	Both sides of the main traffic road	Nanyang road，60m	

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80	Buildings 6#, 5#, 4#, and Buildings 3# and 2# in the south of Community of Zhengzhou Textile Machinery Co., Ltd.	K7+214 ～ K7+696	Left	Huanghe Road-Jinshui Road Station Section	15	13.9	House	4 floors，mixed structure		-3	about 150 househlds	Both sides of the main traffic road	Nanyang road，60m	
81	Hongyihua Hong Kong City	K7+770 ～ K7+900	Left	Huanghe Road-Jinshui Road Station Section	20	18.9	House	34 floors，Frame structure		-10	about 170 househlds	Both sides of the main traffic road	Nanyang road，60m	
82	Nanyang Road No. 12 courtyard, 1 #, 2 # Building	K7+900 ～ K8+150	Left	Huanghe Road-Jinshui Road Station Section	10	18.6	House	3～6 floors，mixed structure		-3	about 46 househlds	Both sides of the main traffic road	Nanyang road，60m	
83	Jinshui District Police Fire Brigade	K7+970 ～ K8+010	Left	Huanghe Road-Jinshui Road Station Section	14	18.6	institution	7 floors，mixed structure		-3	—	Both sides of the main traffic road	Nanyang road，60m	
84	Nanyang Road No. 8 courtyard,	K08+110 ～ K08+180	Left	Huanghe Road-Jinshui Road Station Section	14	18.6	House	7 floors，mixed structure	II	-3	about 24 househlds	Both sides of the main traffic road	Nanyang road，60m	
85	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)）	K8+174 ～ K8+190	Left	Huanghe Road-Jinshui Road Station Section	0	14.8	House	5 floors，mixed structure		-3	about 32 househlds	Both sides of the main traffic road	Nanyang road，60m	
86	Zhengzhou City Library	K8+250 ～ K8+300	Left	Huanghe Road-Jinshui Road Station Section	5	14.4	Library	2～6 floors，mixed structure		-3	—	Both sides of the main traffic road	Nanyang road，60m	
87	Garden community, (Nanyang Road 300) 5 # building	K7+220 ～ K7+320	Right	Huanghe Road-Jinshui Road Station Section	14	13.3	House	7 floors，mixed structure		-3	about 42 househlds	Both sides of the main traffic road	Nanyang road，60m	
88	Nanyang Road, No. 309, (city commercial storage company family member courtyard), 1 #, 4 # 6 # building	K07+420 ～ K07+580	Right	Huanghe Road-Jinshui Road Station Section	40	14.8	House	6 floors，mixed structure		-3	about 72 househlds	The mixed zone	Nanyang road，60m	
89	Zhongheng	K7+710 ～ K7+825	Right	Huanghe Road-Jinshui Road Station Section	32	18.6	House	22 floors，Frame structure		-3	about 261 househlds	Both sides of the main traffic road	Nanyang road，60m	

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90	Nanyang Road No. 309—314 courtyard,	K7+900 ～ K8+020	Right	Huanghe Road-Jinshui Road Station Section	8	19.4	House	5～6 floors，mixed structure		-3	about 122 househlds	Both sides of the main traffic road	Nanyang road，60m	
91	Zhongheng garden No. 2 courtyard,, 4 # to 10 #	K7+830 ～ K7+950	Right	Huanghe Road-Jinshui Road Station Section	27	19.0	House	7 floors，mixed structure		-3	about 294 househlds	The mixed zone	Nanyang road，60m	
92	Qinghua Garden A, B, D, E Block	K8+136 ～ K8+280	Right	Huanghe Road-Jinshui Road Station Section	25	14.4	House	28 floors，Frame structure		-10	about 1986 househlds	Both sides of the main traffic road	Nanyang road，60m	
93	Zhengzhou National Oil Reserve Depot, family member courtyard 1 # building	K8+290 ～ K8+360	Right	Huanghe Road-Jinshui Road Station Section	20	14.4	House	7 floors，mixed structure		-3	about 70 househlds	Both sides of the main traffic road	Nanyang road，60m	
94	Jinshui Road, 11th courtyard, 1 # building	K8+485 ～ K8+495	Left	Jinshui Road-Taikang Road Station Section	11	14.3	House	4 floors，mixed structure		-3	about 12 househlds	Both sides of the main traffic road	Jinshui road，40m	
95	Municipal Supply and Marketing Trading Corporation, family member courtyard, 1 #, 10 #, 11 # building	K8+985 ～ K9+058	Left	Jinshui Road-Taikang Road Station Section	20	20.6	House	3～8 floors，mixed structure		-3	about 128 househlds	Both sides of the main traffic road	Minggong road，45m	
96	Minggong Road No. 67 courtyard, (Jinfeng Golden Coast International), 1 # Building	K9+158 ～ K9+183	Left	Jinshui Road-Taikang Road Station Section	33	14.6	House	28 floors，Frame structure		-10	about 324 househlds	Both sides of the main traffic road	Minggong road，45m	
97	Minggong Road, No. 139 Courtyard(Grain Bureau family member building)	K8+640 ～ K8+690	Right	Jinshui Road-Taikang Road Station Section	6	18.6	House	7 floors，mixed structure		-3	about 48 househlds	Both sides of the main traffic road	Minggong road，45m	
98	Minggong Road, No. 156 Courtyard, 1 #, 2 # Building	K8+920 ～ K9+017	Right	Jinshui Road-Taikang Road Station Section	6	20.4	House	6 floors，mixed structure		-3	about 90 househlds	Both sides of the main traffic road	Minggong road，45m	

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99	Jin Ming Yuan and South, Building # 1	K9+030 ～ K9+100	Right	Jinshui Road-Taikang Road Station Section	4	15.6	House	7 floors，mixed structure		-3	about 72 households	Both sides of the main traffic road	Minggong road，45m	
100	Huarun Yue House (under construction)	K9+245 ～ K9+610	Left	Taikang Road-Erqi square Station Section	45	19	House	58		-10	about 580 households	The mixed zone	Minggong road，45m	
101	Huigang New Town 1 #, 2 #, 3 # Building	K9+700 ～ K9+860	Left	Taikang Road-Erqi square Station Section	0	19.9	House	28 floors，Frame structure		-10	About 1260 households	Both sides of the main traffic road	Jiefang road，20m	
102	Small building mosques	K10+000 ～ K10+059	Left	Taikang Road-Erqi square Station Section	6	23.5	Religion	4～6 floors，mixed structure		-3	—	Both sides of the main traffic road	Jiefang road，20m	
103	West Cai district, (Ming Gong Road No. 240 Courtyard) 1 #	K9+275 ～ K9+315	Right	Taikang Road-Erqi square Station Section	0	14.2	House	4～7 floors，mixed structure		-3	about 82 households	Both sides of the main traffic road	Minggong road，45m	
103	West Cai district, (Ming Gong Road, No. 240 Courtyard), 2 #, 3 # Building	K9+275 ～ K9+315	Right	Taikang Road-Erqi square Station Section	16	14.2	House	7 floors，mixed structure		-3	about 84 households	The mixed zone	Minggong road，45m	
104	Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)	K9+325 ～ K9+410	Right	Taikang Road-Erqi square Station Section	9	14.2	House	2、3，7 floors，mixed structure		-3	about 83 households	Both sides of the main traffic road	Minggong road，45m	
105	Ruishi hotel	K09+420 ～ K09+540	Right	Taikang Road-Erqi square Station Section	10	15.5	House	22 floors，Frame structure	I	-10	about 200 households	Both sides of the main traffic road	Minggong road，45m	
106	Ming Gong Road No. 272, (Rural Credit Cooperative Union, family member building)	K9+545 ～ K9+608	Right	Taikang Road-Erqi square Station Section	0	17.3	House	6 floors，mixed structure		-3	about 40 households	Both sides of the main traffic road	Minggong road，45m	
107	Yalong district, 17 # Building	K9+638 ～ K9+674	Right	Taikang Road-Erqi square Station Section	0	18.3	House	7 floors，mixed structure		-3	about 60 households	Both sides of the main traffic road	Minggong road，45m	
108	Yalong districtl 16 # Building, 1 #, 2 # Building	K9+638 ～ K9+674	Right	Taikang Road-Erqi square Station Section	16	18.3	House	7 floors，mixed structure		-3	about 90 households	The mixed zone	Minggong road，45m	

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109	Catholic Church	K9+687 ～ K9+719	Right	Taikang Road-Erqi square Station Section	2	19.5	Religion	2～5 floors，mixed structure		-3	—	Both sides of the main traffic road	Minggong road，45m	
110	Jiefang Road Elementary School	K9+719 ～ K9+750	Right	Taikang Road-Erqi square Station Section	42	19.5	School	4 floors，mixed structure		-3	1000 peple	Both sides of the main traffic road	Minggong road，45m	
111	Shangfuxin Village House 1#	K10+510 ～ K10+614	Left	Erqi square-Shunchengjie Station Section	6	18.6	House	18 floors，Frame structure		-10	about 255 households	Both sides of the main traffic road	Xidajie，45m	
111	Shangfuxin Village 2 #, 3	K10+510 ～ K10+614	Left	Erqi square-Shunchengjie Station Section	41	18.6	House	10 floors，Frame structure		-10	about 120 households	The mixed zone	Xidajie，45m	
112	Fuchun Apartment 1 # building	K10+625 ～ K10+779	Left	Erqi square-Shunchengjie Station Section	15	14.7	House	7 floors，mixed structure		-3	about 154 households	Both sides of the main traffic road	Xidajie，45m	
113	Huating Apartments, Dehua Street community 1 #, 2 # Building	K10+528 ～ K10+614	Right	Erqi square-Shunchengjie Station Section	15	18.6	House	16 floors，Frame structure		-10	about 336 households	Both sides of the main traffic road	Xidajie，45m	
114	Jinding Huafu House, front 1 #	K10+630 ～ K10+775	Right	Erqi square-Shunchengjie Station Section	13	14.7	House	11 floors，Frame structure		-10	about 60 households	Both sides of the main traffic road	Xidajie，45m	
114	Jinding Huafu House, rear	K10+630 ～ K10+775	Right	Erqi square-Shunchengjie Station Section	8	14.7	House	5～7 floors，mixed structure		-3	about 96 households	Both sides of the main traffic road	Xidajie，45m	
115	Modern XingYuan 1 #	K10+800 ～ K10+873	Right	Erqi square-Shunchengjie Station Section	23	14.4	House	14～17 floors，Frame structure		-10	about 120 households	Both sides of the main traffic road	Xidajie，45m	
116	Hongxin Jia Yuan 1 # building	K10+915 ～ K10+990	Left	Shunchengjie-Dongdajie Station Section	14	14.4	居住	7 floors，mixed structure		-3	about 84 households	Both sides of the main traffic road	Xidajie，45m	
117	Xidan apartments, two buildings	K11+070 ～ K11+151	Left	Shunchengjie-Dongdajie Station Section	8	14.9	House	7 floors，mixed structure		-3	about 138 households	Both sides of the main traffic road	Xidajie，45m	
118	West Street, No. 231	K11+250 ～ K11+286	Left	Shunchengjie-Dongdajie Station Section	13	16.5	House	16 floors，Frame structure		-10	about 126 households	Both sides of the main traffic road	Xidajie，45m	

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							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
119	Zhongkai City Lights Clove Court, 1 #, Building	K11+380 ～ K11+446	Left	Shunchengjie-Dongdajie Station Section	12	16.0	House	12 floors，Frame structure		-10	about 72 households	Both sides of the main traffic road	Dongdajie，45m	
120	Fuhua Building	K11+450 ～ K11+550	Left	Shunchengjie-Dongdajie Station Section	8	15.5	House	27 floors，Frame structure	Ⅰ	-10	about 200 households	Both sides of the main traffic road	Dongdajie，45m	
121	Zi Yan Huating 1 #, 2 # Building	K11+821 ～ K11+917	Left	Shunchengjie-Dongdajie Station Section	23	14.4	House	24 floors，Frame structure		-10	about 288 households	Both sides of the main traffic road	Dongdajie，45m	
122	Ginza International	K10+956 ～ K11+025	Right	Shunchengjie-Dongdajie Station Section	14	14.2	House	15 floors，Frame structure		-10	about 150 households	Both sides of the main traffic road	Xidajie，45m	
123	233 West Main Street (the third secondary school, family member building)	K11+038 ～ K11+100	Right	Shunchengjie-Dongdajie Station Section	11	14.2	House	18 floors，Frame structure		-10	about 90 households	Both sides of the main traffic road	Xidajie，45m	
124	218 West Main Street	K11+168 ～ K11+221	Right	Shunchengjie-Dongdajie Station Section	20	16.0	House	6 floors，mixed structure		-3	about 24 households	Both sides of the main traffic road	Xidajie，45m	
125	Sun Moon Star City, 1 # building	K11+230 ～ K11+300	Right	Shunchengjie-Dongdajie Station Section	14	16.5	House	20 floors，Frame structure		-10	about 80 households	Both sides of the main traffic road	Xidajie，45m	
126	Zhongkai City Lights Clove Court, 1 #, 2 # Building	K11+328 ～ K11+566	Right	Shunchengjie-Dongdajie Station Section	15	15.4	House	7 floors，mixed structure		-3	about 120 households	Both sides of the main traffic road	Dongdajie，45m	
127	Tangzi Lane (Bo’ai Street Community)	K 11+328 ～ K11+566	Right	Shunchengjie-Dongdajie Station Section	38	15.0	House	2、3 floors，mixed structure		-3	about 50 households	The mixed zone	Dongdajie，45m	
128	Changcheng City in City	K11+580 ～ K11+666	Right	Shunchengjie-Dongdajie Station Section	13	16.0	House	7 floors，mixed structure		-3	about 42 households	Both sides of the main traffic road	Dongdajie，45m	
129	Yuhong Garden, 1 #, 2 #, 3 # Buildings	K11+675 ～ K11+800	Right	Shunchengjie-Dongdajie Station Section	25	14.8	House、Office	26 floors，Frame structure		-10	about 500 households	Both sides of the main traffic road	Dongdajie，45m	
130	Municipal Guancheng State Taxation office services hall	K11+929 ～ K11+978	Left	Dongdajie-Chengdong Road Station Section	33	14.3	institution	8 floors，mixed structure		-3	—	Both sides of the main traffic road	Dongdajie，45m	

SN	Target Name	Mileage	Location	Section Name	The recent distance（m）	Target Name（m）	Information of the building					executive standard	the road crossed by and red line width of the road（m）	picture
							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
131	First People's Courtyard of Zhengzhou	K11+990 ～ K12+055	Left	Dongdajie-Chengdong Road Station Section	22	14.3	Hospital	5 floors，mixed structure		-3	--	Both sides of the main traffic road	Dongdajie，45m	
132	Guancheng District Education Center	K12+133 ～ K12+211	Left	Dongdajie-Chengdong Road Station Section	21	14.0	institution	5 floors，mixed structure		-3	—	Both sides of the main traffic road	Dongdajie，45m	
133	Zhigong Road, Building 1,	K12+230 ～ K12+335	Left	Dongdajie-Chengdong Road Station Section	18	14.1	House	7 floors，mixed structure		-3	about 70 households	Both sides of the main traffic road	Dongdajie，45m	
134	Residential community of Zhengzhou Electric Power College	K12+400 ～ K12+500	Left	Dongdajie-Chengdong Road Station Section	43	17.5	House	7loors，mixed structure	II	-3	About56 households	The mixed zone	Dongdajie，45m	
135	220 East Main Street	K11+978 ～ K12+105	Right	Dongdajie-Chengdong Road Station Section	10	14.3	House	6 floors，mixed structure		-3	about 72 households	Both sides of the main traffic road	Dongdajie，45m	
136	Mall Village, (248 East Main Street courtyard)	K12+000 ～ K12+500	Right	Dongdajie-Chengdong Road Station Section	28	14.0	House	2、3 floors，mixed structure		-3	about 50 households	The mixed zone	Dongdajie，45m	
137	Zhongkai City Lights Guangjingcui Court, 1 #, 2 # Building	K12+133 ～ K12+366	Right	Dongdajie-Chengdong Road Station Section	8	14.0	House	7 floors，mixed structure		-3	about 88 households	Both sides of the main traffic road	Dongdajie，45m	
138	East Main Street, No. 1 Court, Building 2	K12+550 ～ K12+600	Right	Dongdajie-Chengdong Road Station Section	38	21.2	House	7 floors，mixed structure		-3	about 42 households	Both sides of the main traffic road	Dongdajie，45m	
139	Dolidongguan96,1#	K12+716 ～ K12+830	Left	Chengdong Road-Weilaidadao Station Section	11	20.5	House	4～7 floors，mixed structure		-3	about 30 households	Both sides of the main traffic road	Zhengbian road，60m	
139	Dolidongguan96,2#	K12+716 ～ K12+830	Left	Chengdong Road-Weilaidadao Station Section	32	20.5	House	4～7 floors，mixed structure		-3	about 66 households	The mixed zone	Zhengbian road，60m	
140	Knitting mill family member courtyard, 1 # building	K12+992 ～ K13+072	Left	Chengdong Road-Weilaidadao Station Section	12	20.3	House	5 floors，mixed structure		-3	about 60 households	Both sides of the main traffic road	Zhengbian road，60m	

SN	Target Name	Mileage	Location	Section Name	The recent distance（m）	Target Name（m）	Information of the building					executive standard	the road crossed by and red line width of the road（m）	picture
							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
140	Knitting mill family member courtyard, 2 # Building	K12+992 ～ K13+072	Left	Chengdong Road-Weilaidadao Station Section	32	20.3	House	floors，mixed structure		-3	about 42 households	The mixed zone	Zhengbian road，60m	
141	Yutong Garden Building 1#	K13+076 ～ K13+226	Left	Chengdong Road-Weilaidadao Station Section	12	18.5	House	6 floors，mixed structure		-3	about 124 households	Both sides of the main traffic road	Zhengbian road，60m	
141	Yutong Garden Building 2#	K13+076 ～ K13+226	Left	Chengdong Road-Weilaidadao Station Section	36	18.5	House	5 floors，mixed structure		-3	about 30 households	The mixed zone	Zhengbian road，60m	
142	Municipal underwear factory family member courtyard, 1 #, 2 #, 3 # Building	K13+230 ～ K13+408	Left	Chengdong Road-Weilaidadao Station Section	14	16.2	House	5～6 floors，mixed structure		-3	about 102 households	Both sides of the main traffic road	Zhengbian road，60m	
142	Municipal underwear factory, family member courtyard, 5 #, 4 # Building	K13+230 ～ K13+408	Left	Chengdong Road-Weilaidadao Station Section	34	16.2	House	6 floors，mixed structure		-3	about 72 households	The mixed zone	Zhengbian road，60m	
143	Zheng Bian Road, Building 60	K13+414 ～ K13+473	Left	Chengdong Road-Weilaidadao Station Section	28	15.9	House	32 floors，Frame structure		-10	about 120 households	Both sides of the main traffic road	Zhengbian road，60m	
144	Zheng Bian Road, Building 23,	K12+820 ～ K12+857	Right	Chengdong Road-Weilaidadao Station Section	7	20.5	House	5 floors，mixed structure	II	-5	about 72 households	Both sides of the main traffic road	Zhengbian road 60m	
145	Great Wall Cambridge Garden	K13+038 ～ K13+091	Right	Chengdong Road-Weilaidadao Station Section	21	19.2	House	31 floors，Frame structure	I	-10	about 702 households	Both sides of the main traffic road	Zhengbian road 60m	
146	Cargo Terminal No. 23 North Street Courtyard, 1 #, (Phoenix Road Community)	K13+158 ～ K13+225	Right	Chengdong Road-Weilaidadao Station Section	18	17.5	House	5 floors，mixed structure		-3	about 30 households	Both sides of the main traffic road	Zhengbian road 60m	
146	Cargo Terminal No. 23 North Street Courtyard, 3 #, (Phoenix Road Community)	K13+158 ～ K13+225	Right	Chengdong Road-Weilaidadao Station Section	18	17.5	House	17 floors，Frame structure	I	-10	about 136 households	Both sides of the main traffic road	Zhengbian road 60m	

SN	Target Name	Mileage	Location	Section Name	The recent distance（m）	Target Name（m）	Information of the building					executive standard	the road crossed by and red line width of the road（m）	picture
							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
147	Langui district 1 # Building	K13+230 ～ K13+325	Right	Chengdong Road-Weilaidadao Station Section	16	17.2	House	29 floors，Frame structure	I	-10	about 567 household	Both sides of the main traffic road	Zhengbian road 60m	
148	Boai ENT Hospital of Zhengzhou	K13+332 ～ K13+390	Right	Chengdong Road-Weilaidadao Station Section	9	16.2	Hospital	6 floors，mixed structure		-3	--	Both sides of the main traffic road	Zhengbian road 60m	
149	Zheng Bian Road, No. 49, family member courtyard, 1 # Building	K13+398 ～ K13+430	Right	Chengdong Road-Weilaidadao Station Section	13	15.9	House	5 floors，mixed structure	II	-3	about 30 household	Both sides of the main traffic road	Zhengbian road 60m	
150	Dongming Road 30 Courtyard, (electric power district), 1 #, 2 # Building	K13+512 ～ K13+650	Right	Chengdong Road-Weilaidadao Station Section	9	14.9	House	6 floors，mixed structure	II	-3	about 96 household	Both sides of the main traffic road	Zhengbian road 60m	
150	Dongming Road 30 courtyard (electric power district), 3 #, 4 # Building	K13+512 ～ K13+650	Right	Chengdong Road-Weilaidadao Station Section	45	14.9	House	6 floors，mixed structure	II	-3	about 48 household	The mixed zone	Zhengbian road 60m	
151	Zhengzhou Huimin High School	K14+686 ～ K14+769	Left	Weilaidadao –Fengtai south Road Station Section	47	14.3	School	5 floors，mixed structure	II	-3	About 2900 peple	Both sides of the main traffic road	Zhengbian road 60m	
152	Zhengzhou City Public Security Bureau Police Detachment	K14+793 ～ K14+942	Left	Fengtai south Road ~ Zhongzhoudadao Station Section	27	14.3	institution	7～8 floors，Frame structure	I	-10	-	Both sides of the main traffic road	Zhengbian road 60m	
153	Henan Provincial People's Procuratorate	K14+942 ～ K15+052	Left	Fengtai south Road ~ Zhongzhoudadao Station Section	26	16.3	institution	2 floors，mixed structure	I	-10	-	Both sides of the main traffic road	Zhengbian road 60m	
154	Yingxie Garden 1 #, 2 # Building	K15+194 ～ K15+485	Left	Fengtai south Road ~ Zhongzhoudadao Station Section	55	20.6	House	29 floors，Frame structure	I	-10	about 116 household	Both sides of the main traffic road	Zhengbian road 60m	
155	District under construction 1 #, 2 # Building	K16+878 ～ K17+052	Left	Tongtai Road–Huanghe east Road Station Section	54	15.6	House	25 floors，Frame structure	I	-10	about 300 household	Both sides of the main traffic road	Shangdu road 60m	
156	Henan Zhongdu Dermatology Hospital	K17+147 ～ K17+199	Left	Tongtai Road–Huanghe east Road Station Section	24	21.9	Hospital	6 floors，mixed structure		-3	--	Both sides of the main traffic road	Shangdu road 60m	

SN	Target Name	Mileage	Location	Section Name	The recent distance（m）	Target Name（m）	Information of the building					executive standard	the road crossed by and red line width of the road（m）	picture
							Using function	scale	Tape of building	Storey of building	Sensitive point overview			
157	Guancheng Traditional Chinese Medicine Hospital	K17+206 ～ K17+266	Left	Tongtai Road–Huanghe east Road Station Section	10	15.6	Hospital	8 floors，mixed structure		-3	--	Both sides of the main traffic road	Shangdu road 60m	
158	Caixin Triana district, 1 #, 2 #, 3 #, 4 # Building	K17+390 ～ K17+766	Right	Tongtai Road–Huanghe east Road Station Section	51	14.6	House	20 floors，Frame structure	I	-10	about 720 househlds	Both sides of the main traffic road	Shangdu road 60m	
159	Zhengshang Eastern Harbour, 1 #, 2 # Building	K19+152 ～ K19+300	Left	Agricultural east Road–Zhongxing Road Station Section	56	15.3	House	18～26 floors，Frame structure	I	-10	about 212 househlds	Both sides of the main traffic road	Shangdu road 60m	
160	Sinosun New World	K20+320 ～ K20+680	Left	Zhongxing road～Boxue road station section	60	15	House	25～30 floors，Frame structure	I	-10	About700 househlds	Both sides of the main traffic road	Shangdu road 60m	
161	Dongyinggang Village	K24+300 ～ K24+800	Left and Right	Boxue Road - Hanghai east Road Station Section	0	13.0	House	Below the second floor are peasant houses		0	about 70 househlds	Both sides of the main traffic road	Shangdu road 60m	

Table 1.9-4 Protection goals of historic buildings and cultural relics along this line

SN	Target Name	Mileage	Location	Section Name	The recent distance（m）	Target Name（m）	The building s	Structure of building	Level	Size /scale	Applicable standard
1	Shanhaimomuduha Tomb	K09+900～K09+930	Left	Taikang road station ～ Erqi square Station Section	38	20	Built in 1843 and revamped during the first years after founding of PRC	Brick structure	A protected cultural relic site, Erqi District	A hexagonal pavilion standing in the height of about 7 meters, facing toward south.	GB/T50452 – 2008 Technical Specification for Protection of Historic Buildings from Man-made Vibrations
2	Zhengzhou Memorial Tower for February 7th Strik	K10+317～ K10+348	Right	Erqi square-Shunchengjie Station Section	3	22.6	Built in 1951 and rebuilt in 1971	Reinforced concrete	Key protected cultural relic site at nation level	Two towers in parallel in total height of 63 meters consisting of 14 floors including 3 floors of tower base and the balance for the tower body.	
3	Zhengzhou Shang Dynasty Ruins	K12+500～ K12+579	Left	Chengdong Road-Weilaidadao Station Section	31	20.0	Built in Yongping Period of Ming Emperor, Donghan Dynasty, and refurbished in 2006	Wooden structure	A protected cultural relic site at the provincial level of Henan	Occupying area of around 9300 SM, consisting of Lingxin gate, The east and west decorated archways, Dacheng gate, Minghuan temple, Temple for past scholars, Dacheng hall, Zunjing pavilion, the east and west houses as	

										well as the monument corridor.	
4	Zhengzhou Shang Dynasty Ruins	K12+500～K12+550	Right	Chengdong Road-Weilaidadao Station Section	6	20.0	Bo Capital of Chengtang Dynasty	Rammed earth	Key protected cultural relic site at nation level	An underground relic, only the wall present but well protected	

1.10 Procedure of assessment

Refer to Figure 10-1 for procedure of assessment.

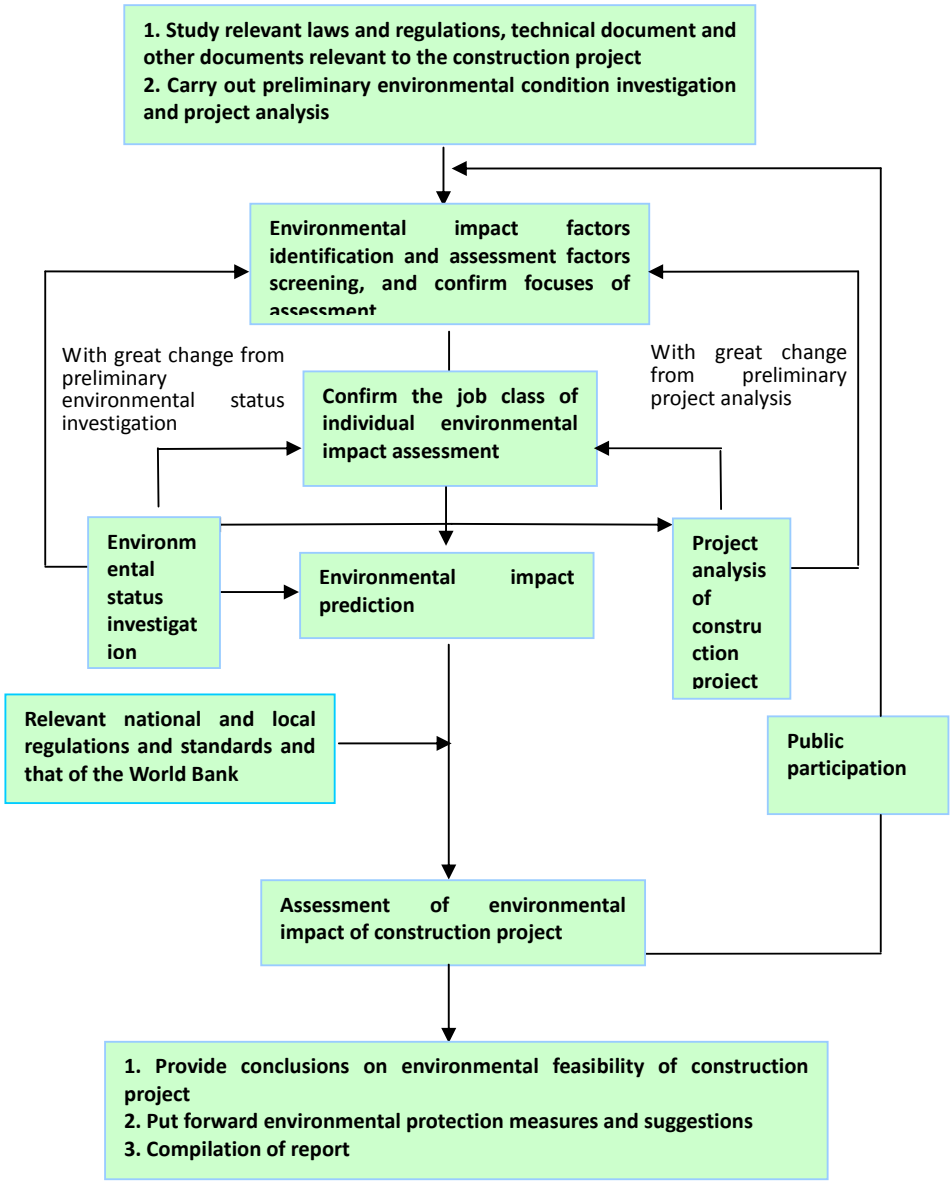


Figure 1.10 Working plan of environmental impact assessment of line 1

2 Environmental policies, laws and regulations framework and compilation basis

2.1 Laws and regulations

(1) Environmental Protection Law of the People's Republic of China (implemented on 1989.12.26)

(2) Environmental Impact Assessment Law of the People's Republic of China (implemented on 2003.9.1)

(3) Air Pollution Prevention Law of the People's Republic of China (implemented on 2000.9.1)

(4) Environmental Noise Pollution Prevention Law of the People's Republic of China (implemented on 1997.3.1)

(5) Water Pollution Prevention Law of the People's Republic of China (revised on February 28, 2008, implemented on June 1, 2008)

(6) Solid Waste Pollution Prevention Law of the People's Republic of China (implemented on 2005.4.1)

(7) Urban and Rural Planning Law of the People's Republic of China (implemented on 2008.1.1)

(8) Soil and Water Conservation Act of the People's Republic of China (revised on December 25, 2010, implemented on march1, 2011)

(9) Cultural Relics Protection Law of the People's Republic of China (implemented on 2007.12.29)

(10) Cleaner Production Promotion Law of the People's Republic of China (implemented on 2003.1.1)

(11) Energy Conservation Law of the People's Republic of China (implemented on 2008.4.1)

(12) State Council of the People's Republic of China (1998) Decree No. 253

Construction Project Environmental Protection Management Regulations (1998.12.12)

(13) State Council of the People's Republic of China (2001), No. 305 Urban Housing Demolition Management Regulations (2001.11.1); Ministry of Construction of the People's Republic of China Urban Housing Units Specification for Administrative Adjudication (implemented on 2004.3.1)

(14) The People's Republic of China State Council Order No. 257 of the Basic Farmland Protection Ordinance (implemented on 1999.1.1)

(15) State [2005] No. 39 Decision to Strengthen Environmental Protection by the State Council on the Implementation of the Scientific Concept of Development;

(16) SEPA UNCED [2006] No. 28 Interim Measures for environmental impact assessment of public participation (implemented on 2006.3.18)

(17) State Environmental Protection Administration Decree 14 "Construction Project Environmental Impact Assessment Classification Catalogue (implemented on 2008.10.1)

(18) SEPA 18 orders Electromagnetic Radiation Environmental Protection Management Approach (implemented on 1997.3.25)

(19) General Office [2003] No. 81, Notice on the General Office of the State Council on Strengthening Urban Rapid Rail Transit Construction Management (2003.9.27)

2.2 Local regulations

1. Implementation approaches of the Water Law of the People's Republic of China in Henan Province (come into effect since August 1st, 2006);

2. Henan Province's Implementation approaches of the Cultural Relics Protection Law (Amendment) (come into effect since February 23rd, 1984);

3. Circular of Henan Provincial People's Government on Intensifying Land Control and Strict Land Management (No.33 [2007] of the People's Government of Henan Province)

4. Circular of Henan Provincial People's Government on Issuing the Five-Year Energy Development Plan (No.36 [2012] of the People's Government of Henan Province)

5. Opinions of the People's Government of Henan Province on Implementing the Decision of the State Council on Implementing the Scientific Development View and Strengthening the Environmental Protection (No.36 [2006] of the People's

Government of Henan Province)

6. Circular of the People's Government of Henan Province on Issuing the Implementation Scheme for Energy Conservation and Emission Reduction (No.46 [2007] of the People's Government of Henan Province)

7. Notice of Designating Water Source Protection Areas on the Two Sides of Main Channel of North-South Water Transfer First-Stage Project Middle Route (No.134 [2006] of State Council North-South Water Transfer Office for Environmental Protection and Resettlement)

8. Circular of the People's Government of Henan Province on Issuing the Implementation Opinion for the Water Source Protection Areas Designation on the Two Sides of Main Channel of North-South Water Transfer First-Stage Project Middle Route (No.32 [2007] of the People's Government of Henan Province);

9. Circular of Zhengzhou Municipal People's Government on Issuing the Implementation Opinion for the Water Source Protection Areas Designation on the Two Sides of Main Channel of North-South Water Transfer First-Stage Project Middle Route (No.74 [2007] of Zhengzhou Municipal Government);

10. Zhengzhou Municipal Government's Opinion on Implementing the Water Source Protection Areas Designation on the Two Sides of Main Channel of North-South Water Transfer First-Stage Project Middle Route & Implementation Scheme;

11. Notification of Zhengzhou Municipal People's Government on Urban Groundwater Resources Protection and Self-supply Wells Closing (No.227 [2002] of Zhengzhou Municipal Government);

12. Notification of Zhengzhou Municipal People's Government on Issuing the Zhengzhou National Economic and Social Development Plan of 2007 (No.13 [2007] of Zhengzhou Municipal Government);

13. Zhengzhou Control Measures of Environmental Noise Pollution (No. 154 of Zhengzhou Municipal Government Notice);

14. Zhengzhou Municipal Regulation on Air Pollution Control (come into effect since November 1st, 2005);

15. Zhengzhou Water Resources Management Ordinance (come into effect since August 1st, 2003);

16. Zhengzhou Urban Drinking Water Sources Protection and Pollution Control Ordinance (come into effect since January 1st, 2000).

2.3 Regulatory documents

1. Zhengzhou Urban Rail Transit Construction Planning compiled by Chinese Academy of Urban Planning & Design and Zhengzhou Urban Planning Design and Survey Research Institute (2011-2015) (2010)

2. Environmental Impact Assessment of Zhengzhou City Rail Transit Network and Construction Planning Report compiled by China Railway Siyuan Survey and Design Group Co., Ltd.

3. Reply to the Environmental impact assessment of Rail Transit

4. Pre-feasibility Study for Zhengzhou Metro Line 3 First-stage Project, China Railway Siyuan project Group Co., Ltd., March, 2012

5. Feasibility Study for Zhengzhou Metro Line 3 First-stage Project, Beijing Urban Construction Exploration & Surveying Design Group Co., Ltd.

2.4 Technical regulations and standards

2.4.1 Technical guides and specifications of environmental impact assessment

(1)The People's Republic of China Environmental Protection Industry Standard Environmental Impact Assessment Technology Guidelines – Master HJ2.1-2011

(2)The People's Republic of China Environmental Protection Industry Standard Technical Guidelines on Environmental Impact Assessment - Atmospheric Environment HJ2.2-2008

(3)The People's Republic of China Environmental Protection Industry Standard Environmental Impact Assessment Technology Guidelines - Surface Water Environment HJ/T2.3-93

(4)The People's Republic of China Environmental Protection Industry Standard Environmental Impact Assessment Technology Guidelines - Sound Environment HJ2.4 -2009

(5)The People's Republic of China Environmental Protection Industry Standard "Environmental Impact Assessment Technology Guidelines - Non - ecological impact "HJ/T19 - 2011

(6)The People's Republic of China Environmental Protection Industry Standard Environmental Impact Assessment Technology Guidelines - Urban Mass Transit HJ453-2008

(7)The People's Republic of China Environmental Protection Industry Standard Guidelines for Environmental Management of radiation- Electromagnetic Radiation, Environmental Impact Assessment Methods and Standards HJ/T10.3-1996

(8)The People's Republic of China Environmental Protection Industry Standard Environmental Impact Assessment Of Electromagnetic Radiation Of 500kv High Pressure Transmission And Distribution Project HJ/T24-1998

9. DL/T5092-1999 "Technical Regulations for 110 ~ 500kV Overhead Power Transmission Line Design";

10. "Health Code for Drinking Water Quality" (June 2001).

11. "Design Code for Metro" (GB50157-2003);

12. "Urban Rapid Rail Transit Project Construction Standards" (Jianbiao 104-2008);

13. "Urban Rail Transit Project Construction Standards" (pilot version)

2.4.2 Assessment standard

2.4.2.1 Noise standard

The noise standard consulted in this assessment is shown in table 2.4-1, according to the Acoustic Environmental Function Zoning Plan of Zhengzhou City (2011) and the Confirmation of Environmental Impact Assessment Standard for Zhengzhou Metro Line 3 First-stage Project issued by the Environmental Protection Bureau of Henan Province.

Table 2.4-1 Summary table of acoustic environmental impact assessment

Name and No. of standard	Standard value and grade (type)	Scope of application
Environmental Quality Standard for Noise GB3096-2008	Type 4a: Daytime 70dB Nighttime 55dB	(1) Areas of 20-50m away from the motor lane border on the road sides; (2) Areas of 50m away from the railway outer track; (3) Areas within 35m from the two sides of car depot access line.
	Type 3: Daytime 65dB Nighttime 55dB	Certain distances away from the two sides of Boxue Road Station to East Hanghai Road Station (included).
	Type 2： Daytime 60dB Nighttime 50dB	Certain distances away from the two sides of Jinshui Road Station to Bocue road station (included).
	Type 1： Daytime 55dB Nighttime 45dB	Certain distances away from the two sides of Xinliu Road Station (included) to Jinshui road station (included)

Emission Standard for Industrial Enterprises Noise at Boundary GB12348-2008	Type 1： Daytime 55dB Nighttime 45dB	1m outside the parking lots
	Type 3: Daytime 65dB Nighttime 55dB	1m outside the car depot
Noise Limits for Construction Site GB12523-2011	Type 4a: Daytime 70dB Nighttime 55dB	Construction site

At the same time, according to General Guide on Environment, Health and Safety, the noise should not exceed relevant requirements of Table 2.4-1, or the increase of noise of the nearest receiving point outside the construction site should not exceed 3 db (A).

Table 2.4-1 General Guide on Environment, Health and Safety

Receiver	dB (A)2/h	
	Day 07:00-22:00	Night 22:00-07:00
Residence, office, school	55	45
Industry, business facilities	70	70

The above two tables show that the class 1 standard of Acoustic Environmental Quality Standard is the same as the standard limit of residence, office and school in General Guide on Environment, Health and Safety. The function zoning of class 2, 3, 4 standards of Acoustic Environmental Quality Standard is the same as the industry and business facilities function zoning in General Guide on Environment, Health and Safety, that is, they have same standard implementation scope. The standard limit of the class 2, 3, 4 standards of Acoustic Environmental Quality Standard is stricter than that of the industry and business facilities in General Guide on Environment, Health and Safety. So, in the process of analysis and evaluation, Acoustic Environmental Quality Standard is taken as the basis for the evaluation.

2.4.2.2 Vibration standard

(I) Executive standard

Refer to Table 2.4-2 for executive standard of vibration environmental impact assessment.

Table 2.4-2 Executive standard of vibration environmental impact assessment

Scope of application	Daytime	Nighttime	Remarks
Residence and cultural and educational area standard	70dB	67dB	VL_{z10}
Mixing area and central business district	75dB	72dB	
industrial concentration district	75dB	72dB	
Both sides of arterial traffic standard	75dB	72dB	

(II) Reference standard

The assessment of Metro running vibration impact is carried out according to the allowable vibration velocity limits of historic brick masonry structures defined in Technical Specifications for Protection of Historic Buildings against Man-made Vibration (GB/T50452-2008), see table 2.4-3.

Table 2.4-3 Permissible vibration velocities of brick masonry structure of historic buildings

Ancient brick structure	Level of protection	Position of control point	Direction of control point	Brick masonry VP(m/s)		
				<1600	1600～2100	>2100
	National key cultural relic protection unit	Highest position of bearing structure	Horizontal	0.15	0.15～0.20	0.20
	Provincial level cultural relic protection unit	Highest position of bearing structure	Horizontal	0.27	0.27～0.36	0.36
Ancient stone structure	Level of protection	Control point position	Control the direction	Stone masonry VP(m/s)		
				<2300	2300～2900	>2900
	National key cultural relic protection unit	Highest position of bearing structure	Horizontal	0.20	0.20～0.25	0.25
	Provincial level cultural relic protection unit	Highest position of bearing structure	Horizontal	0.36	0.36～0.45	0.45
Ancient wood structure	Level of protection	Control point position	Control the direction	Wood masonry VP(m/s)		
				<4600	4600～5600	>5600
	National key cultural relic protection unit	Top of pillars	Horizontal	0.18	0.18～0.22	0.22
	Provincial level cultural relic protection unit	Top of pillars	Horizontal	0.25	0.25～0.30	0.30

(III) Reference Standard

According to GBJ118-88 Code for Design of Sound Insulation of Civil Buildings, the primary standard of residential bedrooms, special rooms requiring quiet environment at schools and hospital wards is: the indoor noise in residences, classrooms and hospitals shall be lower than or equal to 40dB(A). As for secondary structural noise, the standard applied in the assessment is: the indoor secondary structural noise caused by vibration of subway shall be lower than or equal to 40dB (A).

"Limits and Measurement Method Standards for Urban Rail Transit Causing Secondary Radiation Noise and Building Vibration " JGJ / T 170-2009;

"Metro Noise and Vibration Control Specification" DB11/T838-2011.

2.4.2.3 Water environment

The metro line passes Jialu River, Jinshui River, Xiong'er River, Weihe River, Qili River and Chaohe River, and Level IV standards of the Environmental Quality Standards for Surface Water (GB3838-2002) shall be executed here;

For the underground water environment along the Metro line, Environmental Quality Standards for Ground Water (GB/T14848-93) Level III standard shall be executed.

The sewage of the vehicle base and the stations has conditions to be included in the existing or planned drainage pipe network, entering relevant urban sewage treatment plant. The sewage discharge of the vehicle base and the stations perform the standard of urban sewage treatment plant, class 3 standard of Sewage Discharge Standard (GB8978-1996). See table 2.4-4 , table 2.4-5 and table 2.4-6 for the details.

Table 2.4-4 Executive standard of ground water environmental impact assessment (mg /L) (Except the pH)

SN	items	standard value
1	pH value	6～9
2	Do	≥3
3	permanganate index	≤10
4	COD	≤30
5	BOD5	≤6
6	NH3-N	≤1.5
7	TP	≤0.3
8	As	≤0.1
9	Hg	≤0.001
10	Cr	≤0.05
11	cyanide	≤0.2
12	Ar-OH	≤0.01
13	Oil Type	≤0.5
14	sulfide	≤0.5

Table 2.4-5Standard of ground water Quality Standard (mg /L)(Except the pH)

items	standard value	items	standard value
pH	6.5～8.5	Mn	≤0.1
Total hardness	≤450	Cu	≤1.0
Total soluble solids	≤1000	Pb	≤0.05
CODMN	≤3.0	Zn	≤1.0
fluoride	≤1.0	Cd	≤0.01
Nitrates	≤20	Cr+6	≤0.05
Nitrites	≤0.02	Hg	≤0.001
sulfate	≤250	As	≤0.05

ammonia nitrogen	≤0.2	Total Plate Count (个/mL)	≤100
Ar-OH	≤0.002	The total coliforms (个/L)	≤3.0
Fe	≤0.3		

Table 2.4-6 Integrated Wastewater Discharge Standard

Primary standard value	pH value	SS (mg/L)	BOD5 (mg/L)	CODCr (mg/L)	Oil (mg/L)	Animal and vegetable oils (mg/L)	Ammonia nitrogen (mg/L)
Level three	6-9	400	300	500	20	100	/

2.4.2.4 Ambient air

(I)According to ambient air quality functional zone classification, the project site belongs to the class 2 area, so within the scope of the evaluation, the ambient air quality standard is level 2 standard of Ambient Air Quality Standard (GB3095-2012). See Table 2.4-7for standard values.

Table 2.4-7 Level 2 Standard of Ambient Air Quality Standard (GB3095-2012)

SN	Pollutants	secondary standard mg/Nm3			The standard source
		annual mean	daily mean	hourly mean	
1	SO2	0.06	0.15	0.5	standard of Ambient Air Quality Standard （GB3095-2012）
2	NO2	0.04	0.08	0.2	
3	Nitrogen oxides	0.05	0.1	0.25	
4	TSP	0.2	0.3		
5	PM10	0.07	0.15		
6	PM2.5	0.035	0.075		
7	CO		4.0	10.0	

(II) Emission Standard for Odor Pollutants (GB14554-93) is referred and implemented for air exhaust of ventilation system of stations.

(III) For construction dust, execute the Fugitive Emission Limit Values in " Integrated Standards of Air Pollutant Emission " (GB16297-1996) that is, particulate matter 1.0mg / m^3.

2.4.2.5 Electromagnetic radiation

(I) The strength of power frequency electric field and magnetic field of power transmission and transfer facilities is in accordance with stipulations in Technical Regulations on Environmental Impact Assessment of Electromagnetic Radiation Produced by 500 KV Ultrahigh Voltage Transmission and Transfer Power

Engineering (HJ/T24-1998), it's recommended that take 4kV/m as the assessment standard for power frequency electric field of residential area and take 0.1mT which is the power frequency limit value for public being exposed all day long stipulated by National Radiation Protection Association as the assessment standard for magnetic induction.

(II) For impact of electromagnetic interference at entrance-exit ground section on quality of television reception, take the damage measuring method recommended by International Radio Consultative Committee (CCIR) as reference, and the assessment standard is 35dB higher than signal to noise ratio.

2.5 Documents on urban planning and environmental function zoning

1. Zhengzhou Overall Urban Planning (2010-2020)

2. The "Six Lines" Planning of Zhengzhou City (2007-2020)

3. The Overall Planning of Forest Ecological Zhengzhou City (2003-2013)

4. The Historical and Cultural City Protection Planning of Zhengzhou (2007-2020)

5. System Planning of Urban Green Spaces of Zhengzhou City (September, 2002)

6. Ecological Function Zoning and Ecological Environmental Protection Planning of Zhengzhou City (March, 2004)

7. National Highway Passenger and Freight Transport Station Planning of Zhengzhou City (December, 2007)

8. Traffic Development Planning of Zhengzhou City (December, 2007)

9. Main Content Report of the General Zhengzhou Urban Land Use Planning (2005-2020) Modification Outline

10. Environmental Impact Assessment on Zhengzhou Rail Transit Line 1 First-stage Project

11. Environmental Impact Assessment on Zhengzhou Rail Transit Line 2 First-stage Project

12. Zhengzhou Urban Water Supply System Planning (2007-2020)

13. Zhengzhou 11th Five-Year Plan for Environmental Protection

14. Outline of the 11th Five-Year Plan for National Economic & Social Development of Zhengzhou City

15. The Water Environment, Atmospheric Environment, Acoustic Environment and Ecological Environment Function Zonings of Zhengzhou City

16. Planning of Matching Projects for South-to-North Water Diversion Benefited Regions.

2.6 Safeguard Policies of the World Bank

(1) The World Bank OP/BP4.01 and Annex (environmental impact assessment), January 1999

(2) The World Bank OP/BP4.12 (Involuntary Resettlement), June 1990;

(3) The World Bank OP4.11 (material and cultural resources)

(4) The World Bank BP17.50 (Information Publicity Policy)

(5) Common environment, health and security guidelines (EHS Guidelines)

(6) Railway environment, health and security guidelines (EHS Guidelines)

2.7 Analysis on conformance of requested project with relevant regional policies and planning

2.7.1 Analysis on consistency with the overall urban planning

Zhengzhou city overall planning aims to build an urban structure characterized by “one core encircled by four cities, and two axis areas plus one stripe area” based on the main roads and towns along the rail transit line, so as to form the hierarchical urban network with a proper structure and excellent interaction which is centered with central areas and outside groups, supported by medium-sized cities, separated by major towns and surrounded by other towns.

One core: including the central area and three outside groups (the group of Zhengbian area - Zhongmu County, group of Airport, group of Shangjie District - Xingyang County).

Four cities: referring to the four medium-sized county-level cities including Gongyi City, Xinzheng City, Xinmi City and Dengfeng City.

Two axis areas: the east-west axis area comprised of central Zhengzhou city, Zhengbian - Zhongmu group, Shangjie District - Xingyang group, Gongyi City and the towns and small cities, all of which are located along such arterial traffics as Lianyungang-Huoerguosi Expressway and Lianyungang-Lanzhou Railway; the north-south development axis comprised of central Zhengzhou city, Airport District group, Xinzheng City and towns, all of which are along arterials traffics like Beijing-Hongkong - Macao Expressway and Beijing-Guangzhou Railway etc.

One stripe area: the east-west development stripe constituted by cities and towns like Dengfeng city area, Xinmi City area and Xinzheng City area etc. along the provincial-class arterial traffics.

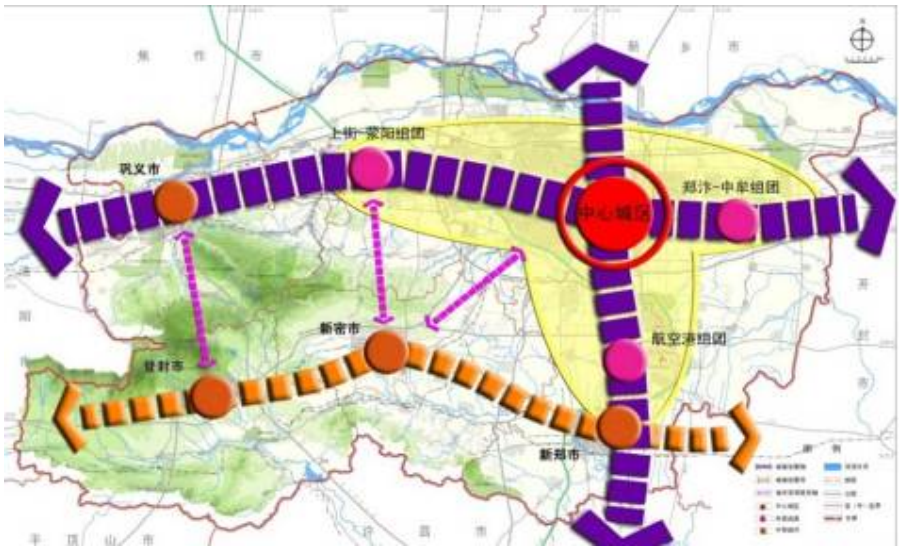


Figure 2.7-1 Zhengzhou City Space Layout

The future nature and size of Zhengzhou City require a modernized comprehensive traffic system suitable for the modern life which is in alignment with the overall urban development level. Hence, it's a necessary trend to build the public transport network centered on rail transit with large and medium passenger capacities, which is essential to the sustainable development of urban transportation.

Such works as the formation of new urban space structure, redistribution of the population and land expansion depend on the strong support of transportation infrastructure system. According to the current urban situation of Zhengzhou, density populated regions are concentrated in several areas, the land expansion speed being greater than the population growth rate though. The phenomenon is caused largely by the existing traffic system failing to satisfy the city's expanding needs in operation characteristics and service levels etc. Take Zhengdong New District for example, after nearly ten years' development, it's still haunted by problems like slow development speed, weak commercial atmosphere, poor supporting facilities and few employment posts etc., which hinder its functioning in leading Zhengzhou's leapfrog development and bearing regional service responsibilities; and here we cannot neglect the contribution of lacking convenient transport communications between the new district

and old district, CBD and Erqi Square. The urban rail transit will provide fast and convenient communications for the medium-distance travels within city scope, being the important transport line connecting central cities and outside groups as well as the connection among outside groups; it will cover major functional centers and passenger flow channels of the city, supporting and leading the urban space development.

The Line 3 project connects the commercial center of Erqi Square, the old city areas and Zhengdong New District, providing powerful transportation support for Zhengzhou's development and being coordinated with Zhengzhou City overall planning.

2.7.2 Analysis on consistency with the construction planning

(1) Overview of the rail transit construction planning

Zhengzhou city government began to draw up the Zhengzhou Urban Rail Transit Construction Planning (2013-2020) in 2010 in order to ensure the continuity, feasibility and reasonability of the construction work, bring the rail transit network into realization as soon as possible, speed up the construction process and provide construction bases for the follow-up projects. The planning has passed the assessment by China International Engineering Consulting Corporation now.

Combined with the progress of original construction planning and the recent development situations of Zhengzhou City, the current planning progress that the second-stage projects of Line 1 and Line 2 and the first-stage projects of Line 3 and Line 4 as well as Line 5 shall be put into construction after completing the first-stage projects of Line 1 and Line 2; the first-stage project of Line 3 will start in 2014 and come into use in 2016.

Figure 2.7-3 Line Sketches of the Second-stage Construction Planning (2013-2020)

(2) Analysis on conformance to the construction planning

The line designing conforms strictly to the Zhengzhou Urban Rail Transit Construction Planning in terms of line routes, laying methods, car depots and parking lot set-up etc., therefore it's consistent with the construction planning.

2.7.3 Analysis on consistency with environmental impact assessment

According to the Environmental Impact Law (EIA), the construction office entrusted Transport Planning and Research Institute of the Transport Ministry with the environmental impact assessment on Zhengzhou Urban Rail Transit Construction Planning (2013-2020) in December, 2010. Now the planning has got appraised by the expert review which is organized by the assessment center of environmental protection ministry.

Main contents related to Line 3 in planned environmental impact assessment:

"Since the first-stage project of Line 3 is planned to go through Erqi Memorial Tower, the line location and burial depth in the passing section of Line 3 shall be optimized in consideration of the anti-vibration distance of historic buildings and it's necessary to take enough mitigation measures so as to eliminate adverse impacts on historic architectures." In March 2010, the Protection Scheme of Erqi Memorial Tower Passed Through by the Rail Transit Project of Zhengzhou City from Sides was compiled by Zhengzhou Metro Limited Corporation and Zhengzhou Cultural Relics Bureau and got approval of the expert review meeting; the design and construction of Line 3 strictly comply with requirements specified in this scheme and conform to the

construction planning.

“The noise protection distance shall be: 10m for class 4a and class 3 areas, 22m for class 2 areas and 47m for class 1 areas. And the protection distance against vibration shall be 35m when the line passes through ‘residential and educational areas’. The minimum distance between architectures above the tunnel and the tunnel outer wall should be greater than 10m so that noise impact of the underground lines on indoor secondary-structure of the architectures could be avoided. And it’s inappropriate to construct high-crowded buildings like schools, hospitals and concentrated residential buildings within areas 30m from the ventilation kiosk. In addition, the main transformer station must be away from sensitive buildings (hospitals, schools, kindergartens, densely-populated residential buildings etc.), ensuring the minimum distance being greater than 50m and away from the residential areas as far as possible; the main substation wire incoming should adopt buried cables so as to weaken the electromagnetic pollution and radio interference caused by aerial transmission lines.” The design and construction of Line 3 as well as its land utilization planning comply with the above requirements completely, therefore, the project is carried out with satisfactory conformance to the planning environmental impact assessment.

2.7.4 Analysis on consistency with regional economic and social development planning

Zhengzhou has undergone a sustained and rapid growth economically and socially in recent years. Since 2000, the average growth rate of its Gross National Product (GNP) has kept 19.2%; in 2011, the urban total output value reached 491.27 billion yuan, ranking the 20th place among all medium and large cities in China; the general budget revenue of local finance for the whole year sumed up to 50.23 billion yuan, ranking the 17th; and the total retail sales of consumer goods reached 198.71 billion yuan, ranking the 19th.

The large urban investment in infrastructures could break through “bottlenecks” in regional economic development, producing direct or indirect “induced investment”, which can bring about great investment benefits. According to rail transit construction experience of other cities in China, the direct contribution of rail transit construction investment to local GDP is considerable - a 100 million yuan investment can produce over 263 million yuan of GDP and create 8,466 employment posts, to say the least. The construction investments of Line 3 can not only promote social employment, but also stimulate domestic demand and play a significant role in promoting and maintaining the sustainable development of economy in Zhengzhou.

Line 3 rail transit goes through the east-west development axis, covers the radial northwestern and southwestern passenger flow corridors, and connects the high-tech development district, northwestern area, Jinshui-Zhongyuan area, central urban area, new railway station area and the Economic And Technological Development Zone;

regions that Line 3 passes are recent priority development areas determined in Zhengzhou Overall Urban Planning (2007-2020).

Construction of Line 3 is critical to urban space expansion, traffic integration, proper industrial layout and optimized spatial arrangement, carrying great significance for integrating regional resources, strengthening competitive industrials, accelerating population and industrial concentration and putting forward balanced development among regions.

2.7.5 Analysis on consistency with ecological function zoning

2.7.5.1 Analysis on coordination with the general land use policy

The land use efficiency of rail transit is much greater than that of other regular ground transportations, hence, it's capable of improving the urban land use efficiency and resource carrying capability of city infrastructures except for its function in alleviating traffic congestion and guiding the urban space layout optimization and adjustment. Developing rail transit is in accordance with "implementing the basic state policy of 'cherish and utilize land rationally'" and the principle of land resources protection and utilization specified in Zhengzhou city overall planning - "Implement scientific development view and change land use patterns. Strictly protect arable land and basic farmland, abide by provisions on construction exclusion and restricted areas; optimize land use structures and layouts and improve the comprehensive benefits; reinforce the reclamation of industrial and mining wastelands, farmland arrangement and pollution control works, protecting and improving the ecological environment; promote coordinating urban-rural integration development, and guarantee sustainable utilization of land resources."

2.7.5.2 Basic farmland protection

The project involves no basic farmland protection areas according to Feasibility Report of Line 3 Project Site Selection and the Opinion of Land Use Pre-approval issued by the Land and Resources Bureau.

3 Description of the project

3.1 Construction background

According to Zhengzhou Rail Rapid Transit Construction Planning (2013-2019), the government plans to start the construction work of Line 1-6 in a short term. The firs-stage projects of Line 1 and Line 2 started in June 2009 and December 2010 respectively, and the first-stage project of Line 3 is planned to begin in 2014 and come into use in 2016.

3.2 Construction necessity

3.2.1 Line 3 runs through the main development axis in the east-west direction and covers the two radial passenger flow corridors in northwestern and southwestern city areas, which has great significance for promoting the concentration and cultivation of east-west axis areas' regional service functions, facilitating city development and playing the steering role in making appropriate urban layout.

According to Zhengzhou Overall Urban Planning (2007-2020), there are four priority development areas in recent years: firstly, continue to develop the high-tech industrial development zone in Xushui groups; secondly, develop university campus park in the west to integrate with the High-Tech Industrial Development Zone; thirdly, develop Zhengdong New District in the east which is the key developing project of Henan Province and will become the new city center, and large construction projects such as the International Convention and Exhibition Center and Longzi Lake university campus park have been put into implementation planning; fourthly, build the eastern economic and technological development zone.

The rail transit line 3 links the High-Tech Industrial Development Zone, northwestern area, Jinshui-Zhongyuan area, city core area, New Railway Station District and the Economic and Technological Development Zone together; the areas Line 3 passes belong to the recently prioritized developing areas determined in the Zhengzhou Overall Urban Planning (2007-2020); its construction plays an important role in accelerating the concentration and cultivation of east-west developing axis area's regional service function, promoting city development and guiding the appropriate urban layout.

3.2.2 The construction of Line 3 can effectively alleviate traffic congestion in the east-west transportation corridor, relieve the traffic pressure of city center and offer convenience for people's daily travel.

The latest demographic information shows there are 2.33 million registered population and 1.2247 million floating population in Zhengzhou now, and the total population is 3.5547 million. The urban center is highly populated, which brings tremendous pressure to the city center's traffic. And there are defects in the existing road traffic system, reflecting the contradiction between traffic supply and demand more prominently, thus traffic paralysis caused by congestion in the core city zone may occur at any time. It's predicted that the annual passenger traffic volume of public transport in 2015 will increase to 1.6 billion person-times from the number of 0.65 billion in 2007, with an average annual growth rate of 10.5%, and the number will reach up to 2.13 billion person-times in recent years (in 2020).

Without rail transit, the average travel speed in urban center will decrease to 13.5km/h in 2015, which shall bring more serious traffic congestion. Assuming the plan was executed, a cross-shaped skeleton line would have been built in 2015, which would relieve road congestion to some extent and increase the average travel velocity to 15.1km/h, effectively improving the travel efficiency. Another example, if the rail transit is not constructed, the average travel speed in core areas will decrease to 9.37km/h in 2020 and the traffic congestion problem will turn extremely severe (the average travel speed in the urban center shall be 10.9km/h). However, if the intersecting line network composed of rail transit line 1, 2, 3 and 4 has been constructed in 2020 according to the planning, the congestion problem would be largely solved with a significantly improved travel efficiency (especially the average traffic speed in city center will reach 18.7km/h, maintaining the reachable level in 2007.)

3.2.3 Construction of Line 3 is the inevitable choice for enhancing city environment of Zhengzhou, implementing sustainable development and facilitating social and economic development.

Transportation acts as a guide in city development in certain cases. The urban rail transit can increase land use benefits, improve the developing intensity of lands along the line, becoming the urban land developing axis or city development axis so as to bring the planned city layout into realization. Besides, the rail transit construction can lead the formation of outer groups and satellite cities, transforming city development from the groups mode into that based on land layout of the overall urban planning.

In order to lead the future urban layout effectively, the spatial and efficiency constraints reflected on omnibuses must be eliminated. It's necessary to choose rail transit as the backbone of public transport system for its characteristics of high speed, large capacity, small land occupation and no pollution, so as to widen the developing framework of Zhengzhou city, enlarge city size, and realize the strategic objective of transforming

Zhengzhou from the provincial capital into a national regional central city. Therefore, the construction of Line 3 project is extremely essential.

3.3 Project overview

3.3.1 Project construction scale

Line 3 is a northwestern - southeastern slant and radial backbone line in the city center. The first-stage project starts in the north from Xinliu Road Station of Provincial Sports Center in Huiji District and ends in the south at East Hanghai Road Station of Jingkai 17th Avenue in Economic and Technological Development District; the total length is about 25.2km with 21 stations, 1 car depot and 1 parking lot, and the whole line is underground. The line is laid along Changxing Road, Nanyang Road, Minggong Road, Jiefang Road, Xidajie Street, Dongdajie Street, Zhengbian Road, Shangdu Road and Jingkai 17th Avenue, linking different-level urban function centers like Erqi Square commercial center and the Economic and Technological Development District center, with an average station spacing of 1.29km. The project construction is planned to start in the beginning of 2014 and complete for trial running in 2016. Total static investment in the first-stage construction is 18.20853 billion yuan, coming from the financial fund and commercial loan. Among the total investment, the urban and district-level financial contribution and commercial loan are respectively 7.64758 billion yuan and 10.56095 billion yuan, accounting for about 42% and 58% separately.

3.3.2 Line

3.3.2.1 Main technical standard of line

(1) Number of main line: double line

(2) The minimum curve radius of line plane

Main line of section: 350m for general section, and 300m for difficult section.

Auxiliary line: 250m for general section, and 150m for difficult section.

(3) The longitudinal grade of line

The interval maximum gradient: 30‰ for general section and 35‰ for difficult section

The tunnel minimum gradient : 3‰ for general section of main line, less than 3‰ for difficult section under the condition of ensure the drainage; 2‰ for general section of the station platform part.

The turnout should be located in the grade of no more than 5‰for general section,and no more than10‰ for difficult section.

(4)The minimal vertical curve radius

5000m for the interval main line and 3000m for difficult section.

3000m for the end of the station and 2000m for difficult section.

3.3.2.2 Line route

Line 3 construction is divided into two stages; the first-stage project ranges from Xinliu Road Station to East Hanghai Road Station, including 21 stations, 1 car depot and 1 parking lot with the total length being about 25.2km.; the second-stage project ranges from East Hanghai Road Station to Jingnan 15th Road, including 4 stations and the total length being about 6.1km. This assessment is directed at the first-stage project only.

The line starts in the north from Provincial Sports Center and is laid along Changxing Road with Xinliu Road Station as the first station, then the line crosses the overpass of Nanyang Road underground, turns southward to Nanyang Road, runs southward along Nanyang Road, setting stations at Nanyang Road and Xinglongpu Road, Dongfeng Road, Nongye Road and Huanghe Road (crossed with line 5 for passenger transfer); later it crosses Dashiqiao overpass underground and Jinshui River, setting Jinshui Road Station at the north side of Dashiqiao overpass; the line continues to run along Minggong Road, setting Taikang Road Station at the intersection of Minggong Road and Taikang Road; then it turns to Jiefang Road and runs until Erqi Square which is set as a station and intersected with line 1 for passenger transfer; later the line passes around Erqi Memorial Tower and runs eastward along Xidajie Street, Dongdajie Street and Zhengbian Road, setting stations at Shuncheng Street, Dongdajie Street (intersected with line 2 for passenger transfer), Chengdong Road, Weilai Avenue (intersected with line 6 for passenger transfer), South Fengtai Road, Zhongzhou Avenue (intersected with line 4 for passenger transfer), Tongtai Road, East Huanghe Road, East Nongye Road, Zhongxing Road (intersected with line 5 for passenger transfer) and Boxue Road; then the line runs toward Economic and Technological Development District and stops at East Hanghai Road Station. There are double turn lines and in-and-out segment lines behind the station connecting the car depot. See Figure 3.3-1 “Sketch of Zhengzhou Urban Rail Transit Line 3” for the line details.

Figure 3.3-1 Sketch of Zhengzhou Urban Rail Transit Line 3

3.3.3 Station

Twenty one stations are laid in the first-stage project of Line 3 totally, all of which are underground stations. See Table 3.3-1 for the station distribution.

The first-stage project includes 10 stations for passenger transfer to 9 rail transit lines:

Xinliu Road Station, transfer station for the planned Metro line 4.

Dongfeng Road Station, transfer station for the planned Metro line 8 (the long-term line network planning).

Huanghe Road Station, transfer station for the planned Metro line 5.

Erqi Square Station, transfer station for Metro line 1 which is under construction now and the planned line 7 (the long-term line network planning).

Dongdajie Street Station, transfer station for line 2 which is now under construction.

Weilai Avenue Station, transfer station for the planned line 6.

Zhongzhou Avenue Station, transfer station for the planned line 4.

East Huanghe Road Station, the planned transfer station for line 13 (the long-term line network planning).

Zhongxing Road Station, transfer station for the planned line 5.

Boxue Road Station, transfer station for the planed line 9 (the long-term line network).

The table 3.3-1 The station distribution table Phase I Project of Zhengzhou Rail Transit Line 3

SN	Station	mileage	Length (m)	Form of station	Notes
	starting point.	K0+0			The starting point of the Phase I Project.
			130		
1	Xinliu road station	K0+130		Second floor underground island station	Set single crossover and out of line
			1430		
2	Samen road station	K1+560		Second floor underground island station	
			1310		
3	Xinglongpu road station	K2+870		Second floor underground island station	Set single crossover before the Station
			1630		
4	Dongfeng road station	K4+500		Second floor underground island station	And the 8th line transfer
			1220		
5	Agriculture road station	K5+720		Second floor underground island station	
			1480		
6	Huanghe road station	K7+200		Second floor underground island station	And the 5th line transfer Set double stop line
			1135		
7	Jinshui road station	K8+335		Detached island station	
			910		
8	Taikang road station	K9+245		Second floor underground island station	
			890		
9	Erqi square station	K10+135		Third floor underground island station	And the first and 7th line transfer
			780		
10	Shuncheng Sreet station	K10+915		Second floor underground island station	
			990		
11	Dongdajie Str eet station	K11+905		Third floor underground island station	And the second line transfer Set single crossover
			795		
12	Chengdong road station	K12+700		Third floor underground island station	
			1145		
13	Future road station	K13+845		Second floor underground island station	And the 6th line transfer
			930		
14	Fengtai south road station	K14+775		Second floor underground island station	
			1010		

SN	Station	mileage	Length (m)	Form of station	Notes
15	Zhongzhou avenue station	K15+785	940	Third floor underground island station	And the 4th line transfer
16	Tongtai road station	K16+725	1080	Second floor underground island station	Set double stop line
17	Huanghe east road station	K17+805	1020	Second floor underground island station	And the 13th line transfer
18	Agriculture east road station	K18+825	1465	Second floor underground island station	
19	Zhongxing road station	K20+290	1850	Second floor underground island station	And the 5th line transfer Set single crossover and connecting line
20	Boxue road station	K22+140	2840	Second floor underground island station	And the 5th line transfer Set connecting line
21	Hanghai east road station	K24+980	2500	Second floor underground island station	Behind the terminal station, there will be incoming and outgoing lines.

3.3.4 Track

1）Steel rail：Main line, test track and entrance & exit depot line all adopt 60kg/m steel rail；the other track adopts 50kg/m steel rail. Track gauge: 1,435mm。

2）Rail fastening：Elastic rail fastening.

3）Turnout: main line and auxiliary line adopt No. 9 turnout; yard track adopts No. 7 turnout.

4）Ballast bed

Main line: long-sleeper integrated ballast bed structure is adopted. According to the eia forecast vibration condition，using the corresponding vibration isolation track structure。

5）Sleeper laid the number：Main line：1600 roots/km for general section，The curve radius≤400m or line longitudinal slope≥20‰: 1680 roots/km；Yard line：1440 roots/km。

6）The maximum superelevation :120mm.

7）Average track structure height: 560mm (underground, (rectangular and U-shaped structure, open transitional section, monolithic track bed), 760mm (round); with elevated 520mm.

3.3.5 Vehicle

① Vehicle type selection

A type vehicle is adopted.

② Vehicle main geometric parameters

Under the "General Technical Conditions for Subway Cars" (GB/T7928-2003) and the Ministry of Construction's "Urban Rail Transit Project Construction Standards" (Jianbiao 104-2008), for the main technical specifications for Type-A cars, see Table 3.3-2.

Table3.3-2 The main technical specifications for Type-A cars

SN	NAME		A type vehicle
1	Body length of the basic /mm		22000
2	Body width of the basic /mm		3000
3	The maximum height of vehicle	The inverter vehicle	3800
		Motor Car with pantograph	3810
		Pantograph working height	3900~5600
4	interior height /mm		≥2100
5	High floor /mm		1130
6	axle weight /t		≤16
7	length between truck centers /mm		15700
8	rigid wheel base /mm		2200~2500
9	Each side door number		5
10	Passenger capacity	Fixed number of staff members or passengers（6 peoples/m2）	310
		overman（9 peoples /m^2）	432

③ The train operation parameters

Maximum driving speed: 80km/h

Start the average acceleration（0～35km/h）：0.9～1.0m/s^2

Common braking deceleration（80～0km/h）：1.0m/s^2

Emergency braking deceleration（80～0km/h）：1.2m/s^2

Shock Limit：≤0.75m/s^3

Riding index：<2.5

④Marshalling

Marshalling form of six-car metro train including four motor cars and two trailers in initial stage,short-term and long-term.

3.3.6 Power supply

Power supply mode

Advantages of centralized power supply rest with its few interfaces with urban power grids, self-developed system, convenience for scheduling management and high reliability etc.; besides, both line 1 and line 2 are constructed with the centralized power supply mode and the main substations of Science Avenue and Municipal Gym on line 1 reserve conditions for line 3 power supply; therefore, this study recommends centralized power supply mode for line 3.

Main substation

The main substation of line 3 is set up making full use of the proven design or substations under construction of line 1 and 2; the firs-stage project of line 1 builds two 110/35kV main substations at the Convention and Exhibition Center and Municipal Gym supplying power for electrical loads of line 1 first-stage project; and line 2 is also set up with 2 main substations, one of which is located at Guoji Road Station, the other of which shares the same one at Municipal Gym. And the Municipal Gym main substation under construction has already reserved conditions for line 3.

Line 3 is newly built with one main substation located at Boxue Road Station and one 35kV power switching station at Erqi Square. Two power paths are led from the main substation at Municipal Gym of line 1 to the 35kV power switching station at Erqi Square, the capacity being 2×40MVA. And the capacity of main substation at Boxue Road is also 2×40MVA, supplying power for line 3 and line 9 to realize resources sharing.

Traction substation system

The main track is set with 12 traction and step-down combined substations: Xinliu Road Station, Xinglongpu Road Station, Nongye Road Station, Jinshui Road Station, Shuncheng Street Station, Weilai Avenue Station, Tongtai Road Station, East Nongye

Road Station, Boxue Road Station, East Hanghai Road Station, Jingnan 8th Road Station and Jingnan 15th Road Station.

There is respectively one traction substation at the car depot and parking lot.

Step-down substation

There is one step-down substation at each station of line 3, and for stations with traction substation, the two kinds are integrated into traction and step-down combined substation.

Traction network system

The traction network of line 3 adopts the DC1500V overhead contact network.

3.3.7 Ventilation and air-conditioning system

3.3.7.1 System mode

The ventilation and air-conditioning system adopts the shield gate setting mode.

3.3.7.2 System constitution

The ventilation and air-conditioning system of shield gate mode is mainly constituted of the tunnel ventilation system and station ventilation and air-conditioning system. The tunnel ventilation system is composed of interzone tunnel ventilation system and the heat extraction system of station vehicle running district; the station ventilation and air-conditioning system includes the ventilation and air-conditioning as well as smoke exhaust system at the public zone of station (large system for short), the ventilation and air-conditioning as well as smoke exhaust system at the equipment and management room (small system for short) and the station refrigeration and air-conditioning system (water system for short).

The air-conditioning system includes air-conditioning water system and air-conditioning ventilation system. The air-conditioning water system is composed of chilled water system which includes water-cooling chiller, chilled water pump, pipeline and corresponding parts and the cooling water system which consists of cooling tower, cooling water pump, pipeline and corresponding parts. The air-conditioning ventilation system is installed at the public zone of station and the equipment and management room. The air-conditioning system is composed of air handler, fresh air handling unit, return/exhaust fan, air duct, air valve and muffler etc.

The ventilation system is composed of blowing/exhaust fan, air duct, air valve and muffler etc.

And the smoke exhaust system is composed of smoke extraction fan, smoke pipe and valve etc.

3.3.7.3 Operating mode of the system

(I) Tunnel ventilation system

A. Normal operating condition

Running tunnel ventilation system shall conduct vertically mechanical ventilation for half an hour before operation in the morning; and switch to normal operating mode after completion of ventilation.

When the train is normally operating, station tunnel ventilation system is put into operation, and running tunnel ventilation system stops operation, ventilation is conducted through piston air shafts at both sides of station by piston effect of train.

After off-running at night, running tunnel ventilation system shall conduct vertically mechanical ventilation for half an hour, and air valves in all air ducts shall be opened after the completion of ventilation.

B. Blocking condition

When the train is blocked in running tunnel, running tunnel ventilation system shall conduct vertically mechanical air supply and exhaust for half an hour for blocked tunnel so that air environment conditions in blocked section can be met.

C. Fire accident

When the train on fire stops in station tunnel and passengers are evacuated, station tunnel ventilation system shall be operated for smoke exhaust; when the train on fire stops in running tunnel and passengers are evacuated, running tunnel ventilation system shall be operated for smoke exhaust as scheduled fire mode in tunnel, and passengers shall be evacuated under guidance.

(II) Ventilation and air conditioning system in public zone of station

A. Normal operating condition

Three basic operating modes are set according to seasonal variation during normal operating period of train, including little fresh air under air conditioning condition, full fresh air under air conditioning condition and full ventilation under non-air conditioning condition; operation of large scale system and water system shall be stopped operating after night train is stopped.

B. Passenger overcrowding at station

When passengers are over-crowded at station, combined air conditioner, refrigerating machine, chilled water pump, cooling water pump and cooling tower of large scale system shall operate at full-load under three basic operating modes.

C. Fire accident

When fire accident occurs in public zone of station, air conditioning water system of large scale system of station shall be immediately stopped and switched to fire operating mode of large scale system of station.

When fire occurs in platform (or station hall), air return system/exhaust system of platform (or station hall) and tunnel ventilation system shall be simultaneously operated for smoke extraction; natural air supply is realized through entrance & exit and channel of station.

(III) Ventilation and air conditioning system in rooms for equipment management at station

A. Normal operating condition

When full-air air conditioning system is adopted, little fresh air under air conditioning condition, full fresh air under air conditioning condition and full ventilation under non-air conditioning condition can be selected for operation; when fan coil unit plus fresh air conditioning system is adopted, air conditioning condition adopts fan coil plus fresh air for operation, non-air conditioning condition only supplies fresh air and exhausts air for these rooms; rooms for equipment management only equipped with ventilation system operate under ventilation mode in the whole year.

B. Fire accident

When fire occurs in rooms for equipment management, corresponding system will immediately switch to scheduled fire operating mode, smoke extraction shall be conducted for internal channels with smoke extraction system, and pressurized air supply shall be performed for station control room, internal channels and closed stair halls.

3.3.8 Water supply & drainage and fire protection

3.3.8.1 Water supply

Water source is from urban tap water network, and two lines of water main are set.

3.3.8.2 Drainage

Fecal sewage of stations along the line shall be discharged with ordinary domestic sewage into nearby urban sewage system after treatment in septic tank; waste water from fire protection and washing shall be discharged into urban rain water system through natural flow or pumping.

Waste water from car washing in car depot, overhaul and protection technology shall be discharged into nearby municipal supporting pipelines after treatment and coming up to standard.

3.3.8.3 Fire protection

Fire protection water system is set in stations and fire hydrant system is set in underground sections.

3.3.9 Car depot and comprehensive base

The total length of line 3 is 31.3km, including one car and one parking lot in the whole line. The car depot is located in the area south of Jingnan 3rd Road, east of Beijing-Hongkong Expressway, west of Circle-city Railway and north of Xin'an Road, covering a surface of about 33.9ha; the parking lot is located in the plot which is south of Jialu River, east of Changxing Road, north of Lianyungang-Huoerguosi Expressway and west of Jinbei Road, covering an area of about 8.9ha.

3.3.9.1 Xinliu road parking lot

(1) Entry-exit line segment

The entry-exit line is designed to start from the scissors crossover behind Xinliu Road Station and laid northward about 600m, then turns northwest along a curve with a diameter of 500m, runs through Lianyungang-Huoerguosi Expressway vertically and enters the parking lot from northeast. There are two curves in the entry-exit line, the diameter being 500m and 200m respectively.

When coming out of the station, the entry-exit line should remain slope of the main track. A 2‰-gradient downward slope is set used for station-end turn-back, the length of which is 300m; then a 827.65m-long, 10.15‰-gradient upward slope is set to guarantee the clear distance for running through Lianyungang-Huoerguosi Expressway underground; after running through Kaifeng-Luoyang Expressway underground, the line runs along the 35‰-gradient slope into the parking lot, the rail top elevation of which is 94.14m.

(2) Layout

The overall layout of Xinliu Road parking lot is designed on the basis of stub-end depot type. According to technologic needs, the scheme plans such production rooms like

application depot and project garage, and production support constructions like complex building, canteen and bathroom, drivers' apartment, combined substation, signal cabin and sewage treatment station etc.

The application depot is arranged at the east part of the plot, containing parking train checkup shed, maintenance warehouse and car washing house. The parking train checkup shed is designed with the layout of one line and two columns, including 12 tracks and 24 parking positions. The maintenance warehouse is constructed at the north side of parking train checkup shed, designed with 2 parking positions. The car wash house is located at the south side of parking train checkup shed, washing trains at the stub-end; the car washing machine is separated with a line segment no shorter than the length of a car in the long-term planning at each end so as to satisfy the washing requirements. The project garage is built at the north side of application depot's throat.

Such constructions like complex buildings, canteens and drivers' apartments constitute the life and office area in front of the plant which is arranged at the north side of entry-exit line, being close to the main access, south side of the combined substation and signal cabin's throats, as well as the load center.

There are two accesses connecting to outside in Xinliu Road parking lot. The main access is located at the west part of the plot, opening to the planned Changxing Road and being close to the life and office area in front of plant; the secondary access is located at the east part of the plot, opening to the planned Guhe Road.

The overall layout of Xinliu Road parking lot is shown in Figure 3.3-2.

(3) Operating character and scale

The main equipment in Xinliu Road parking lot includes parking train checkup shed, maintenance warehouse, car washing house and track garage, the former three are integrated into the application depot.

According to needs of application and overhaul process, there are totally 20 lines in Xinliu Road parking lot:

Twelve lines are designed with the stub-end type for parking train checkup, through which each track can park 2 trains and there are 24 parking positions totally; two lines are for train maintenance; one line is for car washing, built together with the parking garage, and there is one effective line segment no shorter than the length of a car at each end of the car washing machine; one line is for project vehicle parking; and one line is for flat car which is close to the project garage and convenient for cargo transportation; one is lead track, used for car scheduling within the area; the left two are access tracks.

Main overhauling tasks assumed by Xinliu Road parking lot are shown in Table 3.3-3.

Table 3.3-3 Main overhauling tasks assumed by Xinliu Road parking lot

	Intermediate repair	Temporary repair	month examination	Parking lot		
				initial stage	Short-term	Long-term
Hanghai east road car depot	3+3	2	2	32	32	32
Xinliu road parking lot	0	0	2	16	16	32
total	3+3	2	4	48	48	64

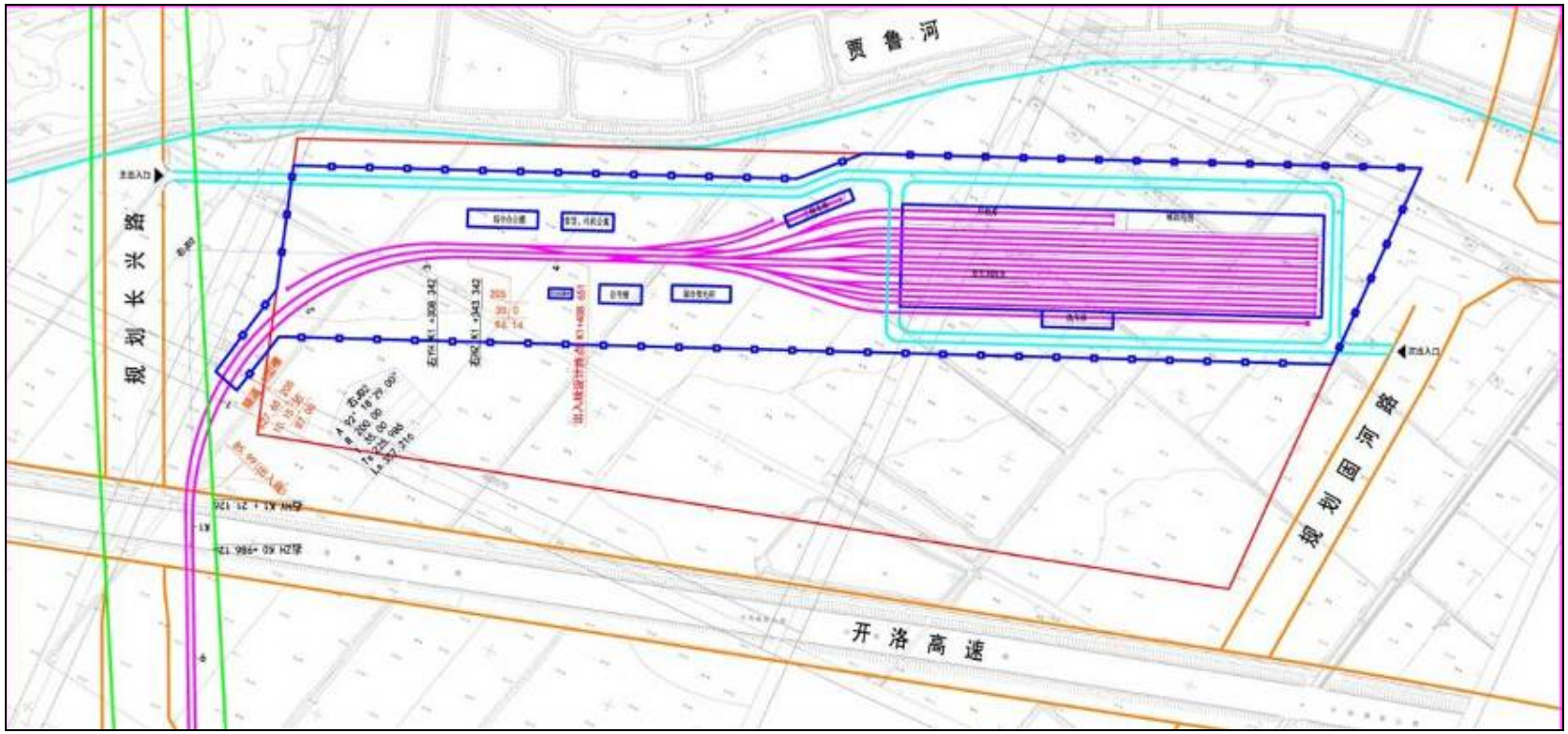


Figure 3.3-2 Layout Plan of Xinliu Road Parking Lot

3.3.9.2 East Hanghai Road car depot

(1) Entry-exit line segment

The car depot access line is connected from behind the East Hanghai Road Station. There are less control factors for horizontal aspect of the access line, but 3 control factors for vertical section including running across the left main track, passing through Chaohe River from underground and gonging through Beijing-Hongkong-Macao Expressway from underground.

The starting point of access line is designed at the scissors crossover behind East Hanghai Road Station, and the line is laid southward until about covering 300m, then turns east along a curve with the diameter of 300m and later turns south along another curve with the diameter of 250m after being laid along Jingnan 3rd Road about 1.6km, finally enters the car depot. The access line is set with 2 curve areas, the diameters of which are respectively 300m and 250m.

After leaving the station, the access line is set with a 880m-long and 2‰-gradient upward slope which runs across the left main track and can be used for station-end turn-back; then it is set with a 700m-long and 2‰-gradient downward slope for running through Chaohe River from underground; after running through Chaohe River, the access line is set with a 788.9m-long and 14.42‰-gradient upward slope for running through Beijing - Hongkong - Macao Expressway; finally a 220m-long and 30‰-gradient slope is set for entering the car depot, the rail top elevation of which is 95.64m.

(2) Layout

The overall layout of the scheme is designed with paralleled stub-end depot type. According technological needs, the scheme plans production rooms like application depot, unite overhauling house, track garage, scheduling machine house and service shop etc. and such production supporting houses as complex buildings, drivers' apartments, canteens and bath rooms, material depots, combined substations and signal cabins and so on.

The overall layout of East Hanghai Road car depot is shown in Figure 3.3-3.

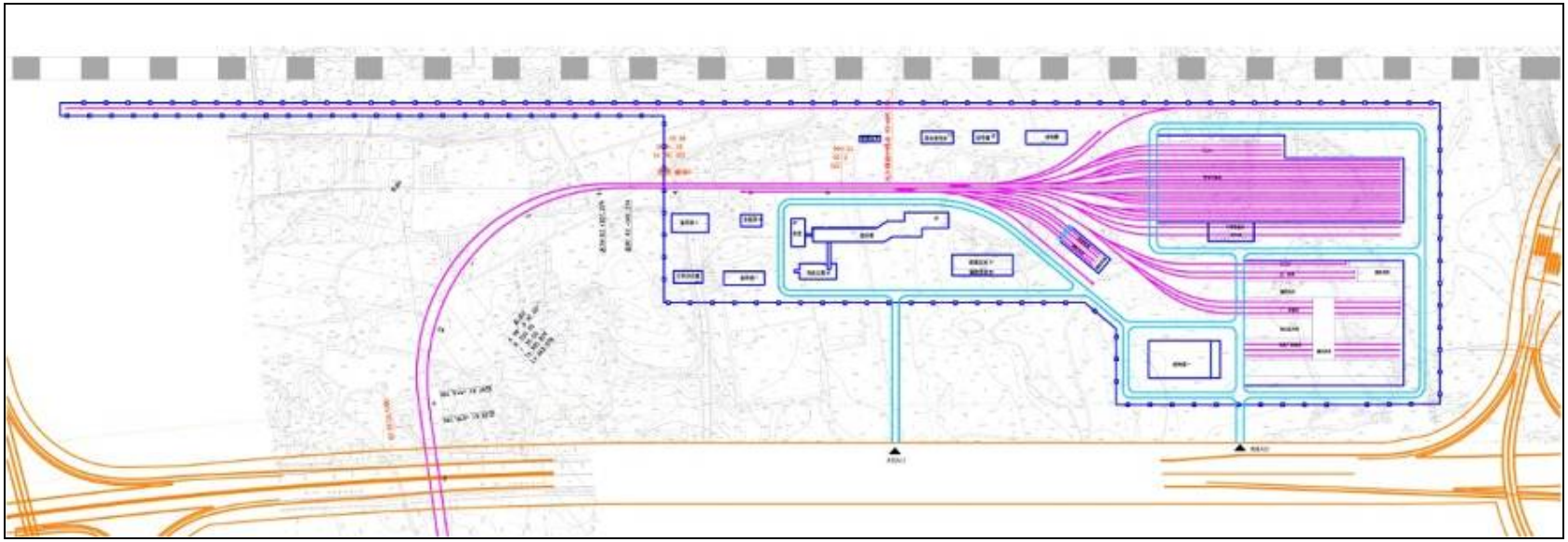


Figure 3.3-3 Layout Plan of Hanghai east Road Parking Lot

(3) Operating character and scale

East Hanghai Road car depot is mainly composed of two construction groups: the application depot and unite overhauling house; other production and life supporting facilities are arranged around the two construction groups.

The application depot includes parking train checkup shed, maintenance warehouse, static scheduling house and car washing house as well as the workshop supporting house.

The unite overhauling house includes regular and provisional maintenance depot, shop and intermediate repair depot, cleaning depot, bogie maintenance shop, motor elements maintenance shop, parts maintenance shop, car moving platform and shop supporting house.

Other constructions include scheduling machine depot, equipment maintenance shop, accessories storage warehouse, signal cabin, substation, office building and drivers' apartment etc.

Main overhauling tasks of East Hanghai Road car depot are listed in Table 3.3-3.

3.3.10 Control center

According to project plan of Zhengzhou Rail Transit Dispatching Center, physical locations of 10 lines control center share Dispatching Center Building near Zhengzhou East Railway Station, and project of dispatching center is under construction. When multiple line delivery operation forms network operation, establish Line Network Emergency Command center at proper time. Each line control center reports running status of this train and running status of relevant system equipment (Integrated Supervisory Control System "ISCS", Automatic Fare Collection "AFC" system, communication and signal) to Emergency Command Center so that Emergency Command Center can collect, conduct statistics and analyze relevant information (including video information) of each line in rail transit network to supervise running condition of this line.

3.3.11 Transport capacity and operating plan

1）Designed year

Initial stage: 2022; short-term: 2029; long-term: 2044

2）Passenger flow volume

Table 3.3-4 Predicted Passenger Flow of Zhengzhou Subway Line 3

design period	Total passenger traffic volume of all day (10,000 person-time/day	Passenger transport intensity (10,000 person-time/km)	Maximum section of passenger flow of all day(10,000 person-time)	Average riding distance (km)
Initial stage （2022）	42.38	1.35	2.23	7.94
short-term （2029）	86.92	2.77	2.90	6.79
long-term （2044）	117.47	3.75	4.05	6.96

2）Traffic organization

① Marshalling:Marshalling form of six-car metro train including four motor cars and two trailers in initial stage,short-term and long-term.The maximum driving speed is 80km/h, and operation speed is 35 km/h.

② Operating time：Operating time in the whole day is 18 hours from 5 o'clock to 23 o'clock.

③ Number of trains：In initial stage: 129/day; in short-term: 181/day; in long-term: 247/day.

④ Operating plan

Table 3.3-5 Driving Plan of Whole Day (number of trains/day)

Time period	Initial stage	short-term	long-term
5:00-6:00	4	6	8
6:00-7:00	8	10	15
7:00-8:00	15	15+3	20+5
8:00-9:00	8	15+3	20+5
9:00-10:00	6	10	15
10:00-11:00	6	8	10
11:00-12:00	6	8	10
12:00-13:00	6	8	10
13:00-14:00	6	8	10
14:00-15:00	6	8	10
15:00-16:00	6	8	10
16:00-17:00	8	8	15

17:00-18:00	12	15+3	20+5
18:00-19:00	8	12+3	15+5
19:00-20:00	8	10	15
20:00-21:00	6	8	10
21:00-22:00	6	6	8
22:00-23:00	4	6	6
Total	129	169+12	227+20

3.3.12 Operating organization and seating capacity

Zhengzhou rail transit adopts transversal management mode, and operation of Line 3 is assumed by Branch Company of Zhengzhou Rail Transit Operation which is subordinate to Zhengzhou Rail Transit Co., Ltd.

Total length of Zhengzhou Rail Transit Line 3 in initial stage is 25.2km, seating capacity is 1,860 for operating management in initial stage with average 74 persons per kilometer line; total length of the line in short-term is 31.3km, seating capacity is 2,060 with average 66 persons per kilometer line; total length of the line in long-term is 31.3km, seating capacity is 3,010 with average 96 persons per kilometer line.

3.3.13 Construction period and project planning

(1) Construction period

According to the requirements of Zhengzhou Rail Transit Co., Ltd. for Line 3, Phase I project of Line 3 plans to be started at the beginning of 2014 and be open to traffic at the end of 2016 with total construction period of 3 years.

Construction progress of main projects:

Time of tunnel through: in the middle of February, 2014

Completion of rail laying: the end of July, 2014

Completion of power supply system installation and commissioning: the end of October, 2015

Completion of joint commissioning of system equipment: the end of June, 2016

Time of test run: the end of July, 2016

Test operation of opening to traffic: the end of December, 2016

(2) Construction methods

Phase I Project of Zhengzhou Metro Line 3 runs through current city zones of Zhengzhou and passes through prosperous commercial trade center of Zhengzhou. All adopt open-cut method except Jinshui Road Station. See Table 3.3-6.

Underground interval tunnel of this project adopts open-cut and shield methods for construction, see Table 3.3-7.

Table 3.3-6 Summary of Construction Method and Structural Shape of Line 3 Stations

SN	Name of station	Form of station	Construction method	Structural shape of station	Depth of foundation pit (m)	Containment form	Remarks
1	Xinliu Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	Transfer with Line 4
2	Shamen Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	
3	Xinglongpu Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	
4	Dongfeng Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	Transfer with Line 8
5	Agricultural Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	
6	Huanghe Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	Transfer with Line 5
7	Jinshui Road Station	Second floor underground separted island station	Cover dig method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	
8	Taikang Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	

9	Erqi square Station	Third floor underground island station	Open-cut method	Three-layer three-span box frame	23	The underground continuous wall	Transfer with Line 1 and 7
10	Shunchengjie Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	
11	Dongdajie Station	Third floor underground island station	Open-cut method	Three-layer three-span box frame	23	The underground continuous wall	Transfer with Line 2
12	Chengdong Road Station	Third floor underground island station	Open-cut method	Three-layer three-span box frame	23	The underground continuous wall	
13	Weilaidadao Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	Transfer with Line 6
14	Fengtai south Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	
15	Zhongzhoudadao Station	Third floor underground island station	Open-cut method	Three-layer three-span box frame	23	The underground continuous wall	Transfer with Line 4
16	Tongtai Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	
17	Huanghe east Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	Transfer with Line 13
18	Agricultural east Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	
19	Zhongxing Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	Transfer with Line 5
20	Boxue Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	Transfer with Line 9

21	Huanghai east Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	The terminal station of first phase of line 3
22	Nansanhuan Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	
23	Jingba south Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	Transfer with Line 11
24	Jingnan 12 Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	
25	Jingnan 15 Road Station	Second floor underground island station	Open-cut method	Double-layer three-span box frame	17	Cast-in-situ bored pile & waterproof curtain	

Table 3.3-7 Construction Method of Interval Tunnel

SN	Name of interval	Construction method	Structural shape of interval	Length of interval (m)	Buried depth (m)	Remarks
1	Xinliu Road-Shamen Road Station Interval	Shield & open-cut methods	Circular section and rectangular section	1090	10-16	Distributing area of Xinliu Road Station adopts open-cut method.
2	Shamen Road-Xinglongpu Road Station Interval	Shield methods	Circular section	1130	10~18	
3	Xinglongpu Road -Dongfeng Road Station Interval	Shield & open-cut methods	Circular section and rectangular section	1300	10~16	Distributing area of Xinglongpu Road Station adopts open-cut method.
4	Xinglongpu Road-Agricultural Road Station Interval	Shield methods	Circular section	980	10~16	
5	Agricultural Road-Huanhhe Road Station Interval	Shield & open-cut methods	Circular section and rectangular section	900	10~11	Distributing area of Hunaghe Road Station adopts open-cut method.
6	Huanghe Road-Jinshui Road Station Interval	Shield methods	Circular section	900	10~16	
7	Jinshui Road-Taikang Road Station Interval	Shield methods	Circular section	740	10~16	

8	Taikang Road-Erqi square Station Interval	Shield & open-cut methods	Circular section and rectangular section	605	10~16	Distributing area of Taikang Road Station adopts open-cut method.
9	Erqi square-Shunchengjie Station Interval	Shield methods	Circular section	630	10~19	
10	Shunchengjie-Dongdajie Station Interval	Shield methods	Circular section	760	10~11	
11	Dongdajie-Chengdong Road Station Interval	Shield & open-cut methods	Circular section and rectangular section	480	10~16	Distributing area of Dongdajie Station adopts open-cut method.
12	Chengdong Road-Weilaidadao Station Interval	Shield methods	Circular section	950	10~16	
13	Weilaidadao-Fengtai south Road Station Interval	Shield methods	Circular section	670	10~15	
14	Fengtai south Road-Zhongzhoudadao Station Interval	Shield methods	Circular section	785	10~18	
15	Zhongzhoudadao – Tongtai Road Station Interval	Shield & open-cut methods	Circular section and rectangular section	470	10~16	Distributing area of Tongtai Road Station adopts open-cut method.
16	Tongtai Road – Huanghe east Road Station Interval	Shield methods	Circular section	890	10~19	
17	Huanghe east Road –Agricultural east Road Station Interval	Shield methods	Circular section	785	10~16	
18	Agricultural east Road ~Zhongxing Road Station Interva	Shield methods	Circular section	1250	10~15	
19	Zhongxing road – Boxue Road Station Interval	Shield & open-cut methods	Circular section and rectangular section	1520	10~20	Distributing area of Zhongxing Road Station adopts open-cut method.
20	Boxue Road – Hanghai east Road Station Interval	Shield methods	Circular section	2590	10~16	

3.3.14. Quantity of Major Works

3.3.14.1. Construction Site

(1) The layout of a construction site should make full use of a station's building land,

and as far as possible, combine development plots, green belts, squares, etc, which will be used as temporary construction sites, but should be subject to consent of the municipal environmental protection and planning departments. For a location whose site layout is difficult and whose traffic volume is smaller, after a traffic police department's approval, its roads may be temporarily closed or part of its roads may be occupied as a construction site.

(2) The construction site for an underground station normally will take about 25 thousand square meters. Each station's geographical location is different, with a different environment and a different construction method, and some construction sites are relatively concentrated, and some are more dispersed, which requires that a construction team's comprehensive ability be stronger and its construction management level be higher.

(3) A shield shaft should be used as the assembly shaft and construction-related earth-going shaft of a shield.

(4) In order to ensure the smooth progress of the work of laying tracks, the track laying for the Phase-1 project of Line 3 should have two track panel bases at the car depot and parking lot to facilitate the track-laying operation.

3.3.14.2. Earthwork

The total amount of earthwork of Zhengzhou's Metro Line 3 will be approximately 4,974,000 cubic meters, of which the station excavation will be approximately 2,661,000 m^3, and filling will be 293,000 m^3; the interval shield soil excavation will be approximately 531,000 cubic meters, and the filling will be approximately 58,000 cubic meters; the Xinliu Road station's car park's dredging excavation will be a total of 120,000 cubic meters, and the filling will be 279,000 cubic meters; Hanghai East Road's car depot's excavation will be about 393,000 cubic meters, and the filling will be about 638,000 cubic meters. In this project, the total cut will be 3,705,000 m^3 and the total fill will be about 1,269,000 m^3 all of which will come from the cut.For the earthwork quantity of the project of Line 3, see Table 3.3-8.

Table 3.3-8.Earthwork Quantity of Phase-1 Project of Zhengzhou's Metro Line 3

Item	Excavation (ten thousand cubic meters)	Filling (ten thousand cubic meters)	Total (ten thousand cubic meters)
Station	266.1	29.3	295.3
Interval	53.1	5.8	58.9
Parking lot	12.0	27.9	39.9
Car depot	39.3	63.8	103.2
Total (ten thousand cubic meters)	370.5	126.9	497.4

Note: the earth for the inter-regional fill refers to those filling the area for the vehicle section and accesses to the parking lot.

3.3.14.3 Project Land

For the land covering situation of the Phase-1 project of Zhengzhou's Metro Line 3, see Table 3.3-9.

Table 3.3-9 Along-the-Line of Quantity of Land for the Project: Unit: hm 2

	Vegetable plot	Arable land	Orchard	Woodland	Other land	Total
Parking lot	5.5	6.4	0	0	2.3	14.2
Car depot	0	7.7	7.5	19.1	3.9	38.2
Station					2.9	2.9
Interval	0	0	0	0	0	0
Total						55.3

3.3.14.4 Quantity of Major Works

For the quantity of major works of the Phase-1 project of Zhengzhou's Metro Line 3, see Table 3.3-10.

Table 3.3-10. Quantities of Major Works

Item	Unit	Quantity	Remark
Length of line	km	25.2	All underground lines
Station	set	21	All underground stations
Car depot and parking lot	Set	2	Hanghai East Road's parking lot and Xinliu Road Station and car depot
Main substation	Set	1	Boxue Road Station's main substation
Demolition of buildings	m 2	101660	
Permanent site	Chinese acre	829.68	
Project investment	Ten thousand yuan	1820853	

4 Environmental Conditions

4.1 Overview of natural environment

4.1.1 Geographic location

Zhengzhou belongs to the central area of China, between the southeastern coastal region and the western expansion region and in both the Longhai economic belt and the Jingguang economic belt. It plays an important role in bridging the east and the west of China, and is one of the core cities that promote the rise of central China.

Zhengzhou, the capital of Henan Province, is the political, economic and cultural center of Henan Province. It is located in the north-central part of Henan Province, south of the Yellow River, east of Songshan Mountain, northwest of broad Huanghuai Plain, between 112°42′E and 114°14′E, and between 36°16′N and 34°58′N. It is 166km from east to west and 75km from north to south. Zhengzhou is 25km south from the Yellow River, 760km north from Beijing, 514km south from Wuhan, 570km east from Lianyungang and 480km west from Xi'an. Zhengzhou has one county (Zhongmu County), five county-level cities (Gongyi, Xingyang, Xinmi, Xinzheng and Dengfeng) and six districts (Zhongyuan, Erqi, Guancheng, Jinshui, Shangjie and Huiji, among which Shangjie District is an exclave). Its total area is 7446.2km2, among which urban area accounts for 1010.3km2 and built-up area was 328.6km2 (including Shangjie District 26.6km2) at the end of 2008. At the end of 2009, total population of Zhengzhou was 7,521,000 and urban population was 3,331,000. Green coverage ratio of Zhengzhou is up to 35.5%, so it is honored as "Green City in Central Plains of China". Jingguang Railway and Lianyungang-Lanzhou Railway intersect here. Therefore, it is one of the important railway terminals in China.

4.1.2 Landform

(1) Landform of the city

Zhengzhou is located in extension of eastern section of Qinling Mountains and in the transition zone between the second class landform sidestep and the third class landform sidestep. The overall topography is higher in the southwest and lower in the northeast. The topography steps down in the form of ladder from structural erosion middle-low mountains in the west and the southwest to structural denudation hills, loess hills, inclined plains (downland) and alluvial plains which form relatively complete geomorphologic sequence.

Mountains in Zhengzhou occupy area of 2377km^2 which accounts for 31.9% of total

area. Average altitude of mountain land is between 400m and 1000m. The highest point is main peak of Shaoshi Mountain (Yuzhai Mountain) with the altitude of 1512.4m.

Hills are distributed in the west of Jingguang Railway and in front and in the north of Songshan Mountain. Hills in Zhengzhou occupy area of 2255km^2 which accounts for 30.3% of total area. Altitudes of most hills are between 200m and 300m. Undulating degree of hills is relative small and the land exploitation potential is relatively large.

Plains can be divided into two parts, i.e. east plains and west plains. The east plains are located in the south of alluvial fan of the Yellow River and are mainly distributed in central area of Zhengzhou, Zhoumu and Xinzheng. The west plains are located in two sides of downstream of Yiluo River and Kuhe River and are distributed in Gongyi and Xingyang. Plains in Zhengzhou occupy area of 2815km2 which accounts for 37.8% of total area. The lowest point of Zhengzhou is in Shaogang of Zhongmu with the altitude of 75m. In plains, topography is flat, the soil is thick and water is adequate. Therefore, the plains are the main crop areas of Zhengzhou.

(2) Landform along the project

Line 3 of Rail Transit of Zhengzhou is located in central zone of Zhengzhou and belongs to plain area. The line mainly passes through municipal roads and green land. Elevation of the whole line is between 86.70m and 103.10m.

Based on geological data of Zhengzhou, the line mainly passes through two geomorphic units. Geomorphic unit between start point of the project and the inter-junction of the line and the Lianyungang-Lanzhou Railway is alluvial-diluvial plain of the Yellow River (area A). Geomorphic unit between East Hanghai Road and the end of the line is alluvial-diluvial plain of the Yellow River and the micro-topography is aeolian sand dune.

4.1.3 Climate and weather

Zhengzhou belongs to continental subtropical monsoon climate, so change in temperature is large. In summer, it is hot and rainy; in winter, it is cold and dry. Zhengzhou has four distinct seasons. Annual average temperature is 14.9℃. Average temperature in July is 27.8℃, and extreme highest temperature is 43.3℃. Average temperature in January is -0.3℃ and extreme lowest temperature is -17.9℃. The annual average rainfall is 640mm and the most rainfall is in summer. On record, the maximum rainfall is 866.8mm and the minimum rainfall is 439.3mm. Maximum snowfall thickness is 150mm and maximum thickness of accumulated snow is 230mm. Maximum freezing depth is 270mm. The annual average evaporation is 2048.8mm, maximum evaporation is 341.4mm in June and minimum evaporation is 80.5mm in January. October to April next year is frost period. In plain area, frost free period is more than 200 days. Throughout the entire year, northeaster and southeaster prevail

with average wind velocity 2.5m/s and maximum wind velocity 24m/s. Maximum sunshine hours are 4430.7h and average sunshine hours are 2189.5~2352.2h.

4.1.4 Engineering geology

4.1.4.1 Engineering geology of Zhengzhou city proper

Zhengzhou city proper is covered by quaternary loose deposits. Outcrops are middle Pleistocene, late Pleistocene and Holocene series stratum of quaternary.

(1) Middle Pleistocene series stratum (Q_2)

Middle Pleistocene series stratum is divided into middle Pleistocene series aeolian deposit, alluvium and diluvium. Aeolian deposit is mainly distributed in hills and rolling plains without outcrop. A layer of grit stone lens can be seen at the bottom of the stratum and light loam and loam in upper part of the stratum. Alluvium and diluvium are mainly distributed in inclined plains and flood plains without outcrop and are covered by late Pleistocene and Holocene series stratum. Buried depth of roof is 15-50m and thickness is 10-70m. The lower part is fine sand, medium-fine sand and gravel layer; the upper part is clay, loam and light loam.

(2) Late Pleistocene series stratum (Q_3)

Late Pleistocene series deposits are widely distributed in Zhengzhou city proper. Except for northeast of Zhengzhou, almost all outcrops are late Pleistocene series stratums. Late Pleistocene series aeolian deposits are widely distributed in hill downlands and rolling plains in the southwest. The top layer is dark brown paleosol (thickness about 1m). The lower layer is composed of light loam and loam. Late Pleistocene series alluvium and diluvium is distributed in surface layer of rolling plains. In the northeast, alluvium and diluvium are covered by Holocene series deposit with the thickness of 15-45m. The lower part is light loam, loam mixed with find sand, medium-fine sand and grit stone lens with thickness of 5-8m. The middle part is almost loam with thickness of 5m. The upper part is light loam as primary and loam mixed with sand lens as supplementary with thickness of 10m. There is a layer of breen loam with thickness of 1m at the top layer.

(3) Holocene series accumulation (Q_4)

It is distributed in flood plains and valleys in the east. It can be divided into three types, alluvial, aeolian and artificial accumulation. The artificial accumulation is mainly distributed in old city zone of Zhengzhou with thickness of 0.5-7m.

4.1.4.2 Engineering geology along the line

Based on geomorphic units and geotechnical properties along the line of the project, engineering geology along the whole line 3 is divided into two districts, i.e. district A

and district B.

Zone A: the range is from start point, through Nanyang Road, Erqi Square, Dongdajie Street and Zhengbian Road, to inter-junction of the line and Lianyungang-Lanzhou Railway. The mileage is K0+0.000~K23+200. Elevation of the ground is between 86.70m and 103.10m.

Zone B: the range is from inter-junction of the line and Lianyungang-Lanzhou Railway to the end point. The mileage is K23+200~K31+350.000. Elevation of the ground is between 87.10m and 95.00m.

Geomorphic unit of Zone A is alluvial-diluvial plain of the Yellow River. Stratum of the site within depth of 30m is mainly the Q4 Stratum. As to stratum of the site within 0-19.0m, the surface layer is artificial fill and miscellaneous fill and the lower layer is slightly dense and medium dense silt soil, and soft plastic and plastic silty clay mixed with silt sand and fine sand. Main stratum of 19.0-30.0m is medium dense and dense silt sand, fine sand and medium sand layer. The stratum under the depth 30m is Q_3 and earlier one. It is mainly hard plastic silty clay and dense silt soil and find sand layer.

Geomorphic unit of Zone B is alluvial-diluvial plain of the Yellow River and micro-topography is aeolian sand dune. Stratum of the site within depth of 30m is mainly the Q4 Stratum. As to stratum within 0-15m, the surface layer is artificial fill and miscellaneous fill and the lower layer is medium dense fine sand and silt soil mixed with thin silty clay. Main stratum of 15-33m is medium dense and dense fine sand layer. The stratum under the depth 33m is Q_3 and earlier one. It is mainly hard plastic silty clay and dense silt soil and find sand layer.

4.1.5 Hydrogeology

4.1.5.1 Characteristics of aquifer system

Groundwater types of Zhengzhou can be divided into clastic rock fissure water and loose rock pore water which are mainly and widely distributed groundwater types in Zhengzhou. The groundwater types and water yield property distribution figure are as shown in figure 4.1-1.

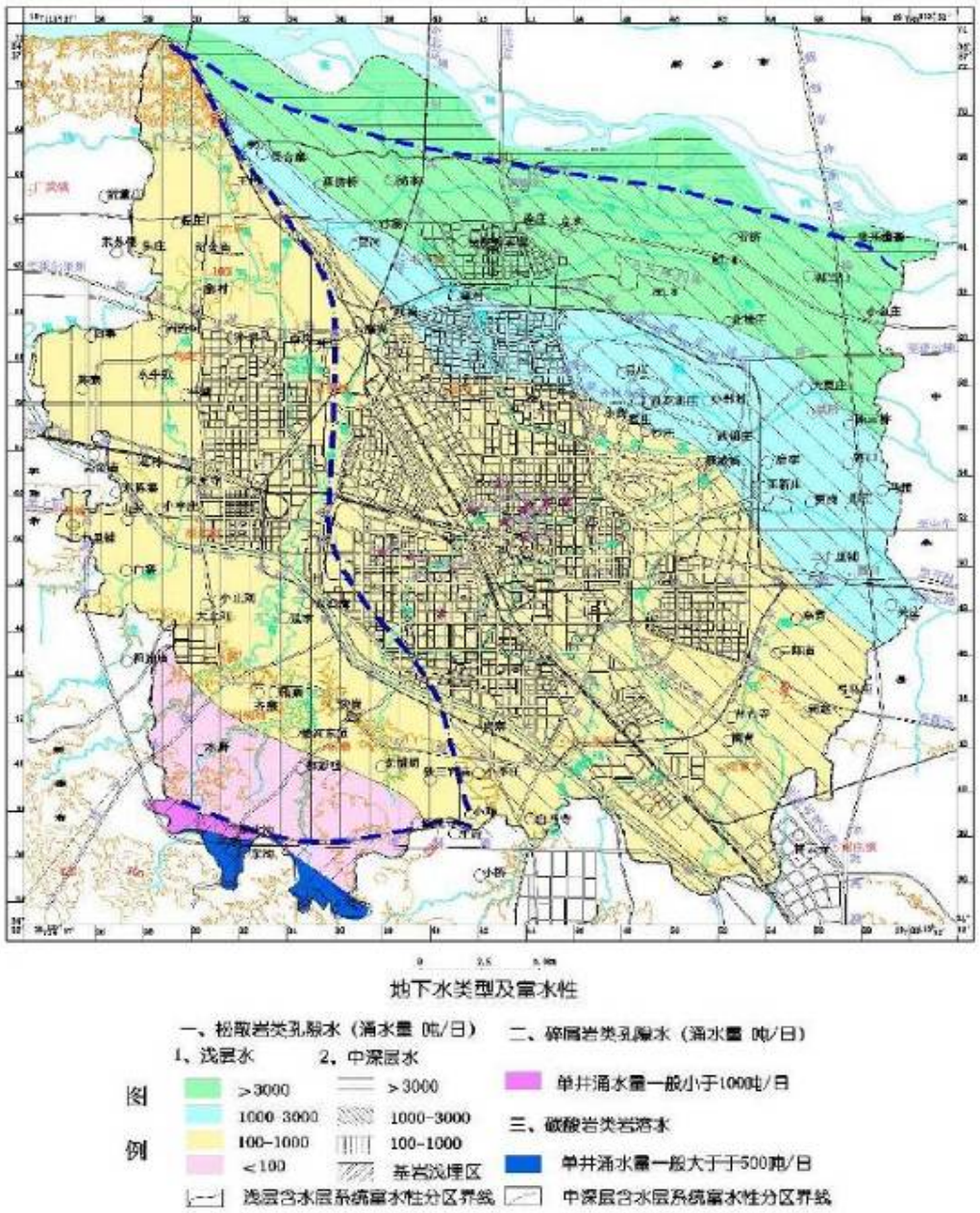


Figure 4.1-1 Groundwater types and water yield property distribution of Zhengzhou

Based on buried depth, hydraulic properties and exploitation condition of groundwater, Quaternary groundwater can be divided into shallow groundwater and mid-deep groundwater.

(I) Shallow aquifer system

Shallow groundwater generally refers to concealed water and micro confined water with the buried depth less than 60m. The zonation is clear. It covers from mountains

to alluvial plains. The particles are from coarse to fine. The water yield property depends on lithology and thickness of aquifer. Buried depth of bottom of shallow aquifer system is 50-70m in general. Buried depth in the east is relatively large and in the west is relatively small. In the east of Jingguang Railway, it is mainly composed of upper Pleistocene and Holocene series; Yuanqian plain in the west is composed of Holocene and upper Pleistocene series; Taiyuan zone has middle Pleistocene series as primary and lower Pleistocene series as secondary. The part under shallow aquifer system is separated by loam or loam sand aquitard and underlay aquifer. Thickness of aquitard is 25-45m. Shallow water is major water supply for suburban agriculture. Based on occurrence condition, lithology characteristics can be divided into:

(1) The pore water with sand and grit stone as main is distributed in alluvial plain of the Yellow River in the east of Jingguang Railway and in the north of Lianyungang-Lanzhou Railway. Aquifer is composed of one or two layers of middle and coarse sand, find sand and gravel in partial position. Buried depth of roof is 10-20m. Partial depth is less than 5m or more than 25m.

(2) The sand and clay pore water is distributed in Gouzhao, Shibali River and Yuanqian alluvial-diluvial plain in Nancao zone. Aquifer is mainly composed of silt, loam, clay and loam mixed with loess doll. Partial aquifer contains find sand with thickness of 2~6.5m (maximum 16.6m). The buried depth of roof is 4.3～30m.

(3) Clay and loess fissure pore water is distributed in Sanli and loess Taiyuan zone of Kuangshan Mountain in the southwest. Pore water in loess has been drained. The aquifer is mainly the underlay loam including loess doll layer.

(II) Mid-deep aquifer system

Mid-deep groundwater refers to confined water with buried depth of 60～350m. The particles are relatively coarse. Thickness is relatively large and water quality is good. Therefore, it is major water supply for industrial and agricultural production and urban domestic water. Mid-deep groundwater is distributed under the first stable aquiclude with the buried depth of roof 50-100m. Procuratorial College and Mazhuang Zone in the east achieve buried depth of the bottom. It is 300-380m in the east and 220-280m in the west. Aquiclude in the roof is mainly loam, sandy loam and clay with thickness of 10-50m. Aquiclude at the bottom is mainly the clay with thickness of 20-50m (maximum 80m). The aquifer system can be divided into two aquifers.

Aquifer of middle Pleistocene series is composed of one or two layers and multi-layer fine sand and mid-fine sand. Partial section is composed of mid-coarse sand or silt layer. The thickness is 10-30m. Buried depth of roof increases from 50m in the southwest to about 60-80m in the northeast. The maximum buried depth is almost 100m.

Aquifer of lower Pleistocene series: none in southwest; Northeast of

Wali-Dazhuang-Zhangweizhai is composed of 3-5m middle sand layer, mid-coarse sand and gravel. Partial section is composed of fine sand and silt. The thickness is 20-50m. Buried depth of roof increases from 70m in Yuanqian downland in the southwest to 140m in the northeast (maximum 155.5m). The structure is loose or semi-cemented. Water is abundant. It is the major exploitation target layer in Zhengzhou.

4.1.5.2 Recharge, runoff and discharge conditions

(1) Recharge, runoff and discharge of shallow groundwater

Shallow water of city proper and suburb is primarily from atmospheric precipitation infiltration and surrounding lateral runoff recharge and secondarily from canal infiltration and infiltration recharge of irrigation water. Shallow water near the Yellow River is primarily from lateral recharge of the Yellow River and the atmospheric precipitation infiltration. Based on relevant data, precipitation infiltration coefficient of alluvial plain of the Yellow River in the northeast is $(10\sim20)\times10^4m^3/km^2\cdot a$ and of surrounding suburbs is more than $20\times10^4m^3/akm^2$. Ground of the city proper is hardened, so it is not benefit for precipitation infiltration and precipitation infiltration coefficient is less than $5\times10^4m^3/km^2\cdot a$. Lateral seepage of the Yellow River is $8337.8\times10^4m^3/a$. Infiltration capacity of Changzhuang reservoir, Jiangang reservoir, Xiliu Lake and other artificial water bodies is $1010.56\times10^4m^3/a$.

Topography of Zhengzhou City is high in the southwest and low in the northeast. Influenced by the topography, natural flow direction of shallow groundwater of Zhengzhou City is from the southwest to the northeast. Influenced by increased exploitation, the groundwater depression cone is formed. In the cone area, the shallow groundwater flows from surrounding area to cone center. Statistic and cruising data of buried depth of water level in July, 2008 shows (in figure 3-4) buried depth of water level in suburbs in the east and alluvial plain in the north is mostly less than 5m or 5～10m and in city proper in the east of Jingguang Railway is mostly 10～15m, in the west of Jingguang Railway 15～35m, and suburbs in the west 20～40m.

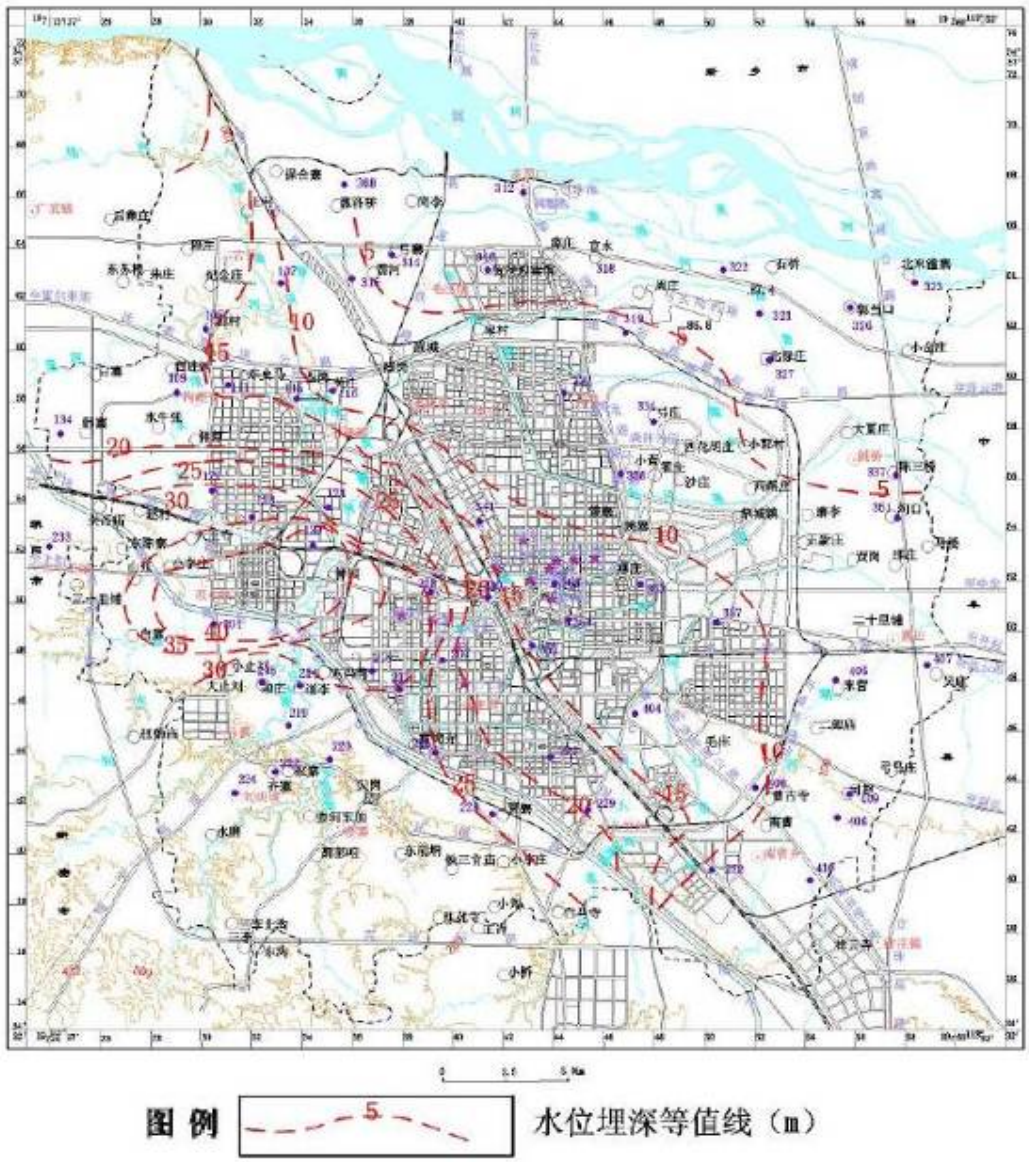


Figure 4.1-2 Contour line of buried depth of Quaternary shallow groundwater in Zhengzhou city proper

Discharge of shallow groundwater: in early period of exploitation, evaporation and exploitation are main approaches of discharge of shallow groundwater. Secondary approaches are runoff to the east out Zhengzhou and discharge in Huaihe River. After 1970s, influenced by labor exploitation, Zhengzhou has strengthened the exploitation of mid-deep groundwater. The mid-deep groundwater which was higher than shallow groundwater is lower than shallow groundwater now, which stimulates the shallow groundwater recharging the mid-deep groundwater. There is evaporation discharge in shallow buried area of shallow groundwater in the east and northeast. Besides, there is a little river discharge and lateral discharge.

(2) Recharge, runoff and discharge of mid-deep groundwater

Recharge of mid-deep groundwater is mainly the leakage of shallow groundwater and surrounding groundwater flowing to the cone center, among which the leakage of shallow groundwater accounts for about 80% of total recharge. Before exploitation of mid-deep groundwater, mid-deep confined water of Zhengzhou city proper flows from the southwest to the northeast. Hydraulic gradient is about 1/1500～1/2500. Influenced by exploitation, after 1970s, the exploitation has been enhanced, so the groundwater depression cone is formed and the surrounding groundwater flows to the cone center. Main discharge approach of mid-deep groundwater is labor exploitation. The lateral discharge is small.

4.1.5.3 Exploitation of groundwater resource

Water supply type of Zhengzhou city proper is surface water and groundwater. There are 4 modes of water supply. Firstly, water is supplied by surface water plant and groundwater plant. Shiyuan Water Plant and Baimiao Water Plant adopt surface water of the Yellow River. Shifo Water Plant and Dongzhou Water Plant adopt groundwater near the Yellow River. Well Water Plants adopt groundwater in central city proper flowing in public water supply network. Secondly, self sufficient wells of company adopt groundwater. Thirdly, the Yellow River diversion project adopts ecological water from surface water of the Yellow River to Zhengzhou city proper. Fourthly, urban villages adopt centralized water supply from groundwater in decentralized area. According to *Management Report of Water Supply, Consumption and Groundwater of Zhengzhou City Proper in 2011*, the total water consumption of Zhengzhou city proper was 278,220,000m^3, among which water consumption for industry was 46,160,000m^3, domestic water consumption was 193,190,000m^3, and water consumption for other purposes (water for fire control, free water consumption and water for buildings) was 38,870,000m^3.

4.1.6 Seism

According to *Seismic Ground Motion Parameters Zonation Map of China* (GB18306-2001), peak acceleration of seismic ground motion of Zhengzhou is 0.15g. Characteristic period of response spectrum of seismic ground motion is 0.40s. Seismic fortification intensity of Zhengzhou is 7. Classification of design seism is the second class and design basic acceleration of seismic ground motion is 0.15g.

Mileage in zone A is K0+0.000~K23+200. Thickness of coverage on site is more than 50m. According to article 4.1.6 in *Code for Seismic Design of Buildings* (GB50011-2010), type of soil on site is mid-soft type. Classification of construction site is class III. Design characteristic period is 0.55s. Because there is little liquid soil in the line, division of anti-seismic section for buildings belongs to disadvantageous anti-seismic section.

Mileage in zone B is K23+200~K31+350.000. Thickness of coverage on site is less than 50m. Classification of construction site is class II. Design characteristic period is

0.40s. Division of anti-seismic section for buildings belongs to advantageous anti-seismic section.

4.1.7 Animal and plant resources

In Zhengzhou, there are mountains, hills, plains, eastern sand region and the Yellow River wetland with area of 34,000 hectares which provide good inhabit environment for many animals. Animal fauna of Zhengzhou belongs to north China animal fauna. Species and quantity of animals in mountains and hills in the west are more. Animal resources in forests are relatively abundant. Zhengzhou has two kinds of first class nationally protected animals (Aquila heliaca and Aquila chrysaetos) and more than 40 kinds of second class nationally protected animals (including Andrias, Cygnus cygnus and Cygnus columbianus) among which Ciconia ciconia, Cygnus cygnus, Cygnus columbianus and other aquatic birds are distributed in the Yellow River wetland and other wetlands in Zhengzhou in the centralized or decentralized way and Aquila chrysaetos, Aquila heliaca, Accipiter gentiles, Accipiter soloensis and other protected animals are distributed in mountains, hills and plains in Zhengzhou in widespread or scattered way.

Cultivated area is 313,900 hectares and orchard area of Zhengzhou is 2.45 hectares. Green rate of Zhengzhou city proper is 27.8%. There are poplars, willows, chinars, locust trees, elms, kiris, pines, cypresses and other trees. Floristic division of Zhengzhou belongs to warm temperate deciduous broadleaf forest vegetation type. It crosses two vegetation zones. Area in the east of Jingguang Railway belongs to cultivated crop vegetation zone of Eastern Henan Plain. Area in the west of Jingguang Railway belongs to vegetation zone of deciduous broadleaf forest in mountains, hills and mesas.

Plant resources of Zhengzhou are abundant. Main crops are wheat, corn, rice, peanut and cotton etc. Local specialties are honeysuckles in Xinmi, Chinese dates in Xinzheng, persimmons in Xingyang, garlics, watermelons and peanuts in Zhongmu, pomegranates in Heyin, tobaccos in Dengfeng and Chinese roses in Zhengzhou. There are 19 national key protected plants, including Metasequoia glyptostroboides, Ginkgo biloba, Eucommia ulmoides Oliv, Paeonia suffruticosa with spots, Pteroceltis tatarinowii, Juglansregia Linn, Pistacia chinensis Bunge, Glycine soja and Kolkwitzia amabilis Geaebn etc, which are mainly centralized in mountains in different counties and the Yellow River wetland in Zhengzhou.

4.2 Overview of social environment

4.2.1 Administrative division

Zhengzhou is the political, economic and cultural center of Henan Province. It has

one county (Zhongmu County), five county-level cities (Gongyi, Xingyang, Xinmi, Xinzheng and Dengfeng) and six districts (Zhongyuan, Erqi, Guancheng, Jinshui, Shangjie and Huiji, among which Shangjie District is an exclave). Its total area is 7446.2km^2, among which urban area accounts for 1010.3km^2. According to *Zhengzhou Statistical Yearbook (2012)*, at the end of 2011, built-up area of Zhengzhou city proper was 354.7km^2, total population of Zhengzhou was 8,857,000 and of Zhengzhou city proper 4,563,000.

4.2.2 Regional economy

In recent years, society and economy of Zhengzhou have continuously developed in fast speed. From 2000 to now, average annual growth rate of GNP is 20.6%. In 2011, annual total output value of Zhengzhou was 497.98 billion Yuan which increased by 13.8% that that of last year. Proportion of primary, secondary and tertiary industry was from 12.4:53.7:33.9 in 1990 to 2.7:57.7:39.6 in 2011. The secondary and tertiary industry accounted for 97.3% of total output value.

At present, Zhengzhou accelerates process of industrialization, urbanization and agricultural modernization, optimizes economic structure, changes growth mode, constructs advanced manufacturing base, modern service industry center and modern agricultural demonstration district and constructs ecological Zhengzhou, peaceful Zhengzhou and harmonious Zhengzhou. Zhengzhou shall be built into a national regional central city, national important modern logistics and business city, national important transportation and communication city and national famous historical culture city. Industrial structure of Zhengzhou is gradually optimized. Industrial upgrade step obviously accelerates. Zhengzhou has obvious advantages in textile, machinery, building material, refractory material, energy and raw material industries. Therefore, four leading industries (non-ferrous metal, food, coal and cigarette) are formed. Economic development of Zhengzhou has huge potential. According to latest general plan of the city, orientation of Zhengzhou is a national regional central city, national important modern logistics center, regional finance center, advanced manufacturing base and science and technology innovation base.

In 2011, total output value of Zhengzhou was 491.27 billion Yuan which was the 20th among large and middle sized cities in China; the general budget revenue of local finance was 50.23 billion Yuan which was the 17th among large and middle sized cities in China; total retail sales of consumer goods was 198.71 billion Yuan which was the 19th among large and middle sized cities in China.

4.2.3 Natural resources

Zhengzhou is a city with most abundant natural resources in China. There are 36 proved mineral resources, including coal, bauxite, fireclay and oil stone. Proved reserves of coal are 7.208 billion tons, of fireclay 100 million tons and of bauxite 260

million tons (40% of the whole province). Natural oil stone is excellent in quality. Zhengzhou has one of largest natural oil stone bases in China.

4.2.4 Overview of transportation

4.2.4.1 Overview of urban comprehensive transportation

Zhengzhou is an important transportation hub in China. With development of economy and society of Zhengzhou, transportation industry has developed rapidly. At present, Zhengzhou Railway Network is formed, and Zhengzhou Road Network and Zhengzhou Air Harbor has preliminarily taken shape. A comprehensive transportation system integrated with railways, highways, civil aviation and pipeline transportation has primarily formed.

4.2.4.2 Railways

At present, as to railway hub in Zhengzhou, the pattern of Zhengzhou North Marshalling Station and Zhengzhou Railway Station in parallel has formed. Railway transportation of Zhengzhou in recent years has grown rapidly. In 2008, railway passenger volume of Zhengzhou was 26,240,000 person-trips which accounted for 9.22% of total passenger volume of Zhengzhou. In recent 5 years, average growth rate of railway passenger transportation volume is 8.3%. In 2008, total freight volume of railway was 31,080,000 tons which accounted for 8.31% of total freight volume. In recent 5 years, average growth rate of railway freight transportation volume is 4.79%.

Zhengzhou Railway Station is the only large scale passenger transportation station in Zhengzhou railway hub and is one of large passenger transportation stations in China. After expansion and renovation in many times, the building area of Zhengzhou Railway Station is up to 40,000m^2. Its scale and area of waiting rooms are the third in China. In Zhengzhou Railway Station, departure, arrival and passing operation and changing and hanging operation of all passenger trains in Jingguang and Lianyungang-Lanzhou Railway are provided. Capacity for the departure/arrival track of the station is 296 trains.

Zhengzhou North Marshalling Station is the largest marshalling station in Asia. The marshalling station belongs to network marshalling station and bidirectional longitudinal three-class and six-yard type. Zhengzhou North Marshalling Station undertakes break-up, marshalling, arrival and departure operation of freight trains in Jingguang and Lianyungang-Lanzhou Railway and in Jiaozhi Railway (North of Xiangfan to North of Zhengzhou and Shangfu to Zhengzhou North) and provides exchange trains for Zhengzhou East Railway Station and Zhengzhou West Railway Station.

Zhengzhou East Railway Station is a principal freight station in China and is established with the only comprehensive freight yard in the hub. It mainly provides

arrival, departure and transshipment of full-truck-load, less-than-truck-load and containers and placing-in and taking-out operation in freight yard and special lines.

4.2.4.3 Highways

Highway network layout of Zhengzhou is Zhengzhou City as center, G107, G310, Lianhuo Expressway and Jingzhu Expressway as double cross framework, S102 and S103 as radial support, G207, S223, S232 and S237 vertical lines as supplementary, and S314, S315, S316, S317, S321 and S323 horizontal lines as linkage support. Above mentioned lines and criss-cross highways in counties and towns form the highway network which links trunk lines and branch lines.

At the end of 2008, total mileage of Zhengzhou City highway was 12144.0km and density of network was 1.63km/km^2, among which mileage of national highways was 444.2km, provincial highways 783.4km, county highways 1011.3km, town highways 3889.7km, village highways 5770.6km and special roads 244.7km.

There are 10 bus stations in Zhengzhou which are public stations with area of 18.7ha. The daily passenger dispatched number is 71,300, among which 17,700 passengers go out of Henan Province, 41,000 passengers go to other places in Henan Province (excluding passengers to counties and cities under jurisdiction of Zhengzhou) and 12,600 passengers go to counties and cities under jurisdiction of Zhengzhou. The passenger volume of bus stations (Long-distance Center Bus Station, Erma Road Long-distance Bus Station, Jingguang Long-distance Bus Station and South Bus Station) near Zhengzhou Railway Station accounts for 70% of total passenger volume of long-distance passenger volume of Zhengzhou.

In 2008, passenger volume of highway in Zhengzhou was 254.65 million. In recent 5 years, average growth rate is 12.5%. Highway passenger transportation is in leading position of external transportation system in Zhengzhou. In 2008, passenger volume accounted for 89.5% of passenger volume of the whole society.

4.2.4.4 Aviation

Xinzheng International Airport is an aviation airport of Zhengzhou and is an important trunk airport and air hub in China. It is one of five air stations in China and is the first class air port. The airport is designed based on international standard. Aircraft movement area reference code is class 4E. Runway is 3400m in length and 60m in width and is large enough for take-off and landing of B747-400 passenger planes. Area of airdrome is 110,000m^2 which is large enough for 12 large scale planes. At present, Xinzheng International Airport has offered 51 air routes and 274 scheduled flights every week. Compared with 1995, 21 air routes and 155 scheduled flights are increased. At present, it has become a modern international airport with business covering Henan and surrounding regions.

In 2008, air passenger volume of Zhengzhou was 3,560,000 person-trips and freight

volume was 40,000 tons. During 2004~2008, average annual growth rate of air passenger volume was up to 13% and of air freight volume was up to 18.9%. Base and proportion of air traffic are small. Therefore, although growth speed is fast, the gross volume is still small.

4.2.4.5 Traffic Situation of Urban Roads

Until 2008, Zhengzhou has constructed many roads with the total length of 1232.3km, including 177.4km expressway, 551.4 km arterial road, 213.2 km sub arterial road and 290.3 km by-pass. The density of road network is 4.19 km/km2. The road network structure of “ring + radiation” has been preliminarily formed.

Being divided by Beijing-Guangzhou Railway and Lianyungang-Lanzhou Railway, the traffic flow in Zhengzhou is the largest in the east-west direction in the southwest quadrant and northeast quadrant. The traffic flow is decreasing gradually from the axis composed by the southwest quadrant, northeast quadrant and East New Zone of Zhengzhou to the south and north. The intensity of road network traffic is gradually decreasing.

The traffic in the east-west direction is mainly concentrated on Jinshui Road, Zhongyuan Road and Longhai Road. The intensity is decreasing obviously from the trunk road to both sides and the suburban areas.

The traffic flow of Zhengzhou in the east-west direction is larger than that in the south-north direction. The traffic flow of motor vehicles is the largest in the section of northeast district and southwest district; the next is the northeast district and east new district; the traffic flow is gradually decreasing from the axis of southwest district-northeast district-east new district to the south and north. In the south-north direction, the traffic flow in the northeast district and southeast district is larger.

During the peak hours, the traffic flow of motor vehicles in the section of northeast district and southwest district is the largest. The two-way traffic is 16420 vehicles/h, which account for 52% of the total traffic flow crossing the Beijing-Guangzhou Railway. The traffic flow of motor vehicles in the northeast district and east new district takes the second place. The maximum peak hour flow in the section of Lianyungang-Lanzhou Railway occurs in the southeast district and northeast district.

Generally speaking, the traffic flow in the urban area has obvious characteristics: 1. Divided by Beijing-Guangzhou Railway and Lianyungang-Lanzhou Railway, the traffic flow crossing the railways is large, as manifested in the overlapping part of these two railways, which is the border between the northeast district and the southwest district; 2. The throughput of motor vehicles in different sections is basically decreasing from the axis composed by the southwest quadrant, northeast quadrant and East New Zone of Zhengzhou to the south and the north; 3. The traffic flow of non-motor vehicles is the same as the motor vehicles.

The first phase of rail transit No.3 is a passenger transport corridor linking up the northwest and southeast of Zhengzhou. It links up the northern area, the old town, the east new district and the economic and technological development zone. This phase is basically in the urban built-up area. The surroundings of stations along this line are provided with good road network. The straight forward and intersected road conditions are good. Except the old town and the economic development zone, the road planning along this line has been basically realized. Please refer to table 4.2-1 and table 4.2-2 for roads along this line and intersected roads.

Table 4.2-1 Current status and planning of straight forward roads at the surrounding of the stations and along this line

no.	name of road	road grade	width of red line (m)	remarks
1	Changxing road	Arterial road	45	Current status
2	Nanyang road	Arterial road	50	Current status
3	Minggong road	Arterial road	45	Current status
4	Jiefang road	Sub arterial road	45	Current status
5	Xidajie	Sub arterial road	45	Current status
6	Dongdajie	Arterial road	45	Current status
7	Zhenbian road	Arterial road	60	Current status
8	Shangdou road	Arterial road	60	Current status
9	Chenyang road	Arterial road	60	Current status

Table 4.2-2 Current status and planning of intersected roads at the surrounding of the stations and along this line

no.	name of road	Road name	road grade	width of red line (m)	remarks
1	Xingliu road station	Xingliu road	Arterial road	50	Current status
2	Shamen road station	Shamen road	Arterial road	45	Planning roads
3	Xinglongpu road station	Xinglongpu road	Arterial road	25	Current status
4	Xinglongpu road station	Boxu road	branch	20	Current status

no.	name of road	Road name	road grade	width of red line (m)	remarks
5	Dongfeng road station	Dongfeng road	Arterial road	50	Current status
6	Agricuture road station	Agricuture road	Arterial road	50	Current status
7	Huanghe road station	Huanghe road	Arterial road	60	Current status
8	Jinshui road station	Jinshui road	Arterial road	60	Current
9	Jinshui road station	Shiqiao east li	branch	20	Current
10	Taikang road station	West taikang road	Sub arterial road	35	Current
11	Erqi square station	Renmin road	Arterial road	45	Current
12	Shunchengjie station	Shuncheng road	Sub arterial road	25	Current
13	Dodajie station	Zijinshang road	Arterial road	50	Current
14	Chengdong road station	Chengdong road	Arterial road	35	Current
15	Weilaidadao station	Weilai road	Arterial road	60	Current
16	Fengtai nouth road station	Fengtai nouth road	branch	25	Current
17	Zhongzhoudadao station	Zhongzhoudadao	Expressway	100	Current
18	Tongtai road station	Tongtai road	Sub arterial road	40	Current
19	Huanghe east road station	Huanghe east road	Arterial road	60	Current
20	Agricuture east road station	Agricuture east road	Arterial road	50	Current status
21	Zhongxing road station	Zhongxing road	Sub arterial road	40	规划
22	Boxue road station	Boxue road	Arterial road	50	Current
23	Hanghai east road station	Hanghai east road	Arterial road	50	Current

4.2.4.6 Current Status of Bus Routes along this Line

(1) Overview of Urban Buses

Until 2011, Zhengzhou has 239 operating routes, which basically cover the downtown and surrounding urban areas. The density of bus network in the central urban area has reached to 4km/km2.

Currently, the bus routes are mainly concentrated within the third ring road. The bus

passenger corridors include 7 in east-west direction and 8 in south-north direction. The corridors in east-west direction include Jianshe Road-Jinshui Road, Zhongyuan Road-Zhengbian Road, Dongfeng Road, Nongye Road, Huanghe Road, Longhai Road and Hanghai Road. The corridors in south-north direction include Huayuan Road－Zijingshan Road, Wenhua Road, Nanyang Road-Minggong Road. Jingsan Road-Chengdong Road, Jingguang Road, Daxue Road, Songshan Road and Dongbai Road.

The structure of the current public transit network in Zhengzhou has the following characteristics:

1) On the whole, the orientation of bus routes in Zhengzhou City is in east-west direction and south-north direction;

2) The bus routes in Zhengzhou are mainly concentrated in Jianshe Road-Jinshui Road, Zhongyuan Road, Hanghai Road, Huayuan Road-Zijingshan Road, Nanyang Road, and Wenhua Road. Most of them are connected with Erqi Square and central station;

3) The density of bus roads in the east new district, economic development zone and high and new industrial district is low.

(2) Overview of Buses along this Line

The first phase project of Zhengzhou Subway No.3 connects the northwest and southeast of the city, and coincides with the busiest arterial road in the east-west direction. Therefore, this district is the one with the most developed urban traffic, the highest road network density, the largest passenger flow, and the most troublesome district in traffic operation and organization. The road network within the third ring road is dense. Nearly each intersection is provided with a bus station, and the distance between stations is not more than 500m. The bus stations outside the third ring road are yet to be developed.

The connection between the existing bus rapid transit systems of Zhengzhou and the first phase of rail transit No.3 is not close. Only a part of B20 line is overlapping with the first phase of line No.3. The overlapping part is from Nongye Road to Minggong road along Nanyang Road. So the overlapping rate is very low. On the other hand, only B1 main line has two intersections on Nongye Road and Weilai Road with the first phase of rail transit No.3; B10, B11, B15, B16 and B19 lines only have one intersection with the first phase of line No.3; while the other 6 BRT lines are far away from the first phase.

From the direction of line No.3, there is a large passenger flow from ground bus routes passing by this line, which will be the basic passenger flow and the main source of passengers. The distribution of bus routes along line No.3 is listed in table 4.2-3.

Table 4.2-3 Distribution of bus routes and stations along rail transit No.3 in Zhengzhou

name of station	name of road	station		route			
		bus stop	remarks	orthogonal	parallel	turn	total
Xinliu Road Station	Sanquan road	61、159	Bus station about 100 meters from crossing	0	2	2	4
	Changxing road	28	Bus station about 100 meters from crossing				
Shamen road Station	Changxing road	28	Bus station about 50 meters from crossing		4		4
	Guoji road	No any bus	none				
Xinglongpu road Station	Nanyang road	游 16、91、303	Bus station about 100 meters from crossing	0	7	5	11
	Xinglongpu road	No any bus with in 200m					
Dongfeng road Station	Dongfeng road	502、86、127、72	Bus station about 120 meters from crossing	3	10	3	16
	Nanyang road	8、78、178、904、577、Y808、27、61、B23	Bus station about 50 meters from crossing				
Agricultural road Station	Agricultural road	B1、B11、100、79、B23、502、72、215	Bus station about 50 meters from crossing	5	9	5	19
	Nanyang road	8、24、78、79、100、502、722、T4、Y808、B20、B23	Bus station about 50 meters from crossing				
Huanghe road Station	Huanghe road	Y811、23、30、71、83	Bus station about 200 meters from crossing	4	10	1	15
	Nanyang road	16、8、24、41、67、78、91、722、T4、Y808	Bus station about 50 meters from crossing				
Jinshui road Station	Jinshui road	26、41、52、104、518、916、919、Y866	Bus station about 200 meters from crossing	4	11	13	28
	Nanyang road	16、67、91、205、8、78、178、904、Y811	Bus station about 50 meters from crossing				
Taikang road Station	Mingong road	67、91、101、Y808、Y811	Bus station about 50 meters from crossing			19	19
	East Taikang road	101、518	Bus station about 100 meters from crossing				
Erqi square Station	Erqi road	6、966、34、93、32、603、95、903、28、256、106、105	Bus station about 50 meters from crossing	4		12	16
	Renmin road	57、65、900、2、B17、98、26、58、26、900、312	Bus station about 50 meters from crossing				
	XIdajie	35、85、60、909、10、35、60、85、57	Bus station about 50 meters from crossing				
	Jiefang road	152、966、985、34、60、105、903、65、B17、6、256、312、900	Bus station about 50 meters from crossing				
	Zhengxingjie	985、28、906、98、95、82、106、85、105、58、60、966、26、905、34、93、900、903、6、909、21、32、35	Bus station about 100 meters from crossing				
Shunchengjie Station	Shunchengjie	40、98	Bus station about 80 meters from crossing	2	4		6
	East Taikang road	35、60、85、Y805、Y812	Bus station about 20 meters from crossing				
Dongdajie Station	Dongdajie	35、Y812、152、60、85、89、Y805	Bus station about 40 meters from crossing	5	9		13
	Zijinshan road	Y816、962、62、29、86、Y866、269	Bus station about 40 meters from crossing				
Chengdong road Station	Dongdajie	35、60、85、152、985、89、Y805	Bus station about 20 meters from crossing	2	10	2	14
	Chengdong road	B17、603、80	Bus station about 60 meters from crossing				
Weilaidadao Station	Zhengbian road	27、35、42、85、985、Y805	Bus station about 20 meters from crossing	2	8	6	16
	Weilai road	727、3	Bus station about 50 meters from crossing				
Fengtai south road Station	Zhengbian road	3、14、35、152、603、521、Y805、27、42、60、985	Bus station about 20 meters from crossing	0	10	2	13
	Yufeng road	No any bus	none				
Zhongzhoudadao Station	Zhengbian road	Y805、35、570、285、521、215、152、52、14、3、603、60、165、42、85、985	Bus station about 20 meters from crossing	2	14	8	24
	Zhongzhoudadao	B16、261、215、263、165	Bus station about 150 meters from crossing				
Tongtai road Station	Shangdu road	B16、52、114	Bus station about 20 meters from crossing		4	4	8
	Tongtai road	52、87	Bus station about 100 meters from crossing				
Huanghe east road Station	Shangdu road	85、14、60、Y805、570、521、916	Bus station about 20 meters from crossing		4	2	6
	Huanghe south road	152	Bus station about 20 meters from crossing				
Agricultural east road Station	Shangdu road	60、570、916、85、14、Y805	Bus station about 20 meters from crossing		5	1	6
	Agricultural east road	47	Bus station about 100 meters from crossing				
Zhongxing road Station	Shangdu road	160、14、326、521	Bus station about 20 meters from crossing		1	1	1
	Zhongxing road	No any bus	The north has not been opened to traffic				
Boxue road Station	Shangdu road	14、521、985	Bus station about 50 meters from crossing		1		1
	Boxue road	No any bus	The south has not been opened to traffic				
Hanghai east road Station	Hanghai east road	600	Bus station about 100 meters from crossing		1		1
	Jingkaishibadadao	No any bus	The south is pocampal group factory				

4.2.5 Minority

Residents in Zhengzhou mainly belong to Han nationality, population of Han nationality accounted for 98.80% of Zhengzhou permanent population by 2010, and population of minorities accounted for 1.2%. Minorities mainly include Hui nationality, and population of Hui nationality reached over 127,000 by 2009. There are also 47 minorities including Manchu, Mongolian nationality, Zhuang nationality and Korean nationality.

4.2.6 Tourism resources

With long history, Zhengzhou is the national famous historic and cultural city approved by the State Council. As early as 3,600 years ago, here is the important city of Shang Dynasty. Zhengzhou once was the capital of Xia Dynasty, Shang Dynasty, Guan State, Zheng State and Han State as well as *Zhou* (equivalent to present province) in Sui Dynasty, Tang Dynasty, the Five Dynasties, Song Dynasty, Jin Dynasty, Yuan Dynasty, Ming Dynasty and Qing Dynasty.

Zhengzhou has rich tourism resources, natural landscape, history & culture and modern civilization add radiance and beauty to each other. With long history, beautiful scenery, assembled human landscape and various scenic spots and historic sites, Zhengzhou now has 499 culture relic protection sites, 43 historical and cultural relics under state protection and 76 historical and cultural relics under provincial protection, there are also Songshan Mountain Scenic Spot mainly including Shaolin Temple, Zhongyue Temple and Songshan Mountain National Forest Park, Yellow River Historic and Cultural Scenic Spot mainly including Yellow River Tourist Area and Dahe Village Primitive Village Site, and Fuxi Mountain, Huancui Valley, Imperial Mausoleum of Northern Song Dynasty, Stone Cave Temple of Northern Wei Dynasty, Native Place of Xuanyuan Yellow Emperor and Native Place of Poet Dufu etc.

4.3 Material culture resources

Three culture relic protection sites are involved in assessment range of this line, including Erqi Memorial Tower (Memorial Tower of the Great Strike of February 7, 1923), Zhengzhou Confucious' Temple and Shang Dynasty Site in Zhengzhou.

With reinforced concrete structure and built in 1971, Erqi Memorial Tower located in Erqi Square of Zhengzhou is unique and archaized conjoined twin tower in Chinese buildings, and a memorial tower built in honor of the great strike of the Beijing-Hankou Railway workers. It was listed as historical and cultural relics under state protection in 2006 and is the youngest historical and cultural relics under state protection in China. With reinforced concrete structure, Erqi Memorial Tower is

double-body tower in parallel connection with total height of 63m and 14 stories, of which tower base has 3 stories and tower body has 11 stories. Apex angle of each story is archaized jet angle cornice and green glazed tiles cover the top. Belfry is built on the top of the tower, six large bells with diameter of 2.7m tell time by playing music of “The East Is Red”. One red five-star is placed on the belfry. Tower plain is two pentagons with east-west connection, and it is single tower from the east-west direction and twin tower from north-south direction. Erqi Memorial Tower is now called Erqi Memorial Hall. There are 10 tower-story halls and 1 underground hall in the Memorial Hall, displaying various historical relics, pictures and written materials of the Great Strike of February 7, 1923 in the tower. Erqi Memorial Tower is the landmark building of Zhengzhou, the minimum horizontal distance between Line 3 rail and Erqi Memorial Tower is only 3m, and protection state of Erqi Memorial Tower is good.

Zhengzhou Confucious’ Temple was founded in Yongping Period of Eastern Hanming Emperor reign, built on a large-scale in the third year of Qianlong Emperor Reign, and fired in the second year of Guangxu Emperor Reign. Dacheng Hall of Qing Dynasty survived after liberation, due to large historical, artistic and scientific values, it was listed as historical and cultural relics under provincial protection by People’s Government of Henan Province in June, 1963. People’s Government of Zhengzhou City allocated 30 million yuan to build 18 palaces and temples including over 80 rooms with area of about 9,333m^2 from 2004 to 2006, large timber frames all adopted solid wood structure, tiles for roof all adopted traditional tiles, black bricks were laid in yards, details for building components adopted traditional wood carving, stone carving and tile carving, and reserved Dacheng Hall foundation in Ming Dynasty, Qing Dynasty and the period of the Republic of China. Dacheng Bell with weight of 2557 Jin (1278.5kg) is hung in front of Dacheng Hall in Confucious’ Temple, meaning that confucius’ birthday of 2557 years, Ceremony of ringing the bell was held at night of December 31st, 2006, marking bell tone of Confucious’ Temple which disappeared for over 100 years ring again. The minimum distance between Line 3 rail and Zhengzhou Confucious’ Temple is about 82m, and protection state of Zhengzhou Confucious’ Temple is good now.

The ruins of middle Shang Dynasty’s capital. It’s located both within Zhengzhou city and in the suburb, being basically a square and covering an area of about 25km^2. Uncovered in 1950, the ruins belong to Shang-Dynasty rammed earth construction. The city wall has a ladder-shaped profile, built with foundation trench under and protection slope at the two sides, all of which are constructed with rammed earth by section and layer. There are dense rounded pointed-bottom or rounded circular-bottom ramming trails on each layer of earth, and the city wall is also imprinted with board building marks. The whole city wall is about 7km in circumference, including the 1690m length of north wall, about 1870m length of west wall and the two 1700m lengths of south and east walls. The width of wall foundation is approximately 20-32m, and the maximum height of remaining foundation on the ground is about 5m. Historical relics unearthed from the ruins are mainly earth wares and bronze wares etc.

The ruins were announced as historical and cultural relics by the People's Government of Henan Province on August 1956 and later named as historical and cultural relics under state protection in 1961 by the State Council. Since the ruins are close to city constructions and isolation protection measures for the site outskirts are insufficient, there still exist destructive phenomena like citizens damaging the rammed earth, digging holes and climbing etc. The distance between line 3 rails and the ruins is about 6m.

4.4 Current situation of environmental quality

4.4.1 Current situation of quality of air environment

Ambient air quality of Zhengzhou city area in 2012 reached Level III standard; ambient air quality of four county-level cities and one county including Xinmi City, Xinzheng City, Xingyang City, Dengfeng City and Zhongmu County reached Level II standard, and that of Shangjie District reached Level III standard. Primary pollutants of urban ambient air are inhalable particle except sulfur dioxide in Xingyang City and Shangjie District.

Days of good ambient air quality in Zhengzhou city area in 2012 were 319 with rate of reaching the standard being 87.2%, days of good ambient air quality in four county-level cities, one county and one district under municipal administration were 312-345 with rate of reaching the standard being above 85%. Ambient air in Zhengzhou city area remained basically unchanged than 2011 in terms of pollution level. There was no acid rain.

4.4.2 Current situation of water environment quality

(1) Current situation of urban water environment

In 2012, surface water quality of Yellow River basin under administration of Zhengzhou City was good and in conformity with Level III standard. Surface water of Huaihe River basin under municipal administration was seriously polluted, of which Jialu River was seriously polluted, Shuangji River was moderately polluted, and Yinghe River was mildly polluted; one of 12 monitoring sections conformed to Level II standard, one conformed to Level III standard, two conformed to Level IV standard, and other eight ones were poor Level V, accounting for 8.3%, 8.3%, 16.7% and 66.7% respectively; main pollutants affecting river water quality were ammonia nitrogen, chemical oxygen demand and permanganate index. Baisha Reservoir, Jian'gang Reservoir and Changzhuang Reservoir monitored by Zhengzhou City in 2012 did not show eutrophication, water quality in Baisha Reservoir and Jian'gang Reservoir was Level III, and that in Changzhuang Reservoir was Level IV.

In 2012, water quality by comprehensive evaluation for underground water environmental quality in Zhengzhou city area was good (Level I), water quality basically remained stable, and 7 points all reached underground water Level III standard.

In 2012, water quality of centralized drinking-water sources in Zhengzhou City reached surface water or underground water Level III respectively, water in-taking quality had rate of reaching the standard of 100%, and water quality of drinking-water sources was good. Water quality level remained unchanged than that in 2011.

(2) Current situation of water environment along the Line

①Current situation of environmental quality of surface water along the Line

The line underneath passes through Jinshui River, Xiong'er River, Qili River and Chaohe River in the form of tunnel (shield construction), and parking lot is located at southern bank of Jialu River. Due to strengthened environmental management during construction period, project construction will not have direct impact on urban surface water quality. According to feedback opinion of Zhengzhou Environmental Protection Agency, make-up water of Jinshui River, Xiong'er River and Chaohe River are urban reclaimed water now, belonging to Level IV, details refer to Table 4.4-1.

Table 4.4-1 Environmental Functional District Planning and Current Water Quality of Surface Water Body Involved along the Line

Name of water body	Located drainage basin	Environmental function	Water quality objective	Current water quality	Construction technology
Jialu River	Jialu River Basin	Recreational water zone	Level IV	Level IV	
Jinshui River	Jialu River Basin	Recreational water zone	Level IV	Level IV	Shield method for tunnel construction
Qili River	Jialu River Basin	Recreational water zone	Level IV	Level IV	Shield method for tunnel construction
Xiong'er River	Jialu River Basin	Recreational water zone	Level IV	Level IV	Shield method for tunnel construction
Chao River	Jialu River Basin	Recreational water zone	Level IV	Level IV	Shield method for tunnel construction

②Current situation of environmental quality of underground water along the Line

Main water quality indexes of underground water along the Line all meet Level III water quality requirements of GB/T14848-93 *Quality Standard for Ground Water*.

Table 4.4-2 Current Water Quality of Under Water Body Involved along the Line

取样位置	水质（mg/L）				
	pH	总硬度	氯化物	硝酸盐	硫酸盐
YAK20+400	6.0	95.62	19.00	66.40	12.0
YAK24+550	6.0	138.2	1.42	66.40	14.0

YAK30+400	5.8	105.1	10.43	44.27	30.0
YAK35+400	6.5	77.37	40.06	22.14	15.0
YAK40+700	6.4	82.99	21.56	8.85	100.0
GB/T14848-93 之 III 类标准	6.5~8.5	≤450	≤250	≤20	≤250

③Planning and construction of municipal drainage pipe network in the area where the project is located

According to site survey and feedback opinions of Zhengzhou environmental sanitation department, sewage of car depot and comprehensive base of this project as well as of each car depot and station along the Line can be brought into nearby existing or planned drainage pipe network and discharged into their respective sewage treatment plants for centralized treatment. Details refer to Table 4.4-3.

Table 4.4-3 Drainage Destination of Pollution Source along the Line and Situation of Municipal Sewage Treatment Plant

SN	Name	Mileage	Drainage destination	Overview of sewage treatment plant
1	Jialuhe parking lots	/	At present, municipal road and supporting drainage pipe network are under construction. Sewage of parking lot and Xinliu Road station during operation of the Line can be discharged into nearby municipal drainage pipe network to flow into expanded Matougang Sewage Treatment Plant.	Scale of planned Matougang Sewage Treatment Plant is 500,000t, sewage after secondary treatment is discharged into Jialu River, and reclaimed water after tertiary treatment is used for landscape planting of Zhengdong New District.
2	Xinliu Road Station	K0+130		
3	Shamen Road Station	K1+560	Sewage is discharged into nearby existing drainage pipe network to flow into Matougang Sewage Treatment Plant.	Current treatment scale of Matougang Sewage Treatment Plant is 300,000t/d, UCT technology (advanced nitrogen and phosphorus removal technology for water treatment) is adopted, tail water after treatment shall reach Level I A standard before discharging into Jialu River.
4	Xinglongpu Road Station	K2+870		
5	Dongfeng Road Station	K4+500		
6	Agricultural Road Station	K5+720		
7	Huanghe Road Station	K7+200		
8	Jinshui Road Station	K8+335		
9	Taikang Road Station	K9+245	Sewage is discharged into nearby existing drainage pipe network to flow into Wangxinzhuang Sewage Treatment Plant.	Daily treatment scale of Wangxinzhuang Sewage Treatment Plant is 400,000t. Sewage treatment technology adopts “traditional activated sludge process” and A2/O process to
10	Erqi square Station	K10+135		
11	Shunchengjie Station	K10+915		
12	Dongdajie Station	K11+905		

SN	Name	Mileage	Drainage destination	Overview of sewage treatment plant
13	Chengdong Road Station	K12+700		conduct nitrogen and phosphorus removal for sewage. 50,000t tail water after treatment reaches Level I A standard and discharges into Jinshui River. Planned treatment scale after expansion is 600,000t, tail water after secondary treatment discharges into Qili River on the east, and reclaimed water after tertiary treatment is used for thermal power plant is sourthern suburb, Zhaojiazhai power plant and landscape greening of Zhengdong New District.
14	Weilaidadao Station	K13+845		
15	Fengtai south Road Station	K14+775		
16	Zhongzhoudadao Station	K15+785		
17	Tongtai road Station	K16+725		
18	Huanghe east Road Station	K17+805		
19	Agricultural east Road Station	K18+825		
20	Zhongxing Road Station	K20+290		
21	Boxue Road Station	K22+140		
22	Hanghai east Road Station	K24+980		
23	Hanghai east road car depot		Municipal road and supporting drainage pipe network have been planned. Sewage of car depot during operation of Line can rely on Gengzhuang Sewage Treatment Plant, if not, temporary pipe network can be newly built to connect with Chensanqiao Sewage Treatment Plant.	Gengzhuang Sewage Treatment Plant is planned to be built at the end of “the 12th Five-year” Plan and located at near crossroad of East Hanghai Road and Qili River with designing scale of 70,000t/d and planning service area of 40km2, and tail water after secondary treatment discharges into Qili River.

4.4.3 Current situation of acoustic environment quality

(1) Situation of urban acoustic environment

In 2009, average annual equivalent sound levels in the day at each measurement site of 4 functional zones in Zhengzhou urban area conform to national *Environmental Quality Standard for Noise*, and average annual equivalent acoustic sound levels at night exceed standard to varying degrees. Average value of regional environmental

noise is 54.4dB (A), with a reduction of 1.2 dB (A) than that in 2008, and environmental quality level is Better. Average equivalent sound level of traffic noise weighting is 66.0 dB (A), with a reduction of 1.7 dB (A) than that in 2008, and environmental quality level is Good.

4.4.4 Current situation of vibration environment quality

(1) Situation of urban vibration environment

Present environmental vibration in Zhengzhou is mainly from highway traffic vibration and mechanical vibration caused by construction machinery in partial areas being built, current situation of general environmental vibration is good and can basically meet corresponding standard requirements of *Standard of Vibration in Urban Area Environment* (GB10070-88).

4.4.5 Current situation of electromagnetic radiation

(1) Investigation on sensitive points of watching TV along the Line

According to design information, Zhengzhou Metro Line 3 is an underground project, car depot and parking lot are in farmland, and there is no resident for 500m around, so this report does not conduct monitoring for sensitive points of television signal.

(2) Investigation and monitoring for construction of main transformer station

Line 3 sets one main transformer station and one 35kV power switching station, Boxue Road Main Transformer Station is a newly set one, and 35kV power switching station at Erqi Square introduces two different power supplies from main transformer station of municipal gymnasium of Line 1.

Boxue Road Main Transformer Station is surrounded by land for warehouse logistics without sensitive points, and high and low-voltage incoming and outgoing lines adopt the method of underground buried laying.

4.4.6 Current situation of urban ecological environment

4.4.6.1 Situation of urban ecological environment

(1) Land and vegetation

Cultivated area in Zhengzhou is 313,900 hectares and fruit garden area is 2.45 hectares. Greening rate of Zhengzhou city area is 27.8%, main tree species include poplar, willow, sycamore, Chinese scholar tree, elm, paulownia, pine and cedar etc. Zhengzhou belongs to vegetation type of warm temperate zone broadleaved deciduous forest in terms of Flora, including two vegetation regions. Areas at east of

Beijing-Guangzhou Railway belong to plant vegetation region of Eastern Henan Plain, and areas at west of Beijing-Guangzhou Railway belong to broadleaved deciduous forest vegetation region of Western Henan mountain, hill and tableland.

Plant resources are rich in Zhengzhou. Main crops include wheat, corn, paddy, peanut and cotton etc. Native products include Honeysuckle in Xinmi, Chinese date in Xinzheng, persimmon in Xingyang, garlic, watermelon and peanut in Zhongmu, pomegranate in Heyin, tobacco in Dengfeng and Chinese rose in Zhengzhou. There are 19 types of plants under state key protection, including metasequoia, gingko, eucommia, Paeonia suffruticosa with spots, wingceltis, walnut, pistacia chinensis bunge, glycine ussuriensis and Kolkwitzia amabilis which are mainly distributed in mountainous area of each county or wetland of Yellow River.

(2) Biodiversity conservation project

According to *Overall Planning of Zhengzhou Forest Eco-friendly City* (2003-2010), biodiversity conservation projects of Zhengzhou city area include: Provincial Nature Reserve of Yellow River Wetland with total area of 38,007hm^2 is located at north of Zhengzhou, and key protected objects mainly include Yellow River Wetland Ecosystem and valuable and rare water bird; Yanming Lake Bird Sanctuary with protection area of 300hm^2 is located at north of Zhongmu County, and main protected objects are water birds and migrant birds; Pomegranate Genetic Resource Conservation Area in Heyin County with protection area of 460hm^2 is located in Beimang County of Xingyang, and protected objects are pomegranate genetic resources in Heyin County; Xinzheng Chinese Date Genetic Resource Conservation Area with protection area of 230hm^2 is located at west of Maxianzhang Village and Liyuanshi Village in Mengzhuang Town of Xinzheng, and protected objects are Xinzheng Chinese date genetic resource forest; Xishan Botanic Garden with area of 345hm^2 located in Guxing Town of Huiji District mainly shows zonal plant community landscape and plant species; Changzhuang Botanic Garden with area of 1282hm^2 located in Xushui Town of Zhongyuan District mainly shows zonal plant community landscape and plant species; Take old and famous trees in Zhengzhou Forest Eco-friendly City as nature conservation point and conduct key protection.

(3) Current situation of water and soil loss:

Loess hill ravine region in western and middle part of Zhengzhou has serious water and soil loss due to steep slope and little vegetation. Water and soil loss is mainly distributed in Yingyang Town and Xuzhuang County in Dengfeng, Shecun Town, Xiaoyi Town, Kangdian Town and Nanhedu Town in Gongyi; Goutang Town and Yuanzhuang Town in Xinmi; Guangwu Town in Xingyang and Qianhuzhai Town in Xinzheng. Area of weathering and desertification in Zhengzhou is 50,033 hm^2, accounting for 18.69% of total land area, and area of flowing and semi-flowing sand dune is 7,244 hm^2.

4.4.6.2 Current situation of main ecological systems along the Line

This project is located at Zhengzhou urban area, the areas passed by this project take human activities as the core, there are row upon row of office buildings, stores, residential buildings and Party and government organizations, which is artificial ecosystem based on urban structure; areas around Jialu River Parking Lot at north of Lianyungang - Huoerguosi Expressway, Boxue Road and East Hanghai Road are mainly farmland and wasteland, and ecosystem type is farmland ecosystem, areas around car depot are forests now, and ecosystem type is forest ecosystem. Ecosystem type along the Line refers to Table 4.4-4.

Table 4.4-4 Ecosystem type along the Line

SN	Line mileage	Ecosystem type	Picture
1	Parking lot——The starting point line	Farmland Ecosystem type	
2	The starting point line——K21+140	Urban Ecosystem type	
3	K21+140——terminal point	Farmland Ecosystem type	
4	Car depot	Forest Ecosystem type	

4.4.6.3 Current situation of land utilization and landscape along the Line

(I) Current situation of land and landscape for the Line

Line of this project is basically laying along existing roads, land for the Line is mainly road and less agricultural land now, details refer to Table 4.4-5.

Table 4.4-5 Current Situation of Land for Each Station and Interval along the Line and Main Contents of Planning

SN	Name of station	Name of district	Main planning functions	Laying method	Current situation of landscape along the Line
1	The parking lot	Huiji District	High-quality residential area, concentrating on developing tourism resort, commercial leisure and ecological industry	Above-ground	Farmland landscape
2	Xinliu Road Station			Underground laying along planning road	Urban landscape
3	Shamen Road Station				
4	Xinglongpu Road Station				
5	Dongfeng Road Station				
6	Agricuitural Road Station	Jinshui District	Provincial and municipal political and cultural center, traditional commercial service center, main living space of central urban area, and core area of famous historic and cultural city protection	Underground laying along existing road	Urban landscape
7	Huanghe Road Station				
8	Jinshui Road Station				
9	Weilaidadao Station				
10	Fengtai south Road Station				
11	Zhongzhoudadao Station				
12	Taikang Road Station	Erqi District		Underground laying along existing road	Urban landscape
13	Erqi square Station				
14	Shunchengjie Station	Guancheng District		Underground laying along existing road	Urban landscape
15	Dongdajie Station				
16	Chengdong Road Station				
17	Tongtai Road Station	Zhengdongxin District	The window of the reform and opening up of Henan Province, regional modern service industry center, financial, convention & exhibition, cultural, higher education and sports center as well as provincial administration center	Underground laying along existing road	Urban landscape
18	Huanghe east Road Station				
19	Agricuitural east Road Station				
20	Zhongxing Road Station				
21	Boxue Road Station				Farmland landscape
22	Hanghai east Road Station	Gaokai Distric	Modern manufacturing base and export-oriented economic base	Underground laying along existing road	
23	The car depot			Above-ground	Forest and fruit garden landscape

(II) Current situation of land and landscape for project surface structures

(1) Current situation of land and landscape for stations (Entrance & Exit and ventilation kiosk) along the Line

Current situation of land and landscape for stations (Entrance & Exit and ventilation kiosk) along the Line refers to Table 4.4-6.

Table 4.4-6 Current Situations of Land and Landscape for Stations (Entrance & Exit and Ventilation kiosk) along the Lin

SN	Name of station	Current situation of environment and land usage overview	Project overview	Current situation of landscape
1	Xinliu Road Station	This station is located near Henan Sports Center. It is surrounded by Henan Sports Center, Zhengzhou University Sports Institute and relevant administrative institutions of Huiji District etc.	This station is the second floor underground island station.	
2	Shamen Road Station	This station is located near Huayuan Residential Area. The station has Huayuan Residential Area on the northwest side, Urban Bei'an Residential Area on the southwest side and Baiwen Huayuan Residential Area etc.	This station is the second floor underground island station.	
3	Xinglongpu Road Station	This station is located at south side of Dashiqiao Overpass with family member court of Municipal Bus Company on the west side, Huarun Urban Zhiyin Residential Area on the northeast side and Municipal Hufeng Glass Wholesale Market on the southeast side.	This station is the second floor underground island station.	

SN	Name of station	Current situation of environment and land usage overview	Project overview	Current situation of landscape
4	Dongfeng Road Station	This station is located at the west side of Tongle Wenhua Square with Tongle Wenhua Residential Area on the east side and Yangguang Jiari Residential Area on the east side.	This station is the second floor underground island station.	
5	Agricuitural Road Station	This station is located at west side of family member courtyard of Zhengzhou Ceramics Factory with family member courtyard of cattle and sheep processing factory of Zhengzhou Food Company on the north side and Zhengzhou Xianghe Group Electrical Installing Co., Ltd. on the southwest side.	This station is the second floor underground island station.	
6	Huanghe Road Station	This station is located at the crossroad on the west of Nanyang Road No. 1 Primary School with Nanyang Renjia Residential Area on the northwest side, Fujian Leiyi Landscape Architecture Decoration Co., Ltd. on the southwest side and family member courtyard of Zhengzhou Textile Machinery Co., Ltd. on the southeast side.	This station is the second floor underground island station.	

SN	Name of station	Current situation of environment and land usage overview	Project overview	Current situation of landscape
7	Jinshui Road Station	This station is located at the north side of Jinshui Road Overpass and north bank of Jinshui River. The station has Zhengzhou Library on the northeast side, Nine days Fashion Hotel and warehouse on the east side, and family member courtyard of National Oils & Fats Reserve Depot on the west side.	This station is detached island station.	
8	Weilaidadao Station	This station is located at southeast side of hardware mechanical and electrical products wholesale market. This station has New Taikang Electromechanical Market on the northeast side and a square on the southeast side.	This station is the second floor underground island station.	
9	Fengtai south Road Station	This station is located at the south side of Jiefang Road Sub-branch of ICBC (Industrial and Commercial Bank of China) at Erqi Square, the station is surrounded by land for municipal square with Erqi Hotel at the south side.	This station is the second floor underground island station.	
10	Zhongzhoudadao Station	This station is located at the north side of China Huarong Asset Management Co., Ltd. The station has Modern Xingyuan Residential Area on the southwest side, Yinzuo International Commercial Building on the	This station is the second floor underground island station.	

SN	Name of station	Current situation of environment and land usage overview	Project overview	Current situation of landscape
		southeast side and Jinyu Commercial Building on the northeast side.		
11	Taikang Road Station	This station is located at the south side of Ziyanhuating Residential Area. The station has Tax Service Hall of State Administration of Taxation in Zhengzhou Guancheng District on the northeast side and Zhengzhou Post Mansion on the south side.	This station is the second floor underground island station.	
12	Erqi square Station	This station is located at the crossroad on the east of Zhengzhou Shang Dynasty Site. It is surrounded by entertainment club, Netcom Corporation and Community Health Service Center of Guancheng District etc.	This station is the second floor underground island station.	
13	Shunchengjie Station	This station is located at the crossroad on east of Zhengbian Road Long-distance Passenger Transportation Bus station. The station has Zhongyuan Trust Building on the northeast side, open space on the northwest side and warehouse building on the south side.	This station is the second floor underground island station.	
14	Dongdajie Station	This station is located at the crossroad on the south of Zhengzhou Huimin Middle School. The station has Special Policeman and	This station is the second floor underground island station.	

SN	Name of station	Current situation of environment and land usage overview	Project overview	Current situation of landscape
		Patrolman Detachment of Zhengzhou Public Security Bureau on the northeast side and building material market on the south side.		
15	Chengdong Road Station	This station is located at the north side of Zhengzhou East Building Material World and a project under construction is at the north side of the station.	This station is the second floor underground island station.	
16	Tongtai Road Station	This station is located near Juranzhijia on Shangdu Road and at the north side of New Furniture and Building Material Market and Metro Supermarket.	This station is the second floor underground island station.	
17	Huanghe east Road Station	This station is located at the crossroad on the east of Qilihe Bridge and Shangdu Road. The station has Henan Seed Control Station on the northeast side, Zhengzhou International Boutique Curtain Fabric City on the northwest side, residential building in construction on the southwest side and Zhengzhou Nanyao Pharmaceuticals Co., Ltd. on the southeast side.	This station is the second floor underground island station.	

SN	Name of station	Current situation of environment and land usage overview	Project overview	Current situation of landscape
18	Agricuitural east Road Station	This station is located at the south side of Kinhom Home Furnishing Shopping Mall on Shangdu Road and at the north side of Yaxing International Square.	This station is the second floor underground island station.	
19	Zhongxing Road Station	This station is located at the northeast side of Jinxiang Logistics Distribution Base of Zhengzhou Transportation Group and surrounded by construction site under construction.	This station is the second floor underground island station.	
20	Boxue Road Station	This station is located at the crossroad of Shangdu Road and Boxue Road. The station has Huafeng Logistics of Iron and Steel on the northeast side, open space on the south and construction site under construction on the northwest side.	This station is the second floor underground island station.	
21	Hanghai east Road Station	This station is located on East Hanghai Road at the south of Dongyinggang Village and surrounded by open space to be developed.	This station is the second floor underground island station.	

(2) Current situation of land and landscape for car depot and parking lot

According to the scheme provided by the design organization, parking lot of Rail Transit Line 3 is in the open space with area of about 142,000m^2 surrounded by Changxing Road and Jinbei Road and located at the south of Jialu River and south of Lianyungang-Huoerguosi Expressway. The open space is farmland currently and mainly planted with wheat and less vegetable, belonging to Laoyachen village in

Changxing Sub-district and Gucheng Village in Xincheng Sub-district. According to the plan, the land for parking lot will have Changxing Road on the east and Jinbei Road on the west, and 200m away from Jialu River on the north will be planned land for greening.

Figure 4.4-1 Current Situation of Land Occupied by Parking Lot of Jialu River

With area of 382,000m^2, car depot of Rail Transit Line 3 is located at southeast of Zhengzhou Economic and Technological Development Zone, its east and west sides are between Beijing-Hong Kong-Macau Expressway and Eastern Ring Road of Beijing-Zhuhai Expressway, north and south sides are between South Jingwu Road and South 3rd ring. This land lot has been listed in the integrated planning of development of Zhengzhou Economic and Technological Development Zone, belonging to Dawangzhuang of Jinghang Sub-district Office and Danzhuang Village and Gongma Village of Chaohe Sub-district Office of Economic and Technological Development Zone. It is afforestation forest and garden now.

Figure 4.4-2 Current Situation of Land for Car Depot

(3) Current situation of land and landscape for main transformer station

Zhengzhou Rail Transit Line 3 plans to build one main transformer station-Boxue Road Main Transformer Station. The planned location is in the development zone and

surrounded by construction land to be developed, and it is a temporary building for freight depot now, current situation of land and landscape refers to Table 4.4-7.

Table 4.4-7 Current Situations of Land and Landscape for Main Transformer Station

Name	Location	Current situation of land	Picture
Boxue Road Main Transformer Station	Norwest side of crossing of Boxue Road and Shangdu Road	Freight depot, temporary building	

4.4.6.4 Current situation of wild animal resources along the Line

Since this project is basically located in urban area, there is no large wild animal along the Line after long-term development activities, and current wild animals are mainly small animals living in trees, bushwood and farmland. Wild animal species along the Line mainly include birds with sparrow as the dominant species and other wild birds such as Shrike, turtledove, crow, thrush, sandpiper, Lesser Coucal, Black Drongo, Cyanopica cyana and Crested myna; amphibians dominant species include bufo bufo gargarigans and Hyla chinensis; reptiles dominant species include gecko, tortoise and turtle; beasts dominant species are Common pipistrelle and mus musculus; aquatic animals include whitebait, mandarin fish, crucian, black carp, grass carp and siniperca chuatsi etc. These wild animal resources are mainly distributed in farmland ecological system in suburb and not involved along most of the Line.

4.4.6.5 Current situation of vegetation resources and distribution of old and famous trees along the Line

Current vegetation along the Line mainly includes urban vegetation and little agricultural vegetation, urban vegetation mainly includes Chinese scholartree and Chinese parasol distributed in urban areas along the Line; agricultural vegetation mainly includes paddy and various vegetables distributed in Jialu River Parking Lot, East Hanghai Road car depot and near Entrance & Exit Line.

4.4.6.6 Distribution of green area along the Line

Public green land area of Zhengzhou is 1,132.99hm^2, of which 439.5hm^2 is for Jinshui District, 123.50hm^2 for Guancheng District, 128.21hm^2 for Erqi District, 118.54hm^2 for Zhongyuan District, 16.25hm^2 for Gaokai District and 14.67hm^2 for Economic and Technological Development Zone.

In recent years, Zhengzhou has gradually rebuilt Jinshui River, Dongfeng Canal and Xiong'er River into Riverfront Park with area of 231.08hm^2, 20 squares with area of

62.23hm^2 have been built, including Lvcheng Square, Jingwei Square, Zijing Square, Lvyin Square, Wenhua Square, Wenbo Square and Weilai Square; 17 street parks and green areas with area of 26.97hm^2 have been built, including Ruhe Residential Area Park, Tongbai Road Park, Park of Affiliated Hospital of Institute of Traditional Chinese Medicine, Shangcheng Park and residential block green belt of Administrative Committee; 11 overpass green areas with area of 46.78hm^2 have been built, including Zijingshan Overpass greenbelt, Xintongqiao Overpass greenbelt and Dashiqiao Overpass greenbelt; Shang Dynasty Site greenbelt is being built at wall of ancient city in light of conservation of historic cultural city and by exploring Central Plain cultural essence. Construction and production of garden and nursery stock in Zhengzhou is mainly of state-owned nursery garden, supplemented with enterprise nursery garden and a few collective and individual nursery gardens. At present, Zhengzhou has productive plantation area of 405.81hm^2, accounting for 3.13% of urban built-up area. Zhengzhou has green area for environmental protection of 22.94hm^2, including 15.68hm^2 for Jinshui District, 4.48hm^2 for Guancheng District and 2.78hm^2 for Gaokai District, and they are mainly protection forests along railways (Beijing-Guangzhou Railway and Lianyungang-Lanzhou Railway) and rivers (Dongfeng Canal and Xiong'er River).

Among greening tree species in Zhengzhou, deciduous tree mainly includes Paulownia elongata, populus tomentosa, Platanus acerifolia (Platanus orientails), Robinia pseudoacacia and Chinese scholartree etc.; aiphylium mainly includes oriental arborvitae, cedar, Chinese pine and glossy privet etc.; defoliation flowering shrub mainly includes Chinese rose, peony, winter jasmine, flowering peach, crape myrtle, Chinese redbud, flowering almond and clove etc.; evergreen flowering shrub mainly includes Chinese littleleaf box, Viburnum awabuki (sweet viburnum), moundily (Spnish bayonet), sweet-scented osmanthus, photinia serrulata and pittosporum tobira etc.; akebi plants mainly include Chinese wisteria, honeysuckle, grape, Japanese creeper and elecampane etc.

Zhengzhou is located in Central Plains with long history, there are more than 1,200 old trees preserved in Zhengzhou, 17 of which are in urban area with the highest tree-age of over 500 years. Famous trees mainly include 4 cedars - Friendship Trees of Zhengzhou in China and Urawa in Japan which are planted in Bishagang Park now. 13 Friendship Flowers of Zhengzhou in China and Urawa in Japan are planted in People's Park. Platycladus orientailis and cedar forest, Memorial Forest of the 4th conference of Central Afforestation Committee, are planted in Yellow River Tourist Area. 5 cedars, China-Japan Youth Friendship Memorial Forest, are planted in Penoy Garden of Yellow River Tourist Area. There is also memorial forest planted in Bishagang Park at annual meeting of the 14th session International Small and Medium-sized Cities. These famous and old trees in parks and institutions have fair growth potential, and Chinese scholartree and cypress in Guancheng District and Erqi District have poor growth potential since they are seriously affected by diseases and pests and human factors.

This project passes through Dashiqiao Overpass greenbelt and public green space of Shangyun Park in Shang Dynasty Site in the form of underground line, involving Jinshui Road Station and Chengdong Road Station, Jinshui Road Station is located at the north of Dashiqiao Overpass without occupying overpass greenbelt; Chengdong Road Station sets one passageway and one ventilation kiosk cooling tower with area of about 520m^2 in Shangyun Park, most occupied land is hardened land for leisure, and public green space is not occupied basically. Lands occupied by other stations are mostly green belts at both sides of road.

4.4.6.7 Distribution of nature reserves, scenic spots, forest park and basic farmland along the Line

Since this project is mostly located in urban center, nature reserves, scenic spots and forest park of Zhengzhou are relatively far away from the assessment range. According to field investigation, scenic spots, nature reserves and forest park are not involved in the assessment range along the Line. At the same time, various ecological function zones of Zhengzhou are mostly located at outer city with long distance, so current various nature reserves and forest park of Zhengzhou are not involved along the Line.

According to *Opinions on site location of Zhengzhou Rail Transit Line 3*, this project does not involve basic farmland preservation area.

5 Environment impact analysis

5.1 Analysis of safeguard policies of World Bank

5.1.1 Screening of safeguard policies

In this environment impact assessment, analyze the relationship between World Bank loan part and related projects of Zzhengzhou rail transit line 3 project and World Bank safeguard policies/procedures, and list the results in table 5.1-1.

Table 5.1-1 Schedule of relationship between Zhengzhou Rail Transit Line 3 project and World Bank safeguard policies/procedures

Policy/procedure	Zhengzhou Rail Transit Line 3 Project
World Bank business policy/procedure Environment Assessment (OP/BP4.01)	Relevant
World Bank business policy/procedure Natural Habitats (OP/BP4.04)	Not Applicable
World Bank business policy/procedure Involuntary Resettlement (OP/BP4.12)	Relevant
World Bank business policy/procedure Pest Management Irrelevant	Not Applicable
World Bank business policy/procedure Physical Cultural Resources (OP4.11)	Relevant
World Bank business policy/procedure Dam Safety (OP/BP4.37)	Not Applicable
World Bank business policy/procedure Minority Nationalities (OP/BP 4.10)	Not Applicable
World Bank business policy/procedure Forest (OP 4.36)	Not Applicable
World Bank business policy/procedure International Watercourses (OP7.50)	Not Applicable
World Bank business policy/procedure Projects in Disputed Areas (OP7.60)	Not Applicable
World Bank business policy/procedure Projects in Disputed Areas (OP7.60)	Relevant

5.1.2 Analysis of the evaluation

(1) Environment assessment (OP4.01)

According to the requirements of environment assessment of World Bank safeguard policies (OP4.01), the environment assessment of this project shall include following

contents: potential environment impact and risk predictive assessment; project alternative program analysis; mitigation measures for adverse environment impact and safeguard measures of favorable environment influence; environment management and monitoring plan and etc.

Based on the analysis of type, location, sensitive spots, scale and the characteristics and size of potential environment impacts of this project, the project to be constructed will not generate any major adverse environment impact. According to the requirements of environment screening and categories in environment assessment of World Bank safeguard policy (OP4.01), this project is classified as Class A.

(2) Natural Habitats (OP4.04)

Zhengzhou rail transit line 3 has no issue of Natural Habitats, so the Natural Habitats (OP4.04) policy is not applicable for this project.

(3) Involuntary Resettlement (OP4.12)

The resettlement in World Bank loan Zhengzhou rail transit line 3 project mainly includes housing demolition due to station construction which involves 449 private families and affected population of 1308; construction land requisition for car depot with the affected population of 239 and affected 767 households; demolition for stations involving 264 enterprises and units; involving 1026store employees. As shown above, the Involuntary Resettlement in World Bank Policy applies to this project.

(4) Forest policy (OP/BP 4.36)

This project does not support any activity involving major transformation and deterioration for forest and key habitats.

(5) Pest Management (OP 4.09)

This project does not support any activity involving pest management, so the Pest Management (OP4.09) policy does not apply to this project.

(6) Physical culture resources (OP/BP 4.11)

According to survey, the construction area of this project has the Feb 7 Monument, the Literature Temple of Zhengzhou, the Zhengzhou Shang Dynasty Ruins and three cultural relics sites. Therefore, the project will apply to the policy for material and cultural resources (OP / BP 4.11).

(7) Minority Nationalities (OP/BP 4.10)

According to survey, there is no minority nationality in the residents affected by the land acquisition and demolition of Zhengzhou rail transit line 3project.

(8) International Watercourses (OP/BP 7.50)

No international watercourse is involved in Zhengzhou rail transit line 3 project.

(9) Projects in Disputed Areas (OP/BP 7.60)

The Zhengzhou rail transit line 3 project is located at any disputed area.

(10) Dam Safety (OP/BP 4.37)

There is no section involving dam project in Zhengzhou rail transit line 3 project.

(11) World Bank Procedures Information Disclosure BP7.15

Zhengzhou rail transit line 3 project features open, fair and just, so the public participation is critical. Thus the World Bank Procedures Information Disclosure BP7.15 applies to this project.

5.2 Analysis of environment issues of similar projects in China

5.2.1 Main problems

The main environment problems generated from urban rail transmit include: noise interference on residence area, school, hospital and office area at both sides of line from the operation of train and environment control equipment; impact of environment vibration on the building above and near the line due to traveling of train (especially for underground line) and secondary structure noise impact; impact on underground water level, water quality and ground building settlement during construction of underground line and stations; impact on water environment from domestic and production sewage from stations and car depots; disposal of hazard wastes such as battery of car depots; impact on traffic and resident livings by construction works during construction period, especially the open-cut station; impact on resident livings by relocation, demolition and resettlement during rail transit construction.

5.2.2 Lesson of experience

(1) Noise nuisance issue

After operation of urban rail transmit, especially the elevated line, it has large range and long time impact from noise radiation, and will lead to nuisance of surrounding residents if no effective insulation measures have been taken. According to the experience of subway line built, such as the overhead layout of Beiyuan to Tiantongyuan section of Beijing subway line 5, the complaint of surrounding

residents is increasing by time. Under these conditions, the operation company has to re-install noise barrier at both sides of line or other measures to reduce the subway noise pollution.

The noise nuisance during rail transit construction period, especially individual subway project in some cities, which, to shorten the construction period, has the uncivilized construction phenomena such as night construction of large noise equipment, and it has been also complained by the residents.

(2) Subway vibration issue

Currently the environment vibration problem from subway vibration is mainly the vibration interference on the buildings above and near the line when subway train passes, which leads to vibration of buildings and therefore impact on the livings, study and rest of residents in the buildings. For example, although the vibration damper measures have been taken in Qingniao Jiayuan community near Beijing subway Daxing line (line 4), the residents in buildings can sense the vibration due to the vibration when train passes has exceeded the standard requirements, and the resident complaint has drawn high attentions by government departments and subway operation departments.

(3) Impact on underground water and ground building settlement by subway construction

When the subway is built in the city with low underground water level and abundant underground water resource, it may lead to falling of underground water level. At same time, the accidents of underground space such as collapse, explosion, improper or fault support will directly lead to settlement of ground. For example, the ground settlement accidents account for 25% of total accidents during construction period. The tunnel construction in subway section led to large range of ground settlement at crossing of Shennan Middle Road and Hongling Road with the settlement of more than 50cm; the cast iron water supply pipes along both sides of Shennan Middle Road and Hongling Road and therefore the water supply works are affected and damaged to certain extent due to ground settlement.

(4) Wastewater discharge of station and car depot

In the subway construction process of some domestic cities, the subway line is long and especially the car depots and stations at both ends of line are normally within municipal planning zones of which the sewage pipeline network has not fully provided. After subway servicing, the domestic and production sewage from stations and car depots can not discharge into municipal pipeline network and then relative sewage treatment plant for disposal, and will lead to pollution of surrounding waters.

(5) Impact on traffic and resident living during subway construction period

The large scale and long period subway construction project will inevitably exert impact on the traffic and livings of local residents. Especially in urban center area, it will increase the traffic load and lead to continuous traffic congestion, and affect the traffic and livings of residents. During station construction of Zhengzhou subway line 1 and subway line 2, the traffic dispersion programs have been elaborately designed, and effectively relieved the congestion under strict implementation of traffic management departments and construction units and minimized the impact on traffic and resident livings.

5.2.3 Counter-measure of the project

(1) Noise reduction measures

To relieve the noise interference, this project adopts underground line layout throughout the line, even in Gaoxinqu district with the conditions for elevated line, so that it not only eliminates the impact of line on existing sensitive spots at both sides of line, but also is favorable for the implementation of planning at both sides of line.

Aiming to the noise interference during construction period such as of open-cut stations, a series of measures have been requested for this project such as prohibiting large noise equipment construction at night time and surrounding noise barrier so as to minimize the noise impact on surrounding residents.

(2) Vibration reduction measures

The full line 3 is of underground line and passes under some buildings. To minimize the impact on buildings and residents, the strict vibration damping measures such as steel-spring floating-slab track bed have been taken in line 3 for the sensitive spots passing beneath and nearby environment wit h over-limit vibration so as to minimize the impact on surrounding environment after train servicing.

(3) Measures for mitigation of Geological risk and underground water impact

Considered the features of collapse and settlement risks during subway construction, and various geological conditions and construction conditions at different sections along line 3 project, determine different construction methods, mainly of shield method for underground section construction which has the least impact on underground water and ground settlement. During station construction, the underground diaphragm wall retaining structures are adopted for the foundation pits of stations in Huijiqu with existing narrow road and near the surrounding buildings, so as to effective prevent leakage and reduce the fall of underground water level and ground settlement surrounding the stations.

(4) Sewage treatment measures

The Jialu River parking depot and Xinliu Road Station of 3 line are in the range of

Matougang sewage treatment plant phase II project, and there is no municipal pipeline network. It is predicted that the expansion construction of Matougang sewage treatment plant can be completed before operation of subway (the capacity after expansion will be 50×104m3/d, and it is in Huiji District old city (Shamen Road Station (inclusive) - Jinshui Road Station (inclusive)). The existing municipal sewage pipeline network and current Matougang sewage treatment plant (30×104m3/d) will treat the sewage collected. The section from Jinshui Road Station (exclusive) to Zhongxing Road Station (exclusive) has municipal sewage pipeline network and it is possible to connect the Wangxinzhuang sewage treatment plant (current 40×104m3/d and 60×104m3/d after expansion) via existing municipal pipeline for treatment; the section from Zhongxing Road Station (exclusive) to Hanghai East Road (inclusive) has part of municipal sewage pipeline network and is within the service range of Chensanqiao sewage treatment plant, so it can connect to Chensanqiao sewage treatment plant (in construction, 20×104m3/d) via existing main pipe or newly-built temporary pipeline for treatment; The Hanghai East Road car depot has no supporting municipal pipelines at present and it is within in the service range of Gengzhuagn sewage treatment plan in planning, so the sewage in this area can be discharged into Chensanqiao sewage treatment plant through Gengzhuang sewage treatment plant (7×104m3/d) or newly built temporary pipeline. The sewage treatment capacity of above sewage treatment plants can meet the requirements for Zhengzhou 3 line

The municipal sewage pipeline network near the section from Shamen Road Station to Zhongxing Road Station of 3 line has the supporting conditions, and the sewage pipeline network of others such as Xinliu Road Station, Boxue Road Station, Hanghai East Road Station, Parking depot and car depot is to be completed. During construction of 3 line, it is necessary to track the synchrony of construction of sewage pipeline network near Jialu River parking depot area and Hanghai East Road car depot with the subway project.

(5) Traffic dispersion measures

Based on the experience from 1# Line, the detailed traffic dispersion programs are prepared for the stations along the line, especially the stations in old city and the open-cut stations with large traffic flow so as to mitigate the traffic congestion, and the proper construction programs are planned to reduce the impact on resident livings.

5.3 Sound environment influence assessment and sound measures of environment protection

5.3.1 Analysis of noise source

5.3.1.1 Noise source analysis during construction period

The construction sites of this project are classified as: underground station, section, car depot, integrated base and etc. The noises during construction period mainly come from open-cut construction of underground station (including civil construction of station entrance/exit and air shaft), civil construction of car depot and integrated base; it is mainly from the operation noises of various construction machines, such as road breaker, excavator, bulldozer, air compressor and etc, and also the noises of various construction transport vehicles and noises of building demolition and breaking works of existing road. The shield method construction of sections, installation of mechanical and electrical equipment in full line and the decoration works have less impact on ground surface noise sensitive objectives.

The main construction machines used in all construction phases with open-cut and covered cut method for underground stations include hydraulic grooving machine, 50t and 100t crane, caterpillar excavator, loader, concrete pump truck, bulldozer, grader machine, air compressor and vibrator.

The main construction machinery used in integrated base construction sites includes bulldozer, loader, dump truck, crane, concrete pump truck, air compressor and v vibrating bar.

According to analog survey and monitoring, the noise levels of various construction machinery and vehicles at different construction stages are shown in table 5.3-1.

Table 5.3-1 Noise levels of construction machinery and vehicles

Construction phase	No.	Construction machine	Distance from measurement point to construction machine (m)	Lmax (dBA)
Civil construction phase	1	Wheeled hydraulic excavator	5	84
	2	Bulldozer	5	84
	3	Wheeled loader	5	90
	4	Various drill rigs	5	87
	5	Truck	5	92
Foundation construction phase	6	Various pile driver	10	93 – 112
	7	Grader machine	5	90
	8	Air compressor	5	92
	9	air hammer	5	98
Structure construction phase	10	vibrating machine	5	84
	11	concrete pump	5	85
	12	air wrench	5	95
	13	mobile crane	5	96
	14	Various rolling machine	5	76 – 86
	15	paving machine	5	87
Each phase	16	generator	5	98

As shown in table 5.3-1, the noise levels of construction machinery and vehicles are relatively high. In actual construction process, it is normal that several machines operate at same time, so the noises from various noise sources superpose with more impact.

5.3.1.2 Noise source intensity during operation period

Zhengzhou rail transit 3 line phase I project is of underground line and it is configured with 1 parking depot and 1 car depot.

According to the characteristics of noise source impact, the noise sources impacting external environment in underground section mainly include ventilation pavilion noise, cooling tower and main substation noise; the train running noise will occur at the access section of car depot and the fixed sound source devices in workshop also generate certain noise effect. The analysis results of main noise sources of this project are listed in table 5.3.2.

Table 5.3-2 Table for noise source analysis

<table>
<tr><td rowspan="2">Section</td><td colspan="3">Main noise source</td><td rowspan="2">Related technical parameters of this project</td></tr>
<tr><td>Category</td><td colspan="2">Noise radiation presentation or composition</td></tr>
<tr><td rowspan="5">Underground station environment control system</td><td rowspan="3">Ventilation pavilion noise</td><td rowspan="2">The aerodynamic noise is the most important part.</td><td>Rotation noise is from the interaction of circumferential non-uniform air flow generated by impeller rotation with volute, especially the volute tongue; its noise spectrum presents the low-medium frequency characteristics.</td><td rowspan="4">The underground station adopts shielded door system;
The silences are installed on air supply and exhaust pipe of station ventilation and AC system and before and after the ventilation system fan of section tunnel.
Silencer: plate type, installed in air duct; the integral type installed on air pipe;
The station fans operation period is of 4:30 - 23:30, totaling 19h, in which TVF fan and impelling fan of piston/mechanical ventilation pavilion are only activated in case of blocking or fire hazard of train.</td></tr>
<tr><td>Eddy noise refers that the eddy of ambient air is generated when impeller rotates and a series of small eddies occur under the effect of air viscous force so as to generate the air turbulence and noise; the noise spectrum is of continuous spectrum with medium-high frequency characteristics.</td></tr>
<tr><td colspan="2">mechanical noise</td></tr>
<tr><td colspan="2">Noise of installed noise</td></tr>
<tr><td rowspan="3">cooling tower noise</td><td colspan="2">Noise of axial flow fan</td><td rowspan="3">Adopt water cooling type water chilling unit; the cooling tower is installed out of the station. The refrigeration station is set at one end of each station and normally two water chilling units are set for each station.
Cooling towers normally operate during air conditioning period of June to September (properly adjusted according to the climate conditions). The operation time normally is of 4:30 - 23:30, totaling 19h.</td></tr>
<tr><td colspan="2">The water-spouting noise is generated from the striking of cooling water dripping from sprayer on lower tower chassis and the ponded water in chassis; the noise level relates to the dripping height and water flow in unit time, and it is normally second to fan noise; the noise spectrum presents high frequency characteristics.</td></tr>
<tr><td colspan="2">Water pump, reducer and motor noise, associated equipment noise and etc.</td></tr>
<tr><td rowspan="2">car depot and integrated base</td><td>Train running noise</td><td colspan="2">Running noise of train when getting in and out of the section</td><td></td></tr>
<tr><td>Noise of high noise equipment</td><td colspan="2">Noise of high noise equipment such as air compressor, forging device and fan</td><td>8h at day time</td></tr>
</table>

5.3.2 Predictive assessment

5.3.2.1 Construction period sound environment predictive assessment

(I) Noise impact prediction during construction period

The noise during construction period is approximately calculated as point sound source and the calculation formula is as follow:

$$L_{Ap} = L_{P0} - 20 \cdot \lg \frac{r}{r_0} - L_c$$

.

Where:

L_{Ap} —— A sound level at prediction point (rm from sound source), dB;

L_{P0} —— A sound level at reference point (r0m from sound source), dB;

L_c --- Corrective sound level determined according to HJ2.4-2008 Technical Guideline for Environment Impact Assessment - Sound Environment and HJ/T17247.2-1998 Acoustic – Outdoor Acoustic Propagation; Part 2: General Calculation Method.

The noise attenuation with the distance of single construction machinery or vehicle calculated with above formula refers to table 5.3-3

Table 5.3-3 Noise attenuation with the distance of single construction machinery or vehicle Unit: [dB(A)]

No.	Distance(m) Construction machinery	10	20	30	40	60	80	100	150	200	250	300	350
1	Wheeled hydraulic excavator	76	70	65	61	57	54	51					
2	Bulldozer	76	70	65	61	57	54	51					
3	Wheeled loader	82	75	70	67	63	60	57	53				
4	Various drills	79	72	68	64	60	57	54					
5	Truck	84	77	73	69	65	62	59	55	52			
6	Various pile driver	94	87	83	79	75	72	69	65	62	60	58	56
7	Grader machine	82	75	70	67	63	60	57	53				
8	Air compressor	84	77	73	69	65	62	59	55	52			
9	Air hammer	90	83	79	75	71	68	65	61	58	56	54	
10	Vibrating machine	76	70	65	61	57	54	51					

11	Concrete pump	77	70	66	62	58	55	52					
12	Air wrench	87	80	76	72	68	65	62	58	55	53		
13	Mobile crane	88	81	77	73	69	66	63	59	56	54		
14	Various rollers	73	66	62	58	54	51						
15	Paving machine	79	72	68	64	60	57	54					
16	Generator	90	83	79	75	71	68	65	61	58	56	54	

In case of simultaneous operation of several devices, the sound level is calculated with following formula:

$$L_{总} = 10 \log \sum_{i=1}^{N} 10^{Li/10}$$

Where:

L 总 —— Total sound level accumulated, dB;

Li—— Sound level of ith sound resource, dB.

Considered the worst case of simultaneous operation of construction devices of different construction phases, the construction noise impact calculated refers to table 5.3 -4.

Table 5.3-4 Construction noise impact during different construction phases Unit: [dB(A)]

No.	Distance (m) Construction phase	10	20	30	40	60	80	100	150	200	250	300	350
1	Civil phase	92	85	81	77	73	70	67	63	60	58	56	54
2	Foundation phase	96	88	85	81	77	74	71	69	64	62	60	58
3	Structure phase	94	87	83	79	75	72	69	65	62	60	58	56

(II) Noise impact assessment during construction period

(1) Assessment standard

The noise during construction period complies with standard GB12523-90 Noise Limits for Construction Site. The standard limits are as follows:

Table 5.3-5 Standard GB12523-90 Noise Limits for Construction Site

Construction phase	Main noise source	Noise limit (dB(A))	
		Daytime	Nighttime
Earthrock	Bulldozer, excavator, loader	75	55
Pile driving	Various pile drivings	85	Prohibit construction
Structure	Concrete mixer, vibrating machine, electric saw	70	55
Fitment	Crane, elevator	65	55

(2) Impact assessment of subway stations

During independent construction of construction machines, at earthwork phase, the noise 40m away from sound source can meet daytime standard in construction site of 75dB(A); at foundation stage, the noise 30m away from sound source can meet daytime standard in construction site of 85dB(A); at fitment and structure phase, for mobile crane, the noise 80m away from the sound resource can meet daytime standard in construction boundary of 65dB(A); for other construction machinery, the noise 60m away from the sound resource can meet daytime standard in construction boundary of 70dB(A)

If it is necessary to construct at night time, the noise in construction site shall meet the requirement of 55 dB(A). At earthwork phase, it shall be 150m away from the sound resource; at foundation phase, the pile driving works is impermissible at night time; at other construction phases, it shall be 150m away from the source resource; at fitment and structure stage, it shall be 200m away from the sound resource; the generator shall be 260m away from the sound resource.

If the machines used at the phase work at same time during each construction phase, for earthwork stage, all construction machines shall be kept for 60m away from construction boundary at daytime and 350m at nighttime so as enable the construction boundary noise meeting the requirements; at foundation phase, all construction machines shall be kept 30m away from construction boundary at daytime and the pile driving works are prohibited at nighttime; at structure phase, all construction machines shall be kept 150m away from construction boundary at daytime and 350m at night time so as to enable the construction boundary noise meeting the requirements.

The summary of main sensitive spots and populations suffered by construction noise of this project is shown in table 5.3-6.

Table 5.3 -6 Summary sheet of main sensitive spots affected by construction noise

Sensitive point code	Station located	Name of sensitive spot	Position relative to the station yard	Scale	Least distance from construction field boundary (m)	Administrative area located	Executed standard
1	Shamen Road Station	Chengshi Bei'an Community 1# building	North end west side	5 units - 2 households, 6 floors, 1 building, about 60 households	18	Huiji District	Category 4a
2		Changxing Building	South end west side	5 units, 12 households each unit, about 60 households	13		Category 4a
3		Huiji District Changxing Road Subdistrict Office	North end east side	Subdistrict Office	9		Category 4a
4		Changxing Road 2# Yard 13#, 10# building	North end east side	5 units, 2 households, 7 floor, 2 buildings, about 140 households	24		Category 4a
5		Baiwen Garden 1#, 2#, 6#, 7# building	South end east side	3 units, 2 households for each stairs, 1 building; 4 units, 2 households for each stairs, 2 buildings; 8 nits, 2 households for each stair, 1 building, 6 floors (in which the first floor is for store); total about 190 households	Close neighboring		Category 4a
6	Xinglongpu Road Station	Zhengzhou Public Transportation Company Family Area	North end west side	3 units, 2 households for each stair, 7 floors, 3 buildings; 1 units, 4 households for each stair, 7 floors, 1 building; total about 154 households	Close neighboring		Category 4a
7		Huarun Chengshi Zhiyin (Xinyu Yayuan) Community 1#, 5# building	North end east side	2 units, 2 households, 5 floors, total about 40 households	15		Category 4a
8		Changjian Yufeng (in construction)	South end west side	8 households per floor, 17 floors, total about 136 households	22		Category 1
9	Dongfeng Road Station	Sunshine Holiday Community 3# Building Sunshine Holiday Community 2# Building	North end west side	3 units, 2 households for each stair, 7 floors, 4 buildings, total about 84 households	6		Category 1
10		Tongle Community 46# Building Tongle Community 61# Building Food Machinery Plant Family Area 2# Building	South end east side	4 units, 2 households for each stair, 6 floors, 1 building; 1 units, 3 households for each stair, 4 floors, 1 building; 1 units, 3 households for each stair, 7 floors, 1 building; total about 81 households	closely neighboring		Category 1
11		Tongle Community North Area 1#, 2#, 3#, 4#, 5# building	North end east side	1 unit, 2 households for each stair, 7 floors, 2 buildings; 1 unit, 2 households for each stair, 5 floor, 1 building; 5 units, 2 households for each stair, 6 floors, 1 building; 3 units, 2 households for each stair, 7 floors, 1 building; total about 140 households	3		Category 4a
12		Futian Lijing Garden Community 39#, 40# building	South end west side	7 floors, 2buildings, about 40 households each floor; total about 560 households	closely neighboring		Category 4a
13	Nongye Road Station	Ronghua Family Area 3#, 4#	North end west side	3 units, 2 households, 5 floors, 1 building; 7 floors, 1 building; total about 72 households	12	Jinshui District	Category 1
14		Zhengzhou Ceramics Factory Family Area 1#, 3# building, Nanyang Road No. 62	South end east side	3 units, 2 households for each stair, 5 floors, 2 buildings, total about 60 households	6		Category 4a
15		Nanyang Road 68# Yard Zhengtie Nanyang New Town Community 1#, 2#, 3#, 10#, 41# building	North end east side	4 units, 2 households, 7 floors, 1 building; 1 unit, 4 households, 7 floors, 3 building; 5 units, 2 households, 7 floors, 1 building; total about 210 households.	11		Category 4a
16		Xiaoyuzhai (Nanyang Road 266# Yard) 3#, 5# building	South end west side	5 units, 3 households, 6 floors, 1 building; 2 units, 3 households; 6 floors, 1 building; total about 114 households	6		Category 4a
17	Huanghe Road Station	Nanyang Road the 1st Primary School	North end east side	About 200 teachers and students at school	7		category 2
18		Zhengzhou Textile Machinery Staff Apartment 18# - 20# building	North end east side	3 units, 2 households, 7 floors, 3 buildings; total about 126 households	7		Category 4a
19		Nanyang Road 296# Yard (Nanyang Renjia) 1#, 2#, 3#	North end west side	2 units, 3 households, 12 floors, 1 building; 3 units, 2 households, 6 floors, 1 building; 1 unit, 2 households, 6 floors, 12 households; 9 units, 2 households, 6 floors, 1 building; total about 312 households	closely neighboring		Category 4a
20		Zhengzhou Textile Machinery Co., Ltd.	South end east side	10 households per floor, 4 floors, 5 buildings, total about 150	closely neighboring		Category 4a

Sensitive point code	Station located	Name of sensitive spot	Position relative to the station yard	Scale	Least distance from construction field boundary (m)	Administrative area located	Executed standard
		Family Area 6#, 5#, 4#, south 3#, south 2# building		households			
21		Huayuan Community (Nanyang Road No.300) 5# building	South end west side	3 units, 2 households, 7 floors, 1 building, total about 42 households	closely neighboring		Category 4a
22	Jinshui Road Station	Film Bureau Family Area 6#, 7# building (Nanyang Road No. 7)	North end east side	3 units, 2 households, 5 floors, 1 building; 1 unit, 2 households, 5 floors, 1 building; total about 32 households	closely neighboring		Category 4a
23		Tingdao Foreign Language training	North end east side	Training institution	closely neighboring		category 2
24		Zhengzhou City Library	North end east side	In library	closely neighboring		Category 4a
25		Zhengzhou National Oil Reserve Base Family Area 1# building	South end west side	5 units, 2 households, 7 floors, 1 building, total about 70 households	24		Category 4a
26		Downtown Community Phase II 1# building	South end east side	3 units, 2 households, 18 floors, 1 building, total about 108 households	31		Category 1
27	Taikang Road Station	Xicai Community (Minggong Road 240# Yard)2#, 3# building	South end west side	7 floors, 10 households 2 buildings; total about 140 households	closely neighboring	Erqi District	category 2
28		Minggong Road N0.245 (Xiqian Street 85# Yard 1#, 2# building)	South end west side	about 20 households for low rise; 3 units, 3 households, 7 floors, 1 building, about 63 households; total about 83 households	closely neighboring		Category 4a
29		Huarun Yuefu (in construction)	South end east side	10 households per floor, 58 floors, 1 building; about 580 households	20		category 2
30	Erqi Square Station	Huigang New Town 1#, 2#, 3# building	Northwest end west side	15 households per floor, 1 building; 10 households per floor, 1 building; 20 households per floor, 1 building; total about 1260 households	10		category 2
31		Xiaolou Mosque, Female Mosque	West end north side	Religion	12		Category 4a
32	Shuncheng Street Station	Hongxin Garden 1# building	East end north side	3 units, 4 households, 7 floors, 1 building; about 约 84 households	6	Guancheng District	Category 4a
33		Xidan Apartment 2# Building	East end north side	7 households per floor, 7 floors, 1 building; 4 units, 4 households; 7 floors, 1 building; about 138 households	26		category 2
34		Xiandai Xingyuan 1#	West end south side	About 120 households	9		Category 4a
35		Yinzuo International	East end south side	15 floors, 5 units, 2 households per stair; about 150 households	closely neighboring		Category 4a
36	East Street Station	Changjiang Chengzhongcheng	West end south side	4 units, 2 households, 7 floors, 1 building, about 42 households	closely neighboring		Category 4a
37		Hongyu Garden 1#, 2#, 3# building	West end south side	About 500 households	20		Category 4a
38		East Street 220# Yard	East end south side	6 units, 2 households 6 floors, 1 building; about 72 households	7		Category 4a
39		Ziyan Huating 1#, 2# building	West end north side	6 households per floor, 24 floors, 2 buildings, about 288 households	14		Category 4a
40		Zhengzhou Guancheng District State Administration of Taxation Office Service Hall (to be relocated)	West end north side	Government office, 8 floors	closely neighboring		Category 4a
41		The First People’s Hospital of Zhengzhou	East end north side	1200 beds	19		category 2
42	Chengdong Road Station	Dongguandongli 96# Yard 1# building	East end north side	3 units, 2 households, 5 floors, 1 building, about 30 households	16		Category 4a
43		Shangcheng Garden 1# building	West end north side	2 units, 3 households, 7 floors, about 42 households	43		category 2
44	Fengtainan Road Station	Zhengzhou Huimin Middle School	West end north side	About 72 classrooms, 2900 teachers and students	25	Jinshui District	category 2
45		Zhengzhou City Public Security Bureau SWAT Detachment	East end north side	Government office, 8 floors	27		Category 4a

From the field survey, the construction sites at stations of this project are close to the sensitive spots of ambient environment and the noise in construction site is hard to meet the requirements in GB12523-2011 Emission Standard of Environment Noise for Boundary of Construction Site.

(3) Noise source analysis of transport vehicle

During the transport process of construction materials and construction spoils, the noise from transport vehicles will impact the noise sensitive spots at both sides of transport road. The main construction materials transported include commercial concrete, steels, woods and etc.

According to analog test, the sound level at the location 10m from the truck is 79-85 dB(A), and 72-78dB(A) at 30m; there is only a few transport vehicles working every day in this project, of which the impact can be neglected in comparison with the urban road traffic flow.

5.3.2.2 Sound environment predictive assessment during operation period

(I) Main working contents

(1) According to field survey, there are 44 noise sensitive spots in the assessment range out of underground station ventilation pavilion, cooling tower, main substation, car depot and integrated base. The current status monitoring and predictive assessment in the sound environment involve all sensitive spots.

(2) To coordinate the construction and development of urban areas along the line and provide reference to the environment management and city planning, it provides the noise protection distance of typical sound sources such as underground station ventilation pavilion and cooling tower, and the sound level isoline profile of car depot and integrated base.

(3) Carry out the noise source analysis of project to analyze the over-limit cause of sensitive spots and noise influence degree and population.

(4) In combination with the evaluation results, provide the noise pollution control measures for the over-limit sensitive spots; after comparison with technical and economical feasibilities, recommend the measures and suggestions with optimal effect and complying with engineering actual conditions to describe the noise reduction effect.

(II) Noise source analog investigation and analysis

(1) Analysis of main noise sources

Zhengzhou rail transit 3 line project adopts full underground line configured with 1 car depot and 1 Parking depot, and newly added 1 main substation.

According to the characteristics of noise source impact, the noise sources impacting external environment in underground section mainly include ventilation pavilion noise and cooling tower noise; the lead track and trial run line of car depot and

integrated base will generate the noise impact of train operation; the fixed sound source device in workshop will also generate certain noise impact; the noises in main substation mainly consists of the noises of transformer and cooling fan. The analysis results of main noise source in this project are listed in table 5.3-2.

(2) Analog survey and monitoring of underground station ventilation pavilion and cooling tower noise source

To provide reference for noise environment impact assessment, the assessment selects Shanghai Metro line 1, Shanghai rail transit line 6 and Beijing subway double line 8 as main analog sites on basis of full research of design data of this project, and collects the noise source monitoring data and research results related to domestic existing subways (urban rail transmit). Now summarize the analog survey and monitoring results of main noise sources in table 5.3-7.

Table 5.3-7 Analog survey and monitoring results of noise level

Noise source category	Measurement point location	A sound level (dBA)	Related conditions of measurement point	Analog location (data source)	Operation time
Exhaust pavilion	2.5 m out of shutter	69.6	HP3LN-B-112-H, with 2m-long silencer	Shanghai Metro line 1 Shanghai Circus World station, screen door system	30 min before normal operation period to 30 min after out of service
New ventilation pavilion	2.5 m out of shutter	59	HL3-2A No.5A, with 2m-long silencer (screen door)		
Piston/mechanical ventilation pavilion	3 m out of shutter	65	TVF (flow rate 45m3/s), 2m-long silencers are separately installed before and after the fan		30 min before normal operation period to 30 min after out of service Mechanical fans operate for each 30min before and after subway operation period
Cooling tower	3.3m from tower body	72	Liangchi cooling tower LRCM-LN150	Beijing subway double line 8 section of Xidan to Dawanglu	The normal operation time of primary system is from 30 min before normal operation period to 30 min after out of service; the secondary system continuously operates.
	3.3m horizontal distance from edge of cooling tower	62.4	SC-125LX2 (motor power: 4kw, flow rate: 125m3/h)	Chengshanlu station of Shanghai rail transit line 6	

Note: 1. The operation period of station fan and that of cooling tower major system during air conditioning period are of 4: 30 - 23: 30, totaling 19h; the operation period of secondary system during air conditioning period is of 23: 30 - 4: 30, totaling 5h.

2. The cooling tower activates during air conditioning period and operation time is from June to September (it can be properly adjusted according to climate conditions).

The noise levels for ventilation pavilion and cooling tower in this prediction are as

follows:

Piston ventilation pavilion: 65dBA, 3m from sound source (installed 2m-long silencer);

Exhaust pavilion: 69.6dBA, 2.5m from sound source (installed 2m-long silencer);

New ventilation pavilion: 59dBA, 2.5m from sound source (installed 2m-long silencer);

Cooling tower: 72.0dBA, 3.3m from sound source (the primary and secondary systems can use this sound level, considering 2 cooling towers for primary system and 1 cooling tower for secondary system)

(3) Analog survey and monitoring of noise of main substation

The ground substation noises mainly include the noise from main substation and cooling fan and the noise impact of underground substation on ambient environment is mainly of fan noise. The transformer noises refer to the electromagnetic noise generated by the periodical vibration of metal components and air gaps excited by alternatively changing electromagnetic field, which are mainly distributed in high-frequency area of more than 1000Hz. This assessment selects Wuhan rail transmit line 1 main substation and Shanghai Metro line 2 Jingansi main substation for analog monitoring, and the monitoring results are shown in table 5.3-8.

Table 5.3-8 Analog survey and monitoring results of main substation noise

Noise source category	Measurement point location	A sound level (dBA)	Related conditions of measurement point	Analog location (data source)
Ground substation	1m from transformer	71.7	110kV, 1 set indoors	Wuhan light rail line 1 Jianghanlu station main substation
	2m from transformer	68.8		
	1m outdoors	63.1	2 main substations operate simultaneously	
Underground substation	1m from exhaust pavilion	71	2 fans operate simultaneously	Shanghai Metro line 2 Jingansi main substation

The project will set up a main substation and a switching station, where the main substation will be located at the northwest corner of Boxue Road Station’s intersection; the switching station will combine with Line 1, with no new construction. The main substation will be set up on the ground .Therefore, the source strength value used for evaluation will be: 1m outdoors: 63.1dBA.

(4) Analog survey and monitoring of sound source in car depot

A. Analog survey and monitoring of noises from fixed sound source device

The sound sources in car depot include the noise from the device with high noise such as air compressor, forging devices and fan, and the operation noise of train on access yard line and test run line. The analog monitoring indicates that the noise at location

1m from depot boundary is between 55 and 60 dBA. The fixed sound source devices refer to table 5.3-9.

Table 5.3-9 Noise level of main fixed noise sources in car depot

Name of sound source	Overhaul and un-wheeling garage	Washing shed	Sewage treatment station	Maintenance center	Integrated inspection and repair garage	Air compressor	Underfloor wheel lathe workshop
Distance from sound source (m)	5	5	5	3	3	1	1
Sound source intensity (dBA)	75 - 80	72	72	75	73	88	80
Operation conditions	Intermittent	Day and night	Day and night	Day and night	Day and night	Irregular	Irregular

B: Analog survey and monitoring of train operation at access yard line and test run line

The train operation noises in and out of the depot and on test run line is similar to the train operation noise on ground line. This assessment, based on adequate research of design data of the project, selects the ground section of Shanghai rail transmit line 3 as analog site. The analog survey and monitoring results refer to table 5.3-10.

Table 5.3-10Sound level of noise sources on test run line and access yard line

Noise source category	Measurement point location	A sound level (dBA)	Related conditions of measurement point	Analog location (data source)
Test run line, access yard line	7.5m from track centerline	87.0	At speed of 60km/h, on gravel track bed, 1.2m from ground	Shanghai rail transmit line 3, ground section

Noise level for ground line in test run line and access yard line used in this assessment: 87.0dBA, 7.5m from track centerline (speed of 60km/h, on gravel track bed).

(III) Prediction and assessment of ambient noise impact

(1) Methods and contents of predictive assessment

Considered that the line is of newly-built project, the sound environment impact prediction mainly bases on the project property and scale of project and it will select existing noise sources similar to boundary conditions for analog monitoring and survey; on this basis and in combination with current ambient status background in the areas where the project is located and design work quantity, adopt the combination method of analog monitoring and mode calculation to predict equivalent A sound level of ambient noise at each sensitive spot.

This assessment separately predicts the equivalent continuous A sound levels during day time operation period (6: 00 - 22: 00) and night time operation period (4: 30 - 6: 00, 22: 00 - 23: 30).

(2) Prediction mode

A. Noise prediction formula of ventilation pavilion and cooling tower in underground section

a. Sound level attenuation prediction formula

Noise propagation attenuation formula:

$$L_{P.A} = L_{P0} \pm \left(C_d + C_f\right)$$

Where:

$L_{P.A}$—Equivalent sound level at prediction point of sound source, dBA;

L_{p0}—Noise source intensity at equivalent distance Dm (or equipment setting) from ventilation pavilion and cooling tower, dB;

C_d—Geometric diffusion attenuation, dB;

C_f—Frequency weighted correction, dB;

b. Prediction formula of equivalent continuous A sound level at prediction point

$$L_{Aeq,P} = 10\log\left[\frac{1}{T}\left(\sum_i t \times 10^{0.1L_{P.A}}\right)\right]$$

Where:

$L_{Aeq.P}$—— Equivalent weighted A sound level of prediction point in assessment period, dBA;

T—— In specified assessment period, day time operation T= 16h = 57600s; night time operation time T = 3h = 10800s;

t—— Operation time of ventilation pavilion and cooling tower, s.

c. Description of prediction parameters and correction factors

a Equivalent distance Dm

Equivalent distance of inlet and exhaust pavilion: $Dm = \sqrt{ab} = \sqrt{se}$ in which a and b refer to the edge length of rectangular air port and se is profiled air port. In this prediction calculation of inlet and exhaust pavilions, Dm is taken as 2.5m and piston ventilation pavilion Dm for 3m.

Circular cooling tower equivalent distance: Dm refers to the distance of twice tower body diameter at tower body inlet side from tower wall. For the analog of Liang Chi This assessment cooling tower LRCM-LN150 in this assessment, Dm is taken as 3.3m;

Rectangular cooling tower equivalent distance: $Dm = 1.13\sqrt{ab}$, in which a and b

refer to tower body edge length. In the analog of low noise transverse flow cooling tower in this assessment, Dm is taken as 3.3m.

b Geometric diffusion attenuation C_d

When the distance from prediction point to ventilation pavilion and cooling tower is more than twice of equivalent distance Dm for maximum dimension limit, the ventilation pavilion and cooling tower will be considered as point source, and the geometric diffusion attenuation formula is as follow:

$$C_d = 18\lg\left(\frac{d}{Dm}\right)$$

Where:

Dm——Equivalent distance of source level, m;

d——Distance from sound source to prediction point, m.

When the distance from prediction point to ventilation pavilion and cooling tower is between equivalent point and twice of equivalent distance Dm for maximum dimension limit, the noise attenuation of ventilation and cooling tower does not comply with the point source attenuation characteristics, and the calculation formula of geometric diffusion attenuation is as follow:

$$C_d = 12\lg\left(\frac{d}{Dm}\right)$$

When the distance from prediction point to ventilation pavilion and cooling tower is less than equivalent diameter Dm, the noise of ventilation pavilion and cooling tower is close to plane source characteristics not considering geometric diffusion attenuation.

B. Prediction formula for train operation noise on ground line in car depot

a. Sound level prediction formula when single train passes at prediction point

When single train passes, noise level at certain prediction point LPi:

$$L_{p_i} = L_0 + \Delta L_v + \Delta L_{di} - \Delta L_{ai} + \Delta L_{gi} + \Delta L_{bi} + \Delta L_{ci}$$

L_{pi} ——Train running A sound level at prediction point, dBA;

L0——A sound level of train at reference distance r0, dBA;

ΔL_v ——Speed correction value, dB;

ΔL_{di} ——geometric diffusion attenuation, dB;

ΔL_{ai} ——air absorption attenuation, dB;

ΔL_{gi} ——ground absorption attenuation, dB;

ΔL_{bi} ——noise barrier attenuation, dB;

ΔL_{ci} ——sound source directive attenuation, dB.

b. In prediction period T, prediction formula for train passing equivalent sound level $L_{Aeq,p}$ at prediction point:

$$L_{Aeq,\mathrm{p}} = 10\log[\frac{1}{T}(\sum nt_{eq}10^{0.1L_{p,A}})]$$

Where: $L_{Aeq,p}$ ——In prediction period, equivalent weighted A sound level at prediction point, in dBA;

T——Specified assessment period, day time T = 16h =57600s; night time T = 2h = 7200s.

n——Number of passing train in T;

t_{eq} ——Equivalent time in train passing period, in second

c. Calculation of each correction factor

a Speed correction factor ΔL_v

According to study data at home and abroad, the variation relationship of train traveling speed with sound level is as follow:

$$\Delta Lv = n\log\frac{V}{V_0}$$

Where: n=30.

b geometric diffusion attenuation factor ΔL_{di}

The geometric diffusion attenuation factor of subway train sound source is as follow:

$$\Delta L_{di} = -10\lg\frac{d\arctan\frac{l}{2d_0}+\frac{2l^2}{4d_0^2+l^2}}{d_0\arctan\frac{l}{2d}+\frac{2l^2}{4d^2+l^2}}$$

Where:

d0——Reference distance of source intensity (d0=7.5m);

d——Horizonal distance of prediction point to outer line centerline, m;

l——Train length, m.

c air absorption attenuation ΔL_{ai}

$$\Delta L_{ai} = \frac{a(r - r_0)}{100}$$

Where: a——Air absorption coefficient every 100m (dB), take a as 0.150 at 500Hz (20 , relative humidity of 70%).

d ground absorption attenuation ΔLgi

The ground attenuation can be calculated as follow:

ΔLgi＝4.8-(2hm/r) ［17+(300/r) ］

Where: hm——Average ground clearance of propagation path, m.

e Noise barrier attenuation correction factor ΔLbi

When the train operation noise is blocked by obstruction (such as noise barrier and building) during propagation, the generated attenuation ΔL_{bi} will be calculated with following formula:

$$\Delta L_{bi} = \begin{cases} 10\log\left[\dfrac{3\pi\sqrt{1-t^2}}{4arctg\sqrt{\dfrac{1-t}{1+t}}}\right] & (t \le 1) \\ 10\log\left[\dfrac{3\pi\sqrt{t^2-1}}{2\ln\left(t+\sqrt{t^2-1}\right)}\right] & (t > 1) \end{cases}$$

Where: $t = \dfrac{40 \times f_e \times \delta_0}{3c}$

C——sound velocity, C=340m/s;

f_e——Sound wave frequency, Hz;

δ——Sound path difference, m.

ϕ Vertical directivity of sound source ΔLci

The vertical directivity of sound source is determined and corrected according to study results of International Union of Railways, i.e. disc characteristics distribution with following formula:

When -100≤θ<240, Cθ, i = -0.012(24-θ) 1.5

When 240≤θ<500, Cθ, i = -0.075(θ-24) 1.5

g The equivalent operation time of train operation noise at sensitive spots (t_{eq}) can be calculated as follow:

$$t_{eq} = \frac{l}{v}(1 + 0.8\frac{d}{l})$$

Where: l - Train length (m);

D - Vertical distance from prediction point to line (m);

v - Train speed (m/s).

C. Prediction formula for noise from fixed equipment in car depot

a. The devices with high noise in car depot such as air compressor, forging devices and fan can be considered as point source and their noise propagation attenuation calculation formula is as follow:

$$L_{p固} = L_{p固0} - 20\lg\frac{r}{r_0}$$

Where:

LP 固——A sound level at prediction point, dBA;

LP 固 0——Sound level of sound source at reference position r0, dBA;

r——Distance of prediction point to noise source, m;

r0——Distance of prediction point to noise source, m.

b. Calculation method of total equivalent sound level L_{Aeq} at prediction point:

$$L_{Aeq} = 10\log\left(\frac{1}{T}\sum_{i=1}^{n} t_{固i} \times 10^{0.1L_{p固i}} + 10^{0.1L_{Aeq列车}} + 10^{0.1L_{Aeq背景}}\right)$$

Where:

L_{Aeq} ——Total equivalent continuous A sound level at prediction point, dBA;

LP 固 i——A sound level of ith fixed device at predication point, dBA;

t 固 i——Action time of ith fixed device at prediction point, s;

$L_{Aeq列车}$ ——Train passing equivalent sound level, dBA;

$L_{Aeq背景}$ ——Background noise at prediction point, dBA.

(3) Technical specification for prediction

A. Predictive assessment volume

The current predictive assessment volume refers to equivalent continuous sound level A during daytime and nighttime operation period.

B. Prediction year

The prediction time periods are taken as design year, initial stage of 2023, short term of 2030 and long term of 2045.

C. Train Pairs

Early period: 129 pairs / day; recent period, 169 +12 pairs / day; forward period 227 +20 pairs / day.

D Train Length

The initial, recent and forward periods will use six-car grouping, that is, 4M2T Model A subway car

Train formation: 6 grouping: = Tc * Mp * M = M * Mp * Tc =

Where: Tc-trailer with cab

Mp - motor car with pantograph

M - Motor car without cab

=: Semi-automatic coupler

*: Semi-permanent rod coupler

Vehicle length: 22000 (Tc car to be appropriately extended by Δ)

Train Length: 140000 (+2 Δ) mm

E. Train speed

Maximum operating speed: 80km / h; travel speed: 35km / h.

Test line speed: 80km / h; Inlet-outlet section speed: 40km / h.

F. Operation time

Subway operation time at daytime: 6: 00 - 22: 00, totaling 16h; operation time at nighttime separately: 5: 00 - 6: 00, 22: 00 - 23: 00, totaling 2h.

(4) Prediction results and assessment of ambient noise

A. Noise prediction and assessment of underground station

a. Prediction results of ambient noise at sensitive spots

The noise of underground station ventilation pavilion and cooling tower in this project will impose impact on surrounding sensitive spots. It can be classified into non-air conditioning period and air conditioning period according to the operation mode prediction period in different seasons. The ambient noise prediction results for 44 sensitive spots near the underground station ventilation pavilion, cooling tower and section air shaft are listed in table 5.3-11.

Table 5.3-11Monitoring/prediction results of ambient noise impact on sensitive spots around underground station ventilation pavilion and cooling tower

SN	Name of sensitive spot	The measuring points	Present value		Standard value		Non-air conditioning period								Air conditioning period							
							Noise contribution from environment control device		Total noise level of prediction		Over-limit amount		Increment		Noise contribution from environment control device		Total noise level of prediction		Over-limit amount		Increment	
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
1	Yuhua 9th City 1# building	Layer 1	61.7	56.2	55	45	38.1	39.1	61.7	56.3	6.7	11.3	0.0	0.1	38.1	39.1	61.7	56.3	6.7	11.3	0.0	0.1
		Layer 2	62.1	56.7	55	45	38.1	39.1	62.1	56.8	7.1	11.8	0.0	0.1	38.1	39.1	62.1	56.8	7.1	11.8	0.0	0.1
		Layer 5	62.6	55.1	55	45	37.4	38.4	62.6	55.2	7.6	10.2	0.0	0.1	37.4	38.4	62.6	55.2	7.6	10.2	0.0	0.1
		Layer 8	61.3	55.1	55	45	36.1	37.1	61.3	55.2	6.3	10.2	0.0	0.1	36.1	37.1	61.3	55.2	6.3	10.2	0.0	0.1
2	Hualian Family Area 3# Building	Layer 1	59.6	55.3	55	45	39.2	40.2	59.6	55.4	4.8	10.8	0.0	0.1	45.8	46.1	59.8	55.8	4.8	10.8	0.2	0.5
		Layer 3	60.5	55.8	55	45	39.0	40.0	60.5	55.9	5.6	11.2	0.0	0.1	45.6	45.8	60.6	56.2	5.6	11.2	0.1	0.4
3	Hualian Family Area 4# building	Layer 1	62.1	54.7	70	55	40.1	41.4	62.1	54.9	/	/	0.0	0.2	46.9	47.2	62.2	55.4	/	0.4	0.1	0.7
		Layer 3	62.5	55.5	70	55	39.8	41.0	62.5	55.7	/	1.1	0.0	0.2	46.6	46.9	62.6	56.1	/	1.1	0.1	0.6
4	Hualian Family Area5# building	Layer 1	61.8	53.2	70	55	41.4	42.1	61.8	53.5	/	/	0.0	0.3	50.3	50.4	62.1	55.0	/	0.0	0.3	1.8
		Layer 3	59.2	52.5	70	55	40.9	41.7	59.3	52.8	/	/	0.1	0.3	49.6	49.7	59.7	54.3	/	/	0.5	1.8
5	Chengshi Bei'an Residence Community 1# building	Layer 1	58.6	52.9	70	55	37.4	38.4	58.6	53.1	/	/	0.0	0.2	37.4	38.4	58.6	53.1	/	/	0.0	0.2
		Layer 2	59.6	52.1	70	55	37.3	38.3	59.6	52.3	/	/	0.0	0.2	37.3	38.3	59.6	52.3	/	/	0.0	0.2
		Layer 5	59.6	51.9	70	55	36.7	37.7	59.6	52.1	/	/	0.0	0.2	36.7	37.7	59.6	52.1	/	/	0.0	0.2
6	Chengshi Bei'an Residence Community 4# building	Layer 1	62.5	53.0	55	45	42.9	44.3	62.5	53.5	7.5	8.5	0.0	0.5	42.9	44.3	62.5	53.5	7.5	8.5	0.0	0.5
		Layer 2	61.2	53.6	55	45	42.7	44.1	61.3	54.1	6.3	9.1	0.1	0.5	42.7	44.1	61.3	54.1	6.3	9.1	0.1	0.5
		Layer 5	61.4	53.3	55	45	40.7	41.9	61.4	53.6	6.4	8.6	0.0	0.3	40.7	41.9	61.4	53.6	6.4	8.6	0.0	0.3
7	Zhengzhou Public Transportation Company Family Area 2# building	Layer 1	64.3	52.4	70	55	39.4	40.1	64.3	52.6	/	/	0.0	0.2	39.4	40.1	64.3	52.6	/	/	0.0	0.2
		Layer 2	64.7	52.7	70	55	39.3	40.0	64.7	52.9	/	/	0.0	0.2	39.3	40.0	64.7	52.9	/	/	0.0	0.2
		Layer 5	63.2	53.2	70	55	38.4	39.1	63.2	53.4	/	/	0.0	0.2	38.4	39.1	63.2	53.4	/	/	0.0	0.2
8	Changjian Yufeng (in construction)	Layer 1	67.5	60.1	55	45	34.5	35.4	67.5	60.1	12.5	15.2	0.0	0.0	43.1	43.3	67.5	60.2	12.5	15.2	0.0	0.1
9	Nanyang Road No.219 Yard 6# building	Layer2	65.2	56.6	70	55	43.6	49.9	65.2	57.4	/	2.4	0.0	0.8	43.6	49.9	65.2	57.4	/	2.4	0.0	0.8
		Layer 4	64.2	56.1	70	55	42.2	44.4	64.2	56.4	/	1.4	0.0	0.3	42.2	44.4	64.2	56.4	/	1.4	0.0	0.3
10	Nanyang Road No.219 Yard 4# building	Layer 1	59.5	55.4	55	45	39.1	41.4	59.5	55.6	4.5	10.6	0.0	0.2	39.1	41.4	59.5	55.6	4.5	10.6	0.0	0.2
		Layer 3	58.7	53.8	55	45	38.8	41.0	58.7	54.0	3.7	9.0	0.0	0.2	38.8	41.0	58.7	54.0	3.7	9.0	0.0	0.2
11	Sunshine Holiday Community 3# Building	Layer 1	62.6	56.4	55	45	50.7	51.7	62.9	57.7	7.9	12.7	0.3	1.3	50.7	51.7	62.9	57.7	7.9	12.7	0.3	1.3
		Layer 3	62.3	56.8	55	45	47.4	48.3	62.4	57.4	7.4	12.4	0.1	0.6	47.4	48.3	62.4	57.4	7.4	12.4	0.1	0.6
12	Sunshine Holiday Community 2# Building	Layer 1	60.6	56.6	70	55	42.8	43.5	60.7	56.8	/	1.8	0.1	0.2	42.8	43.5	60.7	56.8	/	1.8	0.1	0.2
		Layer 3	59.5	55.9	70	55	42.2	42.9	59.6	56.1	/	1.1	0.1	0.2	42.2	42.9	59.6	56.1	/	1.1	0.1	0.2
13	Tongle Community 46th building	Layer 1	58.5	51.2	55	45	38.4	39.0	58.5	51.5	4.1	8.7	0.0	0.3	50.0	50.0	59.1	53.7	4.1	8.7	0.6	2.5
		Layer 3	59.2	49.9	55	45	38.1	38.8	59.2	50.2	4.6	7.7	0.0	0.3	49.3	49.4	59.6	52.7	4.6	7.7	0.4	2.8
14	Tongle Community 61th building	Layer 1	60.2	51.3	55	45	38.9	39.7	60.2	51.6	5.4	7.8	0.0	0.3	47.5	47.6	60.4	52.8	5.4	7.8	0.2	1.5
		Layer 3	60.8	50.4	55	45	38.7	39.5	60.8	50.7	6.0	7.1	0.0	0.3	47.1	47.3	61.0	52.1	6.0	7.1	0.2	1.7
15	Food Machinery Plant Family Area 2# Building	Layer 1	63.4	52.9	55	45	38.7	39.7	63.4	53.1	8.5	8.6	0.0	0.2	44.8	45.0	63.5	53.6	8.5	8.6	0.1	0.7
		Layer 3	63.1	52.8	55	45	38.4	39.4	63.1	53.0	8.2	8.4	0.0	0.2	44.6	44.9	63.2	53.4	8.2	8.4	0.1	0.6

SN	Name of sensitive spot	The measuring points	Present value		Standard value		Non-air conditioning period								Air conditioning period							
							Noise contribution from environment control device		Total noise level of prediction		Over-limit amount		Increment		Noise contribution from environment control device		Total noise level of prediction		Over-limit amount		Increment	
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
16	Xincun Community 3# Building	Layer 1	64.1	53.6	55	45	37.8	39.7	64.1	53.8	9.1	8.8	0.0	0.2	37.8	39.7	64.1	53.8	9.1	8.8	0.0	0.2
		Layer 3	63.4	52.9	55	45	37.6	39.5	63.4	53.1	8.4	8.1	0.0	0.2	37.6	39.5	63.4	53.1	8.4	8.1	0.0	0.2
17	Ronghua Community 2#	Layer 1	58.7	50.5	55	45	45.3	46.3	58.9	51.9	3.9	6.9	0.2	1.4	45.3	46.3	58.9	51.9	3.9	6.9	0.2	1.4
		Layer 3	59.6	50.7	55	45	44.1	45.1	59.7	51.8	4.7	6.8	0.1	1.1	44.1	45.1	59.7	51.8	4.7	6.8	0.1	1.1
18	Ronghua Community 3#	Layer 1	61.5	52.6	55	45	39.8	40.5	61.5	52.9	6.5	7.9	0.0	0.3	39.8	40.5	61.5	52.9	6.5	7.9	0.0	0.3
		Layer 3	60.2	52.8	55	45	39.5	40.2	60.2	53.0	5.2	8.0	0.0	0.2	39.5	40.2	60.2	53.0	5.2	8.0	0.0	0.2
19	Xiaoyuzhai (Nanyang Road 266# Yard) 3# building	Layer 2	57.4	49.8	70	55	41.3	41.9	57.5	50.5	/	/	0.1	0.7	50.1	50.2	58.1	53.0	/	/	0.7	3.2
		Layer 5	56.2	49.9	70	55	39.7	40.5	56.3	50.4	/	/	0.1	0.5	48.1	48.2	56.8	52.2	/	/	0.6	2.3
20	Transport Company Family Area (Nanyang Road No. 268) 1# building	Layer 1	58.5	50.3	70	55	40.7	43.8	58.6	51.2	/	/	0.1	0.9	49.0	49.6	59.0	53.0	/	/	0.5	2.7
		Layer 3	59.4	49.7	70	55	40.3	42.8	59.5	50.5	/	/	0.1	0.8	48.5	49.0	59.7	52.4	/	/	0.3	2.7
21	Zhengzhou Textile Machinery Apartment 29#	Layer 1	62.9	52.8	70	55	57.9	58.0	64.1	59.2	/	16.6	1.2	6.4	71.5	71.5	72.1	71.6	2.1	16.6	9.2	18.8
		Layer 3	63.1	53.3	70	55	48.6	49.1	63.2	54.7	/	/	0.1	1.4	56.8	56.8	64.0	58.4	/	3.4	0.9	5.1
22	Zhengzhou Textile Machinery Apartment 30#	Layer 1	63.1	53.2	70	55	45.0	49.8	63.2	54.8	/	/	0.1	1.6	48.7	51.3	63.3	55.4	/	0.4	0.2	2.2
		Layer 3	63.3	53.7	70	55	43.9	46.3	63.3	54.4	/	/	0.0	0.7	48.0	49.1	63.4	55.0	/	/	0.1	1.3
23	Zhengzhou Textile Machinery Apartment 18#	Layer 1	61.8	51.3	55	45	43.0	44.0	61.9	52.0	7.3	10.3	0.1	0.7	53.0	53.2	62.3	55.3	7.3	10.3	0.5	4.0
		Layer 2	62.7	51.6	55	45	42.9	43.9	62.7	52.3	8.1	10.3	0.0	0.7	52.7	52.8	63.1	55.3	8.1	10.3	0.4	3.7
		Layer 5	62.1	51.2	55	45	40.8	41.8	62.1	51.7	7.3	8.5	0.0	0.5	49.5	49.6	62.3	53.5	7.3	8.5	0.2	2.3
24	Zhengzhou Textile Machinery Apartment 19#	Layer 1	60.7	52.6	55	45	36.4	37.2	60.7	52.7	6.0	9.1	0.0	0.1	48.6	48.6	61.0	54.1	6.0	9.1	0.3	1.5
		Layer 2	59.7	52.4	55	45	36.4	37.2	59.7	52.5	5.0	8.9	0.0	0.1	48.5	48.5	60.0	53.9	5.0	8.9	0.3	1.5
		Layer 5	59.1	51.8	55	45	35.9	36.7	59.1	51.9	4.4	8.1	0.0	0.1	47.0	47.0	59.4	53.1	4.4	8.1	0.3	1.3
25	Huayuan Community 5#	Layer 1	57.2	51.2	55	45	44.9	45.4	57.4	52.2	2.4	7.2	0.2	1.0	44.9	45.4	57.4	52.2	2.4	7.2	0.2	1.0
		Layer 3	58.7	52.7	55	45	43.8	44.4	58.8	53.3	3.8	8.3	0.1	0.6	43.8	44.4	58.8	53.3	3.8	8.3	0.1	0.6
26	Huayuan Community6#	Layer 1	58.2	52.2	55	45	36.7	37.4	58.2	52.3	3.2	7.3	0.0	0.1	36.7	37.4	58.2	52.3	3.2	7.3	0.0	0.1
		Layer 3	59.3	50.3	55	45	36.5	37.3	59.3	50.5	4.3	5.5	0.0	0.2	36.5	37.3	59.3	50.5	4.3	5.5	0.0	0.2
27	Film Bureau Family Area 6# building	Layer 1	62.8	52.8	70	55	40.4	43.6	62.8	53.3	/	/	0.0	0.5	50.6	51.0	63.1	55.0	/	0.0	0.3	2.2
		Layer 2	61.5	53.7	70	55	40.3	43.4	61.5	54.1	/	/	0.0	0.4	50.4	50.8	61.8	55.5	/	0.5	0.3	1.8
		Layer 5	62.5	53.8	70	55	39.1	41.0	62.5	54.0	/	/	0.0	0.2	48.3	48.6	62.7	54.9	/	/	0.2	1.1
28	Film Bureau Family Area 5# building	Layer 1	62.1	54.7	55	45	35.0	36.0	62.1	54.8	7.2	10.1	0.0	0.1	44.1	44.2	62.2	55.1	7.2	10.1	0.1	0.4
		Layer 2	62.6	54.3	55	45	34.9	35.9	62.6	54.4	7.7	9.7	0.0	0.1	44.1	44.2	62.7	54.7	7.7	9.7	0.1	0.4
		Layer 5	61.7	53.8	55	45	34.6	35.6	61.7	53.9	6.8	9.2	0.0	0.1	43.6	43.7	61.8	54.2	6.8	9.2	0.1	0.4
29	Zhengzhou City Library	Layer 1	64.8	/	55	45	37.7	38.4	64.8	/	9.8	/	0.0	/	45.3	45.4	64.8	/	9.8	/	0.0	/
30	Downtown Community Phase II 1# building	Layer 1	57.6	51.5	55	45	37.9	38.9	57.6	51.7	2.6	6.7	0.0	0.2	37.9	38.9	57.6	51.7	2.6	6.7	0.0	0.2
		Layer 2	58.6	50.8	55	45	37.8	38.8	58.6	51.1	3.6	6.1	0.0	0.3	37.8	38.8	58.6	51.1	3.6	6.1	0.0	0.3
		Layer 5	58.7	50.4	55	45	37.1	38.1	58.7	50.7	3.7	5.7	0.0	0.3	37.1	38.1	58.7	50.7	3.7	5.7	0.0	0.3
		Layer 8	58.4	50.9	55	45	36.0	37.0	58.4	51.1	3.4	6.1	0.0	0.2	36.0	37.0	58.4	51.1	3.4	6.1	0.0	0.2

SN	Name of sensitive spot	The measuring points	Present value		Standard value		Non-air conditioning period								Air conditioning period							
							Noise contribution from environment control device		Total noise level of prediction		Over-limit amount		Increment		Noise contribution from environment control device		Total noise level of prediction		Over-limit amount		Increment	
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
31	Nanyang Road No. 326 (Zhengzhou National Oil Reserve Base Family Area) 1#	Layer 1	57.7	52.9	55	45	36.1	36.9	57.7	53.0	2.7	8.0	0.0	0.1	36.1	36.9	57.7	53.0	2.7	8.0	0.0	0.1
		Layer 3	59.4	53.1	55	45	36.0	36.8	59.4	53.2	4.4	8.2	0.0	0.1	36.0	36.8	59.4	53.2	4.4	8.2	0.0	0.1
32	Xicai Community (Minggong Road 240# Yard) 2#, 3# building	Layer 1	59.5	51.2	70	55	35.2	36.1	59.5	51.3	/	/	0.0	0.1	46.0	46.0	59.7	52.4	/	/	0.2	1.2
		Layer 3	58.9	50.7	70	55	35.1	36.0	58.9	50.8	/	/	0.0	0.1	45.7	45.8	59.1	51.9	/	/	0.2	1.2
33	Minggong Road No.245 (Xiqian Street 85# Yard 1#, 2# building)	Layer 1	64.3	55.6	70	55	41.5	42.2	64.3	55.8	/	6.8	0.0	0.2	60.6	60.6	65.8	61.8	/	6.8	1.5	6.2
		Layer 3	64.5	54.8	70	55	41.0	41.8	64.5	55.0	/	3.0	0.0	0.2	55.2	55.2	65.0	58.0	/	3.0	0.5	3.2
34	Huigang New Town 3# building	Layer 1	67.5	55.1	55	45	40.7	43.8	67.5	55.4	12.5	10.4	0.0	0.3	40.7	43.8	67.5	55.4	12.5	10.4	0.0	0.3
35	Female Mosque	Layer 2	63.2	/	70	55	35.7	36.7	63.2	/	/	/	0.0	/	35.7	36.7	63.2	/	/	/	0.0	/
		Layer 5	64.1	/	70	55	35.3	36.2	64.1	/	/	/	0.0	/	35.3	36.2	64.1	/	/	/	0.0	/
36	Hongxin Garden 1# building	Layer 2	64.9	53.5	70	55	37.0	37.8	64.9	53.6	/	/	0.0	0.1	45.0	45.1	64.9	54.1	/	/	0.0	0.6
		Layer 5	65.6	54.1	70	55	36.4	37.3	65.6	54.2	/	/	0.0	0.1	44.3	44.5	65.6	54.5	/	/	0.0	0.4
37	Xidan Apartment 3#	Layer 1	64.5	53.2	70	55	36.7	37.7	64.5	53.3	/	/	0.0	0.1	46.4	46.5	64.6	54.0	/	/	0.1	0.8
		Layer 3	63.5	53.6	70	55	36.6	37.6	63.5	53.7	/	/	0.0	0.1	46.1	46.2	63.6	54.3	/	/	0.1	0.7
38	Xidan Apartment 1#	Layer 1	63.2	53.5	70	55	35.6	37.2	63.2	53.6	/	/	0.0	0.1	43.5	43.8	63.2	53.9	/	/	0.0	0.4
		Layer 3	64.1	52.9	70	55	35.5	37.1	64.1	53.0	/	/	0.0	0.1	43.3	43.7	64.1	53.4	/	/	0.0	0.5
39	East Street 220# Yard	Layer 1	59.4	51.6	70	55	/	/	/	/	/	/	/	/	58.8	58.8	62.1	59.5	/	4.5	2.7	7.9
		Layer 3	58.9	50.8	70	55	/	/	/	/	/	/	/	/	54.5	54.5	60.2	56.1	/	1.1	1.3	5.3
40	Shangcheng Licun (East Street 248# Yard)	Layer 1	65.7	53.8	70	55	/	/	/	/	/	/	/	/	58.8	58.8	66.5	60.0	/	5.0	0.8	6.2
41	Shangcheng Garden 1# building	Layer 1	62.7	54.4	55	45	32.8	34.0	62.7	54.4	7.7	9.7	0.0	0.0	42.4	42.6	62.7	54.7	7.7	9.7	0.0	0.3
		Layer 3	62.5	55.5	55	45	32.7	33.9	62.5	55.5	7.5	10.7	0.0	0.0	42.3	42.5	62.5	55.7	7.5	10.7	0.0	0.2
42	Dongguandongli 96# Yard 1# building	Layer 1	59.3	49.9	70	55	38.3	40.8	59.3	50.4	/	/	0.0	0.5	38.3	40.8	59.3	50.4	/	/	0.0	0.5
		Layer 3	58.9	53.6	70	55	38.1	40.4	58.9	53.8	/	/	0.0	0.2	38.1	40.4	58.9	53.8	/	/	0.0	0.2
43	Dongguandongli 96# Yard 2# building	Layer 1	59.1	53.4	55	45	38.5	40.9	59.1	53.6	4.1	8.6	0.0	0.2	38.5	40.9	59.1	53.6	4.1	8.6	0.0	0.2
		Layer 3	60.7	53.5	55	45	38.3	40.5	60.7	53.7	5.7	8.7	0.0	0.2	38.3	40.5	60.7	53.7	5.7	8.7	0.0	0.2
44	Dongguandongli 96# Yard 6# building	Layer 1	62.5	52.8	55	45	36.4	38.0	62.5	52.9	7.5	7.9	0.0	0.1	36.4	38.0	62.5	52.9	7.5	7.9	0.0	0.1
		Layer 3	60.3	48.9	55	45	36.3	37.8	60.3	49.2	5.3	4.2	0.0	0.3	36.3	37.8	60.3	49.2	5.3	4.2	0.0	0.3

Note:. “/” indicates not exceeding the limit.

b. Prediction result assessment

a. Non-air conditioning period

The sensitive spots of 44 locations in underground station assessment range along the line are only affected by subway environment control device noise (no superposed background); the equivalent continuous A sound levels in day time and night time actual operation periods are separately of 32.7～57.9dB（A）、33.9～58.9dB（A）.

In 44 measurement points at day time, Yuhua 9th City 1# building, Hualian Family Area 3# Building, Chengshi Bei'an Residence Community 4# building, Nanyang Road No.219 Yard 4# building, Sunshine Holiday Community 3# Building, Food Machinery Plant Family Area 2# Building, Xincun Community 3# Building, Ronghua Community 2# and Ronghua Community 3# so on , these 18 sensitive spots at daytime exceed the limits with the over-limit amount of 2.4～12.5dB（A）， and over-limit rate at prediction points of 40.9%.

Among 43 sensitive spots during night time operation period, except sensitive spots which at daytime exceed the limits still exceed the limits during night time, also Hualian Family Area 4# Building, Nanyang Road No.219 Yard 4# building and Sunshine Holiday Community 2# Building so on, 28 sensitive spots exceed the limit with the overlimit amount of 1.1～16.6dBA and prediction point over-limit rate of 65.1%。

The statistics results of overlimit conditions in different sound function areas during non-air conditioning period are shown in table 5.3-12.

Tables 5.3-12 The prediction results exceed the limits of non air conditioning period

Application standard category	prediction point number (pcs)		Number of overlimit point (pcs)		Overlimit amount (dBA)		Overlimit ratio (%)		Name of overlimit sensitive spots
	Day time	Night time operation	Day time	Night time operation	Day time	Night time operation	Day time	Night time operation	
4a	20	20	0	5	-	1.1~16.6	0.0%	25%	① day time overlimit：none；②night time overlimit：Hualian Family Area 4# Building, Nanyang Road No.219 Yard 4# building , Sunshine Holiday Community 2# Building ,Zhengzhou Textile staff apartments, 29 #, Minggong Road No.245 (Xiqian Street 85# Yard 1#, 2# building)；
1	24	23	24	23	2.4~12.5	4.2~15.2	100%	100%	① day time overlimit：Yuhua 9th City 1# building, Hualian Family Area 3# Building, Chengshi Bei'an Residence Community 4# building, Nanyang Road No.219 Yard 4# building, Sunshine Holiday Community 3# Building, Food Machinery Plant Family Area 2# Building, Xincun Community 3# Building, Ronghua Community 2# , Ronghua Community 3#, Huayuan Community 5# and Zhengzhou City Library so on; ② night time overlimit：Yuhua 9th City 1# building, Hualian Family Area 3# Building, Chengshi Bei'an Residence Community 4# building, Nanyang Road No.219 Yard 4# building, Sunshine Holiday Community 3# Building, Food Machinery Plant Family Area 2# Building, Xincun Community 3# Building, Ronghua Community 2# , Ronghua Community 3#, Huayuan Community 5# and Zhengzhou City Library so on;

a. Air conditioning period

The sensitive spots are only affected by subway environment control device noise (no superposed background); the equivalent continuous A sound levels in day time and night time actual operation periods are separately of 35.3～71.5dB（A）和 36.2～71.5dBA.

Among 44 sensitive spots during daytime operation period, Yuhua 9th City 1# building, Hualian Family Area 3# Building, Chengshi Bei'an Residence Community 4# building, Nanyang Road No.219 Yard 4# building, Sunshine Holiday Community 3# Building, Food Machinery Plant Family Area 2# Building, Xincun Community 3# Building, Ronghua Community 2# , Ronghua Community 3#, Huayuan Community 5# and Zhengzhou City Library so on,25 sensitive spots exceed the limit with the overlimit amount of 2.1～12.5dBA , and prediction point over-limit rate of 56.8% .

Among 43 sensitive spots during night time operation period,exceptHualian Family Area 5# Building , Cityorth Shore District, 1 # building,Dongguandongli No.96Courtyard 1#、2#,and so on,at all about 13 sensitive spots do not exceed the limit .other 30 sensitive spots all exceed the limit with the overlimit amount of 0.4～16.6dBA , and prediction point over-limit rate of 69.8% .

The statistics results of overlimit conditions in different sound function areas during air conditioning period are shown in table 5.3-13.

Tables 5.3-13 The prediction results exceed the limits of air conditioning period

Application standard category	prediction point number (pcs)		Number of overlimit point (pcs)		Overlimit amount (dBA)		Overlimit ratio (%)		Name of overlimit sensitive spots
	Day time	Night time operation	Day time	Night time operation	Day time	Night time operation	Day time	Night time operation	
4a	20	20	1	9	2.1	0.1~16.6	5%	45%	①day time overlimit：Zhengzhou Textile staff apartments, 29 # ②night time overlimit：：Zhengzhou Textile staff apartments, 29 #, 30 # Building、Minggong Road No.245 (Xiqian Street 85# Yard 1#, 2# building), East Street 220# Yard,Hualian Family Area 4# and 5# BuildingNanyang Road, No. 268 Courtyard, 1 #Building, Sunshine Holiday Community 3# Building,
1	24	23	24	23	2.4~12.5	4.2~15.2	100%	100.0%	①day time overlimit：Yuhua 9th City 1# building, Hualian Family Area 3# Building, Chengshi Bei'an Residence Community 4# building, Nanyang Road No.219 Yard 4# building, Sunshine Holiday Community 3# Building, Food Machinery Plant Family Area 2# Building, Xincun Community 3# Building, Ronghua Community 2# , Ronghua Community 3#, Huayuan Community 5# and Zhengzhou City Library so on;②Yuhua 9th City 1# building, Hualian Family Area 3# Building, Chengshi Bei'an Residence Community 4# building, Nanyang Road No.219 Yard 4# building, Sunshine Holiday Community 3# Building, Food Machinery Plant Family Area 2# Building, Xincun Community 3# Building, Ronghua Community 2# , Ronghua Community 3#, and Huayuan Community 5# so on;

© Prediction result analysis

Within the scope of the evaluation of the underground stations, among the 44 sensitive points, 20 sensitive points are only affected by wind pavilion noise, and the noise prediction results of air-conditioning period and non-air-conditioning are the same; in addition, 22 sensitive points are also affected by the air conditioning period's cooling tower noise, and two sensitive points are only affected by the air-conditioning period's cooling tower noise. Therefore, the prediction results of the air-conditioning period should be higher than those of the non-air conditioning period.

The vast majority of sections in this project advances under existing urban road and the ventilation pavilion area is not far from the road, so most of assessment points are interfered by road traffic noises and it is general for background noise overlimit. The traffic noise will be still the main cause after project is built and put into service.

d. Population affected by noise

The population in sensitive spots along the line which is directly affected by subway pavilion and cooling tower noise is about 10,101.

c. Analysis of impact range

According to noise source intensity of ventilation pavilion and cooling tower, the protection distances of sound sources are summarized in table 5.3-14 (not considering ambient noise current value and open without blocking).

Table 5.3-14 Noise protection distance of ventilation pavilion and cooling tower

Noise source category	Description	Standard-reaching distance (m)					
		GB3096-2008 Category 4a		GB3096-2008 Category 2		GB3096-2008 Category 1	
		Day time	Night time	Day time	Night time	Day time	Night time
Two pitons + exhaust pavilion +new ventilation pavilion	Set 2m long-plate type silencer	≥3	≥20	≥10	≥38	≥18	≥71
	Set3m long-plate type silencer	*	≥6	≥3	≥11	≥6	≥20
cooling tower	Normal cooling tower	≥7	≥42	≥23	≥80	≥42	≥154
	Low noise cooling tower	≥4	≥13	≥7	≥24	≥13	≥45
Ventilation pavilion (piston + exhaust + new) + cooling tower	Set 2m long-plate type silencer in ventilation pavilion	≥7	≥48	≥25	≥90	≥48	≥170
	Set 2m long-plate type silencer in ventilation pavilion; adopt low noise cooling tower	≥4	≥24	≥12	≥45	≥24	≥85
	Set 3m long-plate type silencer in ventilation pavilion; adopt low noise cooling tower	≥4	≥14	≥8	≥26	≥14	≥50
Two piston ventilation pavilions	Set 2m long-plate type silencer	*	⩾9	⩾3	⩾17	⩾6	⩾32
	Set 3m long-plate type silencer	*	⩾3	*	≥6	*	≥9

Note: "*" indicates it can meet the standard outside of ventilation pavilion shutter; night time standard-reaching distance refers to the standard-reaching distance in

actual operation period.

As shown in table 5.3-14, in the noise of ventilation pavilion and cooling tower, the noise from cooling tower plays the predominant position, so the noise standard-reaching protection distances in zone categories 4a, 2 and 1 around the ventilation pavilion during non-air conditioning period (cooling tower not activated) are separately of 20m, 38m and 71m; during air conditioning period, if conventional cooling towers are used, the noise protection distances for zone categories 4a, 2 and 1 around the ventilation pavilion are separately of 48m, 90m and 170m; if the low noise cooling tower is used, the noise protection distances for zone categories 4a, 2 and 1 around the ventilation pavilion are separately of 24m, 45m and 85m. From this view, to reduce the project demolition and save the urban land resource, the application of low noise environment control device or "combination of prevention and management" purposeful noise control program can effectively control the noise impact in underground station ventilation pavilion area.

B. Noise prediction and assessment in area of car depot and integrated base

Parking depot is located at north of Lian-Huo highway and south of Jialu River, and there is no noise sensitive spot around it. The car depot is located at east of Chaohe River and south to Jingnansan Road, and there is makeshift houses sporadically distributed around the traction line. The fixed sound source devices are set in workshop or factory with the feature of quick attenuation, so it has less impact on external environment in the car depot. The main interference from the noise of the car depot and parking lot on the external environment is from the parking lot's inlet and outlet segments and test line, and from the parking lot's vehicle operating noise. For the factory boundary noise prediction of the parking lot and car depot is shown in Table 5.3-15 and Table 5.3-16.

Table 5.3-15 Prediction results of sound environment impact on sensitive spots around the parking lots(dBA)

Sensitive spot name	Relative position	Design year	Standard value		Boundary noise prediction value (dBA)		Boundary noise over-limit amount (dBA)		note
			Day time	Night time	Day time	Night time	Day time	Night time	
east boundary	1m from boundary	Initial phase	60	50	48.7	33.4	/	/	
north boundary	1m from boundary	Initial phase	60	50	55.1	49.7	/	/	Consider the adverse effects of incoming and outgoing lines
west boundary	1m from boundary	Initial phase	60	50	57.5	50.7	/	0.7	Consider the adverse effects of incoming and outgoing lines
south boundary	1m from boundary	Initial phase	60	50	56.9	49.9	/	/	Consider the adverse effects of incoming and outgoing lines

Table 5.3-16 Prediction results of sound environment impact on sensitive spots around car depot (dBA)

Sensitive spot name	Relative position	Design year	Standard value		Boundary noise prediction value (dBA)		Boundary noise over-limit amount (dBA)		note
			Day time	Night time	Day time	Night time	Day time	Night time	
east boundary	1m from boundary	Initial phase	60	50	71.1	47.0	11.1	/	Consider the adverse effects of incoming and outgoing lines
north boundary	1m from boundary	Initial phase	60	50	57.9	50.0	/	/	Consider the adverse effects of incoming and outgoing lines
west boundary	1m from boundary	Initial phase	60	50	55.6	46.3	/	/	Consider the adverse effects of incoming and outgoing lines
south boundary	1m from boundary	Initial phase	60	50	49.6	36.3	/	/	

Jialu River parking depot is located in rural area and out of the central urban area planning zone, as category 2 area; as shown in table 5.3-15, the east of parking depot is mainly affected by the release line and the predicted noise contribution value is 48.7 - 57.5 dB(A) at daytime and 33.4 -50.7 dB(A) at nighttime; except the west boundary, all others do not exceed the category 2 standard in GB12348-2008 Emission Standard for Industrial Enterprises Noise at Boundary with the over-limit amount of about 0 dB（A）和 0.7 dB(A).

Hanghai East Road car depot is located in the development zone as category 2 area; the car depot is mainly affected by the vehicle operation noises of testing line and release line during operation period. As shown in table 5.3-16, the noise at boundary of car depot is 49.6-71.1 dB(A) at daytime and 36.3-50.0dB(A) at nighttime; in contrast to the category 2 standard in GB12348-2008 Emission Standard for Industrial Enterprises Noise at Boundary, the noise at east boundary at daytime exceeds the standard value for 11.1dBA due to close to the testing line and all other boundaries meet the standard requirements.

C. Noise impact prediction and assessment of main substation

This project newly builds one 110kV main substations of BoXue road Station main substation, which is of indoor ground layout. There is no sensitive spot around BoXue road Station main substation; which is affected by road noises and social noises with the day time level of 60.5dBA and 54.2dBA at night time. The noise level simply affected by the main substation is 33.6dBA. The environment noise prediction value maintains the present status without any increment.

5.3.3 Noise pollution control measures

5.3.3.1 General

According to the basic principles of environment protection “Mainly of prevention, combination of prevention and control, comprehensive management” in domestic and basic strategic policy of “Integration of social benefit, economic benefit and environment benefit”, and the guiding concept of “Eliminate the root cause for pollution control”, the noise pollution prevention measures of this project shall comply with following sequences:

(1) Firstly carry out noise control on sound sources and select the device and structure types with low noise.

(2) Secondly strengthen the design of noise pollution abatement works, mainly from blocking of noise propagation path and sound receiving points.

(3) Finally, based on “Prevention First” principle and in combination with urban modification and planning, reasonably plan the land functions along the line and optimize the building layout to avoid new environment problems.

5.3.3.2 Suggestions for noise pollution control during construction period

According to the regulations in Law of the People's Republic of China on Prevention and Control of Pollution from Environmental Noise articles 27, 28, 29 and 30, the project shall comply with national ambient noise emission standards at building construction boundary; the construction unit shall report, 15 days before commencement of construction, to the competent administrative department for environmental protection of the local people's government at district level the name of the project, the construction site, the length of time needed for completion of the project, the possible level of environmental noise and the measures taken for prevention and control of such pollution. In an urban area where noise-sensitive structures are concentrated, construction operation that produces environmental noise pollution is forbidden at night. For continued operation due to special needs, there must be a permit issued by the people's government at or above the district level or by the relevant competent department, and the approved night time operations be made known to the residents in the neighborhood.

Furthermore, put forth following measures and suggestions for noise environment impact during construction period in combination with actual conditions of this project:

(1) During construction period, it must accept the supervision and inspection of environment protection department and take effective vibration damping and noise reduction measures according to the regulations in Noise Limits for Construction site (GB12523-90) without disturbing the residents. The Night Construction Permit shall be obtained for night construction.

(2) The machines with large noise such as generator and air compressor shall be laid out at remote place or in tunnel, and kept from sound environment sensitive spots

such as residential area, schools and hospitals; they shall be regularly maintained and strictly comply with the operation specifications. The mobile diesel generator car must not be used as possible, instead the low noise generator car with noise control measures must be used or reliable ventilation and sound insulation measures must used for both diesel generator or air compressor.

(3) The static pile driver shall be used in sensitive section rather than cast-in-place pile. The low noise processes such as “reverse construction method” and “covered excavation method in amplitudes” shall be used as possible instead of open cut construction method. It is forbidden to drive the pile. If necessary, it shall be reported to Zhengzhou Environment Protection Bureau for approval and limit the operation time period in the range of 7:00 - 12:00 and 14:00 - 22:00; the application of other construction machinery and devices with high noise shall be also limited in the time range of 7:00 - 12:00 and 14:00 - 22:00. If necessary for continuous construction, it must obtain the advance approval from Zhengzhou Environment Protection Bureau. Arrange the low noise construction works such as shielding and hoisting at night time.

(4) The access of transport vehicles to construction site shall be arranged at the side far from the residential area.

(5) Adopt commercial concrete rather than the operation method to set the concrete mixer in construction site.

(6) Optimize the construction program, reasonably arrange the construction time limit and minimize the noise hazard of building construction environment. During tendering and bidding of construction project, list the measures to reduce the environment noise pollution in the contents of construction organization design, and specify them in the contract signed.

(7) According to Notice on Strengthening the Ambient Noise Pollution Supervision and Management during College Entrance Examination issued by State Environmental Protection Administration of China in April 26th in 1998, during college entrance examination and half an month before the period, prohibit any building construction works which may lead to noise over-limit and resident disturbance besides strict control for various environment noise sources acceding to related national environment noise standards.

(8) During construction period, the employer, construction unit, design unit and street office establish the special leading group. Set 24h on-duty hotline and special liaison man and strengthen the communication with the residents along the line, and timely improve the management measures according to resident advices so as to ensure the living quality of the residents along the line.

(9) For the machines and tools with high noise, increase the height of temporary noise barrier if necessary. For the sensitive spots with heavy noise impact by station construction (see table 5.3-6), recommend setting temporary 3-4m high sound insulation fencing or noise barrier or directly set up the sound insulation work shed (or sound insulation flexible curtain) with effective design; it can also consider to establish temporary workshop near the sensitive spots to function as insulation wall so as to relieve the noise impact. The estimated cost for noise prevention and control and noise compensation during construction period is 2.25 million Yuan.

（See table 5.3-17）

Table 5.3-17 List of measures to be taken on noise-sensitive points during construction

No.	Station	Sensitive point	Position relative to stations	Size	Closest distance from the constructional boundary (m)	Predicted noise before measures (dB(A))	Measures to reduce noise	Investment (RMB ¥:×10^4)	Predicted noise after measures (dB(A))
1	Shamen Road Station	Chengshi Bei'an Community 1# building	North end west side	5 units - 2 households, 6 floors, 1 building, about 60 households	18	54.4	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the west side.	25	47.4
2		Changxing Building	South end west side	5 units, 12 households each unit, about 60 households	13	57.3			50.3
3		Huiji District Changxing Road Subdistrict Office	North end east side	Subdistrict Office	9	60.5			53.5
4		Changxing Road 2# Yard 13#, 10# building	North end east side	5 units, 2 households, 7 floor, 2 buildings, about 140 households	24	51.9			44.9
5		Baiwen Garden 1#, 2#, 6#, 7# building	South end east side	3 units, 2 households for each stairs, 1 building; 4 units, 2 households for each stairs, 2 buildings; 8 nits, 2 households for each stair, 1 building, 6 floors (in which the first floor is for store); total about 190 households	Immediately Close to	70.0			63.0

6	Xinglongpu Road Station	Zhengzhou Public Transportation Company Family Area	North end west side	3 units, 2 households for each stair, 7 floors, 3 buildings; 1 units, 4 households for each stair, 7 floors, 1 building; total about 154 households	Immediately Close to	70.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the east side.	25	63.0
7		Huarun Chengshi Zhiyin (Xinyu Yayuan) Community 1#, 5# building	North end east side	2 units, 2 households, 5 floors, total about 40 households	15	56.0			49.0
8		Changjian Yufeng (in construction)	South end west side	8 households per floor, 17 floors, total about 136 households	22	52.7			45.7
9	Dongfeng Road Station	Sunshine Holiday Community 3# Building Sunshine Holiday Community 2# Building	North end west side	3 units, 2 households for each stair, 7 floors, 4 buildings, total about 84 households	6	64.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles;	25	57.0
10		Tongle Community 46# Building Tongle Community 61# Building Food Machinery Plant Family Area 2#	South end east side	4 units, 2 households for each stair, 6 floors, 1 building; 1 units, 3 households for each stair, 4 floors, 1 building; 1 units, 3 households for each stair, 7 floors, 1 building; total about 81 households	Immediately Close to	70.0			63.0

		Building							
11		Tongle Community North Area 1#, 2#, 3#, 4#, 5# building	North end east side	1 unit, 2 households for each stair, 7 floors, 2 buildings; 1 unit, 2 households for each stair, 5 floor, 1 building; 5 units, 2 households for each stair, 6 floors, 1 building; 3 units, 2 households for each stair, 7 floors, 1 building; total about 140 households	3	70.0			63.0
12		Futian Lijing Garden Community 39#, 40# building	South end west side	7 floors, 2buildings, about 40 households each floor; total about 560 households	Immediately Close to	70.0			63.0
13	Nongye Road Station	Ronghua Family Area 3#, 4#	North end west side	3 units, 2 households, 5 floors, 1 building; 7 floors, 1 building; total about 72 households	12	58.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the north side.	25	51.0
14		Zhengzhou Ceramics Factory Family Area 1#, 3# building, Nanyang Road No. 62	South end east side	3 units, 2 households for each stair, 5 floors, 2 buildings, total about 60 households	6	64.0			57.0
15		Nanyang Road 68# Yard Zhengtie Nanyang New Town Community	North end east side	4 units, 2 households, 7 floors, 1 building; 1 unit, 4 households, 7 floors, 3 building; 5 units, 2 households, 7 floors, 1 building; total about 210	11	58.7			51.7

		1#, 2#, 3#, 10#, 41# building		households.					
16		Xiaoyuzhai (Nanyang Road 266# Yard) 3#, 5# building	South end west side	5 units, 3 households, 6 floors, 1 building; 2 units, 3 households; 6 floors, 1 building; total about 114 households	6	64.0			57.0
17	Huanghe Road Station	Zhengzhou Textile Machinery Staff Apartment 18# - 20# building	North end east side	3 units, 2 households, 7 floors, 3 buildings; total about 126 households	7	62.6	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the east side.	25	55.6
18		Nanyang Road 296# Yard (Nanyang Renjia) 1#, 2#, 3#	North end west side	2 units, 3 households, 12 floors, 1 building; 3 units, 2 households, 6 floors, 1 building; 1 unit, 2 households, 6 floors, 12 households; 9 units, 2 households, 6 floors, 1 building; total about 312 households	Immediately Close to	70.0			63.0
19		Zhengzhou Textile Machinery Co., Ltd. Family Area 6#, 5#, 4#, south 3#, south 2# building	South end east side	10 households per floor, 4 floors, 5 buildings, total about 150 households	Immediately Close to	70.0			63.0

20		Huayuan Community (Nanyang Road No.300) 5# building	South end west side	3 units, 2 households, 7 floors, 1 building, total about 42 households	Immediately Close to	70.0			63.0
21	Jinshui Road Station	Film Bureau Family Area 6#, 7# building (Nanyang Road No. 7)	North end east side	3 units, 2 households, 5 floors, 1 building; 1 unit, 2 households, 5 floors, 1 building; total about 32 households	Immediately Close to	70.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the south side.	25	63.0
22		Zhengzhou City Library	North end east side	In library	Immediately Close to	70.0			63.0
23		Zhengzhou National Oil Reserve Base Family Area 1# building	South end west side	5 units, 2 households, 7 floors, 1 building, total about 70 households	24	51.9			44.9
24		Downtown Community Phase II 1# building	South end east side	3 units, 2 households, 18 floors, 1 building, total about 108 households	31	49.7			42.7
25	Taikang Road Station Jinshui Road Station	Xicai Community (Minggong Road 240# Yard)2#, 3# building	South end west side	7 floors, 10 households 2 buildings; total about 140 households	Immediately Close to	70.0			63.0
26		Minggong Road N0.245 (Xiqian Street 85# Yard 1#, 2# building)	South end west side	about 20 households for low rise; 3 units, 3 households, 7 floors, 1 building, about 63 households; total about 83 households	Immediately Close to	70.0			63.0

27		Huarun Yuefu (in construction)	South end east side	10 households per floor, 58 floors, 1 building; about 580 households	20	53.5			46.5
28	Erqi Square Station	Huigang New Town 1#, 2#, 3# building	Northwest end west side	15 households per floor, 1 building; 10 households per floor, 1 building; 20 households per floor, 1 building; total about 1260 households	10	59.5	/		59.5
29		Xiaolou Mosque, Female Mosque	West end north side	Religion	12	58.0			51.0
30	Shuncheng Street Station	Hongxin Garden 1# building	East end north side	3 units, 4 households, 7 floors, 1 building; about 约 84 households	6	64.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the west side.	25	57.0
31		Xidan Apartment 2# Building	East end north side	7 households per floor, 7 floors, 1 building; 4 units, 4 households; 7 floors, 1 building; about 138 households	26	51.2			44.2
32		Xiandai Xingyuan 1#	West end south side	About 120 households	9	60.5			53.5
33		Yinzuo International	East end south side	15 floors, 5 units, 2 households per stair; about 150 households	Immediately Close to	70.0			63.0
34	East Street Station	Changjiang Chengzhongcheng	West end south side	4 units, 2 households, 7 floors, 1 building, about 42 households	Immediately Close to	70.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles	25	63.0
35		Hongyu Garden 1#, 2#, 3# building	West end south side	About 500 households	20	53.5			46.5
36		East Street	East end	6 units, 2 households 6	7	62.6			55.6

		220# Yard	south side	floors, 1 building; about 72 households			instead of drilled and grouted piles; locate the vehicle access at the east side.		
37		Ziyan Huating 1#, 2# building	West end north side	6 households per floor, 24 floors, 2 buildings, about 288 households	14	56.6			49.6
38		Zhengzhou Guancheng District State Administration of Taxation Office Service Hall (to be relocated)	West end north side	Government office, 8 floors	Immediately Close to	70.0			63.0
39		The First People's Hospital of Zhengzhou	East end north side	1200 beds	19	54.0			47.0
40	Chengdong Road Station	Dongguandongli 96# Yard 1# building	East end north side	3 units, 2 households, 5 floors, 1 building, about 30 households	16	55.5	/	/	55.5
41		Shangcheng Garden 1# building	West end north side	2 units, 3 households, 7 floors, about 42 households	43	46.9			39.9
42	Fengtainan Road Station	Zhengzhou Huimin Middle School	West end north side	About 72 classrooms, 2900 teachers and students	25	51.6	/	/	51.6
43		Zhengzhou City Public Security Bureau SWAT Detachment	East end north side	Government office, 8 floors	27	50.9			43.9
	TOTAL							225	

5.3.3.3 Prevention and control suggestion for noise pollution during operation period

(I) Select low noise fan and cooling tower

The fans and cooling towers are the main noise sources effecting ambient environment in underground sections of rail transit. So the proper selection of fan and cooling tower is critical to prevent the ambient noise impact in underground section. In view that the environment control device model in the design of this project has not finally determined, the assessment puts forth following requirements for the model selection:

(1) Fan model selection and design requirements

Under the premise of meeting the project ventilation requirements, adopt the fans with low noise and excellent acoustic performance as possible and note following problems in ventilation pavilion design:

A. During location selection of ventilation pavilion, the noise prevention distance specified in table 5.3-14 shall be kept far from the noise sensitive spots as possible with air outlet opposite to sensitive spots.

B. Make full use of barrier functions of non-sensitive building s such as station devices, entrance/exit and management rooms, and set them between the ventilation pavilion and sensitive buildings.

C. Reasonably control the exhaust speed of ventilation pavilion and reduce the air flow noise.

(2) Model selection of cooling towers

The cooling towers are normally arranged on ground, top of ventilation pavilion or underground low buried depth position, and their radiation noises directly impact the external environment. To block the noise propagation path, it is necessary to fully enclose them. The required enclosed barriers not only feature large volume and also impact the ventilation of cooling tower. So the optimal route is to use low noise cooling tower or ultra-low noise cooling tower and strictly control the noise value of sound source. There are many manufacturers and models of low noise cooling towers and the production technical levels tend to be mature. For example, the acoustic test data of low noise type (DBNL3) and ultra-low noise type (CDBNL3) cooling towers are shown in table 5.3-18.

Table 5.3-18 Noise values of low noise type and ultra-low noise type cooling towers

Model	Low noise type (DBNL3)		Ultra-low noise type (CDBNL3)	
	Distance (m)	Noise value (dBA)	Distance (m)	Noise value (dBA)
150	3.732	58.5	4.6	54.0
	10	52.0	10	47.5

175	3.732	59.5	4.6	55.0
	10	53.0	10	48.5
200	4.342	60.0	5.7	55.0
	10	54.0	10	49.6
250	4.342	61.0	5.7	56.0
	10	55.6	10	50.6
300	5.134	61.0	6.4	56.0
	10	56.8	10	51.8
350	5.134	61.5	6.4	56.5
	10	57.3	10	52.3

As shown by the noise values f various cooling tower models in table 5.3-17, the noise values of low noise type cooling tower is over 10dBA lower than those of normal cooling towers, and the noise reduction of ultra-low noise cooling tower to normal cooling towers is more than 15dBA.

The assessment recommends the employer and design department strictly control the quality when adopting ultra-low noise cooling tower and the noise indexes must reach or excel the noise indexes specified in GB7190.1-1997. The noise indexes of various cooling towers specified by GB7190.1-1997 are shown in table 5.3-19.

Table 5.3-19 Noise indexes of various cooling towers specified in GB7190.1-1997

Nominal cooling flow rate m3/h	Noise index			
	P type	D type	C type	G type
30	68.0	60.0	55.0	70.0
50	68.0	60.0	55.0	70.0
75	68.0	62.0	57.0	70.0
100	69.0	63.0	58.0	75.0
150	70.0	63.0	58.0	75.0
200	71.0	65.0	60.0	75.0
300	72.0	66.0	61.0	75.0
400	72.0	66.0	62.0	75.0

(II) Urban planning and reasonable layout of buildings

For reasonably planning of land use along the line, according to related regulations in Subway Design Specifications and in combination with the noise prediction results of this project, it is recommend that no noise sensitive building such as residential area, school and hospital may be planned to construct in the noise prevention distance range of 15m (category 4 zone), 26m (category 2 zone) and 50m (category 1 zone) from the station ventilation pavilion and cooling tower; if necessary to construct noise sensitive building in related sound environment function area, the developer must

consider the isolation function of building itself, and ensure the internal sound environment of building meets the application functions. Scientifically plan the layout of buildings to arrange the first row buildings near the noise sources as noise non-sensitive building such as commercial and office building. In combination with the modification of old town, firstly demolish the residential houses near the sound source, and, in combination with the greening design and re-arrangement of buildings, reserve the sound prevention distance for newly developed buildings or make use of the sound blocking and insulation effects of non-sensitive buildings so as to ensure the impact on sensitive buildings within allowable range of standard.

(III) Operation management of rail transit

To strengthen the operation management, it can effectively abate the noise impact on external environment by train running mainly with following measures:

(1) Periodically trim the wheel tread

The wheel tread may present rough surface of different extents after operation of certain period. When there is a series of rough spots with the length of more than 18mm on wheel, it must be trimmed. The test demonstrates that the wheel after ground can reduce the squeak by 2-5dBA and roaring by 2-6dBA.

(2) Keep steel rail surface smooth

Since the smoothness of steel rail surface directly influences the noise volume of wheel and track, so it is necessary to grind the ripple and rough surface on steel rails with grinder after operation of certain time after operation of certain time. It can reduce the wheel and track noise for 5 – 6 dBA after taken such measure.

(3) Operation management of car depot and integrated base

Improve the operation management of integrated base, enhance the environment protection awareness of driver and conductor and control the whistling; prohibit test run operation at night time and production in workshop with high noise.

5.3.3.4 Noise control engineering in sensitive spots

(I) Noise control for environment control device in underground section

(1) Demolish the sensitive buildings

(1) Adjust the position of ventilation pavilion and cooling tower

According to requirements of subway design specification, adjust the ventilation pavilion and cooling tower positions so as to ensure the distance from sensitive spots is more than 15m. If some areas can not be moved to beyond 15m, then the wind pavilion and cooling tower shall be relocated to one side of the road center to be away from sensitive points at both sides of the road.

(2) Block the propagation path of sound source

For the ground noise sources such as cooling tower, the measures such as setting noise

barrier or applying sound absorption materials on inside surface can be taken to effectively block the noise propagation path and achieve certain sound insulation and noise reduction effect.

(3) Protection measures of sound receiving point

The sound insulation with building method can be used for protection of sound receiving point; for example, the sound insulation ventilating window can reduce the indoor noise for about 20dBA to enable the indoor noise to meet the application requirements of functions. The sound insulation ventilating window has the advantages of less investment, but affecting the view and ventilation and certain affect on daily lives of residents, so this assessment can be used as an auxiliary measure.

(4) Sound damping design

For exhaust and inlet pavilions, the silencers can be installed on air ducts and before and after the fan to reduce the noise impact by pavilion, the plate type silencer can be installed in air duct and the integrated silencer can be installed in air pipe. The analog survey and test results show that the silencer can reduce the noise for about 10dBA every meter. In addition, the measures such as maximizing the surface area of air duct, affixing sound absorption materials, mounting damping shutter at outlet, optimizing geometric section of silencing shutter and reducing the air noise can effectively reduce the pavilion noise impact to certain extent. It is recommended to use environment friendly, fungi-proofing and mould proof materials to improve the air and hygienic conditions inside and outside the stations.

(II) Protection measurement and effect analysis of noises in underground section sensitive spots

This environment impact assessment, from the view of least favorable conditions, adopts noise prevention measures in reference to environment noise prediction value during air conditioning period and enables the environment noise at sensitive spots to achieve related environment standard, and maintains present level of ambient noise for sensitive spots in which the present ambient noise level has exceeded the limits. The noise prevention measures and effects for environment control devices are listed in table 5.3-20.

Table 5.3-20 Noise control measures for ventilation pavilion and cooling tower

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
1	Yuhua 9th City 1# building	Layer 1	K0+090 ～ K0+100	30	30	30	/	6.72	11.28	0.02	0.08	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	28.13	29.12	0.00	0.01
1	Yuhua 9th City 1# building	Layer 2	K0+090 ～ K0+100	30	30	30	/	7.12	11.77	0.02	0.07			28.07	29.07	0.00	0.01
1	Yuhua 9th City 1# building	Layer 5	K0+090 ～ K0+100	30	30	30	/	7.61	10.19	0.01	0.09			27.36	28.35	0.00	0.01
1	Yuhua 9th City 1# building	Layer 8	K0+090 ～ K0+100	30	30	30	/	6.31	10.17	0.01	0.07			26.13	27.12	0.00	0.01
2	Hualian Family Area 3# Building	Layer 1	K1+436 ～ K1+460	26	26	26	30	4.78	10.79	0.18	0.49	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use Ultra-low noise cooling tower （4）The cooling tower is provided with noise hood at the outside	45	32.51	33.01	0.01	0.03
2	Hualian Family Area 3# Building	Layer 3	K1+436 ～ K1+460	26	26	26	30	5.64	11.22	0.14	0.42			35.60	35.84	0.01	0.04
3	Hualian Family Area 4# building	Layer 1	K1+436 ～ K1+460	23	25	20	26	/	0.41	0.13	0.71			36.89	37.19	0.01	0.08
3	Hualian Family Area 4# building	Layer 3	K1+436 ～ K1+460	23	25	20	26	/	1.06	0.11	0.56			33.21	33.82	0.01	0.03
4	Hualian Family Area5# building	Layer 1	K1+436 ～ K1+460	20	19	23	16	/	0.02	0.29	1.82			40.26	40.37	0.03	0.22
4	Hualian Family Area5# building	Layer 3	K1+436 ～ K1+460	20	19	23	16	/	/	0.45	1.84			39.60	39.72	0.05	0.22
5	Chengshi Bei’an Residence Community 1# building	Layer 1	K1+615 ～ K1+650	33	33	33	/	/	/	0.03	0.15	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）The wind pavilion is moved 10m to the north	15	27.38	28.38	0.00	0.02
5	Chengshi Bei’an Residence Community 1# building	Layer 2	K1+615 ～ K1+650	33	33	33	/	/	/	0.03	0.18			27.34	28.33	0.00	0.02
5	Chengshi Bei’an Residence Community 1# building	Layer 5	K1+615 ～ K1+650	33	33	33	/	/	/	0.02	0.16			26.74	27.73	0.00	0.02
6	Chengshi Bei’an Residence Community 4# building	Layer 1	K1+615 ～ K1+650	16	19	13	/	7.55	8.55	0.05	0.55			30.75	32.48	0.00	0.04
6	Chengshi Bei’an Residence Community 4# building	Layer 2	K1+615 ～ K1+650	16	19	13	/	6.26	9.06	0.06	0.46			30.65	32.34	0.00	0.03
6	Chengshi Bei’an Residence Community 4# building	Layer 5	K1+615 ～ K1+650	16	19	13	/	6.44	8.60	0.04	0.30			29.35	30.76	0.00	0.02
7	Zhengzhou Public Transportation	Layer 1	K2+787 ～	26	23	31	/	/	/	0.01	0.25	（1）Main exhaust port		29.39	30.12	0.00	0.03

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
	Company Family Area 2# building		K2+803									backing to the sensitive spot.					
7	Zhengzhou Public Transportation Company Family Area 2# building	Layer 2	K2+787 ～ K2+803	26	23	31	/	/	/	0.01	0.23			29.32	30.05	0.00	0.02
7	Zhengzhou Public Transportation Company Family Area 2# building	Layer 5	K2+787 ～ K2+803	26	23	31	/	/	/	0.01	0.17			28.36	29.13	0.00	0.02
8	Changjian Yufeng (in construction)	Layer 1	K3+070 ～ K3+090	48	48	48	40	12.52	15.19	0.02	0.09	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use low noise cooling tower	35	33.13	33.28	0.00	0.01
9	Nanyang Road No.219 Yard 6# building	Layer2	K4+405 ～ K4+425	14	18	1	/	/	2.44	0.03	0.84	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）The location of wind pavilion is adjusted, and moved 6m to the center of the road	15	33.63	39.89	0.00	0.09
9	Nanyang Road No.219 Yard 6# building	Layer 4	K4+405 ～ K4+425	14	18	1	/	/	1.38	0.03	0.28			32.17	34.39	0.00	0.03
10	Nanyang Road No.219 Yard 4# building	Layer 1	K4+405 ～ K4+425	26	30	15	/	4.54	10.57	0.04	0.17			29.11	31.45	0.00	0.02
10	Nanyang Road No.219 Yard 4# building	Layer 3	K4+405 ～ K4+425	26	30	15	/	3.74	9.02	0.04	0.22			28.84	30.98	0.00	0.02
11	Sunshine Holiday Community 3# Building	Layer 1	K4+405 ～ K4+425	6	6	6	/	7.87	12.67	0.27	1.27			35.29	36.28	0.01	0.04
11	Sunshine Holiday Community 3# Building	Layer 3	K4+405 ～ K4+425	6	6	6	/	7.44	12.38	0.14	0.58			34.15	35.14	0.01	0.03
12	Sunshine Holiday Community 2# Building	Layer 1	K4+405 ～ K4+425	17	14	21	/	/	1.81	0.07	0.21			31.42	32.14	0.01	0.02
12	Sunshine Holiday Community 2# Building	Layer 3	K4+405 ～ K4+425	17	14	21	/	/	1.11	0.08	0.21			30.95	31.70	0.01	0.02
13	Tongle Community 46th building	Layer 1	K4+600 ～ K4+637	30	25	39	16	4.07	8.66	0.57	2.46	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the	45	34.36	34.50	0.02	0.09
13	Tongle Community 46th building	Layer 3	K4+600 ～ K4+637	30	25	39	16	4.62	7.65	0.42	2.75			33.93	34.08	0.01	0.11

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
14	Tongle Community 61th building	Layer 1	K4+600 ～ K4+637	28	23	31	23	5.43	7.84	0.23	1.54	noise of ventilation pavilion for 10dB;; （3）Use Ultra-low noise cooling tower （4）The location of wind pavilion is adjusted, and moved 3m to the center of the road		32.73	33.02	0.01	0.06
14	Tongle Community 61th building	Layer 3	K4+600 ～ K4+637	28	23	31	23	5.98	7.12	0.18	1.72			32.47	32.78	0.01	0.07
15	Food Machinery Plant Family Area 2# Building	Layer 1	K4+600 ～ K4+637	28	28	28	35	8.46	8.56	0.06	0.66			34.76	35.03	0.01	0.07
15	Food Machinery Plant Family Area 2# Building	Layer 3	K4+600 ～ K4+637	28	28	28	35	8.16	8.45	0.06	0.65			34.59	34.85	0.01	0.07
16	Xincun Community 3# Building	Layer 1	K5+640 ～ K5+660	31	35	20	/	9.11	8.78	0.01	0.18	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	27.75	29.74	0.00	0.02
16	Xincun Community 3# Building	Layer 3	K5+640 ～ K5+660	31	35	20	/	8.41	8.09	0.01	0.19			27.56	29.46	0.00	0.02
17	Ronghua Community 2#	Layer 1	K5+640 ～ K5+660	12	12	12	/	3.89	6.90	0.19	1.40			33.55	34.54	0.01	0.11
17	Ronghua Community 2#	Layer 3	K5+640 ～ K5+660	12	12	12	/	4.72	6.77	0.12	1.07			32.78	33.77	0.01	0.09
18	Ronghua Community 3#	Layer 1	K5+640 ～ K5+660	25	21	29	/	6.53	7.86	0.03	0.26			29.77	30.52	0.00	0.03
18	Ronghua Community 3#	Layer 3	K5+640 ～ K5+660	25	21	29	/	5.24	8.03	0.04	0.23			29.45	30.21	0.00	0.02
19	Xiaoyuzhai (Nanyang Road 266# Yard) 3# building	Layer 2	K5+816 ～ K5+836	21	15	26	16	/	/	0.74	3.20	（1）Main exhaust port backing to the sensitive spot. （2）moved 10m to the center of the road （3）Use Ultra-low noise cooling tower	30	34.66	34.90	0.02	0.14
19	Xiaoyuzhai (Nanyang Road 266# Yard) 3# building	Layer 5	K5+816 ～ K5+836	21	15	26	16	/	/	0.63	2.26			33.29	33.56	0.02	0.10
20	Transport Company Family Area (Nanyang Road No. 268) 1# building	Layer 1	K5+843 ～ K5+878	21	26	10	19	/	/	0.46	2.69			35.22	36.56	0.02	0.18
20	Transport Company Family Area (Nanyang Road No. 268) 1# building	Layer 3	K5+843 ～ K5+878	21	26	10	19	/	/	0.34	2.68			34.76	35.84	0.01	0.17
21	Zhengzhou Textile Machinery Apartment 29#	Layer 1	K7+000 ～ K7+030	4	1	9	1	2.09	16.59	9.19	18.79	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion	45	61.53	61.53	2.38	9.28
21	Zhengzhou Textile Machinery Apartment 29#	Layer 3	K7+000 ～ K7+030	4	1	9	1	/	3.43	0.91	5.13			46.76	46.84	0.10	0.89
22	Zhengzhou Textile Machinery	Layer 1	K7+000 ～	12	16	4	25	/	0.38	0.15	2.18			38.65	41.34	0.02	0.27

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
	Apartment 30#		K7+030									for 10dB; （3）Use Ultra-low noise cooling tower （4）moved 8m to the center of the road					
22	Zhengzhou Textile Machinery Apartment 30#	Layer 3	K7+000 ～ K7+030	12	16	4	25	/	/	0.13	1.29			38.02	39.10	0.01	0.15
23	Zhengzhou Textile Machinery Apartment 18#	Layer 1	K7+000 ～ K7+030	16	16	16	11	7.34	10.34	0.54	4.04			34.94	35.25	0.01	0.11
23	Zhengzhou Textile Machinery Apartment 18#	Layer 2	K7+000 ～ K7+030	16	16	16	11	8.11	10.25	0.41	3.65			34.82	35.14	0.01	0.10
23	Zhengzhou Textile Machinery Apartment 18#	Layer 5	K7+000 ～ K7+030	16	16	16	11	7.33	8.49	0.23	2.29			33.42	33.77	0.01	0.08
24	Zhengzhou Textile Machinery Apartment 19#	Layer 1	K7+000 ～ K7+030	38	34	42	19	5.96	9.07	0.26	1.47			34.12	34.27	0.01	0.06
24	Zhengzhou Textile Machinery Apartment 19#	Layer 2	K7+000 ～ K7+030	38	34	42	19	5.01	8.89	0.31	1.49			34.01	34.16	0.01	0.06
24	Zhengzhou Textile Machinery Apartment 19#	Layer 5	K7+000 ～ K7+030	38	34	42	19	4.36	8.05	0.26	1.25			32.65	32.84	0.01	0.05
25	Huayuan Community 5#	Layer 1	K7+240 ～ K7+320	13	11	18	/	2.45	7.22	0.25	1.02	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	34.87	35.43	0.03	0.11
25	Huayuan Community 5#	Layer 3	K7+240 ～ K7+320	13	11	18	/	3.84	8.30	0.14	0.60			33.82	34.44	0.01	0.06
26	Huayuan Community6#	Layer 1	K7+240 ～ K7+320	37	32	42	/	3.23	7.34	0.03	0.14			26.67	27.44	0.00	0.01
26	Huayuan Community6#	Layer 3	K7+240 ～ K7+320	37	32	42	/	4.32	5.51	0.02	0.21			26.52	27.31	0.00	0.02
27	Film Bureau Family Area 6# building	Layer 1	K8+200 ～ K8+330	22	25	10	15	/	0.02	0.25	2.22	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use low noise cooling tower	35	40.60	41.04	0.03	0.28
27	Film Bureau Family Area 6# building	Layer 2	K8+200 ～ K8+330	22	25	10	15	/	0.50	0.33	1.80			40.41	40.82	0.03	0.22
27	Film Bureau Family Area 6# building	Layer 5	K8+200 ～ K8+330	22	25	10	15	/	/	0.16	1.14			38.28	38.56	0.02	0.13
28	Film Bureau Family Area 5# building	Layer 1	K8+200 ～ K8+330	45	45	45	35	7.17	10.07	0.07	0.37			34.10	34.24	0.01	0.04
28	Film Bureau Family Area 5# building	Layer 2	K8+200 ～ K8+330	45	45	45	35	7.66	9.71	0.06	0.41			34.07	34.20	0.01	0.04
28	Film Bureau Family Area 5#	Layer 5	K8+200 ～	45	45	45	35	6.77	9.20	0.07	0.40			33.55	33.69	0.01	0.04

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
	building		K8+330														
29	Zhengzhou City Library	Layer 1	K8+200 ～ K8+330	32	29	41	31	9.85	/	0.05	/			35.32	35.44	0.00	#VALUE!
30	Downtown Community Phase II 1# building	Layer 1	K8+400 ～ K8+420	31	31	31	/	2.65	6.73	0.05	0.23	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	27.87	28.86	0.00	0.02
30	Downtown Community Phase II 1# building	Layer 2	K8+400 ～ K8+420	31	31	31	/	3.64	6.07	0.04	0.27			27.82	28.82	0.00	0.03
30	Downtown Community Phase II 1# building	Layer 5	K8+400 ～ K8+420	31	31	31	/	3.73	5.65	0.03	0.25			27.15	28.14	0.00	0.03
30	Downtown Community Phase II 1# building	Layer 8	K8+400 ～ K8+420	31	31	31	/	3.42	6.07	0.02	0.17			25.97	26.97	0.00	0.02
31	Nanyang Road No. 326 (Zhengzhou National Oil Reserve Base Family Area) 1#	Layer 1	K8+400 ～ K8+420	39	37	45	/	2.73	8.01	0.03	0.11	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	26.14	26.91	0.00	0.01
31	Nanyang Road No. 326 (Zhengzhou National Oil Reserve Base Family Area) 1#	Layer 3	K8+400 ～ K8+420	39	37	45	/	4.42	8.20	0.02	0.10			26.01	26.79	0.00	0.01
32	Xicai Community (Minggong Road 240# Yard) 2#, 3# building	Layer 1	K9+275 ～ K9+315	44	40	48	27	/	/	0.19	1.15	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use Ultra-low noise cooling tower （4）moved 8m to the center of the road	45	35.95	36.03	0.02	0.13
32	Xicai Community (Minggong Road 240# Yard) 2#, 3# building	Layer 3	K9+275 ～ K9+315	44	40	48	27	/	/	0.20	1.22			35.71	35.79	0.02	0.14
33	Minggong Road No.245 (Xiqian Street 85# Yard 1#, 2# building)	Layer 1	K9+340 ～ K9+375	20	17	24	4	/	6.76	1.53	6.16			39.09	39.21	0.01	0.10
33	Minggong Road No.245 (Xiqian Street 85# Yard 1#, 2# building)	Layer 3	K9+340 ～ K9+375	20	17	24	4	/	3.02	0.48	3.22			37.73	37.88	0.01	0.09
34	Huigang New Town 3# building	Layer 1	K9+890 ～ K9+980	21	25	10	/	12.51	10.41	0.01	0.31	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	30.75	33.79	0.00	0.03
35	Female Mosque	Layer 2	K10+010 ～ K10+020	41	41	41	/	/	/	0.01	/			25.66	26.65	0.00	#VALUE!
35	Female Mosque	Layer 5	K10+010 ～ K10+020	41	41	41	/	/	/	0.01	/			25.25	26.25	0.00	#VALUE!
36	Hongxin Garden 1# building	Layer 2	K10+915 ～	35	32	39	32	/	/	0.04	0.59	（1）Main exhaust port		34.95	35.09	0.00	0.06

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
			K10+990									backing to the sensitive spot.					
36	Hongxin Garden 1# building	Layer 5	K10+915 ～ K10+990	35	32	39	32	/	/	0.03	0.45			34.33	34.47	0.00	0.05
37	Xidan Apartment 3#	Layer 1	K11+070 ～ K11+151	36	36	36	26	/	/	0.07	0.84			36.36	36.48	0.01	0.09
37	Xidan Apartment 3#	Layer 3	K11+070 ～ K11+151	36	36	36	26	/	/	0.08	0.73			36.10	36.22	0.01	0.08
38	Xidan Apartment 1#	Layer 1	K11+070 ～ K11+151	41	46	30	39	/	/	0.05	0.44			33.46	33.78	0.00	0.05
38	Xidan Apartment 1#	Layer 3	K11+070 ～ K11+151	41	46	30	39	/	/	0.04	0.49			33.34	33.65	0.00	0.05
39	East Street 220# Yard	Layer 1	K11+978 ～ K12+105	/	/	/	5	/	4.52	2.70	7.92	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use low noise cooling tower	35	48.75	48.75	0.36	1.82
39	East Street 220# Yard	Layer 3	K11+978 ～ K12+105	/	/	/	5	/	1.05	1.35	5.25			44.51	44.51	0.16	0.92
40	Shangcheng Licun (East Street 248# Yard)	Layer 1	K12+110 ～ K12+200	/	/	/	5	/	4.96	0.80	6.16			48.75	48.75	0.09	1.18
41	Shangcheng Garden 1# building	Layer 1	K12+600 ～ K12+650	60	56	53	43	7.74	9.68	0.04	0.28	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use low noise cooling tower	35	32.43	32.58	0.00	0.03
41	Shangcheng Garden 1# building	Layer 3	K12+600 ～ K12+650	60	56	53	43	7.54	10.71	0.04	0.21			32.33	32.48	0.00	0.02
42	Dongguandongli 96# Yard 1# building	Layer 1	K12+716 ～ K12+830	29	32	16	/	/	/	0.03	0.50	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	28.29	30.77	0.00	0.05
42	Dongguandongli 96# Yard 1# building	Layer 3	K12+716 ～ K12+830	29	32	16	/	/	/	0.04	0.20			28.08	30.35	0.00	0.02
43	Dongguandongli 96# Yard 2# building	Layer 1	K12+716 ～ K12+830	28	32	16	/	4.14	8.64	0.04	0.24			28.54	30.90	0.00	0.02

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
43	Dongguandongli 96# Yard 2# building	Layer 3	K12+716 ～ K12+830	28	32	16	/	5.72	8.71	0.02	0.21			28.30	30.49	0.00	0.02
44	Dongguandongli 96# Yard 6# building	Layer 1	K12+716 ～ K12+830	37	39	28	/	7.51	7.94	0.01	0.14			26.43	27.99	0.00	0.01
44	Dongguandongli 96# Yard 6# building	Layer 3	K12+716 ～ K12+830	37	39	28	/	5.32	4.23	0.02	0.33			26.30	27.82	0.00	0.03

Note: Table 5.3-19shows that a total of 17 wind pavilion areas will make the muffler extended to more than 3m, needing an investment of 2.4 million yuan; 4 stations' cooling towers will be low- noise cooling towers, needing an investment of 1200,000 yuan, and 4 stations' cooling towers will be low-noise cooling towers, needing an investment of 800,000 yuan, with a total of 4.4 million yuan.

In table 5.3-20, for 7 ventilation pavilions and 5 cooling towers including Shamen Road Station south cooling tower and ventilation pavilion, Dongfeng Road Station north ventilation pavilion and cooling tower, Dongfeng Road Station south ventilation pavilion and cooling tower,Nongye Road Station southwest ventilation pavilion and cooling tower, Huanghe Road Station north ventilation pavilion and cooling tower,Taikang road station southwest ventilation pavilion and cooling tower,,Jinshui Road Station northeast ventilation pavilion and cooling tower, Erqi Square Station northwest ventilation pavilion, East Street Station southeast cooling tower, which do not comply with the environment protection control distance requirements in Code for Metro Design, their locations shall be adjusted to control the distance more than 15m far away.

For 17 ventilation pavilions including Xinliu Road Station west side ventilation pavilion, Shamen Road Station north ventilation pavilion, Xinglongpu Road Station south ventilation pavilion, Dongfeng Road Station north ventilation pavilion, Dongfeng Road Station south ventilation pavilion, Nongye Road Station northwest ventilation pavilion, Nongye Road Station southwest ventilation pavilion, Huanghe Road Station north ventilation pavilion, Huanghe Road Station southwest ventilation pavilion, Jinshui Road Station northeast ventilation pavilion, Jinshui Road Station southeast ventilation pavilion, Jinshui Road Station southwest ventilation pavilion, Taikang Road Station south ventilation pavilion, Erqi Square Station northwest ventilation pavilion, Shuncheng Street Station northeast ventilation pavilion, Chengdong Road Station northwest ventilation pavilion, recommend taking the noise reduction measures with silencing treatment and make the exhaust port of ventilation pavilion back to the sensitive buildings.

Recommend using the ultralow noise cross flow type cooling tower at three locations including Shamen Road Station north side, Dongfeng Road Station south side, Nongye Road Station southwest side, Huanghe Road Station north side and Taikang Road Station south side, and the low noise cooling tower at 4 locations including Xinglongpu Road Station south side, Jinshui Road Station east side, Dongdajie Station southeast side and Chengdong Road Station northeast side.

The total environment protection investment required for noise control of underground station environment control devices is 4.85 million yuan (excluding removal expense and modification and design cost), in which includes the newly added 1.5 million yuan for ultralow noise cross flow cooling tower, new added 0.8 million yuan for low noise cooling tower and 2.55 million yuan for addition of silencer in ventilation pavilions.

(III) Noise control measures for car depot and integrated base

The noise control measures for car depot boundary are shown in table 5.3-21 and table 5.3-22.

Table 5.3-21 Schedule for noise control measures at boundary of Jialu River parking depot

Predicted boundary position	Boundary noise over-limit amount (dBA)		Suggestion for control measure program	Control effect analysis	Estimated investment (10,000 yuan)
	Daytime	Actual operation at nighttime			
1m out of west boundary (about 6m from U-channel)	/	0.7	Heighten the fencing wall to 3.5m; set the green belt of no less than 10m wide and about 240 linear meters long	Noise reduction by the fencing wall for about 3dB; about 3dB by green belt; the boundary noise level meets the standard requirement	9.6

Table 5.3-22 Schedule for noise control measures at boundary of Hanghai East Road car depot

Predicted boundary position	Boundary noise over-limit amount (dBA)		Suggestion for control measure program	Control effect analysis	Estimated investment (10,000 yuan)
	Day time	Actual operation at nighttime			
1m out of east boundary (7m from testing line and 52m from train checkup shed)	11.1	/	Set 2m high sound barrier beside testing line; normal fencing wall of 1800 linear meter	Noise reduction by the fencing wall for about 3dB; 10dB by sound barrier; the boundary noise level meets the standard requirement	135

5.3.4 Assessment summary

5.3.4.1 Assessment summary during construction period

For the ambient sensitive spots near the subway station affected by construction noise, after taken the noise control measures during construction period provided in this environment impact assessment, the environment impact of construction noise has been relieved to certain extent, but it still can not meet the requirements of standard GB12523-90 Noise Limits for Construction Site; for the residents affected by construction noise, recommend the employer and construction unit to negotiate the compensation issues.

5.3.4.2 Assessment summary during operation period

(I) Noise of underground station environment control system

(1) Prediction results

The 44 sensitive points within the evaluation scope of the underground stations along the line will be purely affected by subway-related environmental control equipment noise (without superimposed background). The equivalent continuous A sound level during day's and night's actual operational period will respectively be 35.3～71.5dB（A）and 36.2～71.5 dB（A）. Among the daytime 44 measuring points, 18 has sensitive standard-exceeding, with the standard-exceeding amount being 2.4～12.5dB (A), The prediction points' standard-exceeding rate is 40.9%; among nighttime actual operating hours' 43 acoustic sensitive points, in addition to the sensitive points of standard exceeding at daytime still exceeding the standards, there are 28 sensitive points of standard exceeding, with the standard exceeding amount being 1.1～16.6dBA. The prediction points' standard-exceeding rate is 65.1%.

During the air-conditioning period, each sensitive point is purely affected by subway-related environmental control equipment noise (without superimposing background). The daytime's and nighttime's actual operational period's equivalent continuous A sound levels respectively are35.3～71.5dB（A）and 36.2～71.5dBA.dB (A).Among the daytime 44 sound sensitive points' measuring points, 25 sensitive points are standard-exceeding, with a standard-exceeding amount being 2.1～12.5dBA, and with the prediction points' standard exceeding rate being 56.8 percent. For the actual operating hours at night, 30 sensitive points are standard-exceeding, with a standard-exceeding amount being about, 0.4～16.6dBA, and the prediction points' standard-exceeding rate being 69.8 percent.

(2) Scope of Influence

Among the wind pavilion and cooling tower noise, the cooling tower noise is dominant. Therefore, the non-air-conditioning period (not turning on the cooling tower), around the wind pavilion area, Classes 4, 3, 2 and 1 areas' noise standard-reaching distances are 17m, 17m, 30m and 54m respectively, with a relatively small range; if the air conditioning period uses conventional cooling towers, the noise protection distances around the wind pavilion's Classes 4, 3, 2 and 1 areas are respectively 29m, 29m, 52m and 92m, with a larger context; if low-noise cooling towers are used, the noise protection distances of Classes 4, 3, 2 and 1 areas around the wind pavilion area are respectively 19m, 19m, 34m and 59m, with the protective distance being greatly reduced compared with ordinary cooling towers. Thus, in order to increase the supply of land resources along the line, low-noise environmental control equipment will be used or the "combination of prevention and cure" will be put forward for specific noise control solutions, which can effectively control the underground stations' air pavilion areas' noise impact.

(3) Number of people to be affected

For the sensitive points along the line, the number of households directly affected by subway-related wind pavilion and cooling tower noise is about 2886, with a total of

approximately 10,101 people.

(II) Noise at boundaries of car depot and parking depot

(1) The Jialu River parking depot and Hanghai East Road car depot are in suburb area without the sound environment sensitive spots such as village, school and hospital.

(2) The noise at boundaries of Hanghai East Road car depot is 49.6-71.1 dB(A) at daytime and 36.3-50.0dB(A) at night operation period. In contrast to standard for category 2 in GB12348-2008 Emission Standard for Industrial Enterprises Noise at Boundary, the east boundary noise exceeds the standard value by 11.1dBA due to noise from testing line, and all other boundaries meet the standard at different prediction years.

(3) The noises at boundary of Jialu River parking depot is 48.7-57.5 dB(A) at daytime and 33.4-50.7dB(A) at night operation period. In contrast to standard for category 2 in GB12348-2008 Emission Standard for Industrial Enterprises Noise at Boundary, except east boundary, all other boundaries exceed the standard values with the maximum over-limit amount of 0.7 dB(A).

(III) Main substation noise

There is no sound environment sensitive spot around Boxue Road Station main substation at present. The contribution of main substation noise is 33.6dBA; the environment noise prediction value maintains the status quo without increment.

5.3.4.3 Program for noise pollution control measures

(I) Proper selection of device and type

(1) Under the premise of meeting the project ventilation requirements, adopt the fans with low noise and excellent acoustic performance as possible.

(2) Select low noise and ultra-low noise type cooling tower.

(3)The wind pavilions and cooling towers should have rational layout, 15m or more from a sensitive point, with the air outlet facing away from the sensitive buildings.

(II) Urban planning and reasonable layout of buildings

For new development area, according to related regulations in Subway Design Specifications and in combination with the noise prediction results of this project, it is recommend that no noise sensitive building such as residential area, school and hospital may be planned to construct in the noise prevention distance range of 15m (category 4 zone), 26m (category 2 zone) and 50m (category 1 zone) from the station ventilation pavilion and cooling tower; otherwise it shall enhance the building sound insulation requirements according to Law of Noise to ensure the internal sound environment of building meets the application functions. Scientifically plan the layout of buildings to arrange the first row buildings near the noise sources as noise non-sensitive building such as commercial and office building.

The Jialu River parking depot is out of the central urban area planning zone and of category 1 sound functional area. At present, except the east boundary, the noises of all other boundaries exceed the standard value. There is sensitive spot around at present, and recommend not building the sensitive buildings such as residential area, school and hospital within 100m range in future construction.

(3) Pollution control of noise sensitive spot

Noise control measures at underground sections

●For 7 ventilation pavilions and 5 cooling towers including Shamen Road Station south cooling tower and ventilation pavilion, Dongfeng Road Station north ventilation pavilion and cooling tower, Dongfeng Road Station south ventilation pavilion and cooling tower,Nongye Road Station southwest ventilation pavilion and cooling tower, Huanghe Road Station north ventilation pavilion and cooling tower,Taikang road station southwest ventilation pavilion and cooling tower,,Jinshui Road Station northeast ventilation pavilion and cooling tower, Erqi Square Station northwest ventilation pavilion, East Street Station southeast cooling tower, which do not comply with the environment protection control distance requirements in Code for Metro Design, their locations shall be adjusted to control the distance more than 15m far away.

●For 17 ventilation pavilions including Xinliu Road Station west side ventilation pavilion, Shamen Road Station north ventilation pavilion, Xinglongpu Road Station south ventilation pavilion, Dongfeng Road Station north ventilation pavilion, Dongfeng Road Station south ventilation pavilion, Nongye Road Station northwest ventilation pavilion, Nongye Road Station southwest ventilation pavilion, Huanghe Road Station north ventilation pavilion, Huanghe Road Station southwest ventilation pavilion, Jinshui Road Station northeast ventilation pavilion, Jinshui Road Station southeast ventilation pavilion, Jinshui Road Station southwest ventilation pavilion, Taikang Road Station south ventilation pavilion, Erqi Square Station northwest ventilation pavilion, Shuncheng Street Station northeast ventilation pavilion, Chengdong Road Station northwest ventilation pavilion, recommend taking the noise reduction measures with silencing treatment and make the exhaust port of ventilation pavilion back to the sensitive buildings.

●Recommend using the ultralow noise cross flow type cooling tower at three locations including Shamen Road Station north side, Dongfeng Road Station south side, Nongye Road Station southwest side, Huanghe Road Station north side and Taikang Road Station south side, and the low noise cooling tower at 4 locations including Xinglongpu Road Station south side, Jinshui Road Station east side, Dongdajie Station southeast side and Chengdong Road Station northeast side.

The total environment protection investment required for noise control of underground station environment control devices is 4.85 million yuan (excluding removal expense and modification and design cost), in which includes the newly added 1.5 million yuan for ultralow noise cross flow cooling tower, new added 0.8 million yuan for low noise cooling tower and 2.55 million yuan for addition of silencer in ventilation pavilions.

Noise control measures for car depot and integrated base

● Prohibit test run operation and high noise workshop production works at night time.

● Set 10m wide green belt and fencing wall around Jialu River parking depot, in which the west fencing wall is heightened to 3.5m and it needs additional 609,000 yuan investment.

● A 2m high sound barrier is set at a testing line of Hanghai East Road car depot and it needs additional 1.35 million yuan investment.

Above total noise control expense is about 6.809 million yuan (excluding removal expense).

5.4 Ambient vibration impact predication and protection measures

5.4.1 Vibration sources

5.4.1.1 Vibration sources during construction period

The vibration sources during construction period in this project are mainly of vibration from power type construction devices. The vibration source intensities of various construction machines refer to table 5.4-1.

Table 5.4-1 Reference vibration level for construction machinery vibration source intensity

Construction phase	Construction equipment	Distance of measurement point from construction equipment (m)				
		5	10	20	30	40
Civil construction phase	excavator	82-84	78-80	74-76	69-71	67-69
	bulldozer	83	79	74	69	67
	rolling machine	86	82	77	71	69
	Heavy transport vehicle	80-82	74-76	69-71	64-66	62-64
	Shield machine	/	80 - 85	/	/	/
Foundation construction phase	pile driver	104-106	98-99	88-92	83-88	81-86
	vibrating hammer	100	93	86	83	81
	air hammer	88-92	83-85	78	73-75	71-73
	Air compressor	84-85	81	74-78	70-76	68-74
Structure construction phase	Drilling machine	63				
	concrete mixer	80-82	74-76	69-71	64-66	62-64

When the subway train runs on track, it generates knocking vibration, sliding vibration and rolling vibration due to interaction between wheels and rails, and they are transferred to tunnel lining via sleepers and ballast bed and then to the ground, and therefore lead to the vibration of ground buildings and impact on ambient environment.

(1) Underground section

According to Handbook of Vibration and Noise Control of Urban Rail Transit, the

subway vibration source intensities of main cities in domestic are summarized in table 5.4-2.

Table 5.4-2 Vibration source intensity of subway operation of main cities in domestic (VLzmax, dB)

Line name	Vehicle manufacturer	Vehicle length (m/car)	Vehicle dead weight (t/car)	Model	Train marshalling (car)	Train speed (km/h)	Distance of measurement point from track (m)	Vibration level VLzmax(dB)
Guangzhou subway No.1 line	German	24.4	37	A	6	60	0.5	87.0
Tianjin Subway	Changchun	19.0	37	B	4	60	0.5	87.0
Shanghai Metro line 1	German	23.5	38	A	6	60	0.5	87.4
Beijing subway No.1 line	Changchun, Beijing	19.0	37	B	6	60	0.5	87.2

As shown in table above, in case of following line conditions: travel speed of 60km/h, elastic split type fastener, normal integrated ballast bed and 60kg/m seamless steel rail, the vibration source intensity VLzmax generated when rail transit A type train passes the track can be taken as 87.4dB.

(2) Ground section

According to actual measurement data from Jingjiang Park station to Lianhua Road station of Shanghai Metro line 1, the subway vibration source intensities at ground section are summarized in table 5.4-3.

Table 5.4-3 Analog monitoring results of ground vibrations at ground section from Jinjiang Park Station to Lianhua Road Station

Measurement times	VLz10 (dB)			Analog conditions		
	7.5m	15m	30m	Speed	Subgrade	Fastener
1	76.4	69.9	64.3	60 - 65km/h	Subgrade height of 0.5m	National Railway elastic strip type II
2	77.8	72.1	65.9			
3	77.6	71.3	65.5			
4	77	70.7	64.8			
5	76.9	70.2	64.7			
Average	77.1	70.8	65			

(3) Vibration analog of underground line section

The vibration analog monitoring data of underground section from shanghai railway station to Zhongshanbeilu Road station of Shanghai Metro line 1 are shown in table 5.4 -4.

Table 5.4-4 Vibration analog monitoring results of Shanghai Metro line 1 underground section

Analog line	Analog point		Horizontal distance (m)	Tunnel buried depth (m)	Measurement result	
					location	VLzmax
Shanghai railway station - Zhongshanbeilu station (single bore circular tunnel) at speed of 40 - 50km/h	Zhongxiaoli former nursery school Floor 2 (category III)	50s	16	10.2	indoor	70.8
					outdoor	71.3
	Zhongxing Road No. 1480 street floor 7 residential building (category II)	80s	15	11.2	indoor	62.8
					outdoor	70.0

5.4.2 Predictive assessment

5.4.2.1 Construction period predictive assessment

The construction methods of underground section of this project include shield method and open cut method. Among the stations, JinShui east road station adopts covered excavation method and other stations adopt open cut method. As shown by the practices of these construction methods, the vibration impact on external environment can be controlled if strictly controlled and constructed according to specifications. However, since the construction section in urban area is in dense environment sensitive area, the vibration generated from operation of mechanical devices, vehicles and tunnel blasting construction may impact the ambient environment, so it is necessary to analyze the environment impact from construction machines and explosion vibration during construction period.

(I) Environment impact assessment of construction machinery vibration

(1) Source intensity of vibration pollution from construction pollution

According to construction features of this subway project, the mechanical devices and vibration source intensities used during engineering construction are shown in table 5.4 -5.

Table 5.4 -5 Reference vibration levels of vibration source intensity of construction machines (VLzmax: dB)

Construction phase	Construction devices	Distance of measurement point from construction device (m)				
		5	10	20	30	40
civil construction phase	excavator	82-84	78-80	74-76	69-71	67-69
	bulldozer	83	79	74	69	67
	rolling machine	86	82	77	71	69

	heavy transport vehicle	80-82	74-76	69-71	64-66	62-64
	shield machine	/	80 - 85	/	/	/
Foundation construction phase	pile driver	104-106	98-99	88-92	83-88	81-86
	Vibrating hammer	100	93	86	83	81
	air hammer	88-92	83-85	78	73-75	71-73
	Air compressor	84-85	81	74-78	70-76	68-74
Structure construction phase	Drilling machine	63				
	concrete mixer	80-82	74-76	69-71	64-66	62-64

(II) Vibration environment impact analysis of construction machines

The construction machinery of this project is mainly of vibration type operation, including the vibrations from shield machine, construction works such as pile driving and excavation, and transport and handling of transport vehicles, so the construction works inevitably impact the along-line traffic, buildings and residents livings.

As shown in table 5.4 -5, except pile driving works, the vibration level at location 10m from normal construction machinery is 74-85dB, 64-76dB at 30m location and 62-74 dB at 40m, so only the locations with more than 30m distance can meet the requirements of day time 75dB for “mixed zone, CBD”, “industrial concentration area” and “both sides of traffic arterial line”, and the locations more than 40m away can meet the requirements of day time 70dB for residential and culture education area.

As shown by the field survey, the locations affected by construction machinery vibration are mainly of environment sensitive spots near the station (see table 5.4-6). Most of the construction sites of this project are located in urban built-up area and near the resident housing, so part of sensitive spots is hard to meet the limit requirements of GB10070-88 Standard of Vibration in Urban Area Environment and the construction machinery vibration inevitably impacts the sensitive spots around construction sites. The section tunnel adopts shield method construction with less vibration effect on ground surface at both sides of line and certain impact on vibration right above the line, which is mainly of ground settlement.

Table 5.4 -6 Summary list of main sensitive spots of station contruction vibration impact

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
1	Xinliu road station	Yuhua ninth city, Building 1 #~ 3 #	K0+100 ～ K0+280	Xinliu Road-Shamen Road Station Section	46	14.5	House	25 floors，Frame structure	I	about 1475 household s	2010	Open cut methed
2	Shamen road station	Huiji District, Changxing Road, Street office	K1+454 ～ K1+537	Xinliu Road-Shamen Road Station Section	30	14.3	institution	4~5 floors，mixed structure	II	Street agency	In the 1990 s	Open cut methed
3		Changxing Road, No. 2 Courtyard	K1+476 ～ K1+539	Xinliu Road-Shamen Road Station Section	38	14.3	House	7 floors，mixed structure	Ⅱ	about 140 household s	2000	Open cut methed
4		Cityorth Shore District, 1 # building	K1+450 ～ K1+540	Xinliu Road-Shamen Road Station Section	18	14.5	House	6 floors，mixed structure	Ⅱ	about 60 household s	2000	Open cut methed
5		Baiwen Garden, Buildings 1 #, 2 #, 6 #, 7 #	K1+587 ～ K1+700	Shamen Road-Xinglongpu Road Station Section	17	14.7	House	6 floors，mixed structure	Ⅱ	about 190 household s	2010	Open cut methed
6	Xinglongpu road station	CR City Concert (Xinyu Garden) district ,1 #, 5 # Buildings	K2+800 ～ K2+900	Shamen Road-Xinglongpu Road Station Section	9	16.0	House	6 floors，mixed structure	Ⅱ	about 40 household s	In the 1980 s	Open cut methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
7		City bus company, family member courtyard	K2+800 ～ K2+910	Shamen Road-Xinglongpu Road Station Section	15	14.5	House	7 floors，mixed structure	Ⅱ	about 154 household	In the 1990 s	Open cut methed
8		Projects under construction (Chang Jian.Yufeng)	K2+940 ～ K3+170	Xinglongpu Road-Dongfeng Road Station Section	50	14.0	House	17 floors，Frame structure	Ⅰ	about 136 household	Under contruction	Open cut methed
9	Dongfeng road station	Fun district, Northern District, fun district building 1#、2#、3#、4#、5#	K4+291 ～ K4+463	Xinglongpu Road-Dongfeng Road Station Section	11	14.9	House	6～7 floors，mixed structure	Ⅱ	about 140 household	In the 1990 s	Open cut methed
10		Sunshine Holiday district, 1 #, 2 # Building	K4+286 ～ K4+500	Xinglongpu Road-Dongfeng Road Station Section	10	14.9	House	7 floors，mixed structure	Ⅱ	About 80 household	In the 1980 s	Open cut methed
11		Fun district, Southern District, fun district building 46, 61	K4+560 ～ K4+600	Dongfeng Road-Agricultural Road Station Section	36	14.5	House	6 floors，mixed structure	Ⅱ	about 81 household	In the 1980 s	Open cut methed
12		Fu Tian Lijing	K4+585 ～	Dongfeng Road-Agricultural	17	15.0	House	7 floors，mixed	Ⅱ	about 560 household	2000	Open cut methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
		Garden District, 39 #, 40 # Building	K4+774	Road Station Section				structure				
13	Agricultural road station	Nanyang Road 68 homes, 1 #, 2 #, 3 #, 10 #, 41 # Building	K5+480 ～ K5+679	Dongfeng Road-Agricultural Road Station Section	12	14.5	House	7 floors，mixed structure	Ⅱ	about 210 household s	In the 1980 s	Open cut methed
14		Residential Community of Meat Product Branch of Food Company	K5+570 ～ K5+700	Dongfeng Road-Agricultural Road Station Section	40	14.1	House	5～7 floors，mixed structure	Ⅱ	about 72 household s	In the 1980 s	Open cut methed
15		Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	K5+790 ～ K5+890	Agricultural Road-Huanghe Road Station Section	10	14.6	House	5 floors，mixed structure	Ⅱ	about 60 household s	In the 1980 s	Open cut methed
16		Small Yuzhai (Nanyang	K5+753 ～	Agricultural Road-Huanghe Road Station Section	20	14.4	House	6 floors，mixed	Ⅱ	about 114 household s	In the 1980 s	Open cut methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
		Road courtyard 266--275) Building	K5+832					structure				
17	Huanghe road station	Zhengzhou Textile staff apartments, 18 # to 20 # buildings	K7+000 ～ K7+100	Agricultural Road-Huanghe Road Station Section	37	14.5	House	7 floors，mixed structure	Ⅱ	about 126 househlds	2000	Open cut methed
18		Nanyang Road, No. 296 Courtyard, 1 #, 2 #, 3 #	K7+032 ～ K7+168	Agricultural Road-Huanghe Road Station Section	15	13.9	House	6～12 floors，mixed structure	Ⅱ	about 312 househlds	In the 1990 s	Open cut methed
19		Buildings 6#, 5#, 4#, and Buildings 3# and 2# in the south of Community of Zhengzhou Textile Machinery Co., Ltd.	K7+214 ～ K7+696	Huanghe Road-Jinshui Road Station Section	15	13.9	House	4（floors，mixed structure	Ⅱ	about 150 househlds	In the 1970 s	Open cut methed
20		Garden community, (Nanyang	K7+220 ～ K7+320	Huanghe Road-Jinshui Road Station Section	14	13.3	House	7 floors，mixed structure	Ⅱ	about 42 househlds	In the 1980 s	Open cut methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
		Road 300) 5 # building										
21		Zhengzhou Jianguo Medicine Institute	K07+280 ～ K07+400	Huanghe Road-Jinshui Road Station Section	15	13.9	Hospital	4 floors，mixed structure	Ⅱ		In the 1980 s	Open cut methed
22	Jinshui road station	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)	K8+174 ～ K8+190	Huanghe Road-Jinshui Road Station Section	6#(12m)，7#(0m)	14.8	House	5 floors，mixed structure	Ⅱ	about 32 househlds	In the 1980 s	covered excavation methed
23		Zhengzhou City Library	K8+250 ～ K8+300	Huanghe Road-Jinshui Road Station Section	5	14.4	Library	2～6 floors，mixed structure	Ⅱ	—	In the 1980 s	covered excavation methed
24		Jinfeng jinan	K09+158 ～ K09+183	Jinshui Road-Taikang Road Station Section	33	14.6	House	28 floors Frame	Ⅰ	about 324 househlds	Nearly 10 years	Open cut methed
25		Zhengzhou National Oil Reserve Depot, family member courtyard 1 # building	K8+290 ～ K8+360	Huanghe Road-Jinshui Road Station Section	20	14.4	House	7 floors，mixed structure	Ⅱ	about 70 househlds	In the 1980 s	covered excavation methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
26	Taikang road station	Huarun Yue House (under construction)	K9+245 ～ K9+610	Taikang Road-Erqi square Station Section	45	19	House	58 floors	Ⅰ	about 580 household	Under contruction	Open cut methed
27		West Cai district, (Ming Gong Road No. 240 Courtyard) 1 #	K9+275 ～ K9+315	Taikang Road-Erqi square Station Section	0	14.2	House	4～7 floors，mixed structure	Ⅱ	about 82 household	In the 1980 s	Open cut methed
28		West Cai district, (Ming Gong Road, No. 240 Courtyard), 2 #, 3 # Building	K9+275 ～ K9+315	Taikang Road-Erqi square Station Section	16	14.2	House	7 floors，mixed structure	Ⅱ	about 84 household	In the 1980 s	Open cut methed
29		Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)	K9+325 ～ K9+410	Taikang Road-Erqi square Station Section	9	14.2	House	2、3，7 floors，mixed structure	Ⅱ	About 83household	In the 1980 s	Open cut methed
30	Erqi	Huigang	K9+700	Taikang Road-Erqi	0	19.9	House	28	Ⅰ	about	Under	Open cut

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
	square station	New Town 1 #, 2 #, 3 # Building	～ K9+860	square Station Section				floors，Frame structure		1260 househlds	contruction	methed
31		Small building mosques	K10+000 ～ K10+059	Taikang Road-Erqi square Station Section	6	23.5	Religion	4～6 floors，mixed structure	Ⅱ	—	In the 1960 s	Open cut methed
32	Shunchengjie station	Modern XingYuan 1 #	K10+800 ～ K10+873	Erqi square-Shunchengjie Station Section	23	14.4	House	14～17 floors，Frame structure	Ⅰ	about 120 househlds	2000	Open cut methed
33		Hongxin Jia Yuan 1 # building	K10+915 ～ K10+990	Shunchengjie-Dongdajie Station Section	14	14.4	居住	7 floors，mixed structure	Ⅱ	about 84 househlds	2000	Open cut methed
34		Xidan apartments, two buildings	K11+070 ～ K11+151	Shunchengjie-Dongdajie Station Section	8	14.9	House	7 floors，mixed structure	Ⅱ	about 138 househlds	2000	Open cut methed
35		Ginza International	K10+956 ～ K11+025	Shunchengjie-Dongdajie Station Section	14	14.2	House	15 floors，Frame structure	Ⅰ	about 150 househlds	2010	Open cut methed
36	Dongdajie station	Zi Yan Huating 1 #, 2 # Building	K11+821 ～ K11+917	Shunchengjie-Dongdajie Station Section	23	14.4	House	24 floors，Frame structure	Ⅰ	about 288 househlds	2010	Open cut methed
37		Yangtze River City	K11+580 ～	Shunchengjie-Dongdajie Station Section	13	16.0	House	7 floors，mixed	Ⅱ	about 42 househlds	In the 1990 s	Open cut methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
		in City	K11+666					structure				
38		Yuhong Garden, 1 #, 2 #, 3 # Buildings	K11+675 ～ K11+800	Shunchengjie-Dongdajie Station Section	25	14.8	House、Office	26 floors，Frame structure	Ⅰ	about 500 household s	2010	Open cut methed
39		Municipal Guancheng State Taxation office services hall	K11+929 ～ K11+978	Dongdajie-Chengdong Road Station Section	33	14.3	institution	8 floors，mixed structure	Ⅱ	—	In the 1990 s	Open cut methed
40		First People's Courtyard of Zhengzhou	K11+990 ～ K12+055	Dongdajie-Chengdong Road Station Section	22	14.3	Hospital	5 floors，mixed structure	Ⅱ	--	In the 1990 s	Open cut methed
41		220 East Main Street	K11+978 ～ K12+105	Dongdajie-Chengdong Road Station Section	10	14.3	House	6 floors，mixed structure	Ⅱ	about 72 household s	In the 1990 s	Open cut methed
42	Chengdong road station	East Main Street, No. 1 Court, Building 1	K12+716 ～ K12+830	Chengdong Road-Weilaidadao Station Section	11	20.5	House	4～7 floors，mixed structure	Ⅱ	about 30 household s	In the 1980 s	Open cut methed
43		East Main Street, No. 1 Court, Building 2	K12+716 ～ K12+830	Chengdong Road-Weilaidadao Station Section	32	20.5	House	4～7 floors，mixed structure	Ⅱ	about 66 household s	In the 1980 s	Open cut methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
44		East Main Street, No. 1 Court,	K12+550 ～ K12+600	Dong dajie station-Chengdong Road Station Section	38	21.2	House	7 floors，mixed structure	Ⅱ	about 42households	In the 1980 s	Open cut methed
45		Zhengbian road 23	K12+820 ～ K12+857	Chengdong Road-Weilaidadao Station Section	7	20.5	House	5 floors，mixed structure	Ⅱ	about 72 households	In the 1980 s	Open cut methed
46	Fengtai south road station	Zhengzhou Huimin High School	K14+686 ～ K14+769	Weilaidadao –Fengtai south Road Station Section	47	14.3	School	5 floors，mixed structure	II	about2900 peple	In the 1990 s	Open cut methed
47		Zhengzhou City Public Security Bureau Police Detachment	K14+793 ～ K14+942	Fengtai south Road ~ Zhongzhoudadao Station Section	27	14.3	institution	7～8floors，Frame structure	I	-	2010	Open cut methed
48	traction line	Dongyinggang Village	K24+300 ～ K24+800	Boxue Road - Hanghai east Road Station Section	0	13.0	House	Below the second floor are peasant houses	Ⅲ	about 70 households	In the 1990 s	Open cut methed

5.4.2.2 Predictive assessment in operation period

(I) Assessment contents and operation emphasis

The objects of this vibration environment impact assessment include historic and culture sites to be protected, resident housing, hospital and schools along the line.

The main job contents include: On basis of field survey and monitoring, carry out monitoring assessment of ambient vibration status of the project before built-up. The ambient vibration present status monitoring covers all sensitive spots in assessment range, and all present status values of sensitive spots are of actual measurement; Adapt analog measurement method to determine the vibration source intensity, carry out vibration analog monitoring for the vibration sensitive buildings in 10m range from vertical above of tunnel to both sides of outer line centerline and critical historic and culture buildings to be protected, and predict the vibration impact of secondary structures; The vibration environment impact prediction covers all sensitive spots and provides the vibration prediction amount, variation from present status and over-limit amount of each sensitive spot during operation period; Aiming at the environment vibration impact range and extent on environment protection objectives, put forth the vibration protection measures, carry out technical and economic feasibility demonstration and provide the vibration reduction effect and investment estimate; Provide reference from decision making by environment management and urban planning department. This assessment provides the vibration standard-reaching protection distance of buildings along line in table form.

(II) Vibration analog investigation and analysis

When the subway train runs on track, it generates knocking vibration, sliding vibration and rolling vibration due to interaction between wheels and rails, and they are transferred to tunnel lining via sleepers and ballast bed and then to the ground, and therefore lead to the vibration of ground buildings and impact on ambient environment.

(1) Underground section

According to Handbook of Vibration and Noise Control of Urban Rail Transit, the subway vibration source intensities of main cities in domestic are summarized in table 5.4-7.

Table 5.4 -7 Vibration source intensity of subway operation of main cities in domestic (VLzmax, dB)

Line name	Vehicle manufacturer	Vehicle length (m/car)	Vehicle dead weight (t/car)	Model	Train marshalling (car)	Train speed (km/h)	Distance of measurement point from track (m)	Vibration level VLzmax(dB)
Guangzhou subway No.1 line	German	24.4	37	A	6	60	0.5	87.0
Tianjin Subway	Changchun	19.0	37	B	4	60	0.5	87.0
Shanghai Metro line	German	23.5	38	A	6	60	0.5	87.4

1								
Beijing subway No.1 line	Changchun, Beijing	19.0	37	B	6	60	0.5	87.2

As shown in table above, in case of following line conditions: travel speed of 60km/h, elastic split type fastener, normal integrated ballast bed and 60kg/m seamless steel rail, the vibration source intensity VLzmax generated when rail transit A type train passes the track can be taken as 87.4dB.

(2) Ground section

According to actual measurement data from Jingjiang Park station to Lianhua Road station of Shanghai Metro line 1, the subway vibration source intensities at ground section are summarized in table 5.4-8.

Table 5.4 -8 Analog monitoring results of ground section vibrations from Jinjiang Park Station to Lianhua Road Station

Measurement times	VLz10(dB)			Analog conditions		
	7.5m	15m	30m	Speed	Subgrade	Fastener
1	76.4	69.9	64.3	60 - 65km/h	Subgrade height of 0.5m	National Railway elastic strip type II
2	77.8	72.1	65.9			
3	77.6	71.3	65.5			
4	77	70.7	64.8			
5	76.9	70.2	64.7			
Average	77.1	70.8	65			

(3) Vibration analog of underground line section

The vibration analog monitoring data of underground section from shanghai railway station to Zhongshanbeilu Road station of Shanghai Metro line 1 are shown in table 5.4-9.

Table 5.4 -9 Vibration analog monitoring results of Shanghai Metro line 1 underground section

Analog line	Analog point		Horizontal distance (m)	Tunnel buried depth (m)	Measurement result		Theoretic calculation value (*)
					location	VLzmax	VLzmax
Shanghai railway station - Zhongshanbeilu station (single bore	Zhongxiaoli former nursery school Floor 2 (category III)	50s	16	10.2	indoor	70.8	/
					outdoor	71.3	72.5
	Zhongxing Road	80s	15	11.2	indoor	62.8	/

circular tunnel) at speed of 40 - 50km/h	No. 1480 street floor 7 residential building (category II)				outdoor	70.0	72.7

Note: Calculate with the attenuation formula ΔLst=-20LgR+12 in Handbook of Vibration and Noise Control of Urban Rail Transit.

(III) Prediction and assessment of vibration environment impact

(1) Prediction methods

The generation and propagation of subway vibration is very complicated process which is related to many factors including subway train structure, performance and traveling speed, structures and materials of track and tunnel structures and geological conditions along the line. The vibration prediction, based on present status monitoring, adopts the vibration predication model in HJ453-2008Technical Guidelines for Environment Impact - Urban Rail Transit and combination method of analog survey and test for prediction with analysis, analog and calculation survey methods in combination with the engineering actual and environment features of this line. The vibration predication mode is as follow:

$$VLz = VL0 + \Delta Lt + \Delta Ls + \Delta Lr + \Delta Lp + \Delta Lc + \Delta Lst + \Delta Lb \quad \text{(Formula 5-1)}$$

Where:

VLz——Predicted vertical Z vibration level of outdoor (or indoor) of buildings, dB;

VL0——Vibration source intensity of standard line, dB;

ΔLt——Correction of axle load of train car, dB;

ΔLs——Correction of train traveling speed, dB;

ΔLr——Wheel and train condition correction, dB;

ΔLp——Correction for ballast bed and fastener, dB;

ΔLc——Correction of tunnel structure, dB;

ΔLst——Attenuation from distance diffusion and media absorption, dB;

ΔLb——Correction of building type.

(2) Prediction parameters

As shown in formula 5-1, the building outdoor (or indoor) vibration level and the source intensities of standard line closely relate to the traveling speed, wheel and track conditions, ballast bed and fastener type, tunnel structure type, distance absorption and other factors, and separately describe as follows:

A. Vibration source intensity of line section

The source intensity VLzmax of underground line section of the project is 87.4dB (train speed of 60km/h; 0.5m from outer line).

B. Correction of vehicle axle load (ΔLt)

$$\Delta L_t = 20\lg\frac{W_1}{W_0}$$ (Formula 5-2)

Where: W0——Analog vehicle axle load 16t;

W1——Zhengzhou subway line 3 vehicle axle load 16t, ΔLt=0.

C. Traveling speed correction (ΔLs)

Under normal speed (20 - 100km/h), the vibration speed correction ΔLs is as follow:

$$\Delta L_s = 20\lg\frac{v}{v_0}$$ (Formula 5-3)

Where: v0——Reference speed (km/h), taken as 60 km/h;

v ——Train traveling speed (km/h) .

That is, the vibration level increases for 6dB each when the train speed doubles.

D. Correction for wheel and track conditions (ΔLr)

The irregular wheel and track surface may lead to contact vibration of wheels and rails; when the train passes discontinuous steel rail, it may generate impact vibration. They also will increase the vibration level under the rail. The table 5.4 -10 lists the vibration correction under different wheel and track conditions.

Table 5.4 -10 Vibration correction ΔLr under different wheel and track conditions (Unit: dB)

Wheel and rail conditions	Vibration correction ΔLr
Seamless line, round wheel, smooth steel rail surface	0
Short rail circuit, not round wheel and not smooth steel rail surface	5 - 10

E. Correction for ballast bed and fasteners (ΔLp)

The vibration correction of different ballast beds and fasteners are summarized in table 5.4 -11.

Table 5.4 -11 Vibration correction of different ballast beds and fasteners ΔLp (Unit: dB)

Type of ballast bed structure and track fastener	ΔLP	Average
Normal integrated ballast bed	0	0
LORD type fastener	-5 - -7	-6
Elastic supporting block type integrated ballast bed	-8 - -12	-10
III type track vibration damper fastener	-8 - -10	-9
Rubber floating slab ballast bed	-15 - -25	-20
New type integrated damping fastener (Vanguard fastener)	-11 - -15	-13
Steel spring floating slab ballast bed	-20 - -30	-25

F. Correction of tunnel structure (ΔLc)

The vibration corrections of different tunnel structures can be determined according to table 5.4 -12.

Table 5.4 -12 Vibration correction of different tunnel structures ΔLc (Unit: dB)

No.	Tunnel structure type	ΔLc
1	Rectangular tunnel	+1
2	Single bore single line tunnel	0
3	Single bore double line tunnel	-2
4	Station section tunnel	-4

G. Distance attenuation and medium absorption (ΔLst)

The vibration energy attenuates with the distance diffusion. The attenuation law is affected by geological conditions and varies for the geological conditions of different zones. The along-line sites of Zhengzhou rail transit Line 2 project is of tectonic denudation hills and alluvial plain geomorphic unit and the geological conditions are similar to Shanghai. In reference to existing vibration attenuation laws and study results of Shanghai Metro, the distance attenuation and medium absorption ΔLst of vibration assessment of the project are calculated with following formula:

a. Ground at both sides of tunnel (L≥5m)

$$\Delta Lst = -20\lg R + 12 \qquad \text{(Formula 5-4)}$$

b. Ground above tunnel top (vertical) (L<5m)

$$\Delta Lst = -20\lg \frac{H}{H_0} \qquad \text{(Formula 5-5)}$$

Where: R——Straight line distance from prediction point to tunnel bottom outer line centerline, $R = \sqrt{L^2 + H^2}$, m;

L——Horizontal distance from prediction point to outer rail centerline, m;

H0——Distance from tunnel top to steel rail top face (m), taken as 5m for single line tunnel;

H——Distance from tunnel rail face and ground (m) .

c. Ground line

$$\Delta Lst = -15 \lg \frac{r}{7.5} \qquad \text{(Formula 5-6)}$$

Where:

r——Straight line distance from prediction point to outer rail, m;

H .Correction for different building types (ΔLb)

The responses of different buildings to vibration are different. In general, the reinforced concrete frame buildings with large mass and quality foundation (more than 8-10 floors) have large attenuation of vibration, and classified as category I; the brick-concrete structure buildings with normal foundation (3-8 floors or good quality one-storey house, 2 – 3 floors residence) are classified as category II; The low and old buildings with poor foundation or light structure housing with the natural vibration close to the ground surface and apt to resonance after excited and generating amplification effect of vibration are classified as category III. The vibration corrections of various buildings are shown in table 5.4 -13.

Table 5.4 -13 Vibration correction amount of different building categories ΔLb (Unit: dB)

Building type	Building structures and features	Vibration correction value ΔLb
I	Frame structure buildings with quality foundation (highrise building)	-13 - -6
II	Brick-concrete structure building with normal foundation (middle level building or quality low building)	-8 - -3
	Light and old house with poor foundation (poor quality low-rise buildings and simple temporary building)	-3 - 3

(3) Predictive assessment amount

The predictive assessment amount of vibration of sensitive spots along the line such as resident housing, school and hospital is taken as VLz10 (dB); the predictive assessment amount of vibration of historic and culture sites to be protected is taken as V(mm/s), and the noise predictive assessment amount of secondary structures for sensitive spots within 10m from outer line centerline right above the subway is taken as weighted sound pressure level Lp (dB).

(4) Prediction technical conditions

A. Train speed

Design maximum operation speed: 80km/h.

B. Operation time

Day time operation period: 6: 00 - 22: 00, totaling 16h; night time operation periods are separately of 5: 00 - 6: 00 and 22: 00~23: 00 totaling 2h.

C. Vehicle model selection

Adopt A type vehicle, 6 cars marshalling for initial stage, short term and long term with 4 power cars and 2 trailer cars.

D. Line technical conditions

Steel rail: 60kg/m for main line and 50kg/m for car depot line. Lay long steel rail seamless line along the line.

Fastener: adopt elastic split type fastener.

Ballast bed: integrated ballast bed for main line, double layer gravel ballast bed for test run line.

(5) Prediction formula of environment prediction

According to above subway vibration source intensity, prediction mode and various prediction parameters, the ambient vibration prediction formula of Zhengzhou subway line 3 is as follow:

A. Ambient vibration predication formula of outdoor ground surface at both sides of underground section tunnel (or indoor) is as follow:

$$VL_{z10} = 84.2 + 20\log\frac{V}{V_0} + \Delta L_c - 20\log\sqrt{L^2 + H^2} + 12 + \Delta L_b \quad \text{(Formula 5-7)}$$

B. Environment impact prediction formula of outdoor ground surface above tunnel top in underground section (or indoor)

$$VL_{z10} = 84.2 + 20\log\frac{V}{V_0} + \Delta L_c - 20\log\frac{H}{H_0} + \Delta L_b \quad \text{(Formula 5-8)}$$

C. Prediction formula of outdoor ground surface environment vibration on ground section

$$VL_{Z10} = 77.1 + 20\log\frac{V}{V_0} - 15\log\frac{r}{7.5} \quad \text{(Formula 5-9)}$$

(6) Vibration prediction results and assessment

A. Vibration impact range prediction of rail transit

According to above mentioned prediction methods and vibration standard of this assessment, the standard-reaching protection distances of ground vibrations at both sides of line refer to table 5.4 -14.

Table 5.4 -14 Standard-reaching protection distance of ground vibration of track along the line (need certain modification)

Line type	Buried depth (m)	Standard-reaching distance (m)			
		"mixing area, CBD", "industrial concentration area", "both sides of traffic arterial road" standard		"residential and culture education area" standard	
		Day time (75dB)	Night time (72dB)	Day time (70dB)	Night time (67dB)
Underground	10	12	20	26	38
	15	/	16	23	36
	20	/	9	19	33
	25	/	/	11	30
	30	/	/	/	25
	35	/	/	/	16

Note: The train traveling speed in this table is taken as 80km/h.

As shown in table 5.4 -14: the ground surface vibration in areas out of the range 20m from subway outer rail centerline of underground line section along the line can meet the standard requirements of "both sides of arterial traffic", "mixing area, CBD" and "industrial concentration area" in GB10070-88 Standard of Vibration in Urban Area Environment; the ground surface vibration in areas out of the range 38m from subway outer rail centerline can meet the standard requirements of "residential and culture education area" in GB10070-88 Standard of Vibration in Urban Area Environment.

In reference to related regulations in Subway Design Specification (GB 50157-2003) and in combination with the actual conditions of this project, the planned control requirements are provided as follows:

a. For "mixing area, CBD", "industrial concentration area" and "both sides of traffic arterial road", the building protection distance at both sides of underground line is 25m.

b. For "residential and culture education area", the building protection distance at both sides of underground line is 38m.

B. Ambient vibration prediction

a. Prediction result

According to location relationship between sensitive spots along the line and rail

transit line, project technical conditions and train operation conditions, adopt above mentioned prediction formula to predict Z vibration level at sensitive spots as shown in table 5.4 -15.

Table 5.4 -15 Environmental Vibration Z Vibration Level Prediction Results

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
1	New Hope Ao Garden, 17 #, 3 #	K00-195～K00-472	House	8 floors，mixed structure	□	47	14.5	49.2	40	Outdoor 0.5m	59.3	53.2	59.0	54.6	70	67	/	1.4	/	/
2	Fuwa beauty area, Building 3, Building 1,	K00+843 ～ K00+921	House	5 floors，mixed structure	□	18	19.6	26.6	72	Outdoor 0.5m	58.2	53.7	69.5	55.2	75	72	/	1.5	/	/
3	Taili community, Building 1,	K00+940 ～ K00+968	House	19 floors，Frame	□	16	19	24.8	72	Outdoor 0.5m	57.2	55.3	68.1	56.0	75	72	/	0.7	/	/
4	Hongda district, 11 #, 10 #, 9 #, 5 # Buildinsg	K00+986 ～ K01+100	House	8 floors，mixed structure	II	18	18.8	26.0	72	Outdoor 0.5m	60.5	60.9	69.7	56.4	75	72	/	/	/	/
5	Huiji District, Changxing Road, Street office	K01+454 ～ K01+537	institution	4~5 floors，mixed structure	□	15	14.3	20.7	45	Outdoor 0.5m	58.3	/	69.6	56.9	75	72	/	/	/	/
6	Changxing Road, No. 2 Courtyard	K01+476 ～ K01+539	House	7 floors，mixed structure	□	38	14.3	40.6	45	Outdoor 0.5m	63.2	56.3	61.7	57.1	70	67	/	0.8	/	/
7	Yuhua ninth city, Building 1 #~ 3 #	K00+100 ～ K00+280	House	25 floors，Frame	I	46	14.5	48.2	45	Outdoor 0.5m	61.6	59.2	58.2	57.6	70	67	/	/	/	/
8	Angel Kindergarten	K00+310 ～ K00+320	House	2~3 floors，mixed structure	□	18	14.4	23.1	45	Outdoor 0.5m	61.1	/	68.6	57.6	75	72	/	/	/	/
9	Sanquan Food Co., Ltd., staff quarters	K00+644 ～ K00+670	House	7 floors，mixed structure	□	20	17.2	26.4	72	Outdoor 0.5m	59.3	56.2	71.6	57.7	75	72	/	1.5	/	/
10	ChengHuang 5-rings Mansion	K01+010 ～ K01+030	institution	10 floors，Frame	I	25	19.2	31.5	72	Outdoor 0.5m	62.1	/	66.0	57.7	75	72	/	/	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
11	Hualian family member courtyard, Buildings 2, 4, 5,	K01+362 ～ K01+450	House	7 floors，mixed structure	□	23	17	28.6	45	Outdoor 0.5m	60.4	57.5	66.8	57.8	75	72	/	0.3	/	/
12	Cityorth Shore District, 1 # building	K01+450 ～ K01+540	House	6 floors，mixed structure	□	18	14.5	23.1	45	Outdoor 0.5m	65	59.2	66.6	57.8	75	72	/	/	/	/
13	Baiwen courtyard, 1 #, 2 #,6#,7# Buildings	K01+587 ～ K01+700	House	6 floors，mixed structure	□	17	14.7	22.5	45	Outdoor 0.5m	63	58.2	66.9	57.8	75	72	/	/	/	/
14	Phosphate fertilizer factory family member courtyard, 1 #, 2 # Buildings	K02+411 ～ K02+440	House	6 floors，mixed structure	□	17	21.6	27.5	60	Outdoor 0.5m	63.3	60.2	69.6	58.1	75	72	/	/	/	/
15	Huiji District’s office building of Land and Resources	K02+444 ～ K02+495	institution	7 floors，mixed structure	□	5	21.4	22.0	60	Outdoor 0.5m	59.2	/	73.8	58.2	75	72	/	/	/	/
15	Huiji District’s office building of Land and Resources	K02+444 ～ K02+495	institution	7 floors，mixed structure	□	5	21.4	22.0	60	Outdoor 0.5m	53.1	/	73.8	58.3	75	72	5.2	/	/	/
16	Peaceful residential homes, Building 8,	K02+500 ～ K02+619	House	22 floors，Frame	I	9	18.4	20.5	60	Outdoor 0.5m	63	56.2	68.2	58.5	75	72	/	2.3	/	/
16	Peaceful residential homes, Building 8,	K02+500 ～ K02+619	House	22 floors，Frame	I	9	18.4	20.5	60	Indoor	54.5	50.2	68.2	58.7	75	72	4.2	8.5	/	/
17	RCC family member courtyard (Gadameilin district)	K02+623 ～ K02+663	House	17 floors，Frame	I	0	16	16.0	60	Outdoor 0.5m	63.2	56.1	72.3	59.2	75	72	/	3.1	/	/
17	RCC family member courtyard (Gadameilin district)	K02+623 ～ K02+663	House	17 floors，Frame	I	0	16	16.0	60	Indoor	62.1	55.3	72.3	59.6	75	72	/	4.3	/	/
18	CR City Concert (Xinyu Garden) district ,1 #, 5 #	K02+800 ～ K02+900	House	7 floors，mixed		9	16	18.4	45	Outdoor 0.5m	60.4	58.1	70.6	59.7	75	72	/	1.6	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
	Buildings			structure																
18	CR City Concert (Xinyu Garden) district ,1 #, 5 # Buildings	K02+800 ～ K02+900	House	6 floors，mixed structure		9	16	18.4	45	Indoor	55.3	54.3	70.6	59.8	70	67	4.5	5.5	/	/
19	Changxing Building	K01+650 ～ K01+790	House	7 floors，mixed structure		32	16	35.8	45	Outdoor 0.5m	63.1	53.5	62.8	59.8	70	67	/	6.3	/	/
20	Huiji District, Tumor Courtyard of Traditional Chinese Medicine	K01+801 ～ K01+871	Hospital	6 floors，mixed structure		29	17.4	33.8	60	Outdoor 0.5m	59.1	57.3	65.8	60.0	75	72	0.9	2.7	/	/
21	City bus company, family member courtyard	K02+800 ～ K02+910	House	7 floors，mixed structure		15	14.5	20.9	45	Outdoor 0.5m	60.2	57.2	69.5	60.2	70	67	0.0	3.0	/	/
22	Zhongji urban spring	K03+080 ～ K03+140	House	13 floors，Frame	I	33	14	35.8	45	Outdoor 0.5m	59.2	57.2	60.8	60.2	75	72	1.0	3.0	/	/
23	Jianye Yihao Chengbang District, 1 #, 7 #, 8 # Building	K03+144 ～ K03+266	House	5 ～ 13 floors ，Frame	I	33	14	35.8	45	Outdoor 0.5m	62.3	57	60.8	60.4	75	72	/	3.4	/	/
24	National Food Authority’s Zhengzhou Institute of Science and family Courtyard	K03+280 ～ K03+550	institution	3~6 floors ，mixed structure		15	16.2	22.1	72	Outdoor 0.5m	64.2	61.3	73.1	60.7	75	72	/	/	/	/
24	National Food Authority’s Zhengzhou Institute of Science and family Courtyard	K03+280 ～ K03+550	House	5~7 floors ，mixed structure		44	16.7	47.1	72	Outdoor 0.5m	59.4	55.6	66.5	60.9	75	72	1.5	5.3	/	/
25	Tianxiu home district, 1 # ~ 4 # Building	K03+610 ～ K03+723	House	7 floors，mixed structure		16	19.2	25.0	72	Outdoor 0.5m	60.2	55.5	72.0	61.1	75	72	0.9	5.6	/	/
26	Zhengzhou Oriental Tumor	K03+730 ～	Hospital	5 floors，		15	19.8	24.8	72	Outdoor	57.2	53.2	72.1	61.3	70	67	4.1	8.1	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
	Courtyard	K03+784		mixed structure						0.5m										
27	ICBC family member building	K03+957～K03+990	House	5 floors，mixed structure		11	20.2	23.0	72	Outdoor 0.5m	56.2	53.5	72.7	61.5	70	67	5.3	8.0	/	/
28	Zhang Zhaicun	K04+000～K04+213	House	2~7 floors，mixed structure		17	18.8	25.3	72	Outdoor 0.5m	60.6	52.2	71.9	62.1	75	72	1.5	9.9	/	/
29	Fun district, 1 #, 2 #, 3 #, 4 #, 5 # Building	K04+291～K04+463	House	6~7 floors，mixed structure		11	14.9	18.5	45	Outdoor 0.5m	64.2	57.2	70.5	62.2	75	72	/	5.0	/	/
29	Fun district, 6 # - 11 # building	K04+291～K04+463	House	6 floors，mixed structure		28	14.9	31.7	45	Outdoor 0.5m	57.5	55.2	65.9	62.4	75	72	4.9	7.2	/	/
30	Projects under construction (Chang Jian.Yufeng)	K02+940～K03+170	House	17 floors，Frame		50	14	51.9	45	Outdoor 0.5m	63.7	56.5	57.6	62.5	75	72	/	6.0	/	/
31	Grain transport community, Building 9, Building 10	K03+200～K03+328	House	6 floors，mixed structure		11	14.8	18.4	72	Outdoor 0.5m	64.1	51.5	74.7	62.6	75	72	/	11.1	/	/
31	Grain transport community, 3 #~ 8 # Building	K03+200～K03+328	House	4 floors，mixed structure		23	14.8	27.4	72	Outdoor 0.5m	63.2	60.1	71.2	62.6	75	72	/	2.5	/	/
32	Huiji District’s Board of Education family member building	K03+611～K03+621	House	7 floors，mixed structure		13	19.2	23.2	72	Outdoor 0.5m	53.4	52.1	72.7	62.7	75	72	9.3	10.6	/	/
33	Yuhua Wen Hui Garden District, Building 1 to 5	K03+635～K03+773	House	7 floors，mixed structure		16	19.5	25.2	72	Outdoor 0.5m	62.5	58.8	69.9	62.8	75	72	0.3	4.0	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
34	Yuhua Wen Qing Garden District Building 1 to 4	K03+917 ～ K04+049	House	7 floors，mixed structure		13	20.2	24.0	72	Outdoor 0.5m	64.5	60.5	70.4	62.8	75	72	/	2.3	/	/
35	City Brewery, family member courtyard north courtyard Building 25,	K04+056 ～ K04+120	House	6 floors，mixed structure		18	20.1	27.0	72	Outdoor 0.5m	52.1	51	71.4	62.8	75	72	10.7	11.8	/	/
36	Yaxin good times area, 3 to 4 Building	K04+129 ～ K04+211	House	6~8 floors，mixed structure		13	18.8	22.9	72	Outdoor 0.5m	55.2	56.3	72.8	62.9	75	72	7.7	6.6	/	/
37	Chuangye Homes	K04+217 ～ K04+277	House	7 floors，mixed structure		9	16.8	19.1	72	Outdoor 0.5m	64.7	60.3	74.4	62.9	70	67	/	2.6	/	/
37	Chuangye Homes	K04+217 ～ K04+277	House	7 floors，mixed structure		9	16.8	19.1	72	Indoor	63.1	56.3	74.4	62.9	70	67	/	6.6	/	/
38	Sunshine Holiday district, 1 #, 2 # Building	K04+286 ～ K04+500	House	7 floors，mixed structure		10	14.9	17.9	45	Outdoor 0.5m	60.4	60.2	70.8	63.0	75	72	2.6	2.8	/	/
38	Sunshine Holiday district, 1 #, 2 # Building	K04+286 ～ K04+500	House	7 floors，mixed structure		10	14.9	17.9	45	Indoor	58.2	58.3	70.8	63.0	70	67	4.8	4.7	/	/
38	Sunshine Holiday district Building 3# ~ 9 #	K04+286 ～ K04+500	House	7 floors，mixed structure		30	14.9	33.5	45	Outdoor 0.5m	63.5	55.2	65.4	63.2	75	72	/	8.0	/	/
39	Nanyang Road, No. 111 Courtyard	K04+529 ～ K04+558	House	6 floors，mixed structure		6	14.5	15.7	45	Outdoor 0.5m	64.6	61.2	72.0	63.2	70	67	/	2.0	/	/
39	Nanyang Road, No. 111 Courtyard	K04+529 ～ K04+558	House	6 floors，mixed		6	14.5	15.7	45	Indoor	56.5	51	72.0	63.3	75	72	6.8	12.3	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
				structure																
39	Fun district, Southern District, fun district building 46, 61	K04+560～K04+600	House	6 floors，mixed structure		36	14.5	38.8	45	Outdoor 0.5m	65.5	60.1	64.1	63.5	70	67	/	3.4	/	/
40	Xinyuan Garden 3 #, 4 #	K04+620～K04+700	House	6 floors，mixed structure		52	16	54.4	45	Outdoor 0.5m	58.5	56.2	61.2	63.6	75	72	5.1	7.4	/	/
41	Nanyang Road, No. 97 Courtyard (Henan Engineering College family member courtyard), 1 #, 4 #, 5 # Building	K04+720～K04+900	House	5 floors，mixed structure		16	18	24.1	72	Outdoor 0.5m	53.2	50.1	72.3	63.6	75	72	10.4	13.5	/	/
42	Henan Engineering college family member courtyard’s five buildings	K04+720～K04+900	House	6 floors，mixed structure		34	19	38.9	72	Outdoor 0.5m	56.4	48.2	68.2	63.7	70	67	7.3	15.5	/	/
43	China Railway Bridge Bureau family member courtyard 1 #	K04+929～K05+010	House	7 floors，mixed structure		8	19.9	21.4	72	Outdoor 0.5m	63.3	61.2	73.4	63.8	75	72	0.5	2.6	/	/
43	China Railway Bridge Bureau family member courtyard 1 #	K04+929～K05+010	House	7 floors，mixed structure		8	19.9	21.4	72	Indoor	55.2	53.2	73.4	63.8	75	72	8.6	10.6	/	/
44	Home world community 1 #, 2 # Building	K05+024～K05+105	House	16 floors，Frame	I	27	14.1	30.5	72	Outdoor 0.5m	62.6	60.2	66.3	63.8	75	72	1.2	3.6	/	/
45	Zhengzhou Boiler Factory family member courtyard 1 #, 2 #	K05+116～K05+247	House	7 floors，mixed structure		11	20.2	23.0	72	Outdoor 0.5m	65.2	61.2	72.7	63.8	75	72	/	2.6	/	/
45	Zhengzhou Boiler Factory, family member courtyard 3 # - 8 #	K05+116～K05+247	House	7 floors，mixed structure		27	20.2	33.7	72	Outdoor 0.5m	65.1	55.1	69.4	63.9	75	72	/	8.8	/	/
46	Zhengrong Group Limited	K05+268～	House	5 floors，		8	20.2	21.7	72	Outdoor	66.1	60.5	73.2	63.9	75	72	/	3.4	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
	family member courtyard, 3 #, 6 # building	K05+318		mixed structure						0.5m										
46	Zhengrong Group Limited family member courtyard, 3 #, 6 # building	K05+268 ～ K05+318	House	5 floors，mixed structure		8	20.2	21.7	72	Indoor	61.2	57.6	73.2	64.2	70	67	3.0	6.6	/	/
47	Home world community 1 # Building	K05+328 ～ K05+390	House	7 floors，mixed structure		13	20	23.9	72	Outdoor 0.5m	65.2	62.1	72.4	64.2	75	72	/	2.1	/	/
47	Home world community 3 #, 2 # Building	K05+328 ～ K05+390	House	7 floors，mixed structure		33	20	38.6	72	Outdoor 0.5m	56.1	52.3	68.3	64.3	75	72	8.2	12.0	/	/
48	Old meat processing factory family member courtyard, 1 #, 3 #, 5 # Building	K05+392 ～ K05+456	House	5~6 floors，mixed structure		12	17.7	21.4	72	Outdoor 0.5m	68.5	64.5	73.4	64.5	75	72	/	/	/	/
49	Nanyang Road 68 homes, 1 #, 2 #, 3 #, 10 #, 41 # Building	K05+480 ～ K05+679	House	7 floors，mixed structure		12	14.5	18.8	45	Outdoor 0.5m	67.2	64.1	70.4	64.6	70	67	/	0.5	/	/
50	Fu Tian Lijing Garden District, 39 #, 40 # Building	K04+585 ～ K04+774	House	7 floors，mixed structure		17	15	22.7	45	Outdoor 0.5m	64.2	57.3	66.8	64.6	75	72	0.4	7.3	/	/
51	Mold factory family member courtyard 1 # building	K04+785 ～ K04+833	House	6 floors，mixed structure		12	17.5	21.2	72	Outdoor 0.5m	61.2	55.3	73.4	64.7	70	67	3.5	9.4	/	/
52	Vision garden, 1 # building	K04+845 ～ K04+900	House	6 floors，mixed structure		14	19	23.6	72	Outdoor 0.5m	57.2	56.5	72.5	64.8	75	72	7.6	8.3	/	/
53	Nanyang Road, No. 239 Courtyard	K04+937 ～ K05+025	House	6 floors，mixed structure		14	20.3	24.7	72	Outdoor 0.5m	61.2	54.2	72.1	64.8	75	72	3.6	10.6	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
53	Mineral Homeworld 2 # ~ 5 #	K04+937 ～ K05+025	House	6 floors，mixed structure		37	20.3	42.2	72	Outdoor 0.5m	56.2	47.3	67.5	65.0	75	72	8.8	17.7	/	/
54	Nanyang Road, No. 244 Courtyard # 1 (aquaculture company family member courtyard)	K05+325 ～ K05+349	House	5 floors，mixed structure		16	20	25.6	72	Outdoor 0.5m	55.1	53.2	71.8	65.0	75	72	9.9	11.8	/	/
55	Ronghua community, 1 # Building	K05+390 ～ K05+441	House	5 floors，mixed structure		12	18	21.6	72	Outdoor 0.5m	63	60.3	73.3	65.1	70	67	2.1	4.8	/	/
56	Nanyang Road 253 (food company meat branch family member building) 1 #, 3 #	K05+477 ～ K05+520	House	6 floors，mixed structure		11	16	19.4	72	Outdoor 0.5m	55.3	50.2	74.2	65.1	70	67	9.8	14.9	/	/
56	Residential Community of Meat Product Branch of Food Company	K05+570 ～ K05+700	House	5~7 floors，mixed structure		40	14.1	42.4	45	Outdoor 0.5m	62.1	60.5	63.4	65.2	75	72	3.1	4.7	/	/
57	Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	K05+790 ～ K05+890	House	5 floors，mixed structure		10	14.6	17.7	45	Outdoor 0.5m	64.5	59.1	70.9	65.2	75	72	0.7	6.1	/	/
57	Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	K05+790 ～ K05+890	House	5 floors，mixed structure		10	14.6	17.7	45	Indoor	61.4	58.4	70.9	65.2	75	72	3.8	6.8	/	/
57	Zhengzhou ceramics factory family member	K05+790 ～ K05+890	House	6 floors，mixed		25	14.6	29.0	45	Outdoor 0.5m	65.6	60.1	66.7	65.2	75	72	/	5.1	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
	courtyard, 2 #, 4 #, 5 #, 6 #			structure																
58	Provincial Prospecting machinery factory family member courtyard 1 #, 5 #, 6 # building	K05+900～K05+965	House	6 floors，mixed structure		12	14.2	18.6	72	Outdoor 0.5m	59.2	58.3	74.6	65.2	75	72	6.0	6.9	/	/
59	Henan Geology and Mineral Resources Building	K05+986～K06+032	institution	15 floors，Frame		22	14.2	26.2	72	Outdoor 0.5m	57.2	/	67.6	65.3	75	72	8.1	/	/	/
60	Nanyang Road, No. 52 (Yuhua Wen Jinyuan), three buildings	K06+043～K06+082	House	7 floors，mixed structure		13	14	19.1	72	Outdoor 0.5m	63.2	60.3	74.4	65.4	75	72	2.2	5.1	/	/
61	Sipo Road 9	K06+205～K06+234	House	8 floors，Frame		12	14.1	18.5	72	Outdoor 0.5m	63.6	55.3	70.6	65.5	70	67	1.9	10.2	/	/
62	Nantong district, (Sipo Road 7th courtyard) 1 #	K06+250～K06+350	House	6~7 floors，mixed structure		34	14.1	36.8	72	Outdoor 0.5m	65.4	61.2	68.7	65.5	75	72	0.1	4.3	/	/
63	College family member courtyard 1 # 3 #	K06+364～K06+406	House	6 floors，mixed structure		28	14.1	31.3	72	Outdoor 0.5m	57.6	55.3	70.1	65.6	75	72	8.0	10.3	/	/
64	Nanyang Road, No. 46）	K06+429～K06+500	House	17 floors，Frame		11	14.2	18.0	60	Outdoor 0.5m	59.3	62.3	69.3	65.6	75	72	6.3	3.3	/	/
65	Nanyang Road, No. 41 courtyard, 5 # Building	K06+517～K06+548	House	6 floors，mixed structure		9	13.9	16.6	60	Outdoor 0.5m	59.5	62.3	74.0	65.6	70	67	6.1	3.3	/	/
65	Nanyang Road, No. 41 courtyard, 5 # Building	K06+517～K06+548	House	6 floors，mixed structure		9	13.9	16.6	60	Indoor	57.3	60.1	74.0	65.6	75	72	8.3	5.5	/	/
66	Taiji Kindergarten, Beijia Education	K06+550～K06+590	School	2 floors，mixed		6	13.9	15.1	60	Outdoor 0.5m	59.7	/	70.8	65.6	75	72	5.9	/	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
				structure																
66	Taiji Kindergarten, Beijia Education	K06+550～K06+590	School	2 floors，mixed structure		6	13.9	15.1	60	Indoor	57.5	/	70.8	65.6	75	72	8.1	/	/	/
67	Huafu Institute of Dermatology,	K06+613～K06+679	institution	5~7 floors，mixed structure		10	13.8	17.0	60	Outdoor 0.5m	59.5	/	73.8	65.6	75	72	6.1	/	/	/
67	Huafu Institute of Dermatology,	K06+613～K06+679	institution	5~7 floors，mixed structure		10	13.8	17.0	60	Indoor	56.3	/	73.8	65.7	75	72	9.4	/	/	/
68	City No. 71 high school	K06+690～K06+762	School	5 floors，mixed structure		11	13.9	17.7	60	Outdoor 0.5m	63.2	51.3	71.4	66.1	75	72	2.9	14.8	/	/
69	The 2nd Hospital, Zhengzhou University	K06+825～K06+878	Hospital	3~7 floors，mixed structure		23	14.1	27.0	60	Outdoor 0.5m	55.2	52.1	69.8	66.1	75	72	10.9	14.0	/	/
70	Zhengzhou Textile staff apartments, 29 #, 30 # Building	K06+900～K07+073	House	4 floors，mixed structure		14	14.5	20.2	45	Outdoor 0.5m	63.2	58.3	69.8	66.2	75	72	3.0	7.9	/	/
71	Zhengzhou Textile staff apartments, 18 # to 20 # buildings	K07+000～K07+100	House	7 floors，mixed structure		37	14.5	39.7	45	Outdoor 0.5m	57.2	51.2	63.9	66.3	75	72	9.1	15.1	/	/
72	Small Yuzhai (Nanyang Road courtyard 266--279)	K05+753～K06+085	House	5~7 floors，mixed structure		15	14.4	20.8	45	Outdoor 0.5m	62.3	58.6	69.5	66.3	75	72	4.0	7.7	/	/
73	Pearl Factory, family	K06+100～	House	5~6		9	14	16.6	72	Outdoor	61.2	57.6	75.6	66.3	75	72	5.1	8.7	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
	member courtyard, 1 #, 2 #, 3 # Building (Nanyang Road 275)	K06+180		floors , mixed structure						0.5m										
73	Pearl Factory, family member courtyard, 1 #, 2 #, 3 # Building (Nanyang Road 275)	K06+100 ～ K06+180	House	5~6 floors , mixed structure		9	14	16.6	72	Indoor	58.2	55.1	75.6	66.4	75	72	8.2	11.3	/	/
74	Nanyang Road, No. 283 Courtyard	K06+260 ～ K06+305	House	5 floors，mixed structure		13	14	19.1	72	Outdoor 0.5m	65.1	56.3	74.4	66.4	70	67	1.3	10.1	/	/
75	Municipal Corporation family member courtyard (Nanyang Road No. 289 courtyard), 1 #, 2 #, 3 #, 4 # Building	K06+455 ～ K06+511	House	6 floors，mixed structure		36	14.2	38.7	60	Outdoor 0.5m	55.2	50.1	66.6	66.5	70	67	11.3	16.4	/	/
76	Hengtian Heavy Industry Co., Ltd family area	K06+600 ～ K06+975	House	3~6 floors , mixed structure		14	14.1	19.9	60	Outdoor 0.5m	66.3	60.2	72.4	66.5	75	72	0.2	6.3	/	/
77	Nanyang Road, No. 296 Courtyard, 1 #, 2 #, 3 #	K07+032 ～ K07+168	House	6 ～ 12 floors , Frame		15	13.9	20.5	45	Outdoor 0.5m	59.2	55.3	67.7	66.5	70	67	7.3	11.2	/	/
78	Zhengzhou Jianguo Medicine Institute	K07+280 ～ K07+400	Hospital	4 floors，mixed structure		15	13.9	20.5	45	Outdoor 0.5m	60.3	/	69.7	66.5	75	72	6.2	/	/	/
79	Nanyang Road branch of Shiyan Kindergarten, Zhengzhou	K07+280 ～ K07+400	School	3 floors，mixed structure		54	13.9	55.8	45	Outdoor 0.5m	56.3	/	61.5	66.6	75	72	10.3	/	/	/
80	Buildings 6#, 5#, 4#, and Buildings 3# and 2# in the	K07+214 ～ K07+696	House	4 floors，mixed		15	13.9	20.5	60	Outdoor 0.5m	63.3	60.3	72.2	66.6	75	72	3.3	6.3	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
	south of Community of Zhengzhou Textile Machinery Co., Ltd.			structure																
81	Hongyihua Hong Kong City	K07+770～K07+900	House	34 floors，Frame		20	18.9	27.5	60	Outdoor 0.5m	61.2	58.3	65.6	66.7	75	72	5.5	8.4	/	/
82	Nanyang Road No. 12 courtyard, 1 #, 2 # Building	K07+900～K08+150	House	3~6 floors，mixed structure		10	18.6	21.1	60	Outdoor 0.5m	58.4	55.2	71.9	66.7	70	67	8.3	11.5	/	/
82	Nanyang Road No. 12 courtyard, 1 #, 2 # Building	K07+900～K08+150	House	3~6 floors，mixed structure		10	18.6	21.1	45	Indoor	56.9	52.6	69.4	66.8	75	72	9.9	14.2	/	/
83	Jinshui District Police Fire Brigade	K07+970～K08+010	institution	7 floors，mixed structure		14	18.6	23.3	45	Outdoor 0.5m	66	/	68.6	66.8	75	72	0.8	/	/	/
84	Nanyang Road No. 8courtyard,	K08+110～K08+180	House	7 floors，mixed structure		14	18.6	23.3	45	Outdoor 0.5m	66.5	53.7	68.6	66.9	75	72	0.4	13.2	/	/
85	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)）	K08+190～K08+220	House	5 floors，mixed structure		0	14.8	14.8	45	Outdoor 0.5m	66.8	62.1	74.5	67.0	70	67	0.2	4.9	/	/
85	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)）	K08+190～K08+220	House	5 floors，mixed structure		0	14.8	14.8	45	Indoor	57.1	52.9	74.5	67.0	75	72	9.9	14.1	/	/
86	Zhengzhou City Library	K08+250～K08+300	Library	2~6 floors，mixed structure		5	14.4	15.2	45	Outdoor 0.5m	61.4	/	74.7	67.0	75	72	5.6	/	/	/
86	Zhengzhou City Library	K08+250～	Library	2~6		5	14.4	15.2	45	Indoor	59.7	/	74.7	67.1	75	72	7.4	/	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
		K08+300		floors, mixed structure																
87	Garden community, (Nanyang Road 300) 5 # building	K07+220 ~ K07+320	House	7 floors, mixed structure		14	13.3	19.3	45	Outdoor 0.5m	65	60.9	70.2	67.2	75	72	2.2	6.3	/	/
88	Zhongheng Garden	K07+420 ~ K07+580	House	6 floors, mixed structure		40	14.8	42.7	60	Outdoor 0.5m	64.5	60.1	65.8	67.4	75	72	2.9	7.3	/	/
89	Zhongheng	K07+710 ~ K07+825	House	22 floors, Frame		32	18.6	37.0	60	Outdoor 0.5m	66.5	61.2	63.0	67.4	75	72	0.9	6.2	/	/
90	Nanyang Road No. 309--314 courtyard,	K07+900 ~ K08+020	House	5~6 floors, mixed structure		8	19.4	21.0	60	Outdoor 0.5m	66	57.8	72.0	67.4	75	72	1.4	9.6	/	/
90	Nanyang Road No. 309--314 courtyard,	K07+900 ~ K08+020	House	5~6 floors, mixed structure		8	19.4	21.0	60	Indoor	60	54.1	72.0	67.4	75	72	7.4	13.3	/	/
91	Zhongheng garden, 4 # to 10 #	K07+830 ~ K07+950	House	7 floors, mixed structure		27	19	33.0	60	Outdoor 0.5m	62.9	58.7	68.0	67.5	75	72	4.6	8.8	/	/
92	Qinghua Garden A, B, D, E Block	K08+136 ~ K08+280	House	28 floors, Frame		25	14.4	28.9	45	Outdoor 0.5m	55.5	55	62.7	67.6	75	72	12.1	12.6	/	/
93	Zhengzhou National Oil Reserve Depot, family member courtyard 1 # building	K08+290 ~ K08+360	House	7 floors, mixed structure		20	14.4	24.6	45	Outdoor 0.5m	58.9	51.2	68.1	67.6	75	72	8.7	16.4	/	/
94	Jinshui Road, 11th courtyard, 1 # building	K08+485 ~ K08+495	House	4 floors, mixed		11	14.3	18.0	45	Outdoor 0.5m	63.2	54.3	70.8	67.6	75	72	4.4	13.3	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
				structure																
95	Municipal Supply and Marketing Trading Corporation, family member courtyard, 1 #, 10 #, 11 # building	K08+985 ～ K09+058	House	3~8 floors，mixed structure		20	20.6	28.7	60	Outdoor 0.5m	60.4	57.3	69.2	67.7	75	72	7.3	10.4	/	/
96	Minggong Road No. 67 courtyard, (Jinfeng Golden Coast International), 1 # Building	K09+158 ～ K09+183	House	28 floors，Frame		33	14.6	36.1	45	Outdoor 0.5m	55.2	51.3	60.8	67.8	75	72	12.6	16.5	/	/
97	Minggong Road, No. 139 Courtyard(Grain Bureau family member building)	K08+640 ～ K08+690	House	7 floors，mixed structure		6	18.6	19.5	60	Outdoor 0.5m	60.4	55.3	72.6	67.8	75	72	7.4	12.5	/	/
97	Minggong Road, No. 139 Courtyard(Grain Bureau family member building)	K08+640 ～ K08+690	House	7 floors，mixed structure		6	18.6	19.5	60	Indoor	57.9	52.9	72.6	67.8	75	72	9.9	14.9	/	/
98	Minggong Road, No. 156 Courtyard, 1 #, 2 # Building	K08+920 ～ K09+017	House	6 floors，mixed structure		6	20.4	21.3	60	Outdoor 0.5m	63.5	59.3	71.8	67.8	75	72	4.3	8.5	/	/
98	Minggong Road, No. 156 Courtyard, 1 #, 2 # Building	K08+920 ～ K09+017	House	6 floors，mixed structure		6	20.4	21.3	60	Indoor	62.5	58.9	71.8	67.8	75	72	5.3	8.9	/	/
99	Jin Ming Yuan building and the building of South	K09+030 ～ K09+100	House	7 floors，mixed structure		4	15.6	16.1	45	Outdoor 0.5m	63.1	60.3	72.0	67.9	75	72	4.8	7.6	/	/
99	Jin Ming Yuan building and the building of South	K09+030 ～ K09+100	House	7 floors，mixed structure		4	15.6	16.1	45	Indoor	62.3	59.5	72.0	67.9	75	72	5.6	8.4	/	/
100	Huarun Yue House (under construction)	K09+245 ～ K09+610	House	58 floors，Frame		45	19	48.8	60	Outdoor 0.5m	58.2	53.4	60.6	68.0	75	72	9.8	14.6	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
101	Huigang New Town 1 #, 2 #, 3 # Building	K09+700 ～ K09+860	House	28 floors，Frame		0	19.9	19.9	60	Outdoor 0.5m	58.2	62.1	70.4	68.0	75	72	9.8	5.9	/	/
101	Huigang New Town 1 #, 2 #, 3 # Building	K09+700 ～ K09+860	House	28 floors，Frame		0	19.9	19.9	60	Indoor	56.5	56.2	70.4	68.2	75	72	11.7	12.0	/	/
102	Small building mosques	K10+000 ～ K10+059	Religion	4~6 floors，mixed structure		6	23.5	24.3	45	Outdoor 0.5m	61.2	57.2	68.2	68.2	75	72	7.0	11.0	/	/
102	Small building mosques	K10+000 ～ K10+059	Religion	4~6 floors，mixed structure		6	23.5	24.3	45	Indoor	59	50.3	68.2	68.4	75	72	9.4	18.1	/	/
103	West Cai district, (Ming Gong Road No. 240 Courtyard) 1 #	K09+275 ～ K09+315	House	4 ～ 7 floors，mixed structure		0	14.2	14.2	45	Outdoor 0.5m	65.2	63.3	74.8	68.4	75	72	3.2	5.1	/	/
103	West Cai district, (Ming Gong Road No. 240 Courtyard) 1 #	K09+275 ～ K09+315	House	4 ～ 7 floors，mixed structure		0	14.2	14.2	45	Indoor	59.5	58.2	74.8	68.4	75	72	8.9	10.2	/	/
103	West Cai district, (Ming Gong Road, No. 240 Courtyard), 2 #, 3 # Building	K09+275 ～ K09+315	House	7 floors，mixed structure		16	14.2	21.4	45	Outdoor 0.5m	58.6	55.3	69.3	68.4	75	72	9.8	13.1	/	/
104	Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)	K09+325 ～ K09+410	House	2 、3 ,7floors，mixed structure		9	14.2	16.8	45	Outdoor 0.5m	62.1	57.3	71.4	68.4	75	72	6.3	11.1	/	/
104	Courtyard No. 85 West Front Street, 1 # Building	K09+325 ～ K09+410	House	2 、3 ,7floors，		9	14.2	16.8	45	Indoor	60.4	50.7	71.4	68.4	75	72	8.0	17.7	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
	(Ming Gong Road, No. 245 Courtyard)			mixed structure																
106	Ming Gong Road No. 272, (Rural Credit Cooperative Union, family member building)	K09+545 ～ K09+608	House	6 floors，mixed structure		0	17.3	17.3	60	Outdoor 0.5m	61.3	52.3	75.6	68.6	75	72	7.3	16.3	/	/
106	Ming Gong Road No. 272, (Rural Credit Cooperative Union, family member building)	K09+545 ～ K09+608	House	6 floors，mixed structure		0	17.3	17.3	60	Indoor	57.3	49.2	75.6	68.7	75	72	11.4	19.5	/	/
107	Yalong district, 17 # Building	K09+638 ～ K09+674	House	7 floors，mixed structure		0	18.3	18.3	60	Outdoor 0.5m	55.2	60.5	75.1	68.8	75	72	13.6	8.3	/	/
107	Yalong district, 17 # Building	K09+638 ～ K09+674	House	7 floors，mixed structure		0	18.3	18.3	60	Indoor	54.3	59.4	75.1	68.8	75	72	14.5	9.4	/	/
108	Yalong districtl 16 # Building, 1 #, 2 # Building	K09+638 ～ K09+674	House	7 floors，mixed structure		16	18.3	24.3	60	Outdoor 0.5m	62.3	56.1	70.7	68.8	75	72	6.5	12.7	/	/
109	Catholic Church	K09+687 ～ K09+719	Religion	2 ～ 5 floors ，mixed structure		2	19.5	19.6	60	Outdoor 0.5m	63.5	53.6	74.6	68.9	75	72	5.4	15.3	/	/
109	Catholic Church	K09+687 ～ K09+719	Religion	2 ～ 5 floors ，mixed structure		2	19.5	19.6	60	Indoor	60.5	52.7	74.6	68.9	75	72	8.4	16.2	/	/
110	Jiefang Road Elementary School	K09+719 ～ K09+750	School	4 floors，mixed structure		42	19.5	46.3	60	Outdoor 0.5m	62.5	58.3	65.1	69.0	75	72	6.5	10.7	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
111	Shangfuxin Village House 1#	K10+510 ～ K10+614	House	18 floors，Frame		6	18.6	19.5	60	Outdoor 0.5m	59.2	55.3	68.6	69.0	75	72	9.8	13.7	/	/
111	Shangfuxin Village House 1#	K10+510 ～ K10+614	House	18 floors，Frame		6	18.6	19.5	60	Indoor	55.2	51.2	68.6	69.0	75	72	13.8	17.8	/	/
111	Shangfuxin Village 2 #, 3#	K10+510 ～ K10+614	House	10 floors，Frame		41	18.6	45.0	60	Outdoor 0.5m	55.3	53.2	61.3	69.0	75	72	13.7	15.8	/	/
112	Fuchun Apartment 1 # building	K10+625 ～ K10+779	House	7 floors，mixed structure		15	14.7	21.0	60	Outdoor 0.5m	65.2	61	70.0	69.0	75	72	3.8	8.0	/	/
113	Huating Apartments, Dehua Street community 1 #, 2 # Building	K10+528 ～ K10+614	House	16 floors，Frame		15	18.6	23.9	60	Outdoor 0.5m	59.6	57.1	66.8	69.0	75	72	9.4	11.9	/	/
114	Jinding Huafu House, front 1 #	K10+630 ～ K10+775	House	11 floors，Frame		13	14.7	19.6	45	Outdoor 0.5m	65.8	60.2	66.0	69.0	75	72	3.2	8.8	/	/
114	Jinding Huafu House, rear	K10+630 ～ K10+775	House	5 ～ 7 floors，mixed structure		8	14.7	16.7	45	Outdoor 0.5m	60.2	58.9	71.4	69.1	75	72	8.9	10.2	/	/
114	Jinding Huafu House, rear	K10+630 ～ K10+775	House	5 ～ 7 floors，mixed structure		8	14.7	16.7	45	Indoor	51.7	49.1	71.4	69.1	75	72	17.4	20.0	/	/
115	Modern XingYuan 1 #	K10+800 ～ K10+873	House	14 ～ 17 floors，Frame		23	14.4	27.1	45	Outdoor 0.5m	64.3	58.5	63.2	69.2	75	72	4.9	10.7	/	/
116	Hongxin Jia Yuan 1 # building	K10+915 ～ K10+990	House	7 floors，mixed structure		14	14.4	20.1	45	Outdoor 0.5m	64.3	55.2	67.8	69.2	75	72	4.9	14.0	/	/
117	Xidan apartments, two buildings	K11+070 ～ K11+151	House	7 floors，mixed		8	14.9	16.9	45	Outdoor 0.5m	67.2	64.3	69.3	69.3	75	72	2.1	5.0	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
				structure																
117	Xidan apartments, two buildings	K11+070～K11+151	House	7 floors, mixed structure		8	14.9	16.9	72	Indoor	66.3	60.2	73.4	69.3	75	72	3.0	9.1	/	/
118	West Street, No. 231	K11+250～K11+286	House	16 floors, Frame		13	16.5	21.0	72	Outdoor 0.5m	63.3	57.6	69.5	69.3	75	72	6.0	11.7	/	/
119	Zhongkai City Lights Clove Court, 1 #, Building	K11+380～K11+446	House	12 floors, Frame		12	16	20.0	72	Outdoor 0.5m	66.5	56	70.0	69.3	75	72	2.8	13.3	/	/
120	Fuhua Building	K11+450～K11+550	House	27 floors, Frame		8	15.5	17.4	72	Outdoor 0.5m	62.8	58.7	71.7	69.3	75	72	6.5	10.6	/	/
120	Fuhua Building	K11+450～K11+550	House	27 floors, Frame		8	15.5	17.4	72	Indoor	60.7	55.8	72.2	69.4	75	72	8.7	13.6	/	/
121	Zi Yan Huating 1 #, 2 # Building	K11+821～K11+917	House	24 floors, Frame		23	14.4	27.1	45	Outdoor 0.5m	62.2	58.3	63.2	69.4	75	72	7.2	11.1	/	/
122	Ginza International	K10+956～K11+025	House	15 floors, Frame		14	14.2	19.9	45	Outdoor 0.5m	55.2	53.2	65.9	69.5	75	72	14.3	16.3	/	/
123	233 West Main Street (the third secondary school, family member building)	K11+038～K11+100	House	18 floors, Frame		11	14.2	18.0	45	Outdoor 0.5m	65.2	63.2	66.8	69.5	75	72	4.3	6.3	/	/
124	218 West Main Street	K11+168～K11+221	House	6 floors, mixed structure		20	16	25.6	45	Outdoor 0.5m	57.2	53.6	65.7	69.6	75	72	12.4	16.0	/	/
125	Sun Moon Star City, 1 # building	K11+230～K11+300	House	20 floors, Frame		14	16.5	21.6	45	Outdoor 0.5m	65.1	57.3	65.2	69.6	75	72	4.5	12.3	/	/
126	Zhongkai City Lights Clove Court, 1 #, 2 # Building	K11+328～K11+450	House	7 floors, mixed structure		15	15.4	21.5	45	Outdoor 0.5m	59.1	53.5	67.3	69.6	75	72	10.5	16.1	/	/
127	Tangzi Lane (Bo'ai Street Community)	K11+328～K11+666	House	2、3 floors, mixed		38	15	40.9	45	Outdoor 0.5m	65.2	60.4	63.7	69.6	75	72	4.4	9.2	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
				structure																
128	Changcheng City in City	K11+460～K11+666	House	7 floors，mixed structure		13	16	20.6	45	Outdoor 0.5m	65.2	62.1	67.6	69.7	75	72	4.5	7.6	/	/
129	Yuhong Garden, 1 #, 2 #, 3 # Buildings	K11+675～K11+800	House	26 floors，Frame		25	14.8	29.1	45	Outdoor 0.5m	63.1	59.3	62.6	69.7	75	72	6.6	10.4	/	/
130	Municipal Guancheng State Taxation office services hall	K11+929～K11+978	institution	8 floors，mixed structure		33	14.3	36.0	45	Outdoor 0.5m	55.2	50.3	62.8	69.7	75	72	14.5	19.4	/	/
131	First People's Courtyard of Zhengzhou	K11+990～K12+055	Hospital	5 floors，mixed structure		22	14.3	26.2	45	Outdoor 0.5m	65.1	59.2	65.5	69.8	75	72	4.7	10.6	/	/
132	Guancheng District Education Center	K12+133～K12+211	institution	5 floors，mixed structure		21	14	25.2	45	Outdoor 0.5m	65.1	/	65.9	70.1	75	72	5.0	/	/	/
133	Zhigong Road, Building 1	K12+230～K12+335	House	7 floors，mixed structure		18	14.1	22.9	60	Outdoor 0.5m	62.1	60.2	71.2	70.1	75	72	8.0	9.9	/	/
134	Residential community of Zhengzhou Electric Power College	K12+400～K12+500	House	7 floors，mixed structure		43	17.5	46.4	60	Outdoor 0.5m	61.8	59.5	65.6	70.2	75	72	8.4	10.7	/	/
135	220 East Main Street	K11+978～K12+105	House	6 floors，mixed structure		10	14.3	17.4	45	Outdoor 0.5m	59.3	55.2	69.1	70.2	75	72	10.9	15.0	/	/
135	220 East Main Street	K11+978～K12+105	House	6 floors，mixed structure		10	14.3	17.4	45	Indoor	56.1	52.3	69.1	70.2	75	72	14.1	17.9	/	/
136	Mall Village, (248 East Main Street courtyard)	K12+000～K12+500	House	2、3 floors，mixed		28	14	31.3	60	Outdoor 0.5m	56.2	51.5	68.5	70.2	75	72	14.0	18.7	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
				structure																
137	Zhongkai City Lights Guangjingcui Court, 1 #, 2 # Building	K12+133 ～ K12+366	House	7 floors，mixed structure		8	14	16.1	60	Outdoor 0.5m	56.1	53.2	72.3	70.3	75	72	14.2	17.1	/	/
137	Zhongkai City Lights Guangjingcui Court, 1 #, 2 # Building	K12+133 ～ K12+366	House	7 floors，mixed structure		8	14	16.1	60	Indoor	50.1	49.2	72.3	70.4	75	72	20.3	21.2	/	/
138	East Main Street, No. 1 Court, Building 2	K12+550 ～ K12+600	House	7 floors，mixed structure		38	21.2	43.5	45	Outdoor 0.5m	59.2	57.3	61.1	70.4	75	72	11.2	13.1	/	/
139	Dolidongguan96,1#	K12+716 ～ K12+830	House	4 ～ 7 floors，mixed structure		11	20.5	23.3	45	Outdoor 0.5m	57.2	53.1	68.6	70.4	75	72	13.2	17.3	/	/
139	Dolidongguan96,2#	K12+716 ～ K12+830	House	4 ～ 7 floors，mixed structure		32	20.5	38.0	45	Outdoor 0.5m	56.1	50.2	64.3	70.4	75	72	14.3	20.2	/	/
140	Knitting mill family member courtyard, 1 # building	K12+992 ～ K13+072	House	5 floors，mixed structure		12	20.3	23.6	72	Outdoor 0.5m	58.1	56.3	72.5	70.4	75	72	12.3	14.1	/	/
140	Knitting mill family member courtyard, 2 # Building	K12+992 ～ K13+072	House	7 floors，mixed structure		32	20.3	37.9	72	Outdoor 0.5m	63.2	60.2	68.4	70.4	75	72	7.2	10.2	/	/
141	Yutong Garden Building 1#	K13+076 ～ K13+226	House	6 floors，mixed structure		12	18.5	22.1	72	Outdoor 0.5m	62.1	57.2	73.1	70.7	75	72	8.6	13.5	/	/
141	Yutong Garden Building 2#	K13+076 ～ K13+226	House	5 floors，mixed structure		36	18.5	40.5	72	Outdoor 0.5m	64.7	56.5	67.8	70.8	75	72	6.1	14.3	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
142	Municipal underwear factory family member courtyard, 1 #, 2 #, 3 # Building	K13+230 ～ K13+408	House	5 ～ 6 floors , mixed structure		14	16.2	21.4	72	Outdoor 0.5m	62.2	57.2	73.4	70.8	75	72	8.6	13.6	/	/
142	Municipal underwear factory, family member courtyard, 5 #, 4 # Building	K13+230 ～ K13+408	House	6 floors，mixed structure		34	16.2	37.7	72	Outdoor 0.5m	63.2	61.3	68.5	70.8	75	72	7.6	9.5	/	/
143	Zheng Bian Road, Building 60,	K13+414 ～ K13+473	House	32 floors，Frame		28	15.9	32.2	72	Outdoor 0.5m	60.9	59.2	65.8	70.8	75	72	9.9	11.6	/	/
144	Zheng Bian Road, Building 23,	K12+820 ～ K12+857	House	5 floors，mixed structure	II	7	20.5	21.7	45	Outdoor 0.5m	64.3	57.2	67.2	71.0	75	72	6.7	13.8	/	/
144	Zheng Bian Road, Building 23,	K12+820 ～ K12+857	House	5 floors，mixed structure	II	7	20.5	21.7	45	Indoor	62.2	53.1	67.2	71.0	75	72	8.8	17.9	/	/
145	Great Wall Cambridge Garden	K13+038 ～ K13+091	House	31 floors，Frame	I	21	19.2	28.5	72	Outdoor 0.5m	59.3	58.4	66.9	71.2	75	72	11.9	12.8	/	/
146	Cargo Terminal No. 23 North Street Courtyard, 1 #, (Phoenix Road Community)	K13+158 ～ K13+180	House	5 floors，mixed structure		18	17.5	25.1	72	Outdoor 0.5m	56.2	52.3	70.0	71.4	75	72	15.2	19.1	/	/
146	Cargo Terminal No. 23 North Street Courtyard, 3 #, (Phoenix Road Community)	K13+180 ～ K13+225	House	17 floors，Frame	I	18	17.5	25.1	72	Outdoor 0.5m	62.9	57.3	68.0	71.4	75	72	8.5	14.1	/	/
147	Langui district 1 # Building	K13+230 ～ K13+325	House	29 floors，Frame	I	16	17.2	23.5	72	Outdoor 0.5m	57.3	52	68.6	71.4	75	72	14.1	19.4	/	/
148	Boai ENT Hospital of Zhengzhou	K13+332 ～ K13+390	Hospital	6 floors，mixed structure		9	16.2	18.5	72	Outdoor 0.5m	64	59.3	72.6	71.4	75	72	7.4	12.1	/	/

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
148	Boai ENT Hospital of Zhengzhou	K13+332 ～ K13+390	Hospital	6 floors，mixed structure		9	16.2	18.5	72	Indoor	60.1	55	72.6	71.5	75	72	11.4	16.5	/	/
149	Zheng Bian Road, No. 49, family member courtyard, 1 # Building	K13+398 ～ K13+430	House	5 floors，mixed structure	II	13	15.9	20.5	72	Outdoor 0.5m	63.2	60.7	73.7	71.5	75	72	8.3	10.8	/	/
150	Dongming Road 30 Courtyard, (electric power district), 1 #, 2 # Building	K13+512 ～ K13+650	House	6 floors，mixed structure	II	9	14.9	17.4	72	Outdoor 0.5m	58.2	53	73.2	71.6	75	72	13.4	18.6	/	/
150	Dongming Road 30 courtyard (electric power district), 3 #, 4 # Building	K13+512 ～ K13+650	House	6 floors，mixed structure	II	9	14.9	17.4	72	Indoor	53.2	50.2	73.2	71.6	75	72	18.4	21.4	/	/
150	Zhengzhou Huimin High School	K13+512 ～ K13+650	House	6 floors，mixed structure	II	45	14.9	47.4	72	Outdoor 0.5m	58.5	55.3	64.5	71.6	75	72	13.1	16.3	/	/
151	Zhengzhou City Public Security Bureau Police Detachment	K14+686 ～ K14+769	School	5 floors，mixed structure	II	47	14.3	49.1	45	Outdoor 0.5m	57.8	55.6	60.1	71.7	75	72	13.9	16.1	/	/
152	Henan Provincial People's Procuratorate	K14+793 ～ K14+942	institution	7 ～ 8 floors，Frame	I	27	14.3	30.6	45	Outdoor 0.5m	60.5	/	62.2	71.7	75	72	11.2	/	/	/
153	Dongming Road 30 Courtyard, (electric power district), 1 #, 2 # Building	K14+942 ～ K15+052	institution	2 floors，mixed structure	I	26	16.3	30.7	72	Outdoor 0.5m	59.2	/	66.2	71.7	75	72	12.5	/	/	/
154	Yingxie Garden 1 #, 2 # Building	K15+194 ～ K15+485	House	29 floors，Frame	I	55	20.6	58.7	72	Outdoor 0.5m	55.3	51.1	60.6	71.8	75	72	16.5	20.7	/	/
155	District under construction 1 #, 2 # Building	K16+878 ～ K17+052	House	25 floors，Frame	I	54	15.6	56.2	60	Outdoor 0.5m	55.3	51.2	59.4	71.8	75	72	16.5	20.6	/	/
156	Henan Zhongdu Dermatology Hospital	K17+147 ～ K17+199	Hospital	6 floors，mixed		24	21.9	32.5	60	Outdoor 0.5m	57.2	53.1	66.2	72.1	75	72	14.9	19.0	/	0.1

SN	Target Name	Mileage	Using function	scale	Tape of building	Relationship with the line position			Speed	Prediction point Location	Present value (VLz10)		Predictive value (Vlmax)	Predictive value Vlz10	Standard		Increment		VLz10Superscalar	
						L	H	R			Day	Night			Day	Night	Day	Night	Day	Night
				structure																
157	Guancheng Traditional Chinese Medicine Hospital	K17+206 ～ K17+266	Hospital	8 floors，mixed structure		10	15.6	18.5	60	Outdoor 0.5m	56.7	53.6	71.0	72.1	75	72	15.4	18.5	/	0.1
157	Guancheng Traditional Chinese Medicine Hospital	K17+206 ～ K17+266	Hospital	8 floors，mixed structure		10	15.6	18.5	60	Indoor	52.2	51.6	71.0	72.6	75	72	20.4	21.0	/	0.6
158	Caixin Triana district, 1 #, 2 #, 3 #, 4 # Building	K17+390 ～ K17+766	House	20 floors，Frame	I	51	14.6	53.0	60	Outdoor 0.5m	56.4	52.1	59.9	72.6	75	72	16.2	20.5	/	0.6
159	Zhengshang Eastern Harbour, 1 #, 2 # Building	K19+152 ～ K19+300	House	18 ～ 26 floors，Frame	I	56	15.3	58.1	72	Outdoor 0.5m	58.2	51.3	60.7	72.6	75	72	14.4	21.3	/	0.6
160	Sinosun New World	K20+320 ～ K20+680	House	25 ～ 30floors，Frame	I	60	15	61.8	72	Outdoor 0.5m	57.8	51	60.7	72.6	75	72	14.8	21.6	/	0.6
161	Dongyinggang Village	K24+300 ～ K24+800	House	--		0	13	13.0	72	Outdoor 0.5m	57.5	52.6	80.7	77.7	75	72	20.2	25.1	2.7	5.7
161	Dongyinggang Village	K24+300 ～ K24+800	House	--		0	13	13.0	72	Indoor	52.3	50.8	80.7	77.7	75	72	25.4	26.9	2.7	5.7

Note:In the column of location relative to subway: L——Horizontal distance of prediction point from track centerline, H——Height difference of prediction point relative to rail face; in straight line distance column, R: distance from measurement point to vibration source. R=$\sqrt{L^2+H^2}$

b. Evaluation and analysis of prediction results of environment vibration

As shown from table 5.4 -15:

After project is put into operation, the vibration value VLz10 of 161 environment sensitive spots along the line is 54.6~77.7dB at daytime with 0~ 25.4 dB increment than that at present, and 0.3~26.9 dB increment at nighttime. The environment vibration of 6 sensitive spots exceeds the standard requirements, in which there are 1 sensitive spots with the vibration level exceeding the standard value at daytime with the over-limit amount of0～2.7dB, 6 sensitive spots with then noise level exceeding the standard value at nighttime with the over-limit amount of 0.1～5.7dB; and the over-limit rate is up to3.7％.

Among others:

The Dongyinggang village sensitive spot exceeds the standard requirements at day night,is located “industrial concentration district”. Due to the line passes just under the sensitive spot, all residents move out within 5m range at both sides of line; the environment vibration prediction value of the first residential building after removal is about 77.7 dB. In contract to GB10070-88 Standard of Vibration in Urban Area Environment, the noise level of this sensitive spot exceeds the standard requirement; the over-limit amount is 2.7 dB at daytime and the night over-limit amount is 5.7 dB.

c. Prediction results and analysis of vibration speed

There is no subway vibration source around the culture relics along the line in this project. According to GB/T50452—2008 Technical Specifications for Protection of Historic Buildings against Man-made Vibration, the speed response of subway vibration to culture relics structure are determined and evaluated with calculation method.

a. Determination of ground vibration speed

According to GB/T50452-2008 Technical Specifications for Protection of Historic Buildings against Man-made Vibration, the ground vibration speed at different distances from subway vibration source are shown in table 5.4 -16.

Table 5.4 -16 Ground vibration speed Vr (mm/s)

Vibration source type	Site soil type	Vs(m/s)	Distance r(m)		
			10	50	100
Subway	Clay	140~220	0.418	0.166	0.072

The straight line distances of Zhengzhou Memorial Tower for February 7th Strike , Shanhaimomuduha Tomb and Zhengzhou Confucius Temple to vibration source center are separately of 3m,38m and 36m. According to the ground vibration speed values at different distances in table 5.4-16, and with the interpolation method, the ground vibration speeds at historic building of this project are separately of 0.199mm/s , 0.199mm/s and 0.418mm/s .

6) Determination of cultural relics vibration speed

According to structural feature of cultural relics, the dynamic characteristics and response shall be determined according to the calculation formula for masonry ancient tower, masonry bell and drum tower and palace gate structure. The structure calculation parameters and maximum speed response refer to table 5.4-17.

As shown in table 5.4 -17, the maximum speed response values of 3 cultural relics along the line including Zhengzhou Memorial Tower for February 7th Strike , Zhengzhou Confucius Temple and Shanhaimomuduha Tomb exceed the standard requirement, with the over-limit amounts separately of 1.18mm/s、0.96mm/s and1.57mm/s. To ensure the safety of cultural relics, the evaluation takes special level vibration reduction measures for them. It is necessary to strengthen the tracking monitoring for the vibration response of above3 culture relics during operation period and construction period. It is necessary to take measures to solve the problem if detected.

Table 5.4 -17 Structure calculation parameters and maximum speed response for ancient architecture

Ancient architecture name	distance(m)	Buried depth(m)	Horizontal ground vibration speed at foundation (mm/s)	Vibration model order	Vibration model participation factor	Ground vibration frequency (Hz)	Structure calculation height (m)	The quality of stiffness parameters	The first J order natural frequency (HZ) structure	FR/FJ	Vibration model participation factor	Structure maximum speed response (mm/s)	Standard value (mm/s)	Present value	Over-limit amount (mm/s)
Shanhaimomuduha Tomb	38	20	0.1992	Vibration model order No.1	1.273	7.1	7	230	8.2195	0.8638	7.957	2.0199	0.45		1.57
				Vibration model order No.2	-0.424				24.653	0.288	0.7599				
				Vibration model order No.3	0.255				41.092	0.1728	1.311				
Zhengzhou Memorial Tower for February 7th Strike	3	22.3	0.418	Vibration model order No.1	1.634	13.4	63	955.2	0.5596	23.946	1	1.3332	0.15	5.96	1.18
				Vibration model order No.2	-0.984				2.6531	5.0508	1				
				Vibration model order No.3	0.575				6.061	2.2109	4.4457				
Zhengzhou Confucius Temple	36	16.3	0.1992	Vibration model order No.1	1.273	13.65	10	230	5.7537	2.3724	4	1.2267	0.27	22.43	0.96
				Vibration model order No.2	-0.424				17.257	0.791	7				
				Vibration model order No.3	0.255				28.765	0.4745	7				

d. Prediction of noise impact of secondary structure

a. According to HJ453-2008 Technical Guidelines for Environment Impact - Urban Rail Transit, the secondary structure prediction model (instantaneous value) for train passing period in this assessment is as follow:

$$L_{p,i}(f) = VL_i(f) - 20\lg(f_i) + 37 \quad \text{(Formula 5-10)}$$

$$L_p = 10\lg\sum_{i=1}^{n} 10^{0.1[L_{p,i}(f)+C_{f,i}]} \quad \text{(Formula 5-11)}$$

Where: Lp——A weighted sound pressure level in building, dB(A);

Lp, i(f) ——Unweighted sound pressure level in building, dB;

VLi(f) ——Vibration acceleration level in building corresponding to the frequency, dB;

Cf, i——A weighted correction of ith frequency band, dB;

f ——1/3 octave frequency band center frequency (16 - 200 Hz), Hz;

n ——1/3 octave frequency band number.

b. Prediction results and analysis

According to analog survey measurement results and in combination with the model calculation, figure out the prediction results of noise instantaneous values of along-line sensitive building indoor secondary structures and indoor noise equivalent sound levels; the details refer to table 5.4 -18.

Table 5.4 -18 Prediction results of noises of sensitive building secondary structures of underground line

SN	sensitive spots name	Line mileage	Using function	scale	Tape of building	Prediction point Location	speed （ km/h）	Structural noise prediction	Standard		Superscalar	
									Day	Night	Day	Night
16	Peaceful residential homes, Building 8,	K02+500～K02+619	house	22 floors，Frame	Ⅰ类	Indoor	60	38.7	45.0	42.0	/	/
17	RCC family member courtyard (Gadameilin district)	K02+623～K02+663	house	17 floors，Frame	Ⅰ类	Indoor	60	42.8	45.0	42.0	/	0.8
18	CR City Concert (Xinyu Garden) district ,1 #, 5 # Buildings	K02+800～K02+900	house	6 floors，mixed structure	Ⅱ类	Indoor	45	44.2	45.0	42.0	/	2.2
37	Chuangye Homes	K04+217～K04+277	house	7 floors，mixed structure	Ⅱ类	Indoor	72	47.9	45.0	42.0	2.9	5.9
38	Sunshine Holiday district, 1 #, 2 # Building	K04+286～K04+500	house	7 floors，mixed structure	Ⅱ类	Indoor	45	44.4	45.0	42.0	/	2.4
39	Nanyang Road, No. 111 Courtyard	K04+529～K04+558	house	6 floors，mixed structure	Ⅱ类	Indoor	45	45.5	45.0	42.0	0.5	3.5
43	China Railway Bridge Bureau family member courtyard 1 #	K04+929～K05+010	house	7 floors，mixed structure	Ⅱ类	Indoor	72	46.9	45.0	42.0	1.9	4.9
46	Zhengrong Group Limited family member courtyard, 3 #, 6 # building	K05+268～K05+318	house	5 floors，mixed structure	Ⅱ类	Indoor	72	46.8	45.0	42.0	1.8	4.8
57	Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	K05+790～K05+890	house	5 floors，mixed structure	Ⅱ类	Indoor	45	44.5	45.0	42.0	/	2.5
65	Nanyang Road, No. 41 courtyard, 5 # Building	K06+517～K06+548	house	6 floors，mixed structure	Ⅱ类	Indoor	60	47.6	45.0	42.0	2.6	5.6
66	Taiji Kindergarten, Beijia Education	K06+550～K06+590	school	2 floors，mixed structure	Ⅰ类	Indoor	60	41.3	45.0	42.0	/	/
67	Huafu Institute of Dermatology	K06+613～K06+679	institution	5～7 floors，mixed structure	Ⅱ类	Indoor	60	47.3	45.0	42.0	2.3	5.3
73	Pearl Factory, family member courtyard, 1 #, 2 #, 3 # Building (Nanyang Road 275)	K06+100～K06+180	house	5～6 floors，mixed structure	Ⅱ类	Indoor	72	49.1	45.0	42.0	4.1	7.1
82	Nanyang Road No. 12 courtyard, 1 #, 2 # Building	K07+900～K08+150	house	3～6 floors，mixed structure	Ⅱ类	Indoor	45	42.9	45.0	42.0	/	0.9
85	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)	K08+190～K08+220	house	5 floors，mixed structure	Ⅱ类	Indoor	45	48.0	45.0	42.0	3.0	6.0
86	Zhengzhou City Library	K08+250～K08+300	Library	2～6 floors，mixed structure	Ⅱ类	Indoor	45	48.3	45.0	42.0	3.3	6.3
90	Nan yang road 309-314	K07+900～K08+020	house	5～6 floors，mixed structure	Ⅱ类	Indoor	60	45.5	45.0	42.0	0.5	3.5
97	Minggong Road, No. 139 Courtyard(Grain Bureau family member building)	K08+640～K08+690	house	7 floors，mixed structure	Ⅱ类	Indoor	60	46.1	45.0	42.0	1.1	4.1
98	Minggong Road, No. 156 Courtyard, 1 #, 2 # Building	K08+920～K09+017	house	6 floors，mixed structure	Ⅱ类	Indoor	60	45.4	45.0	42.0	0.4	3.4
99	Jin Ming Yuan and South, Building # 1	K09+030～K09+100	house	7 floors，mixed structure	Ⅱ类	Indoor	45	44.6	45.0	42.0	/	2.6
101	Huigang New Town 1 #, 2 #, 3 # Building	K09+700～K09+860	house	28 floors，Frame	Ⅰ类	Indoor	60	40.9	45.0	42.0	/	/
102	Small building mosques	K10+000～K10+059	Religion	4～6 floors，mixed structure	Ⅱ类	Indoor	45	41.7	45.0	42.0	/	/
103	West Cai district, (Ming Gong Road No. 240 Courtyard)	K09+275～K09+315	house	4～7 floors，mixed structure	Ⅱ类	Indoor	45	48.4	45.0	42.0	3.4	6.4

	1 #											
104	Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)	K09+325～K09+410	house	2、3，7 floors，mixed structure	Ⅱ类	Indoor	45	44.9	45.0	42.0	/	2.9
106	Ming Gong Road No. 272, (Rural Credit Cooperative Union, family member building)	K09+545～K09+608	house	6 floors，mixed structure	Ⅱ类	Indoor	60	49.2	45.0	42.0	4.2	7.2
107	Yalong district, 17 # Building	K09+638～K09+674	house	7 floors，mixed structure	Ⅱ类	Indoor	60	48.7	45.0	42.0	3.7	6.7
109	Catholic Church	K09+687～K09+719	Religion	2～5 floors，mixed structure	Ⅱ类	Indoor	60	48.1	45.0	42.0	3.1	6.1
111	Shangfuxin Village House 1#	K10+510～K10+614	house	18 floors，Frame	Ⅰ类	Indoor	60	39.1	45.0	42.0	/	/
114	Jinding Huafu House, rear	K10+630～K10+775	house	5～7 floors，mixed structure	Ⅱ类	Indoor	45	45.0	45.0	42.0	/	3.0
117	Xidan apartments, two buildings	K11+070～K11+151	house	7 floors，mixed structure	Ⅱ类	Indoor	72	46.0	45.0	42.0	1.0	4.0
120	Fuhua Building	K11+450～K11+550	house	27 floors，Frame	Ⅰ类	Indoor	72	42.5	45.0	42.0	/	0.5
135	220 East Main Street	K11+978～K12+105	house	6 floors，mixed structure	Ⅱ类	Indoor	45	42.6	45.0	42.0	/	0.6
137	Zhongkai City Lights Begonia Court # 1 building	K12+133～K12+366	house	7 floors，mixed structure	Ⅱ类	Indoor	60	44.8	45.0	42.0	/	2.8
144	Zheng Bian Road, Building 23,	K12+820～K12+857	house	5 floors，mixed structure	II 类	Indoor	45	39.7	45.0	42.0	/	/
148	Boai ENT Hospital of Zhengzhou	K13+332～K13+390	hospital	6 floors，mixed structure	Ⅱ类	Indoor	72	45.2	45.0	42.0	0.2	3.2
150	Dongming Road 30 Courtyard, (electric power district), 1 #, 2 # Building	K13+512～K13+650	house	6 floors，mixed structure	II 类	Indoor	72	45.7	45.0	42.0	0.7	3.7
157	Guancheng Traditional Chinese Medicine Hospital	K17+206～K17+266	hospital	8 floors，mixed structure	Ⅱ类	Indoor	60	43.6	45.0	42.0	/	1.6
161	Dongyinggang Village	K24+300～K24+800	house	--	Ⅲ类	Indoor	72	56.2	45.0	42.0	11.2	14.2

Note: In the column of location relative to subway: L——Horizontal distance of prediction point from track centerline, H——Height difference of prediction point relative to rail face, $R=\sqrt{L^2+H^2}$

c. Prediction result analysis and assessment

As shown by the prediction results in table 5.4 -18, the indoor secondary structure noises in 38 sensitive buildings within 10m range from right above of project underground section to outer rail centerline are in the range of 38.7~56.2dB dB dB. In reference to standard reference limit of “42dB(A)”, there are total 32sensitive spots affected by secondary structure noise due to subway vibration with the over-limit amount of 0.5~14.2dB.

5.4.3 Ambient vibration protection measures

5.4.3.1 Suggestion for vibration pollution control measures during construction period

To minimize the construction vibration environment impact in the project sections, it is necessary to take effective control measures from following aspects:

(1) Scientifically and reasonable layout of construction site

Scientifically and reasonable layout of construction site is an important approach to reduce the construction vibration. Under the premise of guarantee of construction works, it is necessary to fully consider the position relationships between construction site layout and ambient environment. Concentrate the fixed vibration source in construction sites such as processing workshop and material yard to minimize the vibration disturbance scope. In case of long construction period, it is possible to take some emergency vibration damping measures and make full use of natural conditions of topography and land features so as to reduce the impact of vibration propagation on surrounding sensitive spots. The traveling paths of construction vehicles, especially the heavy transport vehicle shall avoid the vibration sensitive areas as possible.

(2) Scientific management and civilized construction

Under the conditions to guarantee construction progress, optimize the construction program, reasonably arrange the operation time, carry out the high vibration works in the time period with high ambient vibration background value (7:00 - 12:00, 14:00 - 22:00) and limit the construction works with heavy vibration pollution at night time to realize civilized construction.

(3) Optimal construction method

For the interval section with shield construction method, it is necessary to carry out detailed survey and make the record for the sensitive spots near the tunnel in advance, and take preventive measures such as reinforcement to prevent possible building cracking and ground settlement.

(4) During construction period, prepare complete monitoring program for culture relics and ancient architectures affected, focus on the monitoring of their settlement, tilting and crack development, define the pre-alarm value, alarm value and control value and prepare the construction emergency plan; renovate the key buildings in advance; conduct the retaining protection for the building with poor stability; protection measures for the sections near or passing under ground buildings: except reasonable adjustment of parameters such as soil chamber pressure, jack pushing force and grouting pressure during shield propelling, reduction of disturbance for surrounding soil mass as possible and control of surrounding stratum deformation, conduct grouting reinforcement for stratum around the ancient building foundation if necessary so as to enhance the bearing capacity and further control the ancient building deformation.

(5) The construction unit and environment protection department shall properly conduct the promotion works and strengthen the environment management awareness of construction unit. According to national and local related laws, regulations, codes and rules, the construction unit shall actively accept the monitoring management and inspection of environment protection department. It is necessary to designate special person to take charge during engineering construction and supervision so as to ensure the implementation of construction vibration control measures.

5.4.3.2 Suggestion for vibration pollution control measures during operation period

(I) General Principles of vibration pollution prevention

To relieve the disturbance of this project on ground and building along the line, in combination with predictive assessment and analysis results and based on the principle of technical feasibility and economical rationality, conduct vibration reduction design for vehicle types, track construction and line conditions according to production mechanism of subway vibration so as to reduce the vibration source intensity value produced from wheel and rail contact and fundamentally relieve the impact of rail transit vibration on ambient environment. This assessment puts forth the protection measures and suggestions from following aspects:

(1) Vehicle vibration control

The vehicle performance directly influences the size of vibration sources and the vibration reduction design of vehicle structure is important to control the rail transit vibration. According related study data at home and abroad, the application of elastic wheel can reduce the vibration for 4 - 10dB. In addition, it is possible to use damping wheel or wheel with special tread; take vibration reduction measures on bogie; reduce the primary and secondary suspension system quality; adopt measures such as disc brake to reduce the vehicle vibration. In vehicle model selection of this project, it is recommended to mainly consider, except dynamic and mechanical performance of vehicle, the vibration protection measures and vibration indexes. It is preferable to select the vehicle with low noise and vibration values and quality structures.

(2) Vibration control of track structures

The vibration control of track structures mainly include the steel rail and line type, fastener type and ballast bed structure, which are separately described as follows:

A. Steel rail and line type

The 60kg/m steel rail seamless line can not only improve the track stability, reduce the service and maintenance work load and the vehicle operation energy consumption, but also reduce the train impact load, so it is widely applied in urban rail transit. The main line of this project adopts 60kg/m steel rail seamless line, of which the vibration under round wheel conditions is 5-10dB lower than that of short rail line.

B. Fastener type

The sections in this project with high vibration damping requirements shall adopt Vanguard vibration damping fasteners or GJ-III track vibration damper fastener.

C. Ballast bed structure

The underground line sections in this project with high vibration damping requirements shall adopt elastic supporting block type integrated ballast bed, of which the installation is inconvenient; in the section with special vibration reduction requirement, it is possible to use steel spring floating slab ballast bed.

(3) Maintenance of line and vehicle

The smoothness and roundness of subway line and wheel directly affect the size of subway vibration level and the good wheel and rail conditions can reduce the vibration for 5 - 10dB. So it is necessary to intensify the maintenance and service of wheels and rails, regularly lathe the wheel and grind the steel rail and apply oil on small radius curve section for protection so as to ensure good operation conditions and reduce the additional vibration.

(II) Vibration pollution control for over-limit sensitive spots

(1) Comparison and selection of vibration reduction measures and related principles

The comprehensive comparison of construction costs, vibration reduction amount, difficulties of construction and maintenance of vibration reduction measures of different tracks are shown in table 5.4 -19.

Table 5.4 -19 Comprehensive comparison of vibration reduction measures of different tracks

Vibration reduction type	Elastic supporting block type integrated ballast bed	GJ-III track vibration damper fastener	LORD fastener	Vanguard vibration damping fastener	Floating slab track
Structure features	It mainly uses the rubber tie plate under and at side of short sleeper for track vibration damping	Make use of the rubber tie plate under and at side of steel rails for track vibration damping	Combine the rail support plate, porous rubber and vulcanized base plate and make use of compression deformation of rubber for vibration damping	Directly separate the steel rail and ballast bed and make use of rubber support at steel rail side for vibration damping	Locate the ballast bed plate on steel spring pad
Average of predicted vibration reduction effect (dB)	10	9	6	13	25
Construction cost estimation (increment, 10,000 Yuan/single line km)	200	130	100	400	1000
Service life	At least once to twice full replacement in 50 years	At least once to twice full replacement in 50 years	Replace after wearing or falling off	Replace after wearing or falling off of rubber support	At least once to twice full replacement in 50 years
Impact of replacement on operation	Possible impact	No impact	Possible impact	No impact	Likely impact
Construction feasibility	Large construction difficulty	Same to normal integrated ballast bed	Same to normal integrated ballast bed	Same to normal integrated ballast bed, interchangeable	The floating slab can be cast in place, requiring special construction machines and tools, with large construction difficulty and proven technologies
Maintainability	Inconvenient maintenance	Convenient maintenance	Maintainable	Convenient maintenance	Maintainable with less maintenance work load
Practicalness (subway application country or city)	General application abroad, Shanghai, Beijing, Guangzhou	Beijing subway line 5, line 10	Canada, Malaysia, Shanghai M4	England, America, Italia, Spain, Hongkong, Guangzhou	Europe and America, Hongkong, Guangzhou, Beijing

According to application examples of urban rain transit vibration control at home and abroad, refer to the requirements in GB50157-2003 Subway Design Specification and HJ453-2008 Environmental Impact Assessment Technology Guidelines - Urban Mass Transit, and considering the large noise of secondary structure due to subway vibration during train passing, the measures principles in this assessment refer to the class 1 standard of residence bedroom, quiet room with special requirements in school and hospital ward in GBJ118-88 Sound Insulation Design Standards for Civil Architecture: indoor noise of residence, classroom and hospital: ≤40dB(A), and regard this as the standard limit of secondary structure noise during train passing period. the basic principles for vibration reduction measures used are as follows:

A. For historic and culture sites to be protected and the buildings to be managed according to culture relics requirements, adopt steel spring floating slab integrated ballast bed or equivalent moderate shock-absorbing measures.

B. For the sensitive spots such as school, hospital, residential area passing by the line (the right above of track is in 10m range from the outer rail centerline), adopt adopt steel spring floating slab integrated ballast bed or equivalent moderate shock-absorbing measures.

C. For the sensitive spots such as school, hospital, residential area with the over-limit of 10dB of secondary structure noise during train passing period or VLzmax over-limit amount of more than 7dB, adopt steel spring floating slab integrated ballast bed or equivalent moderate shock-absorbing measures.

D. For the sensitive spots such as school, hospital and residential area with the VLzmax over-limit amount of no more than 3-7dB, adopt Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures..

E..For the sensitive spots such as school, hospital, residential area with VLzmax over-limit amount of more than 3dB, adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.

In the view of continuous technical advance, the vibration reduction measures suggested by environment impact assessment can be adjusted to other proven vibration damping measures with equivalent effect, ease for maintenance and less construction cost according to domestic and international technical conditions at time of project construction.

(2) Vibration reduction measures and investment estimation

The vibration reduction measures recommend by the evaluation are as follows:

For three cultural relics protection units of Shanhaimomuduha Tomb ,Zhengzhou Memorial Tower for February 7th Strike, Zhengzhou Confucius Temple and

Zhengzhou Shang Dynasty Relics 4 along both sides of the line in this project, set the steel spring floating slab ballast beds or equivalent moderate shock-absorbing measures., totaling 780m at both sides and requiring 1.95million yuan investment.

For 38 over-limit sensitive spots where the line passes just through (in 5m range from the outer rail center line just above track) such as school, hospital and residence areas, including RCC family member courtyard (Gadameilin district) so on, arrange the steel spring floating slab integral ballast beds, totaling 7052m at both sides and requiring investment of 105.78 million yuan.

For 45 over-limit sensitive spots within 10--15m range mainly including City bus company, family member courtyard, and Tianxiu courtyard so on, use the flexible support block type integral ballast bed or equivalent moderate shock-absorbing measures, totaling 8753m for double line and the investment of 87.53 million yuan.

For the environment sensitive spot with over-limit environment vibration VLz10, or VLz10 is qualified, but VLzmax exceeds the standard environment requirements, including 28 locations of Peaceful residential homes, Building 8 and so on,, use type III vibration reduction fasteners or equivalent moderate shock-absorbing measures, totaling for 5239mm and investment of 17.45 million yuan.

The detailed vibration pollution control measures refer to tables 5.4-20 and 5.4-21.

The implementation of preferable removal measures requires the project vibration protection investment of 3# line of 212.71 million yuan, including vibration reduction investment for cultural relics protection of 1.95 million yuan and the vibration reduction investment for sensitive spots such as residence community of 210.76 million yuan, while excluding the engineering demolition and resettlement fee.

Table 5.4-20.Table Of Sensitive Point Vibration Control Measures

SN	Target Name	Mileage	Relationship with the line position（m）	Location	Using function	Prediction point Location	VLZmax(dB)	VLZ10（dB)	Structural noise prediction	Superscalar of VLZmax		Superscalar of Structural noise prediction		Sensitive Point Vibration Control Measures	Mileage of Sensitive Point Vibration Control Measures	Length (m)	Total investment(Ten thousand yuan)
										Day	Night	Day	Night				
1	New Hope Ao Garden, 17 #, 3 #	K00-195～K00-472	47	Right	House	Outdoor 0.5m	59.0	54.6	/	/	/	/	/				
2	Fuwa beauty area, Building 3, Building 1,	K00+843～K00+921	18	Left	House	Outdoor 0.5m	69.5	55.2	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K0+793～K1+150	357	178.5
3	Taili community, Building 1,	K00+940～K00+968	16	Left	House	Outdoor 0.5m	68.1	56.0	/	/	/	/	/				
4	Hongda district, 11 #, 10 #, 9 #, 5 # Buildinsg	K00+986～K01+100	18	Left	House	Outdoor 0.5m	69.7	56.4	/	/	/	/	/				
5	Huiji District, Changxing Road, Street office	K01+454～K01+537	15	Left	institution	Outdoor 0.5m	69.6	56.9	/	/	/	/	/				
6	Changxing Road, No. 2 Courtyard	K01+476～K01+539	38	Left	House	Outdoor 0.5m	61.7	57.1	/	/	/	/	/				
7	Yuhua ninth city, Building 1 #~ 3 #	K00+100～K00+280	46	Right	House	Outdoor 0.5m	58.2	57.6	/	/	/	/	/				
8	Angel Kindergarten	K00+310～K00+320	18	Right	House	Outdoor 0.5m	68.6	57.6	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K0+260～K0+370	110	55
9	Sanquan Food Co., Ltd., staff quarters	K00+644～K00+670	20	Right	House	Outdoor 0.5m	71.6	57.7	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration	K0+594～K0+720	126	126

														reduction measures			
10	ChengHuang 5-rings Mansion	K01+010～K01+030	25	Right	institution	Outdoor 0.5m	66.0	57.7	/	/	/	/	/				
11	Hualian family member courtyard, Buildings 2, 4, 5,	K01+362～K01+450	23	Right	House	Outdoor 0.5m	66.8	57.8	/	/	/	/	/				
12	Cityorth Shore District, 1 # building	K01+450～K01+540	18	Right	House	Outdoor 0.5m	66.6	57.8	/	/	/	/	/				
13	Baiwen courtyard, 1 #, 2 #,6#,7# Buildings	K01+587～K01+700	17	Left	House	Outdoor 0.5m	66.9	57.8	/	/	/	/	/				
14	Phosphate fertilizer factory family member courtyard, 1 #, 2 # Buildings	K02+411～K02+440	17	Left	House	Outdoor 0.5m	69.6	58.1	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K2+361 ～ K2+573	212	106
15	Huiji District's office building of Land and Resources	K02+444～K02+495	5	Left	institution	Outdoor 0.5m	73.8	58.2	47.3	/	1.8	2.3	5.3				
15	Huiji District's office building of Land and Resources	K02+444～K02+495	5	Left	institution	Indoor	73.8	58.3	47.3	/	1.8	2.3	5.3				
16	Peaceful residential homes, Building 8,	K02+500～K02+619	9	Left	House	Outdoor 0.5m	68.2	58.5	38.7	/	/	/	/				
16	Peaceful residential homes, Building 8,	K02+500～K02+619	9	Left	House	Indoor	68.2	58.7	38.7	/	/	/	/				
17	RCC family member courtyard (Gadameilin district)	K02+623～K02+663	0	Left	House	Outdoor 0.5m	72.3	59.2	42.8	/	0.3	/	0.8	Steel springs, floating slab,or The same level of vibration reduction measures	K2+573 ～ K2+950	377	565.5
17	RCC family member courtyard (Gadameilin district)	K02+623～K02+663	0	Left	House	Indoor	72.3	59.6	42.8	/	0.3	/	0.8				
18	CR City Concert (Xinyu Garden) district ,1 #, 5 # Buildings	K02+800～K02+900	9	Left	House	Outdoor 0.5m	70.6	59.7	44.2	/	/	/	2.2				
18	CR City Concert (Xinyu Garden) district ,1 #, 5 #	K02+800～K02+900	9	Left	House	Indoor	70.6	59.8	44.2	0.6	3.6	/	2.2				

	Buildings																
19	Changxing Building	K01+650～K01+790	32	Right	House	Outdoor 0.5m	62.8	59.8	/	/	/	/	/				
20	Huiji District, Tumor Courtyard of Traditional Chinese Medicine	K01+801～K01+871	29	Right	Hospital	Outdoor 0.5m	65.8	60.0	/	/	/	/	/		//		
21	City bus company, family member courtyard	K02+800～K02+910	15	Right	House	Outdoor 0.5m	69.5	60.2	/	/	2.5	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K2+750 ～ K2+960	210	105
22	Zhongji urban spring	K03+080～K03+140	33	Left	House	Outdoor 0.5m	60.8	60.2	/	/	/	/	/				
23	Jianye Yihao Chengbang District, 1 #, 7 #, 8 # Building	K03+144～K03+266	33	Left	House	Outdoor 0.5m	60.8	60.4	/	/	/	/	/				
24	National Food Authority's Zhengzhou Institute of Science and family Courtyard	K03+280～K03+550	15	Left	institution	Outdoor 0.5m	73.1	60.7	/	/	1.1	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K3+230 ～ K3+378	148	148
24	National Food Authority's Zhengzhou Institute of Science and family Courtyard	K03+280～K03+550	44	Left	House	Outdoor 0.5m	66.5	60.9	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K3+378 ～ K3+560	182	91
25	Tianxiu home district, 1 # ~ 4 # Building	K03+610～K03+723	16	Left	House	Outdoor 0.5m	72.0	61.1	/	/	0.0	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K3+560 ～ K4+479	919	919
26	Zhengzhou Oriental Tumor Courtyard	K03+730～K03+784	15	Left	Hospital	Outdoor 0.5m	72.1	61.3	/	2.1	5.1	/	/				
27	ICBC family member building	K03+957～K03+990	11	Left	House	Outdoor 0.5m	72.7	61.5	/	2.7	5.7	/	/				

28	Zhang Zhaicun	K04+000～K04+213	17	Left	House	Outdoor 0.5m	71.9	62.1	/	/	/	/	/				
29	Fun district, 1 #, 2 #, 3 #, 4 #, 5 # Building	K04+291～K04+463	11	Left	House	Outdoor 0.5m	70.5	62.2	/	/	/	/	/				
29	Fun district, 6 # - 11 # building	K04+291～K04+463	28	Left	House	Outdoor 0.5m	65.9	62.4	/	/	/	/	/				
30	Projects under construction (Chang Jian.Yufeng)	K02+940～K03+170	50	Right	House	Outdoor 0.5m	57.6	62.5	/	/	/	/	/				
31	Grain transport community, Building 9, Building 10	K03+200～K03+328	11	Right	House	Outdoor 0.5m	74.7	62.6	/	/	2.7	/	/	Steel springs, floating slab,or The same level of vibration reduction measures	K3+150 ～ K3+378	228	342
31	Grain transport community, 3 #~ 8 # Building	K03+200～K03+328	23	Right	House	Outdoor 0.5m	71.2	62.6	/	/	/	/	/				
32	Huiji District's Board of Education family member building	K03+611～K03+621	13	Right	House	Outdoor 0.5m	72.7	62.7	/	/	0.7	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K3+561 ～ K4+167	606	606
33	Yuhua Wen Hui Garden District, Building 1 to 5	K03+635～K03+773	16	Right	House	Outdoor 0.5m	69.9	62.8	/	/	/	/	/				
34	Yuhua Wen Qing Garden District Building 1 to 4	K03+917～K04+049	13	Right	House	Outdoor 0.5m	70.4	62.8	/	/	/	/	/				
35	City Brewery, family member courtyard north courtyard Building 25,	K04+056～K04+120	18	Right	House	Outdoor 0.5m	71.4	62.8	/	/	/	/	/				
36	Yaxin good times area, 3 to 4 Building	K04+129～K04+211	13	Right	House	Outdoor 0.5m	72.8	62.9	/	/	0.8	/	/				
37	Chuangye Homes	K04+217～K04+277	9	Right	House	Outdoor 0.5m	74.4	62.9	47.9	4.4	7.4	2.9	5.9	Steel springs, floating slab,or The same level of vibration reduction measures	K4+167 ～ K4+550	383	574.5
37	Chuangye Homes	K04+217～K04+277	9	Right	House	Indoor	74.4	62.9	47.9	4.4	7.4	2.9	5.9				
38	Sunshine Holiday district, 1 #, 2 # Building	K04+286～K04+500	10	Right	House	Outdoor 0.5m	70.8	63.0	44.4	/	/	/	2.4				
38	Sunshine Holiday district, 1 #, 2 # Building	K04+286～K04+500	10	Right	House	Indoor	70.8	63.0	44.4	0.8	3.8	/	2.4				
38	Sunshine Holiday district Building 3# ~ 9 #	K04+286～K04+500	30	Right	House	Outdoor 0.5m	65.4	63.2	/	/	/	/	/				
39	Nanyang Road, No. 111 Courtyard	K04+529～K04+558	6	Left	House	Outdoor 0.5m	72.0	63.2	45.5	2.0	5.0	0.5	3.5	Steel springs, floating slab,or The	K4+479 ～ K4+608	129	193.5

39	Nanyang Road, No. 111 Courtyard	K04+529～K04+558	6	Left	House	Indoor	72.0	63.3	45.5	/	/	0.5	3.5	same level of vibration reduction measures			
39	Fun district, Southern District, fun district building 46, 61	K04+560～K04+600	36	Left	House	Outdoor 0.5m	64.1	63.5	/	/	/	/	/				
40	Xinyuan Garden 3 #, 4 #	K04+620～K04+700	52	Left	House	Outdoor 0.5m	61.2	63.6	/	/	/	/	/				
41	Nanyang Road, No. 97 Courtyard (Henan Engineering College family member courtyard), 1 #, 4 #, 5 # Building	K04+720～K04+900	16	Left	House	Outdoor 0.5m	72.3	63.6	/	/	0.3	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K4+670 ～ K4+879	209	209
42	Henan Engineering college family member courtyard's five buildings	K04+720～K04+900	34	Left	House	Outdoor 0.5m	68.2	63.7	/	/	1.2	/	/				
43	China Railway Bridge Bureau family member courtyard 1 #	K04+929～K05+010	8	Left	House	Outdoor 0.5m	73.4	63.8	46.9	/	1.4	1.9	4.9	Steel springs, floating slab,or The same level of vibration reduction measures	K4+879 ～ K5+060	181	271.5
43	China Railway Bridge Bureau family member courtyard 1 #	K04+929～K05+010	8	Left	House	Indoor	73.4	63.8	46.9	/	1.4	1.9	4.9				
44	Home world community 1 #, 2 # Building	K05+024～K05+105	27	Left	House	Outdoor 0.5m	66.3	63.8	/	/	/	/	/				
45	Zhengzhou Boiler Factory family member courtyard 1 #, 2 #	K05+116～K05+247	11	Left	House	Outdoor 0.5m	72.7	63.8	/	/	0.7	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K5+066 ～ K5+218	152	152
45	Zhengzhou Boiler Factory, family member courtyard 3 # - 8 #	K05+116～K05+247	27	Left	House	Outdoor 0.5m	69.4	63.9	/	/	/	/	/				
46	Zhengrong Group Limited family member courtyard, 3 #, 6 # building	K05+268～K05+318	8	Left	House	Outdoor 0.5m	73.2	63.9	46.8	/	1.2	1.8	4.8	Steel springs, floating slab,or The same level of vibration reduction measures	K5+218 ～ K5+368	150	225
46	Zhengrong Group Limited family member courtyard,	K05+268～K05+318	8	Left	House	Indoor	73.2	64.2	46.8	3.2	6.2	1.8	4.8				

	3 #, 6 # building																
47	Home world community 1 # Building	K05+328～K05+390	13	Left	House	Outdoor 0.5m	72.4	64.2	/	/	0.4	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K5+368 ～ K5+740	372	372
47	Home world community 3 #, 2 # Building	K05+328～K05+390	33	Left	House	Outdoor 0.5m	68.3	64.3	/	/	/	/	/				
48	Old meat processing factory family member courtyard, 1 #, 3 #, 5 # Building	K05+392～K05+456	12	Left	House	Outdoor 0.5m	73.4	64.5	/	/	1.4	/	/				
49	Nanyang Road 68 homes, 1 #, 2 #, 3 #, 10 #, 41 # Building	K05+480～K05+679	12	Left	House	Outdoor 0.5m	70.4	64.6	/	0.4	3.4	/	/				
50	Fu Tian Lijing Garden District, 39 #, 40 # Building	K04+585～K04+774	17	Right	House	Outdoor 0.5m	66.8	64.6	/	/	/	/	/				
51	Mold factory family member courtyard 1 # building	K04+785～K04+833	12	Right	House	Outdoor 0.5m	73.4	64.7	/	3.4	6.4	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K4+735 ～ K5+075	340	340
52	Vision garden, 1 # building	K04+845～K04+900	14	Right	House	Outdoor 0.5m	72.5	64.8	/	/	0.5	/	/				
53	Nanyang Road, No. 239 Courtyard	K04+937～K05+025	14	Right	House	Outdoor 0.5m	72.1	64.8	/	/	0.1	/	/				
53	Mineral Homeworld 2 # ~ 5 #	K04+937～K05+025	37	Right	House	Outdoor 0.5m	67.5	65.0	/	/	/	/	/				
54	Nanyang Road, No. 244 Courtyard # 1 (aquaculture company family member courtyard)	K05+325～K05+349	16	Right	House	Outdoor 0.5m	71.8	65.0	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K5+275 ～ K5+427	152	152
55	Ronghua community, 1 # Building	K05+390～K05+441	12	Right	House	Outdoor 0.5m	73.3	65.1	/	3.3	6.3	/	/				
56	Nanyang Road 253 (food company meat branch family member building) 1 #, 3 #	K05+477～K05+520	11	Right	House	Outdoor 0.5m	74.2	65.1	/	4.2	7.2	/	/	Steel springs, floating slab,or The same level of vibration reduction measures	K5+427 ～ K5+570	143	214.5

56	Residential Community of Meat Product Branch of Food Company	K05+570～K05+700	40	Right	House	Outdoor 0.5m	63.4	65.2	/	/	/	/	/				
57	Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	K05+790～K05+890	10	Left	House	Outdoor 0.5m	70.9	65.2	44.5	/	/	/	2.5	Steel springs, floating slab,or The same level of vibration reduction measures	K5+740 ～ K6+132	392	588
57	Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	K05+790～K05+890	10	Left	House	Indoor	70.9	65.2	44.5	/	/	/	2.5				
57	Zhengzhou ceramics factory family member courtyard, 2 #, 4 #, 5 #, 6 #	K05+790～K05+890	25	Left	House	Outdoor 0.5m	66.7	65.2	/	/	/	/	/				
58	Provincial Prospecting machinery factory family member courtyard 1 #, 5 #, 6 # building	K05+900～K05+965	12	Left	House	Outdoor 0.5m	74.6	65.2	/	/	2.6	/	/				
59	Henan Geology and Mineral Resources Building	K05+986～K06+032	22	Left	institution	Outdoor 0.5m	67.6	65.3	/	/	/	/	/				
60	Nanyang Road, No. 52 (Yuhua Wen Jinyuan), three buildings	K06+043～K06+082	13	Left	House	Outdoor 0.5m	74.4	65.4	/	/	2.4	/	/				
61	Sipo Road 9	K06+205～K06+234	12	Left	House	Outdoor 0.5m	70.6	65.5	/	0.6	3.6	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K6+132 ～ K6+467	335	335
62	Nantong district, (Sipo Road 7th courtyard) 1 #	K06+250～K06+350	34	Left	House	Outdoor 0.5m	68.7	65.5	/	/	/	/	/				
63	College family member courtyard 1 # 3 #	K06+364～K06+406	28	Left	House	Outdoor 0.5m	70.1	65.6	/	/	/	/	/				
64	Nanyang Road, No. 46）	K06+429～K06+500	11	Left	House	Outdoor 0.5m	69.3	65.6	/	/	/	/	/				
65	Nanyang Road, No. 41 courtyard, 5 # Building	K06+517～K06+548	9	Left	House	Outdoor 0.5m	74.0	65.6	47.6	4.0	7.0	2.6	5.6	Steel springs, floating slab,or The	K6+467 ～ K6+598	131	196.5

65	Nanyang Road, No. 41 courtyard, 5 # Building	K06+517～K06+548	9	Left	House	Indoor	74.0	65.6	47.6	/	2.0	2.6	5.6	same level of vibration reduction measures			
66	Taiji Kindergarten, Beijia Education	K06+550～K06+590	6	Left	School	Outdoor 0.5m	70.8	65.6	41.3	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K6+598 ～ K7+123	525	262.5
66	Taiji Kindergarten, Beijia Education	K06+550～K06+590	6	Left	School	Indoor	70.8	65.6	41.3	/	/	/	/				
67	Huafu Institute of Dermatology,	K06+613～K06+679	10	Left	institution	Outdoor 0.5m	73.8	65.6	47.3	/	1.8	2.3	5.3				
67	Huafu Institute of Dermatology,	K06+613～K06+679	10	Left	institution	Indoor	73.8	65.7	47.3	/	1.8	2.3	5.3				
68	City No. 71 high school	K06+690～K06+762	11	Left	School	Outdoor 0.5m	71.4	66.1	/	/	/	/	/				
69	The 2nd Hospital, Zhengzhou University	K06+825～K06+878	23	Left	Hospital	Outdoor 0.5m	69.8	66.1	/	/	/	/	/				
70	Zhengzhou Textile staff apartments, 29 #, 30 # Building	K06+900～K07+073	14	Left	House	Outdoor 0.5m	69.8	66.2	/	/	/	/	/				
71	Zhengzhou Textile staff apartments, 18 # to 20 # buildings	K07+000～K07+100	37	Left	House	Outdoor 0.5m	63.9	66.3	/	/	/	/	/				
72	Small Yuzhai (Nanyang Road courtyard 266--279)	K05+753～K06+085	15	Right	House	Outdoor 0.5m	69.5	66.3	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K5+703 ～ K6+050	347	173.5
73	Pearl Factory, family member courtyard, 1 #, 2 #, 3 # Building (Nanyang Road 275)	K06+100～K06+180	9	Right	House	Outdoor 0.5m	75.6	66.3	49.1	0.6	3.6	4.1	7.1	Steel springs, floating slab,or The same level of vibration reduction measures	K6+050 ～ K6+355	305	457.5
73	Pearl Factory, family member courtyard, 1 #, 2 #, 3 # Building (Nanyang Road 275)	K06+100～K06+180	9	Right	House	Indoor	75.6	66.4	49.1	0.6	3.6	4.1	7.1				

74	Nanyang Road, No. 283 Courtyard	K06+260～K06+305	13	Right	House	Outdoor 0.5m	74.4	66.4	/	4.4	7.4	/	/				
75	Municipal Corporation family member courtyard (Nanyang Road No. 289 courtyard), 1 #, 2 #, 3 #, 4 # Building	K06+455～K06+511	36	Right	House	Outdoor 0.5m	66.6	66.5	/	/	/	/	/				
76	Hengtian Heavy Industry Co., Ltd family area	K06+600～K06+975	14	Right	House	Outdoor 0.5m	72.4	66.5	/	/	0.4	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K6+598 ～ K7+170	572	286
77	Nanyang Road, No. 296 Courtyard, 1 #, 2 #, 3 #	K07+032～K07+168	15	Right	House	Outdoor 0.5m	67.7	66.5	/	/	0.7	/	/				
78	Zhengzhou Jianguo Medicine Institute	K07+280～K07+400	15	Left	Hospital	Outdoor 0.5m	69.7	66.5	/	/	/	/	/				
79	Nanyang Road branch of Shiyan Kindergarten, Zhengzhou	K07+280～K07+400	54	Left	School	室外 0.6m	61.5	66.6	/	/	/	/	/				
80	Buildings 6#, 5#, 4#, and Buildings 3# and 2# in the south of Community of Zhengzhou Textile Machinery Co., Ltd.	K07+214～K07+696	15	Left	House	Outdoor 0.5m	72.2	66.6	/	/	0.2	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K7+164 ～ K7+780	616	616
81	Hongyihua Hong Kong City	K07+770～K07+900	20	Left	House	Outdoor 0.5m	65.6	66.7	/	/	/	/	/				
82	Nanyang Road No. 12 courtyard, 1 #, 2 # Building	K07+900～K08+150	10	Left	House	Outdoor 0.5m	71.9	66.7	45.4	1.9	4.9	0.4	3.4	Steel springs, floating slab,or The same level of vibration reduction measures	K7+850 ～ K8+350	500	750
82	Nanyang Road No. 12 courtyard, 1 #, 2 # Building	K07+900～K08+150	10	Left	House	Indoor	69.4	66.8	42.9	/	/	/	0.9				
83	Jinshui District Police Fire Brigade	K07+970～K08+010	14	Left	institution	Outdoor 0.5m	68.6	66.8	/	/	/	/	/				
84	Nanyang Road No.	K08+110～K08+180	14	Left	House	Outdoor 0.5m	68.6	66.9	/	/	/	/	/				

	8courtyard,																
85	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)）	K08+190～K08+220	0	Left	House	Outdoor 0.5m	74.5	67.0	48.0	4.5	7.5	3.0	6.0				
85	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)）	K08+190～K08+220	0	Left	House	Indoor	74.5	67.0	48.0	/	2.5	3.0	6.0				
86	Zhengzhou City Library	K08+250～K08+300	5	Left	Library	Outdoor 0.5m	74.7	67.0	48.3	/	2.7	3.3	6.3				
86	Zhengzhou City Library	K08+250～K08+300	5	Left	Library	Indoor	74.7	67.1	48.3	/	2.7	3.3	6.3				
87	Garden community, (Nanyang Road 300) 5 # building	K07+220～K07+320	14	Right	House	Outdoor 0.5m	70.2	67.2	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K7+170 ～ K7+370	200	200
88	Zhongheng Garden	K07+420～K07+580	40	Right	House	Outdoor 0.5m	65.8	67.4	/	/	/	/	/				
89	Zhongheng	K07+710～K07+825	32	Right	House	Outdoor 0.5m	63.0	67.4	/	/	/	/	/				
90	Nanyang Road No. 309--314 courtyard,	K07+900～K08+020	8	Right	House	Outdoor 0.5m	72.0	67.4	45.5	/	/	0.5	3.5	Steel springs, floating slab,or The same level of vibration reduction measures	K7+780 ～ K8+070	290	435
90	Nanyang Road No. 309--314 courtyard,	K07+900～K08+020	8	Right	House	Indoor	72.0	67.4	45.5	/	/	0.5	3.5				
91	Zhongheng garden, 4 # to 10 #	K07+830～K07+950	27	Right	House	Outdoor 0.5m	68.0	67.5	/	/	/	/	/				
92	Qinghua Garden A, B, D, E Block	K08+136～K08+280	25	Right	House	Outdoor 0.5m	62.7	67.6	/	/	/	/	/				
93	Zhengzhou National Oil Reserve Depot, family member courtyard 1 # building	K08+290～K08+360	20	Right	House	Outdoor 0.5m	68.1	67.6	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K8+350 ～ K8+410	60	30
94	Jinshui Road, 11th courtyard, 1 # building	K08+485～K08+495	11	Left	House	Outdoor 0.5m	70.8	67.6	/	/	/	/	/	Flexible short sleeper and	K8+435 ～ K8+545	110	110

														monolithic track bedb,or The same level of vibration reduction measures			
95	Municipal Supply and Marketing Trading Corporation, family member courtyard, 1 #, 10 #, 11 # building	K08+985～K09+058	20	Left	House	Outdoor 0.5m	69.2	67.7	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K8+935 ～ K9+108	173	86.5
96	Minggong Road No. 67 courtyard, (Jinfeng Golden Coast International), 1 # Building	K09+158～K09+183	33	Left	House	Outdoor 0.5m	60.8	67.8	/	/	/	/	/				
97	Minggong Road, No. 139 Courtyard(Grain Bureau family member building)	K08+640～K08+690	6	Right	House	Outdoor 0.5m	72.6	67.8	46.1	/	0.6	1.1	4.1	Steel springs, floating slab,or The same level of vibration reduction measures	K8+590 ～ K9+150	560	840
97	Minggong Road, No. 139 Courtyard(Grain Bureau family member building)	K08+640～K08+690	6	Right	House	Indoor	72.6	67.8	46.1	/	0.6	1.1	4.1				
98	Minggong Road, No. 156 Courtyard, 1 #, 2 # Building	K08+920～K09+017	6	Right	House	Outdoor 0.5m	71.8	67.8	45.4	/	/	0.4	3.4				
98	Minggong Road, No. 156 Courtyard, 1 #, 2 # Building	K08+920～K09+017	6	Right	House	Indoor	71.8	67.8	45.4	/	/	0.4	3.4				
99	Jin Ming Yuan building and the building of South	K09+030～K09+100	4	Right	House	Outdoor 0.5m	72.0	67.9	44.6	/	0.0	/	2.6				
99	Jin Ming Yuan building and the building of South	K09+030～K09+100	4	Right	House	Indoor	72.0	67.9	44.6	/	0.0	/	2.6				
100	Huarun Yue House (under construction)	K09+245～K09+610	45	Left	House	Outdoor 0.5m	60.6	68.0	/	/	/	/	/				
101	Huigang New Town 1 #, 2 #, 3 # Building	K09+700～K09+860	0	Left	House	Outdoor 0.5m	70.4	68.0	40.9	/	/	/	/	Steel springs, floating slab,or The	K9+650 ～ K10+109	459	688.5

101	Huigang New Town 1 #, 2 #, 3 # Building	K09+700～K09+860	0	Left	House	Indoor	70.4	68.2	40.9	/	/	/	/	same level of vibration reduction measures			
102	Small building mosques	K10+000～K10+059	6	Left	Religion	Outdoor 0.5m	68.2	68.2	41.7	/	/	/	/				
102	Small building mosques	K10+000～K10+059	6	Left	Religion	Indoor	68.2	68.4	41.7	/	/	/	/				
103	West Cai district, (Ming Gong Road No. 240 Courtyard) 1 #	K09+275～K09+315	0	Right	House	Outdoor 0.5m	74.8	68.4	48.4	/	2.8	3.4	6.4	Steel springs, floating slab,or The same level of vibration reduction measures	K9+225 ～ K9+769	544	816
103	West Cai district, (Ming Gong Road No. 240 Courtyard) 1 #	K09+275～K09+315	0	Right	House	Indoor	74.8	68.4	48.4	/	2.8	3.4	6.4				
103	West Cai district, (Ming Gong Road, No. 240 Courtyard), 2 #, 3 # Building	K09+275～K09+315	16	Right	House	Outdoor 0.5m	69.3	68.4	/	/	/	/	/				
104	Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)	K09+325～K09+410	9	Right	House	Outdoor 0.5m	71.4	68.4	44.9	/	/	/	2.9				
104	Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)	K09+325～K09+410	9	Right	House	Indoor	71.4	68.4	44.9	/	/	/	2.9				
106	Ming Gong Road No. 272, (Rural Credit Cooperative Union, family member building)	K09+545～K09+608	0	Right	House	Outdoor 0.5m	75.6	68.6	49.2	0.6	3.6	4.2	7.2				
106	Ming Gong Road No. 272, (Rural Credit Cooperative Union, family member building)	K09+545～K09+608	0	Right	House	Indoor	75.6	68.7	49.2	0.6	3.6	4.2	7.2				
107	Yalong district, 17 # Building	K09+638～K09+674	0	Right	House	Outdoor 0.5m	75.1	68.8	48.7	0.1	3.1	3.7	6.7				
107	Yalong district, 17 # Building	K09+638～K09+674	0	Right	House	Indoor	75.1	68.8	48.7	0.1	3.1	3.7	6.7				

108	Yalong districtl 16 # Building, 1 #, 2 # Building	K09+638～K09+674	16	Right	House	Outdoor 0.5m	70.7	68.8	/	/	/	/	/				
109	Catholic Church	K09+687～K09+719	2	Right	Religion	Outdoor 0.5m	74.6	68.9	48.1	/	2.6	3.1	6.1				
109	Catholic Church	K09+687～K09+719	2	Right	Religion	Indoor	74.6	68.9	48.1	/	2.6	3.1	6.1				
110	Jiefang Road Elementary School	K09+719～K09+750	42	Right	School	Outdoor 0.5m	65.1	69.0	/	/	/	/	/				
111	Shangfuxin Village House 1#	K10+510～K10+614	6	Left	House	Outdoor 0.5m	68.6	69.0	39.1	/	/	/	/	Steel springs, floating slab,or The same level of vibration reduction measures	K10+460 ～ K10+664	204	306
111	Shangfuxin Village House 1#	K10+510～K10+614	6	Left	House	Indoor	68.6	69.0	39.1	/	/	/	/				
111	Shangfuxin Village 2 #, 3#	K10+510～K10+614	41	Left	House	Outdoor 0.5m	61.3	69.0	/	/	/	/	/				
112	Fuchun Apartment 1 # building	K10+625～K10+779	15	Left	House	Outdoor 0.5m	70.0	69.0	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K10+664 ～ K10+829	165	82.5
113	Huating Apartments, Dehua Street community 1 #, 2 # Building	K10+528～K10+614	15	Right	House	Outdoor 0.5m	66.8	69.0	/	/	/	/	/				
114	Jinding Huafu House, front 1 #	K10+630～K10+775	13	Right	House	Outdoor 0.5m	66.0	69.0	/	/	/	/	/				
114	Jinding Huafu House, rear	K10+630～K10+775	8	Right	House	Outdoor 0.5m	71.4	69.1	45.0	/	/	/	3.0	Steel springs, floating slab,or The same level of vibration reduction measures	K10+580 ～ K10+825	245	367.5
114	Jinding Huafu House, rear	K10+630～K10+775	8	Right	House	Indoor	71.4	69.1	45.0	/	/	/	3.0				
115	Modern XingYuan 1 #	K10+800～K10+873	23	Right	House	Outdoor 0.5m	63.2	69.2	/	/	/	/	/				
116	Hongxin Jia Yuan 1 # building	K10+915～K10+990	14	Left	House	Outdoor 0.5m	67.8	69.2	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate	K10+865 ～ K11+020	155	77.5

														shock-absorbing measures.			
117	Xidan apartments, two buildings	K11+070～K11+151	8	Left	House	Outdoor 0.5m	69.3	69.3	41.9	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K11+020 ～ K11+201	181	181
117	Xidan apartments, two buildings	K11+070～K11+151	8	Left	House	Indoor	73.4	69.3	46.0	/	1.4	1.0	4.0				
118	West Street, No. 231	K11+250～K11+286	13	Left	House	Outdoor 0.5m	69.5	69.3	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K11+201 ～ K11+400	199	99.5
119	Zhongkai City Lights Clove Court, 1 #, Building	K11+380～K11+446	12	Left	House	Outdoor 0.5m	70.0	69.3	/	/	/	/	/				
120	Fuhua Building	K11+450～K11+550	8	Left	House	Outdoor 0.5m	71.7	69.3	42.1	/	/	/	0.1	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K11+400 ～ K11+600	200	200
120	Fuhua Building	K11+450～K11+550	8	Left	House	Indoor	72.2	69.4	42.5	/	0.2	/	0.5				
121	Zi Yan Huating 1 #, 2 # Building	K11+821～K11+917	23	Left	House	Outdoor 0.5m	63.2	69.4	/	/	/	/	/				
122	Ginza International	K10+956～K11+025	14	Right	House	Outdoor 0.5m	65.9	69.5	/	/	/	/	/				
123	233 West Main Street (the third secondary school, family member building)	K11+038～K11+100	11	Right	House	Outdoor 0.5m	66.8	69.5	/	/	/	/	/				
124	218 West Main Street	K11+168～K11+221	20	Right	House	Outdoor 0.5m	65.7	69.6	/	/	/	/	/				
125	Sun Moon Star City, 1 # building	K11+230～K11+300	14	Right	House	Outdoor 0.5m	65.2	69.6	/	/	/	/	/				
126	Zhongkai City Lights Clove Court, 1 #, 2 # Building	K11+328～K11+450	15	Right	House	Outdoor 0.5m	67.3	69.6	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent	K11+278 ～ K11+716	438	219
127	Tangzi Lane (Bo'ai Street	K11+328～K11+666	38	Right	House	Outdoor 0.5m	63.7	69.6	/	/	/	/	/				

	Community)													moderate shock-absorbing measures.			
128	Changcheng City in City	K11+460～K11+666	13	Right	House	Outdoor 0.5m	67.6	69.7	/	/	/	/	/				
129	Yuhong Garden, 1 #, 2 #, 3 # Buildings	K11+675～K11+800	25	Right	House	Outdoor 0.5m	62.6	69.7	/	/	/	/	/				
130	Municipal Guancheng State Taxation office services hall	K11+929～K11+978	33	Left	institution	Outdoor 0.5m	62.8	69.7	/	/	/	/	/				
131	First People's Courtyard of Zhengzhou	K11+990～K12+055	22	Left	Hospital	Outdoor 0.5m	65.5	69.8	/	/	/	/	/		/ /		
132	Guancheng District Education Center	K12+133～K12+211	21	Left	institution	Outdoor 0.5m	65.9	70.1	/	/	/	/	/				
133	Zhigong Road, Building 1	K12+230～K12+335	18	Left	House	Outdoor 0.5m	71.2	70.1	/	/	/	/	/	Steel springs, floating slab,or The same level of vibration reduction measures	K12+180 ～ K12+450	270	405
134	Residential community of Zhengzhou Electric Power College	K12+400～K12+500	43	Left	House	Outdoor 0.5m	65.6	70.2	/	/	/	/	/				
135	220 East Main Street	K11+978～K12+105	10	Right	House	Outdoor 0.5m	69.1	70.2	42.6	/	/	/	0.6	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K11+928 ～ K12+083	155	77.5
135	220 East Main Street	K11+978～K12+105	10	Right	House	Indoor	69.1	70.2	42.6	/	/	/	0.6				
136	Mall Village, (248 East Main Street courtyard)	K12+000～K12+500	28	Right	House	Outdoor 0.5m	68.5	70.2	/	/	/	/	/				
137	Zhongkai City Lights Guangjingcui Court, 1 #, 2 # Building	K12+133～K12+366	8	Right	House	Outdoor 0.5m	72.3	70.3	44.8	/	0.3	/	2.8	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K12+083 ～ K12+450	367	367
137	Zhongkai City Lights Guangjingcui Court, 1 #, 2 # Building	K12+133～K12+366	8	Right	House	Indoor	72.3	70.4	44.8	/	0.3	/	2.8				
138	East Main Street, No. 1	K12+550～K12+600	38	Right	House	Outdoor 0.5m	61.1	70.4	/	/	/	/	/				

	Court, Building 2															
139	Dolidongguan96,1#	K12+716～K12+830	11	Left	House	Outdoor 0.5m	68.6	70.4	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K12+666 ～ K12+880	214	107
139	Dolidongguan96,2#	K12+716～K12+830	32	Left	House	Outdoor 0.5m	64.3	70.4	/	/	/	/	/				
140	Knitting mill family member courtyard, 1 # building	K12+992～K13+072	12	Left	House	Outdoor 0.5m	72.5	70.4	/	/	0.5	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K12+942 ～ K13+458	516	516
140	Knitting mill family member courtyard, 2 # Building	K12+992～K13+072	32	Left	House	Outdoor 0.5m	68.4	70.4	/	/	/	/	/				
141	Yutong Garden Building 1#	K13+076～K13+226	12	Left	House	Outdoor 0.5m	73.1	70.7	/	/	1.1	/	/				
141	Yutong Garden Building 2#	K13+076～K13+226	36	Left	House	Outdoor 0.5m	67.8	70.8	/	/	/	/	/				
142	Municipal underwear factory family member courtyard, 1 #, 2 #, 3 # Building	K13+230～K13+408	14	Left	House	Outdoor 0.5m	73.4	70.8	/	/	1.4	/	/				
142	Municipal underwear factory, family member courtyard, 5 #, 4 # Building	K13+230～K13+408	34	Left	House	Outdoor 0.5m	68.5	70.8	/	/	/	/	/				
143	Zheng Bian Road, Building 60,	K13+414～K13+473	28	Left	House	Outdoor 0.5m	65.8	70.8	/	/	/	/	/				
144	Zheng Bian Road, Building 23,	K12+820～K12+857	7	Right	House	Outdoor 0.5m	67.2	71.0	39.7	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K12+770 ～ K12+907	137	68.5
144	Zheng Bian Road, Building 23,	K12+820～K12+857	7	Right	House	Indoor	67.2	71.0	39.7	/	/	/	/				
145	Great Wall Cambridge	K13+038～K13+091	21	Right	House	Outdoor 0.5m	66.9	71.2	/	/	/	/	/				

	Garden																
146	Cargo Terminal No. 23 North Street Courtyard, 1 #, (Phoenix Road Community)	K13+158～K13+180	18	Right	House	Outdoor 0.5m	70.0	71.4	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K13+108 ～ K13+282	174	87
146	Cargo Terminal No. 23 North Street Courtyard, 3 #, (Phoenix Road Community)	K13+180～K13+225	18	Right	House	Outdoor 0.5m	68.0	71.4	/	/	/	/	/				
147	Langui district 1 # Building	K13+230～K13+325	16	Right	House	Outdoor 0.5m	68.6	71.4	/	/	/	/	/				
148	Boai ENT Hospital of Zhengzhou	K13+332～K13+390	9	Right	Hospital	Outdoor 0.5m	72.6	71.4	45.2	/	0.6	0.2	3.2	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K13+282 ～ K13+700	418	418
148	Boai ENT Hospital of Zhengzhou	K13+332～K13+390	9	Right	Hospital	Indoor	72.6	71.5	45.2	/	0.6	0.2	3.2				
149	Zheng Bian Road, No. 49, family member courtyard, 1 # Building	K13+398～K13+430	13	Right	House	Outdoor 0.5m	73.7	71.5	/	/	1.7	/	/				
150	Dongming Road 30 Courtyard, (electric power district), 1 #, 2 # Building	K13+512～K13+650	9	Right	House	Outdoor 0.5m	73.2	71.6	45.7	/	1.2	0.7	3.7				
150	Dongming Road 30 courtyard (electric power district), 3 #, 4 # Building	K13+512～K13+650	9	Right	House	Indoor	73.2	71.6	45.7	/	1.2	0.7	3.7				
150	Zhengzhou Huimin High School	K13+512～K13+650	45	Right	House	Outdoor 0.5m	64.5	71.6	/	/	/	/	/				
151	Zhengzhou City Public Security Bureau Police Detachment	K14+686～K14+769	47	Left	School	Outdoor 0.5m	60.1	71.7	/	/	/	/	/				
152	Henan Provincial People's Procuratorate	K14+793～K14+942	27	Left	institution	Outdoor 0.5m	62.2	71.7	/	/	/	/	/				
153	Dongming Road 30 Courtyard, (electric power district), 1 #, 2 # Building	K14+942～K15+052	26	Left	institution	Outdoor 0.5m	66.2	71.7	/	/	/	/	/				
154	Yingxie Garden 1 #, 2 #	K15+194～K15+485	55	Left	House	Outdoor 0.5m	60.6	71.8	/	/	/	/	/				

	Building																
155	District under construction 1 #, 2 # Building	K16+878～K17+052	54	Left	House	Outdoor 0.5m	59.4	71.8	/	/	/	/	/				
156	Henan Zhongdu Dermatology Hospital	K17+147～K17+199	24	Left	Hospital	Outdoor 0.5m	66.2	72.1	/	/	/	/	/				
157	Guancheng Traditional Chinese Medicine Hospital	K17+206～K17+266	10	Left	Hospital	Outdoor 0.5m	71.0	72.1	43.6	/	/	/	1.6	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K17+156 ～ K17+316	160	160
157	Guancheng Traditional Chinese Medicine Hospital	K17+206～K17+266	10	Left	Hospital	Indoor	71.0	72.6	43.6	/	/	/	1.6				
158	Caixin Triana district, 1 #, 2 #, 3 #, 4 # Building	K17+390～K17+766	51	Right	House	Outdoor 0.5m	59.9	72.6	/	/	/	/	/				
159	Zhengshang Eastern Harbour, 1 #, 2 # Building	K19+152～K19+300	56	Left	House	Outdoor 0.5m	60.7	72.6	/	/	/	/	/				
160	Sinosun New World	K20+320～K20+680	60	Left	House	室外 0.6m	60.7	72.6	/	/	/	/	/				
161	Dongyinggang Village	K24+300～K24+800	0	Left and Right	House	Outdoor 0.5m	80.7	77.7	56.2	5.7	8.7	11.2	14.2	Steel springs, floating slab,or The same level of vibration reduction measures	K24+250 ～ K24+850	1200	1800
161	Dongyinggang Village	K24+300～K24+800	0	Left and Right	House	Indoor	80.7	77.7	56.2	5.7	8.7	11.2	14.2				

Table 5.4-21 List for vibration control measures for cultural relics sensitive spots

No.	Target to be protected	Mileage	District where it is located	Position relative to the line	Line type	Current value of vibration speed (mm/s)	Predicted value of vibration speed (mm/s)	Exceedance	Measures	Extend 50 from both ends		Length (m)	Investment (×10^4RMB)
										Start	end		
1	Shanhaimomuduha Tomb	K09+900～K09+930	Jinshui District	Left	Underground	0.08	2.019858	1.57	Steel springs, floating slab,or The same level of vibration reduction measures	9850	9980	130	195
2	2/7 Strike Monument	K10+317～K10+348	Erqi district	Right	Underground	0.09	1.333207	1.18		10267	10398	131	196.5
3	Zhengzhou Confucius Temple	K12+340～K12+400	Guancheng Hui-ethnic district	Left	Underground	0.08	1.226718	0.96		12290	12450	160	240
4	Shang-dynasty relic, Zhegnzhou	K12+500～K12+580	Ditto	Both left and right	Underground	0.08	/	0.00		12450	12630	180	270

(III) Reasonably plan the layout

For reasonable planning of land use along the line, predict the vibration pollution during operation period of rail transit; suggest as follows: According to the regulations in Subway Design Specification (GB50157-2003) and vibration protection distance of this report, the protection distance of buildings at both sides of underground line in areas of “mixing area, CBD”, “industrial concentration area” and “both sides of traffic arterial road” specified in GB10070-88 Standard of Vibration in Urban Area Environment is 25m; the protection distance of buildings at both sides of underground line in “residential and culture education area” area is 38m.

Scientifically plan the layout of buildings to arrange the first row buildings near the vibration sources as vibration non-sensitive building such as commercial and office building. In combination with the modification of old town, firstly demolish the residential houses near the vibration source, and, in combination with the greening design and re-arrangement of buildings, reserve the vibration prevention distance for newly developed buildings so as to ensure the impact on sensitive buildings within allowable range of standard.

5.4.4 Assessment summary

(1) Assessment and analysis of environment vibration prediction results

After project is put into operation, the vibration value VLz10 of 161 environment sensitive spots along the line is 54.6~77.7dB at daytime with 0~ 25.4 dB increment than that at present, and 0.3~26.9 dB increment at nighttime. The environment vibration of 6 sensitive spots exceeds the standard requirements, in which there are 1 sensitive spots with the vibration level exceeding the standard value at daytime with the over-limit amount of 0～2.7dB, 6 sensitive spots with then noise level exceeding the standard value at nighttime with the over-limit amount of 0.1～5.7dB; and the over-limit rate is up to3.7％.

(2) Prediction results and analysis of vibration speed

The structure maximum speed response values of two cultural relics protection sites in this project as Shanhaimomuduha Tomb ,Zhengzhou Memorial Tower for February 7th Strike, Zhengzhou Shang Dynasty Relics and Zhengzhou Confucius Temple along the line exceed the standard requirements and the over-limit amounts are separately of 1.57mm/s、1.18mm/s、0.96 mm/s.

(3) Prediction results and analysis of secondary structure noise

The indoor secondary structure noises in 38 sensitive buildings within 10m range from right above of project underground section to outer rail centerline are in the range of 38.7~56.2dB dB dB. In reference to standard reference limit of “42dB(A)”, there are total 32sensitive spots affected by secondary structure noise due to subway vibration with the over-limit amount of 0.1~14.2dB dB.

5.4.5 Suggestion of pollution control measures

(1) In the vehicle model selection of this project, besides the dynamic and mechanical performance, it also focuses on the vibration protection measures and vibration indexes. It is preferable to select the vehicle with low noise and vibration values and quality structures.

(2) The 60kg/m steel rail seamless line for project design has positive effect on prevention of vibration pollution.

(3) The operation unit shall intensify the maintenance and service of wheels and rails, regularly lathe the wheel and grind the steel rail, and apply oil on small radius curve section for protection so as to ensure good operation conditions and reduce the additional vibration.

(4) In this project, there are totally 161 susceptible places to installed with GJ-III track vibration damper fasteners or equivalent moderate shock-absorbing measures in the length of 5239m (dual lines), elastic supporting one-piece track bed or equivalent high-level shock-absorbing measure in the length of 8753m (dual lines), and steel-spring floating-plate track bed in the length of 7182m (dual lines), so requiring investment of RMB 212,710,000.

(5) During subway operation period, it is necessary to prepare complete monitoring program for culture relic protection unit, timely feed back the monitoring information. If any problem is found, timely take measures to ensure the safety of culture relics.

(6) To prevent the impact from subway vibration, according to the regulations in Subway Design Specification (GB50157-2003) and vibration protection distance in this report, the protection distance of buildings at both sides of underground line in “mixing area, CBD”, “industrial concentration area” and “both sides of traffic arterial road” area specified in GB10070-88 Standard of Vibration in Urban Area Environment is 25m; the protection distance of buildings at both sides of underground line in “residential and culture education area” is 38m.

5.4.6 Summary of vibration environment impact assessment

The design unit has considered the vibration pollution control issues in project design. This report, in combination with project features and ambient quality present status, puts forth purposeful prevention measures and suggestions from aspects of vehicle model selection, urban planning and management, project operation and maintenance, line and track structure vibration reduction. As long as these measures and suggestions have been completely and carefully implemented, the impact of vibration environment along the line of this project can be controlled within national and Zhengzhou municipal specifications and standards.

5.5 Water environment impact predictive assessment and measures of water environment

5.5.1 Surface water predictive assessment

5.5.1.1 Water pollution source

(1) Water pollution source during construction period

The waste water generated in construction period of this project mainly come from: muddy water from construction works excavation, drilling, construction of continuous diaphragm maintenance structure and shield, washing water of construction machinery and transport vehicles, domestic sewage from construction staff, the surface runoff sewage from flushing capping mass and construction silt and etc.

According to survey of construction waste water drainage conditions of rail transit, there are normally about 100 persons in each station (section); calculated with the water consumption of 0.04m3 per person per day, the discharge volume of domestic sewage for construction staff in each section is about 4m3/d. The main pollutants in sewage include COD, animal and vegetable oil, SS, ammonia nitrogen and etc. The construction also discharges the structure curing drainage, the construction site flushing drainage. The COD content in domestic sewage of construction wastewater is high and up to 200 - 300mg/L, and the SS content in washing drainage of construction site is high and up to 150 - 200mg/L.

(2) Water pollution source during operation period

The sewage during operation period of this project mainly comes from the domestic sewage from the stations along the line, and the oily sewage, washing sewage and domestic sewage generated from car depot and integrated base.

A Station Drainage

This project will have a total of 21 stations, all underground stations, with a total amount of wastewater discharge beng 771.4m 3 / d.

The sewage in the stations mainly includes the fecal sewage in toilets of stations, domestic sewage of staff and the washing sewage of station facilities, of which the water quality of this sewage is simple of domestic sewage. The station sewage is drained into municipal sewage pipeline network and then into local sewage treatment plant for treatment.

B. car depot and integrated base

The production waste water of Hongjiaozhou car depot and integrated base mainly includes the oily wastewater from vehicle inspection and washing, and vehicle washing sewage, in which the main pollutants are of petroleum type products, COD, BOD5, LAS and etc. in addition, it also includes staff office and domestic sewage

such as bathing pool bath water, canteen washing water, cleaning drainage and toilet washing water, in which the main pollutants include BOD5, COD, ammonia nitrogen, animal and vegetable oil.

For the water use for the car depot and parking lot of Line 3 of Zhengzhou Metro, see Table 5.5-1.

5.5.1.2 Assessment method

The assessment, based on engineering design and in reference to existing study results and analog data, predicts the water quality and water quantity of various pollution sources and analyzes the water quality standard-reaching conditions with standard index method. The expression is as follow:

$S_{i,j}=(C_{i,j}/C_{o,i})$

Where:

$C_{i,j}$——Emission concentration of ith pollutant of jth pollution source (mg/L);

$C_{o,i}$——Assessment standard of ith pollutant (mg/L);

$S_{i,j}$——Standard index at jth point of single water quality parameter i.

The standard index of pH is as follow:

$S_{pH,j}=(7.0 - pH_j) /(7.0 - pH_{sd})$ $pH_j \leq 7.0$

$S_{pH,j}=(pH_j - 7.0) /(pH_{su} - 7.0)$ $pH_j > 7.0$

Where:

pH_j——pH value of jth pollution source;

pH_{sd}——Lower limit of pH value specified in standard;

pH_{su}——Upper limit of pH value specified in standard;

$S_{pH,j}$——Standard index of pH value of jth pollution source.

5.5.1.3 Analysis of water environment impact during construction period

The project generates large amount of sediments and dusts during construction period. If not cleaned completely, the residual part will be flushed into sewer with the drainage or rain at construction site. The waste water will increase the sediment contents in surface waters near the construction site and municipal drain pipe, and even lead to sewer silting up, and therefore impact the normal function of municipal drain pipe network and lead to unsmooth rainy season drainage; when there is no municipal sewer line at construction site, the sewage automatically flows to nearby surface waters so that it leads to increase of SS content in received waters and pollution of ambient environment.

The construction sites in urban area will temporarily rent the houses and the domestic sewage and production swage are drained into urban sewer line network and surface waters. If the construction period drainage facilities are not complete, the domestic sewage and production sewage are drained into the sewage receipt waters, which impose certain adverse impact on water quality in waters and living environment of aquatic animals and plants.

According to the survey of construction sewage drainage of rail transit line, there are normally about 100 construction workers in each section for road construction. Calculated with the water consumption of 0.04m3 per person per day, the domestic sewage drainage of construction staff in each section is about 4m3/d. The main pollutants in sewage are mainly of COD, animal and vegetation oil, SS and ammonia nitrogen The construction also discharges the structure curing drainage, the construction site flushing drainage and equipment cooling drainage. The COD content in domestic sewage of construction wastewater is high and up to 200 - 300mg/L, and the SS content in washing drainage of construction site is high and up to 150 - 200mg/L.

Except Hanghai East Road car depot and Boxue Road Station, the municipal drainage pipeline network along the line of this project has been completed; the waste water can be drained into municipal sewage pipeline network or rainwater pipe network during construction period, and it will execute the limits in level 3 standard in Integrated Wastewater Discharge Standard (GB8978-1996). For the areas where the municipal sewage pipe network has not been completed, set temporary toilet pit to collect the domestic sewage, and periodically clear to nearby farm without draining out; the construction waste water will be recycled after sedimentation and not drained out.

Table 5.5-1 Table for drainage prediction of construction wastewater quality

Wastewater type	Item	COD	Petroleum product	SS
domestic sewage	Pollutant concentration (mg/L)	200 - 300	<5.0	20 - 80
road curing drainage	Pollutant concentration (mg/L)	20 - 30	/	50 - 80
construction site washing drainage	Pollutant concentration (mg/L)	50 - 80	1.0 - 2.0	150 - 200

Table 5.5-2 Prediction of construction wastewater drainage in each section

Wastewater type	Drainage amount (m3/d)	Item	COD	Petroleum product	SS
domestic sewage	4.8	Pollutant concentration (mg/L)	200 - 300	<5.0	20 - 80
		standard-reaching state	standard-reaching	standard-reaching	standard-reaching
road curing drainage	2	Pollutant concentration (mg/L)	20 - 30	/	50 - 80
		standard-reaching state	standard-reaching	/	standard-reaching

construction site washing drainage	5	Pollutant concentration (mg/L)	50 - 80	1.0 - 2.0	150 - 200
		standard-reaching state	standard-reaching	standard-reaching	standard-reaching
Class 3 limit in integrated Wastewater Discharge Standard (GB8978-1996) (mg/L)			500	30	400

The drinking water sources in Zhengzhou are separately located at north and south of urban area; the north water sources are located at the south bank of Yellow River, separately of Jiuwuyuan water source and Beijian water source; the south water sources are located at both sides of Zhengzhou-Xi'an railway, separately of Changzhuang reservoir and Jiangang reservoir; moreover, the middle main canal of South-to-North Water Diversion Project passes through the southwest out of the central urban area. There is no centralized drinking water source along the construction line so that it will not impose impact on the earth surface water sources.

The construction wastewater is discharged into the settlement pond at site via the pipeline laid in construction site, and then returned to site washing dust suppression and washing vehicles without draining out; the muddy water generated from shield construction will be fully returned through muddy water separation system without draining out. The muddy are dried and then transported out with engineering waste slag to designated place for uniform treatment by Zhengzhou municipal construction waster management department, and will not pollute the water environment.

5.5.1.4 Predictive assessment of water environment during operation period

(1) Assessment job contents

According to assessment job class, define the job contents of surface water environment impact assessment as follows:

A. Determine the sewage flow according to design data and project analysis; select the car dept with same operation properties and similar scale as those of car depot and the parking lots of this project for survey and analog monitoring, predict the sewage quality and assess in reference to assessment standard;

B. The sewage of each stations shall be evaluated in reference to average water quality of domestic sewage of similar type station and assessment standard according to the sewage amount determined in design;

C. Evaluate the designed sewage treatment faculties and provide assessment conclusion and assessment suggestion according to pollution source prediction results;

D. Calculate the discharge amount of main pollutants,

(2) Environment impact assessment of sewage discharge of car depot &the parking lots

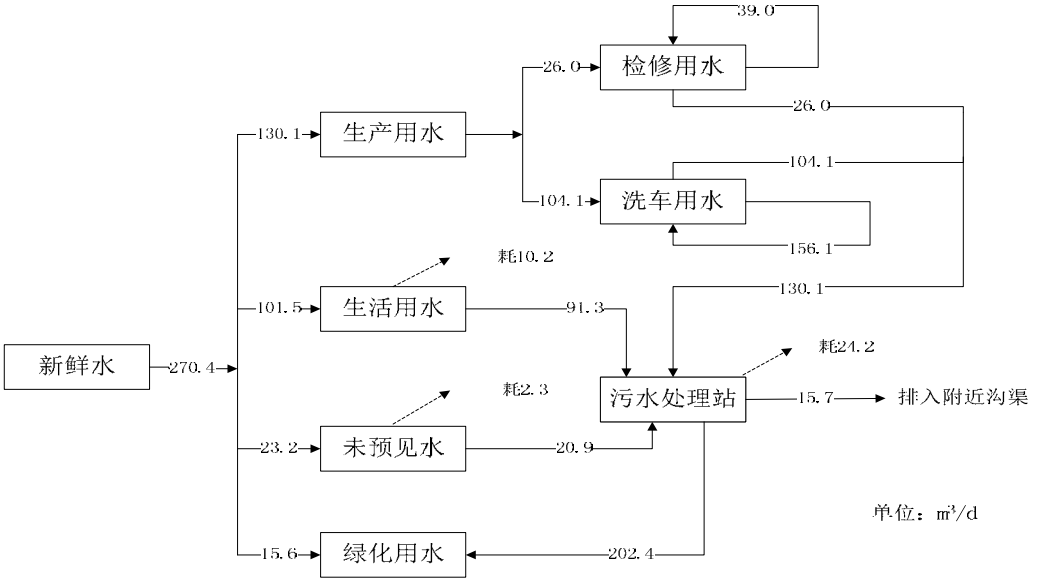
The car depot is near Hanghai East Road. The parking depot is at south bank of Jialu River and north of Xinliu Road Station, and equipped with vehicle operation overhauling facilities and general material warehouse. It is responsible for the parking,

train technical inspection and routine maintenance and service works such as cleaning and wiping for the vehicles in the line. The drained sewage is mainly of overhauling oily sewage, washing waste water and domestic sewage of working staff. The overhauling oily sewage and washing waste water are of production sewage and the main pollutants are of petroleum type; the domestic sewage is mainly of COD, BOD5, ammonia nitrogen and etc. In the design, the overhauling sewage is treated by the grease trap and the car washing sewage is neutralized, deposited and filtered with the car washing auxiliary facilities before recycling. The normal domestic sewage is treated with the septic tank. The sewages are finally discharged into the municipal drainage pipe network and then the municipal sewage treatment plant for centralized treatment.

(I) Prediction of water quality and water volume

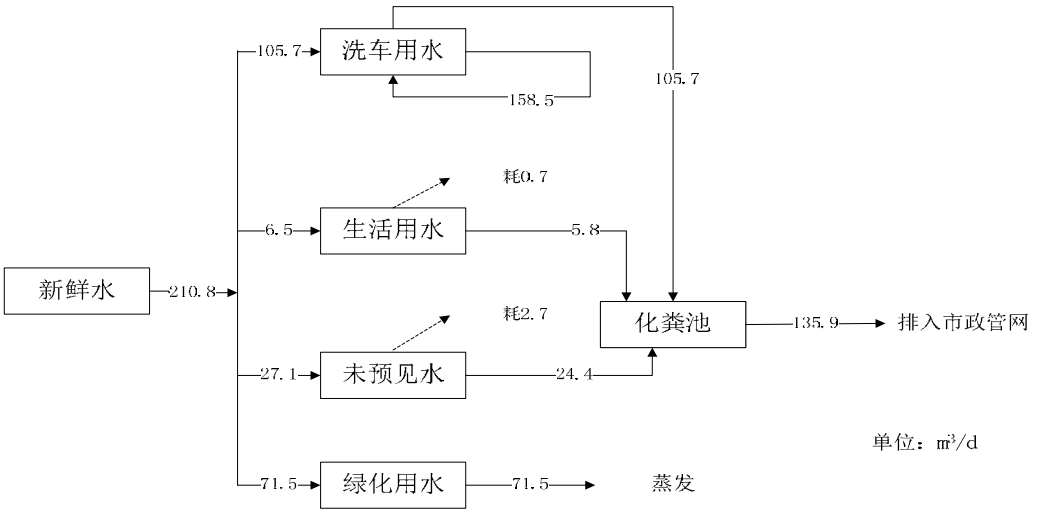
A. Prediction of water volume

According to the design, the maximum water consumption of car depot and the parking lots is 290m3/d, sewage generation volume of 214 m3/d, sewage return volume of 95 m3/d and sewage drainage volume of 119 m3/d. The detailed water balance refers to figure 5.1-1.



新鲜水 Fresh water, 生产用水 process water, 生活用水 domestic water, 未预见水 unforeseen water, 绿化用水 greening water, 检修用水 maintenance water, 洗车用水 car wash water, 污水处理站 sewage treatment station, 排入附近沟渠 Discharged into nearby ditches, 耗 consuming 单位：unit

Water balance chart of car depot at Hanghai East Road



新鲜水 Fresh water, 洗车用水 wash water, 生活用水 domestic water, 未预见水 unforeseen water, 绿化用水 greening water, 化粪池 septic tanks, 耗 consuming, 接入市政管网 connected to municipal pipe network, 单位 unit

Water balance chart of parking lot at Jialu River

Figure 5.5-1.Water balance chart of car depot and parking lot

B. Prediction of water quality

a. Overhaul oily sewage

The discharge amount of inspection & repair sewage in car depot & the parking lots is 26 m3/d. This assessment is in analogy to original water quality of inspection & repair oily sewage in Beijing Ancient City car depot with similar operations. Refer to table 5.5-3.

Table 5.5-3 Water quality analog and prediction of overhaul oily sewage in the car depot and the parking lots

Analog unit	Waste water quality			
	pH value	CODCr (mg/L)	BOD5 (mg/L)	Petroleum product (mg/L)
Raw water quality of overhaul oily sewage of car depot in Beijing ancient city	7.8	420	120	90

b. Car washing sewage

For the washing sewage of vehicle skin, the water volume and quality depend on car washing method. The water quality of production sewage untreated is by analogy with the raw water quality of Beijing Taipinghu car depot car washing sewage; refer to table 5.5-4.

Table 5.5-4 Water quality analog and prediction of car washing sewerage in car depot and the parking lots

Analog unit	Sewage water quality				
	pH value	CODC (mg/L)	BOD5 (mg/L)	Petroleum product (mg/L)	LAS (mg/L)
Raw water quality of washing sewage in Beijing Taipinghu car depot	7.6	400	86.3	25.2	6.84

c. Domestic sewage

According to normal monitoring data, the water quality pH value of station domestic sewage is 7.5 - 8.0, with CODCr of 150 - 200 mg/L, BOD5 of 50 - 90 mg/L, animal and plant oil content of 5 - 10 mg/L and ammonia nitrogen of 10 - 25 mg/L.

(II) Pollution source assessment

According to the prediction results of sewage water quality and in reference to the assessment standard, adopt standard index method for assessment of standard-reaching state of various sewage not treated in car depot & the parking lots. The assessment results refer to table 5.5-5.

Table 5.5-5 Water quality assessment for the sewage not treated at car depot & the parking lots

Pollution resource	Item	pH value	CODCr(mg/L)	BOD5(mg/L)	Petroleum products (mg/L)	Animal and plant oil (mg/L)	Ammonia nitrogen (mg/L)	LAS (mg/L)
inspection & repair sewage	GB8978-1996 class 3 standard	6 - 9	500	300	20	100	-	20
	Water quality prediction value	7.8	420	120	90	-	-	-
	Standard index	0.4	0.84	0.40	4.5	-	-	-
Washing sewage	GB8978-1996 class 3 standard	6 - 9	500	300	20	100	-	20
	Water quality prediction value	7.6	400	86.3	25.2	-	-	6.84
	Standard index	0.3	0.8	0.29	1.26	-	-	0.34
Domestic sewage	GB8978-1996 class 3 standard	6 - 9	500	300	20	100	-	20
	Water quality prediction value	7.8	200	90	-	10	25	-
	Standard index	0.40	0.40	0.30	-	0.1	-	-

As shown by the analysis in above table, domestic sewage can meet the GB8978-1996 class 3 standard; the untreated inspection & repair oily sewage and washing sewage exceed the standard limits, and the over-limit pollutants are of petroleum products (separately 3.5 times and 0.26 times over-limit).

(III) Effluent water quality analysis

A. Inspection & repair sewage

The design adopts adjustment, oil separation and settlement tank to treat the inspection & repair oily sewage. The working principle of adjustment, oil separation and settlement tank is mainly of gravity separation and agglomeration separation with the advantages of high efficiency, quick, stable and less floor area, and is normally used to remove the oil droplets with the diameter of more than with the oil removal efficiency of more than 80%.

B. Car washing sewage

Part of car washing sewage are recycled after treated with neutralization, sediment and filtration devices affiliated to the car washing device, and the rest is discharged into urban pipeline network. According to related data, in the car washing sewage after treatment of neutralization, sediment and filtration, the pollutant concentrations of CODcr, BOD5, petroleum products and LAS contents are separately of 36mg/L, 2 mg/L, 5mg/L and 0.16mg/L; they can meet the standard requirements of "Car washing water" in GB/T18920-2002 Reuse of Recycling water for Urban--Water Quality Standard for Urban Miscellaneous Water Consumption (BOD5≤10mg/L, LAS≤0.5mg/L) and be recycled for car washing. The rest sewage not recycled also excels the class 3 standard requirements in GB8978-1996.

C. Domestic sewage

In the design, the domestic sewage is discharged after treatment with septic tank and meets the class 3 standard requirements in GB8978-1996.

After the treatment of sewage treatment facilities in design, the sewage water quality predictive assessment results refer to table 5.5-6.

Table 5.5-6 Effluent water quality assessment of car depot & parking lots sewage after treatment with sewage treatment facilities in design

Pollution source	Item	pH value	BOD5 (mg/L)	CODCr (mg/L)	Petroleum products (mg/L)	Animal and plant oil (mg/L)	ammonia nitrogen (mg/L)	LAS (mg/L)
inspection & repair sewage	water quality prediction value	7.8	102	357	18	-	-	-
	GB8978-1996 class 3	6 - 9	300	500	20	100	-	20
	standard index	0.4	0.34	0.2	0.9	-	-	-
Washing sewage	water quality prediction value	7.6	2	36	5	-	-	0.16
	GB18920-2002 Reuse of recycling water for urban--Water quality standard for urban miscellaneous water consumption, "car washing water" standard	6.5~9	10	-	-	–	-	0.5

	Standard index	0.30	0.2	-	-	-	-	0.32
	GB8978-1996 class 3	6 - 9	300	500	20	100	-	20
	standard index	0.3	0.1	0.07	0.25	-	-	0.008
Domestic sewage	water quality prediction value	7.5-8.0	90	200	-	10	25	-
	GB8978-1996 class 3	6 - 9	300	500	-	100	-	20
	standard index	0.25~0.5	0.30	0.40	-	0.1	-	-

As shown in above table, for various sewages of car depot & the parking lots after treated by the sewage treatment facilities in design, the pollution factors can meet the class 3 standard requirements in GB8978-1996Integrated Wastewater Discharge Standard, and the washing sewage can meet the “Car Washing” water standard requirements in GB/T18920-2002 Reuse of Recycling Water for Urban--Water Quality Standard for Urban Miscellaneous Water Consumption after treatment by affiliated devices of washing device. The assessment considers the sewage treatment program in design for car depot & the parking lots is feasible.

(3) Environment impact assessment of sewage discharge in stations along the line

There are 21 stations along the line of project. The discharged sewage mainly includes office domestic sewage of staff, washing sewage from station facilities cleaning and fecal sewage in station toilets. The total discharge amount of sewage is 160 m3/d. The sewage features simple sewage property and the main pollution factors include CODcr, BOD5, animal and plant oil, ammonia nitrogen and etc. According to field survey and feedback of related department, the sewage of each station during project construction period is able to be included in existing or planned municipal sewage pipeline network and then into related urban sewage treatment plant for centralized treatment (details refer to table 4.1-8). The sewage discharge of each station complies with GB8978-1996 class 3 standard.

According to analog analysis of related projects, the average water quality of station domestic sewage after treatment by septic tank is as follow: pH value =7.5 - 8.0, CODCr=150 - 200 mg/L, BOD5=50 - 90 mg/L, animal and plant oil content =5 - 10 mg/L and ammonia nitrogen =10 - 25 mg/L.

According to prediction results of sewage water quality and in reference to the assessment standard, adopt standard index method to evaluate the standard-reaching state of station sewage. The assessment results refer to table 5.5-7.

Table 5.5-7 Predictive assessment results of station sewage

Station	Item	pH value	BOD5	CODCr	Ammonia nitrogen	Animal and vegetation oil
21 stations in this project	water quality prediction value (except PH value, mg/L)	7.5 - 8.0	90	200	25	10
	GB8978-1996 class 3	6 - 9	300	500	-	100

	standard (except PH value, mg/L)					
	standard index	0.38	0.3	0.4	-	0.1

The sewage water quality of stations in this project meets the requirements in GB8978-1996 class 3 standard.

(IV) Statistics for main pollutants discharge amount in whole line

Table 5.5-8 Statistics list for discharge amounts of sewage and main pollutants of whole line

Pollution source		Sewage discharge amount	Statistics of main pollutants discharge amount (t/a)				
		(104t/a)	CODcr	BOD5	Petroleum products	Animal and plant oil	ammonia nitrogen
Production amount of pollutants	car depot & the parking lots	7.81	23.73	7.00	1.25	0.38	0.95
	Station along the line	5.84	11.68	5.26	0.00	0.58	1.46
	Subtotal	13.65	35.41	12.26	1.25	0.96	2.41
Reduction amount of pollutants	car depot & the parking lots	3.47	14.76	3.21	1.17	0.00	0.00
	Station along the line	0.00	0.00	0.00	/	0.00	0.00
	Subtotal	3.47	14.76	3.21	1.17	0.00	0.00
Discharge amount of pollutants	car depot & the parking lots	4.34	8.96	3.79	0.07	0.38	0.95
	Station along the line	5.84	11.68	5.26	0.00	0.58	1.46
	Subtotal	10.18	20.64	9.05	0.07	0.96	2.41

5.5.1.5 Impact analysis of the project on Zhengzhou drinking water source protection zone

(1) Position relation of this project with Zhengzhou drinking water source protection zone.

The drinking water sources in Zhengzhou are separately located at north and south of urban area; the north water sources are located at the south bank of Yellow River, separately of Jiuwuyuan water source and Beijian water source; the south water sources are located at both sides of Zhengzhou-Xi'an railway, separately of Changzhuang reservoir and Jiangang reservoir; moreover, the middle main canal of South-to-North Water Diversion Project passes through the southwest out of the central urban area.

The rail transit 3# line project is in the central urban area, while the drinking water source protection areas are out of the central urban area, so the stations, car depot and parking depot in this project do not involve Zhengzhou drinking water source protection areas.

5.5.1.6 Mitigation measures for surface water environment impact

Properly design the construction site drainage system during construction period. The construction staff fecal sewage are regularly collected and treated by Zhengzhou Municipal sanitation workers after storage of septic tank; the sediment tank is set at construction site outlet and the construction sewage is recycled for field site washing dust suppression and washing vehicles after settlement treatment; the muddy water for shield construction are fully reused after treatment by mud-water separation system.

Prohibit the construction site production sewage and domestic sewage directly or indirectly discharged into surface water.

The construction site and spoil field must not be set within range of 200m surface water source protection area. The construction waste slag and the dried sludge treated by shield mud-water separation system shall be deposited at specified locations, fenced and timely delivered to local water slag administration for treatment.

The construction organization design must be orderly fulfilled during construction and the excavation and fill construction must not be done during rainstorm. In rainy day, it is necessary to cover tarpaulin or equivalent on temporary spoil and materials so as to prevent the spoil soil flowing into surface water and polluting the waters under the flushing of rainstorm.

Strengthen the environment protection management during construction period. it is recommended to assign special construction environment protection manager to intensify the implementation of specific environment protection measures and put the prevention first so as to reduce and prevent the pollution on waters.

Treat the car depot production sewage with adjusting, oil-separation and sediment tank, and the domestic sewage of 21 stations with septic tank.

5.5.2 Underground water predictive assessment

The main assessment contents of underground water are as follows: analyze the impact of project construction on underground water quality and provide the protection measures; analyze the impact of construction rainfall on ground settlement and provide prevention measures; analyze the impact of project construction on underground supply, runoff and discharge.

5.5.2.1 Impact on underground water quality

(1) Impact analysis on underground water during construction period

Before the construction of the underground station and the interval, the continuous concrete wall is built first in order to block groundwater and act as a maintenance structure. And then on the basis of good anti-seepage work, lay blind pipe on the bottom on both sides of the tunnel to collect and conduct the residual water on to the ground. The water goes through the sedimentation tank set on the ground and discharges into urban sewage pipe network then into the urban sewage treatment plant. In the construction process, drainage water quantity is low, without influence to the

underground water . Based on the above analysis, the project construction process has little influence to groundwater.

(2) Impact analysis of underground water quality during operation period

The waterproof of underground structures of this project complies with standards Technical Specifications for Underground Construction Moisture Prevention (GBJ108-87) and Code for Design of Subway. The subway tunnels and stations have good waterproof performance, so the external pollution sources during subway operation period will not enter the underground water through subway tunnel and station.

After construction and put into service of this project, the sewage produced from along-line stations and car depot & the parking lots will be discharged into municipal sewage pipeline network after treated. During generation and transport of sewage, the sewage amount seeping into the underground due to leakage and drop-in is small, and the anti-seepage measures are taken in station facilities such as toilet and septic tank, so it will impose remarkable impact on regional underground water quality.

5.5.2.2 Impact analysis of construction dewatering on ground settlement

According to past subway construction experience, if the underground station or underground section adopts open cut or covered cut construction method without any waterproof and waterstop measures, it is necessary to dewater or drain large mass of phreatic water and shallow confined water, which will lead to overall falling of underground level along the construction line and surrounding regions, and therefore the increase of ground settlement volume and settlement rate. So it will lead to the risk of ground settlement and even surface collapse.

The line of this project will go beneath the Jinshui River, Xiong’er River, Qili River and other surface water bodies, and the traction lines of the parking lot and car depot will also go beneath the Jialu River and Chao River. The surface water and groundwater are closely related. The construction process should pay special attention to preventing pumping and discharging groundwater from causing nearby surface water leakage as well as the ground subsidence and other disasters brought thereby.

(1) Prediction of impact range of construction dewatering

Among the project’s 21 underground stations, 20 stations will use the cut and cover construction method. The Jinshui Road Station will use the cover digging method. Each interval will use the shield method as the primary method and the cut and cover method as the secondary method. For the interval structure-related detailed construction plan, see Table 5.5-9.

Table 5.5-9 Summary Table of Construction Program and Structural Model of Underground Section of No. 3 Line

Series No.	Section Name	Construction Method	Sectional Structural Form	Sectional Length	Burial Depth (m)	Note
1	Xinliu Road-Shamen Road Station Section	Shield Tunnel and Open Cut	Circular Section,	1090	10~16	The line distribution

		Method	Rectangular Section			area of the Xinliu road Station's end will use the open-cut method,
2	Shamen Road-Xinglongpu Road Station Section	Shield Tunnel Method	Circular Section	1130	10~18	
3	Xinglongpu Road-Dongfeng Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	1300	10~16	The line distribution area of the Xinglongpu road Station's end will use the open-cut method,
4	Dongfeng Road-Agricultural Road Station Section	Shield Tunnel Method	Circular Section	980	10~16	
5	Agricultural Road-Huanghe Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	900	10~11	The line distribution area of the Huanghe road Station's end will use the open-cut method,
6	Huanghe Road-Jinshui Road Station Section	Shield Tunnel Method	Circular Section	900	10~16	
7	Jinshui Road-Taikang Road Station Section	Shield Tunnel Method	Circular Section	740	10~16	
8	Taikang Road-Erqi square Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	605	10~16	The line distribution area of the Taikang road Station's end will use the open-cut method,
9	Erqi square-Shunchengjie Station Section	Shield Tunnel Method	Circular Section	630	10~19	
10	Shunchengjie-Dongdajie Station Section	Shield Tunnel Method	Circular Section	760	10~11	
11	Dongdajie-Chengdong Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	480	10~16	The line distribution area of the Dongdajie Station's end will use the open-cut method,

12	Chengdong Road-Weilaidadao Station Section	Shield Tunnel Method	Circular Section	950	10~16	
13	Weilaidadao –Fengtai south Road Station Section	Shield Tunnel Method	Circular Section	670	10~15	
14	Fengtai south Road ~ Zhongzhoudadao Station Section	Shield Tunnel Method	Circular Section	785	10~18	
15	Zhongzhoudadao-Tongtai Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	470	10~16	The line distribution area of the Tongtai road Station's end will use the open-cut method,
16	Tongtai Road–Huanghe east Road Station Section	Shield Tunnel Method	Circular Section	890	10~19	
17	Huanghe east Road–Agricultural east Road Station Section	Shield Tunnel Method	Circular Section	785	10~16	
18	Agricultural east Road–Zhongxing Road Station Section	Shield Tunnel Method	Circular Section	1250	10~15	
19	Zhongxing Road-Boxue Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	1520	10~20	The line distribution area of the Zhongxing road Station's end will use the open-cut method,
20	Boxue Road - Hanghai east Road Station Section	Shield Tunnel Method	Circular Section	2590	10~16	
21	Hanghai east Road-South sanhuan Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	2150	10~20	The line distribution area of the Hanghai east road Station's end will use the open-cut method,

The shield construction method is a construction method to construct the tunnel under the protection of shield and the feature is that the main works such as excavation, soil transport, lining assembly, joint waterproof and shield tail gap grouting are conducted under the shield protection. For the enclosed structure and technical features of shield machine, it can fulfill the works with water without need of unwatering; during construction with open cut and covered excavation method, when the bottom elevation of construction structure is lower than underground water level, it must conduct unwatering works.

The unwatering requirements for project construction are listed in table 5.5-10.

Table 5.5-10 Comparison analysis for unwatering requirements for project construction

Item	Without need of unwatering	In need of unwatering
Construction method	Shield method construction	In case of open cut method and covered excavation method, the construction structure bottom elevation is lower than underground water level.

The unwatering situations of along-line stations and sections of this project are separately shown in table 5.5-11 and table 5.5-12.

Table 5.5-11 Unwatering situation of along-line station construction of the project

No.	Name of station	Construction method	Length m	Foundation pit depth (m)	Enclosure type	Aquifer lithology	Observed static water level buried depth (m)	Whether requiring unwatering	Unwatering depth m
1	Xinliu Road Station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain	Silt, silty clay	5.2m~10.0m (taken as 5.2)	Yes	11.8
2	Shamen Road Station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				11.8
3	Xinglongpu Road Station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				11.8
4	Dongfeng Road Station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				11.8
5	Nongye Road Station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				11.8
6	Huanghe road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain	Silt, silty clay	10.5m~13.9m （taken as 10.5）		6.5
7	Jinshui road station	Covered excavation methed	140	17	cast-in-place bored pile +waterpro				6.5

					of curtain				
8	Taikang road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain	Silt, silty clay	4.2m~16.8m （taken as 4.2）		12.8
9	Erqi square station	open-cut method	140	23	underground diaphragm wall				18.8
10	Shunchengjie station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				12.8
11	Dongdajie station	open-cut method	140	23	underground diaphragm wall				18.8
12	Chengdong road station	open-cut method	140	22	underground diaphragm wall				17.8
13	Weilaidadao station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				12.8
14	Fengtai south road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				12.8
15	Zhongzhoudadao station	open-cut method	140	22	underground diaphragm wall				17.8
16	Tongtai road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				12.8
17	Huanghe east road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				12.8
18	Agricultual east road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				12.8

19	Zhongxing road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				12.8
20	Boxue road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				12.8
21	Hanghai east road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				12.8
22	Sorth sanhuan station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain	Silt	12.3m~13.6m （taken as 12.3）		4.7
23	Jingba road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				4.7
24	Jingnan12 road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				4.7
25	Jingnan15 road station	open-cut method	140	17	cast-in-place bored pile +waterproof curtain				4.7

Table 5.2-12 Construction unwatering conditions for sections along the line of this project

SN	Section Name	Construction Method	Sectional Structural Form	Sectional Length	Burial Depth (m)	Observing static water depth	The need for water drainage?	Dewatering for drawdown
1	Xinliu Road-Shamen Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	1090	10~16	5.2m~10.0m （take as 5.2）	need	10.8
2	Xinglongpu Road-Dongfeng Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	1300	10~16			10.8
3	Agricultural Road-Huanghe Road Station Section	Shield Tunnel and Open Cut	Circular Section, Rectangul	900	10~11	10.5m~13.9m （take as		0.5

		Method	ar Section			10.5）		
4	Taikang Road-Erqi square Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	605	10~16	4.2m~16.8m（take as 4.2）		11.8
5	Dongdajie-Chengdong Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	480	10~16			11.8
6	Zhongzhoudadao-Tongtai Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	470	10~16			11.8
7	Zhongxing Road-Boxue Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	1520	10~20			15.8
8	Hanghai east Road-South sanhuan Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	2150	10~20	12.3m~13.6m（take as 12.3）		7.7
9	Jingba Road-Jing south 12 Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	985	10~16			3.7
10	Jing south 12 Road-Jing south 15 Road Station Section	Shield Tunnel and Open Cut Method	Circular Section, Rectangular Section	690	10~12			0

The unwatering will lower the underground level in the range nearby the excavation sites and form water level recess in certain range near the stations and tunnel and even the ground settlement. Considered the unwatering length is far more than the unwatering width, this assessment adopts the calculation formula provided in (TB10049-96) Code for Hydrogeological Investigation of Railway Engineering for unwatering impact range assessment.

$R=\{r2 + 30\times K\times S2(1 + 0.00015r2) \}0.5$

$R= 0.25L$

Where: L——Unwatering length (m)

K——permeability coefficient, in which the aquifer permeability coefficients of station areas are separately obtained according to geo-technical investigation report of along-line stations.

S——drawdown (m) .

The calculation results with above formula are shown in table 5.5-13.

Table 5.5-13 Preaction of impact range of drainage and unwatering for engineering construction (considered for least favorable case)

SN	Drainage range	Unwatering length L(m)	r（m）	permeability coefficient K(m/d)	drawdown S(m)	unwatering range R(m)
1	Xinliu road station	140	35	0.1	11.8	41.5
2	Shamen road station	140	35	0.1	11.8	41.5
3	Xinglongpu road station	140	35	0.1	11.8	41.5
4	Dongfeng road station	140	35	0.1	11.8	41.5
5	Agricultual road station	140	35	0.1	11.8	41.5
6	Huanghe road station	140	35	0.1	6.5	37.1
7	Jinshui road station	140	35	0.1	6.5	37.1
8	Taikang road station	140	35	0.1	12.8	42.5
9	Erqi square station	140	35	0.1	18.8	49.8
10	Shunchengjie station	140	35	0.1	12.8	42.5
11	Dongdajie station	140	35	0.1	18.8	49.8
12	Chengdong road station	140	35	0.1	17.8	48.5
13	Weilaidadao station	140	35	0.1	12.8	42.5
14	Fengtai sorth road staion	140	35	0.1	12.8	42.5
15	Zhongzhoudadao station	140	35	0.1	17.8	48.5
16	Tongtai road station	140	35	0.1	12.8	42.5
17	Huanghe east station	140	35	0.1	12.8	42.5
18	Agricultural east station	140	35	0.1	12.8	42.5
19	Zhongxing road station	140	35	0.1	12.8	42.5
20	Boxue road station	140	35	0.1	12.8	42.5
21	Hanghai east station	140	35	0.1	12.8	42.5
26	Xinliu road~Shamen road station section	1090	272.5	0.1	10.8	280.2
27	Xinglongpu road~Dongfeng road station section	1300	325	0.1	10.8	333.9
28	Agricultural road~Huanghe road station section	900	225	0.1	0.5	225.0
29	Taikang road~Erqi square station section	605	151.25	0.1	11.8	157.3
30	Dongdajie~Chengdong road station section	480	120	0.1	11.8	125.4
31	Zhongzhoudadao~Tongtai road station section	470	117.5	0.1	11.8	122.8
32	Zhongxing road~Boxue road station section	1520	380	0.1	15.8	401.7

As shown by the calculation results in table 5.5-13, under the conditions of no waterproof measure and considering for the least favorable conditions, the impact range for project along-line stations requiring unwatering is between 37.1m and 49.8m, and the impact range of section is between 122.8m and 333.9m.

The along-line groundwater level of Zhengzhou rail transit 3 line is low with small permeability coefficient, so the dewatering impact range is small; the aquifer in section from Zhongxing Road to Nansanhuan Station is mainly of fine sand with good permeability and abundant water, so the impact range of construction unwatering is large (unwatering range of 401.7m) and proper water stop prevention measures must be taken during construction.

(II) Ground settlement impact analysis from construction unwatering

For 21 underground stations in project design, the main body enclosure structure during open cut construction of work well adopts underground diaphragm wall or cast-in-place pile enclosure plus jet grouting pile water stop, and the enclosure structure will enter the impermeable stratum under pit foundation. According to construction sequence of station open cut construction, firstly conduct the enclosure structure construction during construction period, and then set well in pit foundation for pit unwatering before excavation so as to ensure the underground water level is about 1-2m lower than pit foundation excavation face, and finally backfill the bottom and well. By analogy with the underground station construction of other cities, under the conditions of safety construction, the settlement along the line is uniform and the settlement different and inclination at both sides of buildings are within the allowable range specified in GBJ7—89 Specifications for Design of Building Foundations. Since this project adopts underground diaphragm wall or cast-in-place pile enclosure plus jet grouting pile water stop for station construction, it only requires pumping out the underground water in the range of construction foundation pit and discharging to nearby rain drainage system so that the underground water levels inside and outside of the foundation pit keep stable.

Since the underground diaphragm wall and cast-in-place pile enclosure structures have a remarkable waterproof effect, the unwatering in foundation pits can effectively prevent the underground water loss outside of the foundation pit. Under the conditions of underground diaphragm wall or cast-in-place pile enclosure plus jet grouting pile water stop or similar measures, the possible ground settlements mainly concentrate in 10-20m range around the station foundation pit and the settlement amount around the station is normally no more than 30mm.

In addition, the time periods required for construction unwater during subway construction are limited in station construction period, and it will stops when the foundation works complete. The engineering unwatering duration is short and it is implemented along the subway line sections separately, so it has limited impact on urban underground reservoir. The safe unwatering construction of the project will not lead to adverse effect on ground and buildings.

5.5.2.3 Impact analysis of engineering construction on underwater recharge, runoff and discharge

This project does not involve any underwater drinking water source protection area.

The underground water types of regions along the line of project are mainly of perched ground water, quaternary loose rock type hole water and bedrock crevice water, in which the quaternary loose rock type hole water is the priority. The underground water is mainly supplied from surface waters (including Jinshui River,

Xionger River, Chaohe River) with less impact from artificial exploitation. In normal water season and low water season, the underground water feeds surface water and the underwater drains to the surface water; while in flood season, the surface water level rises and the surface water feeds the underground water. The impact of this project construction on underground water feeding is very small.

The sectional impact analysis of constructions of underground stations and section tunnels in this project on ground water runoff are as follows:

(1) Zone A

The section range is from the start point, through Nanyang Road, Erqi Square, East Street, Zhengbian Road to the intersection of line and Longhai Railway, and the mileage range is (K0+0.000~K23+200) and the ground elevation is between 86.70m and 103.10m.

The underground water in section from starting point to Longgang is mainly of bedrock crevice water and lack of quaternary loose rock type hole water (perched ground water), and the aquifer is mainly of angular gravel and shallow weathering gaps, receives the infiltration feeding of atmospheric precipitation and discharges to nearby inter-mountain depression. The included angle of underwater trend and underground water runoff is small and the project tunnel will not block the underground water, so it only has limited impact on ground water runoff and drainage in the area.

(2) Zone B

Zone B: the range is from the intersection of line with Longhai Railway to the destination; the mileage range is (K23+200~K31+350.000) and the ground elevation is between 87.10m and 95.00m.

The underground water types in this section are mainly of phreatic water with weak confined property, and the aquifer is mainly of gravel and pebble and side fed by Qili River and other surface waters. The included angle of line direction with ground water runoff direction is large and some aquifer sections is cut off by the tunnel in local sections, so the project tunnel will cut the shallow aquifer in this zone and lead to high banked-up underground level at local area. however, the tunnels only involves partial space of shallow aquifer section and the shallow underground water fabric has good permeability, the ground water runoff path can bypass the tunnel structures through penetration and normally will not remarkably affect the runoff and drainage of regional ground water runoff.

In this project, the concrete diaphragm wall is constructed before the construction of underground station and section to block off the underground water and use as the retaining structure. Then based on the proper anti-seepage works, lay out the blank tubing under the channel at both sides of tunnel to collect the residual water to the ground surface; set up the sedimentation basin on the ground; the water is discharged to municipal sewage pipe network and then sewage treatment plant after sedimentation in the basin. During construction of project, the drainage water volume is small with less impact on the underground water.

5.5.2.4 Mitigation measures of impact on underground water

(1) Protection measures for underground water quality

According to the regulations in Law of the People's Republic of China on Prevention and Control of Water Pollution article 14 “While constructing underground engineering facilities or carrying out underground prospecting, mining and other underground activities, protective measures shall be taken to prevent ground water pollution”, following measures are taken in construction and operation periods of this project to prevent ground water pollution:

The construction camps shall set septic tanks and equipped with anti-seepage measures to prevent underground water pollution.

The domestic garbage generated during construction period shall be subject to centralized management and delivered to municipal sanitation department for collective treatment so as to prevent pollution of underground water source.

(2) Suggestion for preventive measures from ground settlement and collapse

The construction scale of foundation pit excavation of underground stations is large, so it shall fully consider the adverse factors which may impact the foundation pit stability during construction, and take proper protection measure to ensure the safety of foundation pit construction and surrounding road, underground pipelines and buildings.

Intensify the construction monitoring works and strictly monitor the vertical and horizontal displacement of pit foundation and surrounding buildings, stress conditions of enclosure structures, variation of underground waters and the soil pressure. Strive to fulfill informationization construction for ease of timely adjustment of design parameters and construction methods to ensure the construction safety and eliminate the potential hazards.

Recommend to intensify the monitoring and supervision of underground water level, flow direction and speed along the line (especially: Zhongxing road~Hanghai east Road).

This assessment reserves 500,000 Yuan for setting of temporary sedimentation tank, 600,000 Yuan for monitoring of ground settlement, underground water level and quality.

5.5.2.5 Summary

(1) The project does not involve the protected areas of underground water and drinking water resources.

(2) Before the construction of the underground station and the interval, the continuous concrete wall is built first in order to block groundwater and act as a maintenance structure. And then on the basis of good anti-seepage work, lay blind pipe on the bottom on both sides of the tunnel to collect and conduct the residual water on to the ground. The water goes through the sedimentation tank set on the

ground and discharges into urban sewage pipe network then into the urban sewage treatment plant. In the construction process, drainage water quantity is low, without influence to the underground water . Based on the above analysis, the project construction process has little influence to groundwater.

(3) The engineering construction adopts underground diaphragm wall or cast-in-place pile fence and the auxiliary retaining structure adopts cast-in-place pile fence with jet grouting pile for waterproof so as to effectively control the ground settlement.

(4) The urban sewage infrastructures along the line are complete and the construction sewage quality is simple. The assessment considers the sewage will not pollute the underground water quality if treated with proper process and collected into nearby municipal pipeline network or waters.

(5)The short term falling of local underground water level during construction period will rapidly recover after rainfall completed, and will not affect the underground water resource in the area.

5.5.3 Assessment conclusion

(1) The domestic sewage, muddy water and other production wastewater generated from construction stations, car depot and other sites are reused or drained into urban pipeline network after treatment of sedimentation tank, and will not affect the surface water and underground water environment.

(2) The sewage amount from car depot and the parking lots is 214 m^3/d, in which the sewage reuse amount is 95m^3/d and sewage discharge amount is 119 m^3/d. The total discharge amount of domestic sewage in stations along the line is 160m3/d. The overhaul sewage of car depot integrated base after treated by oil separation tank, and the car washing sewage after treatment of matching neutralization - sediment – filtration by car washing device, are reused, and the normal domestic sewage is treated by septic tank. The domestic sewage of station is treated by septic tank. The above sewage can be discharged into existing or planned municipal sewage pipeline and then into municipal sewage treatment plant. The drainage water quality can meet the requirements of level 3 emission standard in GB8978-1996.

(3) The current water quality of the Jinshui River, Xiong’er River and Qili River the line passes by can reach requirement for water quality category IV in “Quality Standard for Surface Water” (GB3838-2002) . The major water quality indexes of the current underground water can meet the requirements for water quality category III of “Quality Standard for Underground Water” GB/T14848-93.

(4) The project runs beneath surface water bodies such as Jinshui River, Xiong’er River and Qili River etc. in the form of tunnel(constructed with shield tunnel method), and does not run across the protected areas of water resources. The project construction will not cause direct influence on the water quality of the water source and the water intake.

(5) In case the pollutants such as oil etc. enter into underground water during project construction, the underground water quality in the area may be influenced to some

extent. However, the influence on the underground water quality due to construction may be lowered to the minimum level in case of scientific, rational and orderly management of the whole course of construction. No influences will be caused on the underground water quality during the project operational period.

(6) The engineering construction adopts underground diaphragm wall or cast-in-place pile fence and the auxiliary retaining structure adopts cast-in-place pile fence with jet grouting pile for waterproof so as to effectively control the ground settlement.

(7) The urban sewage infrastructures along the line are complete and the construction sewage quality is simple. The assessment considers the sewage will not pollute the underground water quality if treated with proper process and collected into nearby municipal pipeline network or waters.

5.6 Ecological environment impact assessment and ecological environment protection measures

This project is located in urban area of Zhengzhou city and the project scope is mainly of urban regional ecological system. According to the requirements in HJ453-2008 Technical Guideline of Environment Impact Assessment - Urban Rail Transit and the ecological sensitivity of project line and areas, carry out predictive assessment of ecological environment impact. The assessment works highlight the urban ecological environment features as complete, objective and correct as possible to reflect the impact of project to be built in ambient environment, and focuses on the local sensitive ecological issues and typical factors which may generate significant impact and puts forth the prevention and recovery measures of ecological impact.

5.6.1 Predictive assessment

5.6.1.1 Assessment principle

(1) From the view of regional ecological function impact, focus on the ecological function of related urban planning and ecological planning for assessment;

(2) According to features of urban ecological environment, carry out selective analysis fir the ecological factors such as land utilization and urban landscape on rail transit construction;

(3) Predict and analyze main environment impact of project to be built for urban ecological sensitive area, and analyze and describe the possible ecological variation by engineering construction.

5.6.1.2 Assessment contents, emphasis and protection object

(I) Assessment contents

(1) According to urban development planning and function orientation of regions

along the line, in view of urban planning layout, traffic planning and other related planning, comment the relationship of this project with urban planning and urban group, and carry out analysis of related planning conformity and ecological suitability of project line;

(2) Evaluate the variation of regional land utilization function and loss of greenland, vegetation and rare species;

(3) Impact of engineering waste slag and treatment method on urban ecological environment; prediction and analysis of possible water loss and soil erosion;

(4) Ecological structure stability and variation trend of species diversity within range of prediction analysis assessment, describing the impact of project on ecological structure, function and disturbance recovery capability in assessment range;

(5) Impact analysis of buildings such as project stations and ventilation pavilions on urban landscape.

(II) Assessment emphasis

Assessment important area: Impact area of ground buildings along the line including station entrance/exit, ventilation pavilion, car depot and the parking lots, and main substation.

Assessment critical content: compatibility of project and urban planning; coordination analysis of ground building landscape and urban landscape including station entrance/exit and ventilation pavilion; impact of project on ecological sensitive objects.

(III) Protection object

(1) Protection object of ecologic environment during construction period

The construction site, construction unit premise and construction facility will occupy the land, destroy the ground surface vegetation and impact the urban ecology and urban landscape. The protection object during construction period is the urban green land.

(2) Protection object of ecologic environment during operation period

After the project is put into the operation, the main protection objects are of urban landscape; it shall ensure the harmony and unity of newly built artificial building of the project with the natural landscape and artificial landscape of surrounding city and set up the human oriented service concept to benefit the virtuous cycle of urban ecological system, contribute to establishment of “Ecological city” and ensure the sustainable development of city.

5.6.1.3 Assessment method

The present status assessment of ecological environment adopts the combination method of qualitative and quantitative analysis to analyze the ecological completeness

of regional environment and evaluate the regional land utilization features and immunity capacity; the predictive assessment plans to adopt related principles of landscape ecology and architectural aesthetics to analyze the impact of ground buildings such as station entrance/exit, ventilation pavilion, car depot, repair depot and main substation on ambient environment as well as the coordination of project ground buildings with urban landscape.

5.6.2 Analysis and protection measures for urban ecological environment impact

5.6.2.1 Impact analysis of land acquisition and demolition of project construction on ecological environment

(I) Type and volume of project land acquisition and demolition

The land acquisition and demolition at early stage of this project features long line, many points and wide range. Since the project transverses the core zone in city center, to reduce the land acquisition and demolition works, many stations are located in the middle of road. However, most of stations are within the range of main urban roads and downtown area and many transfer stations needs to be constructed at same time, so it still involves a wide range of removal and relocation range to meet the requirements for station layout, construction, social traffic and pipeline relocation. The removal and relocation housing properties mainly include downtown area office building, mature community, school, downtown area store and etc. so the land acquisition and demolition features in this project are as follows: favorable lot for housing demolition, large number of households, great removal and relocation difficulty, high relocation cost and wide impact range.

The total demolition area along project line is 10.2 hm^2, permanent land use of 5.98hm^2 and temporary land use of 30.08hm^2. The temporary ground is temporarily occupied during open cut construction method for underground stations.

By investment and statistics, the total land occupation of this project is 829.68 Mus, including expropriated collective land of 786 Mus and expropriated state land of 43.68 Mus. The expropriated collective lands are of vegetable plot, cultivated land, orchard and forest land at present. The expropriated state lands are of state construction land.

Table 5.6-1 Quantity sheet of land use along project line (unit：hm^2)

Station or section	vegetable plot	Farmland	orcharding	woodland	Others	Land use subtotal (hm2)
The parking lots	5.5	6.4	0	0	2.3	14.2
Car depot	0	7.7	7.5	19.1	3.9	38.2
station					2.9	2.9
section	0	0	0	0	0	0
total						55.3

(II) Regulations and organization of land acquisition, demolition and placement policies

The national, Henan Province and Zhengzhou city laws and regulations related to demolition and placement mainly include:

● Land Administration Law of the People's Republic of China, implemented from January in 1998, revised on August 28, 2004

● Circular of the State Council on Intensifying the Land Control, issued on Aug. 31, 2006

● State Council Decision on Deepening Reform of and Tightening Up Land Management, issued on Oct. 21, 2004;

● Real Right Law of the People's Republic of China, implemented from Oct. 1, 2007;

● Regulation of the People's Republic of China on the Disclosure of Government Information, implemented from May 1, 2008;

● Regulation on the Expropriation of Buildings on State-owned Land and Compensation, implemented from Jan. 21, 2011;

● Measures on the Assessment of Houses on State-owned Land to Be Expropriated, implemented from June 3, 2011;

● Measures of Henan Province for the Implementation of the Land Management Law (Dec. 1, 1999);

● Ministry of Land and Resources Guidance on Improving the Land Requisition Compensation and Resettlement System (Nov. 3, 2004);

● Henan Province People's Government General Office Comments on Regulating the Distribution and Use of Land Requisition Compensation for Peasant Collectively Owned Land (YZB (2006) No.50) June 22, 2006;

● Henan Province Department of Labor and Social Security, Circular of Publicizing the Social Security Expense Standard for Comprehensive Land Price of the Land Requisition Sections (YLSB (2008) No.72);

● Henan Province Department of Labor and Social Security, Henan Province Department of Land and Resources, Henan Province Financial Department Comments on Implementation of Vocational Training and Social Security Works for the Land-Requisitioned Peasants (YLS [2008] No.19) Nov. 26, 2008;

●Henan Province People's Government, Circular on Publicizing and Implementing the Standard of Comprehensive Land Price of the Land Requisition Sections in Henan Province YZ (2009) No.87, Oct. 16, 2009;

●Ministry of Land and Resources, Circular on Further Improving Land Requisition Works (June 26, 2010);

● Measures for Compensation of State Owned Land Purchase in Zhengzhou (June 5, 2008);

● Zhengzhou Municipal People's Government, Circular on Adjusting the Compensation Standards for Young Crops and Land Attachment of Farmland for Requisite Collectively Owned Land for State Building (ZZW (2009) No.127);

● Regulations on management of Zhengzhou Urban Construction Dismantlement (revised in 2005) (November 1, 2005);

● Circular on Adjusting the Standard for Demolition & Relocation Subsidy and Temporary Placement Subsidy for Zhengzhou Urban Construction (ZCGZ (2010) No.44, Nov. 17, 2010);

● Zhengzhou Municipal People's Government, Comments on Land Requisition and Demolition Compensation and Resettlement for Rail Transit Project Construction, June 2, 2009.

The land acquisition and demolition is a complicated systematic engineering widely involved, and the works directly influence the project progress. Based on the experiences of similar project, the employer can establish special agent or entrust other unit to specifically take charge of the land acquisition and demolition works of this project. According to Regulations on management of Zhengzhou Urban Construction Dismantlement (revised in 2005), Zhengzhou Municipal People's Government Administrative Department fulfills the supervision and management of demolition works of urban houses, the district people's government real estate administrative departments are responsible for the houses demolition management works in own district according to the duty allocation.

(III) Environment impact analysis for demolition and placemen

In general, the land acquisition and demolition amount involved in Zhengzhou rail transit 3 line phase I project is small due to full underground layout of the project, and the Zhengzhou Municipal Government will, according to related compensation and placement policies for land acquisition and demolition, properly arrange and reasonably compensate the masses affected by the land acquisition and demolition for rail transit construction, and guarantee their legal rights and benefits. The disputes can be effectively avoided or solved provided that it fulfills the compensation according to actual conditions of Zhengzhou city and related laws and the proper public participation. For the user of houses demolished, make overall arrangement with the principle of in favor of implementation of urban planning and urban old zone modification according to the requirement for construction areas in urban planning and the construction project property. If the residents have other houses in urban or have planned to purchase other houses, the money compensation for demolished houses will be helpful to improve their economic status and enhance the quality of life. In addition, the urban planning department will control the construction project land use according to this planning and avoid new land acquisition works as possible during implementation of this project. As indicated in above conditions, after taken proper placement measures, the adverse impact from demolition is limited, and the land acquisition and demolition problems due to rail transit construction can be properly solved with small impact on urban social environment.

5.6.2.2 Impact analysis of engineering construction on urban ecological function areas

According to Zhengzhou Eco-city Construction Planning, the entire city is divided into 5 class I ecological function areas of northwest Mangshan Mountain Landscape Ecological Tourism Zone, southwest Loess Hilly and Gully Water Conservation Zone, Yellow River Beach Wetland Ecological Protection Zone, southeast Plain High Efficient Ecological Agriculture Development Zone and middle Human Production Activities Zone. On this basis, it specified 15 class II ecological function areas and 84 class III areas, and put forth related classified control planning for ecological protection. The planning line is mainly in middle Human Production Activities Zone.

The line is laid under the existing (or planned) roads and the domestic sewage generated from its stations and car depot & integrated base is discharged into municipal pipeline network and then to the urban sewage treatment plant so that it will not lead to pollution of surface waters. At same time, the features of rail transit of less land occupation and high passenger traffic volume can effectively solve the urban traffic congestion problems, relieve the pressure on road traffic and reduce the road traffic construction land use, and therefore play an active role in optimization of urban and industry space layout. Thus, the construction of rail transit will effectively relieve the ecologic problems such as unreasonable land use structures in Zhengzhou urban ecological function areas and basically will not impose adverse impact on ecological function of various ecological function areas.

The Construction-forbidden areas in Zhengzhou include: Yellow River wetland, core area of national protection area and landscape ad famous scenery (including Songshan World Geopark, Henan Songshan National Forest Park, Zhengzhou National Forest Park, Xinzheng Shizu Mountain Forest Park, Henan Songbei Forest Park, Gongyi Qinglongshan Forest Park, Zhongmou Forest park, Henan Songshan Scenic Spot, Zhengzhou Yellow River Scenic Spot, Fuxi Mountain – Huancui Valley Scenic Spot), basic farmland preservation area, geological disaster prone areas (including debris flow prone areas, mine goaf), underground mineral reserve distribution area, underground cultural relics burial area, water source protection zones (including surface water drinking water source protection zone, south-to-north water diversion project class I protection zone, underwater source core zone, river headwater, river and lake wetlands), main floodwater drawoff passage, large scale infrastructure gallery and its control belt (including west-east natural gas transmission trunk line, Zhongyuan Oil field long distance transport pipeline, Yima coal-gas long distance transport pipeline, Lanzhou-Zhengzhou-Changsha and Jinzhou-Zhengzhou oil pipeline, high voltage power transmission line).

Except Jialu River parking depot, the rain transit 3 line phase I project is within the urban built-up area and planning area and does not involve the construction control area and construction-forbidden area range in the ecologic function zone planning. The land use of Jialu River parking depot is of normal construction land, not of construction-forbidden zone.

5.6.2.3 Impact analysis of engineering construction on the vegetations and urban green lands along the line

(I) Impact on vegetation along the line

In comparison with urban ground traffic, the construction land occupied for urban rail transit is far less and the urban construction land scale along project line can be effectively controlled. The project line is mainly laid along existing road so that it can minimize the urban green land occupation while relieving the ground traffic, and also benefit for the construction and recovery of urban ecological infrastructures such as green land so as to improve the urban landscape.

(II) Impact on urban green land

The urban green land occupation of the project is mainly of the occupation of road greening belt by ground buildings such as station entrance/exit and ventilation pavilion. Through greenling land restoration, this project construction will not reduce the urban greenland, but also can increase the public green land volume after taken proper restore measures (such as parterre above the entrance/exit) and enhance the urban greening coverage rate. In addition, the construction of parking depot and repair depot will damage original agriculture vegetations and green lands, so the greenling design in combination of trees, shrubs and grass will be adopted for the ground buildings and surroundings and interior of fields after project construction so as to effectively restore the vegetation volume.

Before engineering construction, submit to competent authority for approval according to related provisions in Regulations on Zhengzhou Urban Greening Management article 27, and obtain temporary greening land occupation permit and properly compensate the owner unit of greenland before occupation (the temporary green land occupation period must not exceed the construction period of the project, and it must be returned at due time and restored); during construction, it is necessary to strengthen the construction organization design and reduce the occupation amount and period of green land as possible; after construction, it must compensate and restore the damaged green land. The farmland surface cultivated soil in excavation sections shall be independently deposited during construction for later greening or ecological recovery.

Nanyang Road is of the old city area and the trees along the street are mainly of old Chinese scholar tree; a number of sycamore trees with the breast diameter of more than 20cm at Chengdong Road and Zhengbian Road; although these street trees do not reach the protection specification for old and valuable trees, it remarkably improves the urban landscape. If it is confirmed to transplant these Chinese scholar trees or sycamore trees during station or ventilation pavilion construction, firstly consult with the expertise of related departments and prepare transplant program to ensure the survival rate. Following aspects shall be noticed during transplant:

(1) Select proper time for transplantation of large tress. Once the engineering program determines the transplantation of trees, select the transplantation time as early as possible.

(2) Take proper treatment measures and digging measures for large trees before transplantation, such as trimming of branches and wrapping of tree roots.

(3) Select proper transport method and transplantation site for placement of the trees. The above aspects can ensure high survival rate of large tree transplantation.

Meanwhile, for the landscape damage due to tree transplantation during construction, it shall be recovered with proper greening trees such as camphor trees and Chinese scholar trees which are suitable for Zhengzhou local conditions so as to maintain the landscape coordination.

(III) Species selection for urban greening trees

According to site actual investigation, the main plants planted in the streets in Zhengzhou city include: Platanus orientalis, goldenrain tree, photinia serrulata, ligustrum vicaryi, dragon juniper, cedar, boxwood, small-leaf privet, large-leaf privet, Chinese scholar tree, Chinese Rose, southern magnolia, gingko, Ailanthus altissima, Sabina chinensis, aspen, silk tree, crape myrtle, flowering peach, Prunus cerasifera, pyracantha crenatoserrata, Cericis chinensis, hibiscus, nandiana, berberis thunbergi, clove tree, magnolia, photinia glabra, sweet osmanthus, cherry, pomegranatel, pittosporum.

We has also investigated 10 roadside parks such as Lvchegn Squre; the main tree species planted include: prunus cerasifera, salix Salix x aureo-pendula, Chinese Rose, mahonia, Nandina, Chinese little leaf box, Cericis chinensis, southern magnolia, gingko, palm, Mount Huangshan, crape myrtle, berberis thunbergi, ligustrum vicaryi, Viburnum odoratissimum, pyracantha crenatoserrata, small leaf privet, large leaf privet, silk tree, loquat, sweet osmanthus, Juniperus formosana, black pine, five-leaved pine, juniper bush, photinia serrulata, dragon juniper, Chinese holly, Golden scholar tree, oleander, forsythia, Chinese juniper, oriental arborvitae, pittosporum, Sabina procumbens, Magnolia, sisal hemp, Sabina chinensis, Chinese pagoda tree, kerria japonica, Chinese scholar tree, weeping willow, bamboo, Sweet Olive.

Above greening trees have favorable cultivation experiences and adaption. Except the allergic plants with willow blossoms and odors such as willow, others are recommended as the greening garden tree specs for this project.

5.6.2.4 Ecological impact analysis of water and soil loss

By estimation, the quantity of earth work of car depot and parking depot, station and section is 4.974 million m^3 in total, in which the excavation of 3.705m^3 and back filling of 1.269 million m^3. The line construction range is large with wide earthwork area and it will lead to severe water loss and soil erosion. In addition, most of rainfall in Zhengzhou city concentrates in June to September, which amounts 60% of annual precipitation, which provides the dynamical conditions for water loss and soil erosion. So the water loss and soil erosion issue during construction period must be emphasized.

Table 5.6-2 Balance sheet of project earthwork

Sub item	Excavation ($10,000m^3$)	Fill ($10,000\ m^3$)	Total earthwork volume
station	266.1	29.3	295.3
section	53.1	5.8	58.9
The parking lots	12.0	27.9	39.9
Car depot	39.3	63.8	103.2
total	370.5	126.9	497.4

Except the Jinshui Road Station adopts cover-excavation method construction, other stations in the line adopt open-cut method construction. The open-cut method not only damages the road surface and moves the underground pipelines, and also features wide construction working face and excavation area and large excavation earth volume, and requires backfill, so the water loss and soil erosion is severer than covered excavation method. The parking depot and repair depot are the construction sites with maximum area, and they require excavation and backfill during construction, so it will veritably lead to water loss and soil erosion.

The water loss and soil erosion during construction not only affects the construction progress, but also imposes other environment impact. The silting and mud on road will suffer the pedestrian and traffic. The rain water with silt enters municipal rain pipe and ditch. The silt deposition may block the pipeline and ditches and impact the drainage capacity, and therefore further worsen the urban water ponding during rainy season. Based on above analysis, it is necessary to take measures to control and minimize the hazard during planning implementation process.

The specific soil and water conservation measures include: prepare scientific and reasonable construction program, reduce the land occupation and vegetation destroy; reasonably determine the construction period and avoid the centralized construction in rainstorm season so as to prevent soil loss from water erosion, avoid construction in gale season so as to prevent soil loss from wind erosion; prepare adequate protection devices for rainstorm during construction period such as covering net, tarpaulin or grass mat to cover the rupture face of construction works, and properly fulfill the prevention and drainage works before rainy season so as to control the water loss and soil erosion as possible; during the excavation of surface soil for fill construction, the surface soil must be properly deposited and protected to avoid the spoil directly flushed by rainfall runoff into municipal rain or sewage pipeline and ditch; during construction period, to prevent the flushing and silt-up of project or other buildings and other facilities, the temporary drainage facilities shall be built to keep proper drainage conditions of construction site. The temporary drainage facilities shall combine with permanent drainage facilities so as to prevent silt-up, blockage and flushing; select proper enclosure structure type and internal support system, reduce excavation amount, timely remove the spoil and construction waste and determine the disposition of engineering waste slag; the spoil field shall be orderly and stably deposited with smooth drainage so as to prevent interference or damage of buildings near the spoil (slag) pile, drainage and other designs, and minimize the water loss and soil erosion; intensify the temporary greening of field, adopt native species, strictly control the construction excavation disturbance range, strengthen the survey and observation at outlet of drainage facilities, ensure cleaning and sprinkling of construction field and prevent the raise dust polluting the urban air environment; implement full process management of construction project, especially the water and

soil reservation monitoring during construction period; if required purchasing the sand, soil and stone materials during construction, it shall explicitly define the control responsibility of water loss and soil erosion incurred in purchase contract, and define that the unit prices of soil and stone materials have included related water loss and soil erosion control expense.

In addition, it shall conduct application registration and clearing management according to related requirements in Regulations on Administration of Zhengzhou Urban Environment Sanitation and the solid waste treatment administration.

5.6.3 Analysis and protection measures of urban landscape environment impact

The landscapes are divided into two levels of visual landscape and ecological landscape. The visual landscape refers to the observed general vision of ambient environment. The urban visual landscape refers to the combination of urban natural landscape, building landscape and culture landscape. The ecological landscape is the aggregation of different ecological systems, and made up from model lands, piece blocks and galleries. The urban ecological landscape refers to the spatial structures and appearance forms of all spatial range or urban layout of the city. The urban landscape is mainly restricted by the factors such as city features, urban development planning and surrounding environment characteristics.

5.6.3.1 Overview and present status of urban landscape along project line

The areas for locations of parking depot and individual stations to be built in the project are of farmland and waste land, presenting the farmland ecological landscape; the regions passed by the line sections consist of city artificial buildings and road, presenting typical urban ecological landscape. The car depot area is mainly of forest ecology landscape. There are various function blocks such as dense residential area, commercial center, traffic hub, large scale public building, scientific and education unit and public facilities along the line, but the dense population and unsmooth ground road traffic gallery in the regions along the line severely restricts the mitigation of people stream, material flow, energy and information and therefore influences the stability of landscape ecological systems in regions along the line.

According to field survey, there are dense buildings in Erqi Square Station, Shuncheng Street Station, East Street Station, Chengdong Road Station passed by phase I project line and they are located in visual sensitive area with high landscape requirements. The line of this project is laid in underground form, so the engineering factors for landscape impact are mainly of station entrance/exit and ventilation pavilion, and the landscape factors include the appearance, structure and coordination with entire contraction zone.

5.6.3.2 Impact analysis of engineering construction on urban ecological landscape

The urban landscape consists of many ecological systems centered on mutual relationship of human and environment. The urban landscape ecological structure is fragile with low automatic adjustment capability, and highly depends on the input/output of ecologic flows such as material flow and energy flow to maintain the own stability.

The traffic gallery is the only way for urban ecological system energy flow, material flow, information flow and population flow. The smoothness of traffic gallery is the premise of completeness and smoothness of urban functions.

After put into operation of this project, as artificial traffic gallery, the link effect of its traffic transportation combines the basic urban function piece blocks, including large amount of resident area, commercial area, traffic hub, large public building and science & education units, into a complete structure system, enhances the communication of various function blocks landscape in the regions along line, enables the smooth input and output operations of various ecological flow between function blocks along the line, so as to ensure effective operation of city, enhance the stability of urban landscape ecological system and ensure urban healthy development.

Since the subway gallery passes under the ground in urban area, it minimizes the separation of various function blocks along the line and therefore will not increase the fragment of urban landscape; it has no cross interference with ground traffic galleries and features large traffic capacity, quick, comfort and on schedule so that it can attract large ground passenger flow and relive the ground road congestion while maintaining the smoothness of own gallery.

The artificial galley construction not only considers the economic benefit of galley, but also the environment benefit of gallery so as to achieve harmonious urban landscape structure. The rail transit has the advantages of environment friendly, energy saving and high efficiency, so the project can reduce the damage to environment as possible while improving the along-line landscape stability and facilitating the along-line regional economical development.

5.6.3.3 Impact analysis of engineering construction on urban visual landscape

The urban landscape ecology requires coordination of natural landscape, urban buildings, urban resource development, economical development and protection of ecological environment so as to ensure orderly development of city, solve the city ecological problems and form the virtuous cycle of urban ecological system. This landscape impact assessment will emphasize the coordination of project buildings such as subway ventilation pavilion and station entrance/exit with urban visual landscape.

(1) Landscape impact analysis on car depot and the parking lots and main substation

The current situation of the depot and parking lot are green lands and fruit farm etc.. See Figure 5.6-1 and 5.6-2 for the current situation.

Figure 5.6-1 Current Land Occupation by Construction of Parking Lot

Figure 5.6-2 Current Land Occupation by Construction of car depot

For the landscape design around car depot & integrated base and main substation, the greening shall give priority to local native plants and also the fruit trees, but favorable for evergreen and flower species, and dynamically combine the arbors, shrub, flowers and grassland with proper colors and pattern combination so as to form a beautiful seasonal landscape.

(2) Landscape impact analysis at station entrance/exit and ventilation pavilion

Based on the principles of unification of ecology landscape structures and functions, the structures and appearances of underground station entrance/exit shall be subject to the access functions of rail transit. From the view of urban landscape composition, the beautiful city shall have the clear and identifiable features, i.e. clear understanding of districts, roads and objects, and be easy for get awareness of the overview and features of city and make people ease without confusion. The station entrance/exit, for its small land use and building volume, is less attractive; however, the design of building type, mass, height and color of entrance/exit at sensitive section must be uniform with the old town landscape; in suburban area, the station is more attractive, but the overall landscape sensitivity is low, so the design has more extension scope and it is easy to achieve the coordination and unification with surrounding landscape environment.

The design of ventilation pavilion shall firstly consider the combination with existing or newly-built structures, and then the independent devices for different models so as to coordinate with surrounding buildings and ensure the unique scene of each station at same time; thus they can adorn the urban landscape and beautify the urban living environment, and make each entrance/exit, ventilation pavilion and cooling tower as a work of art of city. (The details refer to figure 5.6-3, 5.6-4) .

Figure 5.6-3 Station entrance/exit landscape

Figure 5.6-2 Station ventilation pavilion landscape

The land areas in the locality of the stations(entrances, exits and ventilation pavilion) along the phase project of No. 3 line are mostly urban construction land.

The design of this subway project station entrance/exit shall consider as much as possible the models, coordination with ambient environment, night time lighting and surrounding greening to keep uniform styles for its design structure and appearance so that it can enhance the urban impression for visual joy, but also provide convenience for access of local residents and the riding of rail transmit by visitors and business from other cities.

For the design of entrances and ventilation pavilion of 10 stations including Weilai Avenue Station, Fengtainan Road Station, Zhongzhou Avenue Station, Tongtai Road Station, Huanghedong Road Station, Nongyedong Road Station, Zhongxing Road Station, Boxue Road Station, Hanghai East Road Station, it shall consider in principle their location of new district and economic development zone, which is an integrated modern new downtown and CBD of commercial, office, information and business functions, so their structures and appearances shall be uniform as possible; adopt blending landscape design handling principle to uniformly plan and construct with surrounding buildings and construct the ventilation pavilion station, pavilion and other

ground buildings together to meet the design requirements of local urban regions.

For 5 stations in Zhengzhou old town area including Xinglongpu Road Station, Dongfeng Road Station, Nongye Road Station, Huanghe Road Station and Jinshui Road Station, there are dense buildings around the stations and the ground buildings appears crowded. The rail transit construction shall be considered together with Zhengzhou old town reconstruction planning and Nanyang Road expansion project; The along-line regions integrates the functions of resident, commercial, traffic connection, special mending and lacing, so the design of the stations and ventilation pavilions in this section shall be arranged in combination with surrounding buildings as possible, and it can consider the joint construction with existing ground buildings if conditions allow so as to ensure the coordination of station buildings with surrounding urban building landscape, reduce the impact of newly built facilities on ground landscape visual effect and make them open space presenting the urban style.

For Erqi Square Station and Chengdong Road Station, since they are near national and provincial historic sites to be protected such as Memorial Tower for February 7th Strike, Zhengzhou Confucius Temple and Zhengzhou Shang Dynasty Relics and there are many modern buildings such as Hualian Shopping Center, Wanda Plaza and Zhengzhou Department Store, and also near 3 historic and cultural blocks of Shuyuan Street, Confucius Temple- Chenghuang Temple, Dehua Street-Datong Road, the design of entrance/exit and ventilation pavilion of these stations shall fully consider the actual conditions and adopt the combination design concept of blending method and hidden method to both reduce the impact of station entrance/exit and ventilation pavilion on ground landscape visual effect, and not lose the eye-catching state of station building so that it can maintain the open landscape space of Zhengzhou city and surrounding grandeur feeling, but also blend into the modern atmosphere.

(3) Impact analysis on scenic spots around construction sites

Since this project adopts shield method construction, the construction sites during construction mainly focus on the area near the station, the ambient environments of construction sites of Line 3 phase I project can be classified as following types. The details refer to table 5.6-3.

Table 5.6-3 Environment in areas around engineering construction site

No.	Section name	Present status of surrounding area environment
1	Start point--Xinglongpu Road Station	Present as farmland ecologic system of mountains and hills; the whole section is planned as urban suitable construction land in new round of planning
2	Xinglongpu Road Station --Nongyedong Road Station	Present as typical urban ecological system of communities and commercial office buildings
3	Nongyedong Road Station –Destination	Present as farmland, and this area is planned as economic development zone in new round of planning.

For the construction site in section from start point to Xinglongpu Road Station, the original surface is severely disturbed during excavation with the vegetation destroyed and naked soil (which is apt to water erosion), so it shall focus on the coordination with surrounding ecological functions and take measures such as planting turf besides removal and clearing of construction waste soil and leveling of construction site.

For the construction site in section from Xinglongpu Road Station to Nongyedong Road Station, it shall clear and restore the roads and municipal land occupied during construction period so as to restore the landscape. The measures to be taken mainly include: clear and remove the construction waste soil solid waste and building waste during construction period; restore the municipal lands such as roads occupied during construction period; plant proper urban greening vegetation and maintain original urban greening belt and forest coverage rate.

For the construction sites from Nongyedong Road Station to destination, since this area is planned as urban public green land, it shall be planted with proper species of urban greening trees after construction to restore the ecologic landscape and comply with the urban general planning.

5.6.4 Summary

The urban rail transit system is an important part of urban structure, and also the main space for urban public livings. It directly involves in the formation of urban appearance and style and the living and communication environment of citizens, and becomes the long term daily visual aesthetics object to provide aesthetics outlook and living experience for residents, and also the components of city culture. Zhengzhou is a famous historic city and also a modern city with enormous development potential so that the historic landscape protection in modernization construction is a critical issue to ensure sustainable development of Zhengzhou city. As the new buildings added into the environment, the arrangement of subway ventilation pavilion and entrance/exit shall fully consider the city features and land use pattern, comply with the urban general planning, focus on historic continuity and culture completeness, strengthen the protection of historic relics and landscapes and alternation and blending of the new and the old and ensure the coordination and unity of urban style, clear overall arrangement, complete special development sequences, coordinative body, color and texture treatment so as to establish the aesthetics feeling artificial landscape in coordination with the environment, set up the modern city image with rich culture intension and features of times and enable the station buildings be an integral part of ambient environment.

5.6.5 Conclusion and suggestion

5.6.5.1 Conclusion

(1) The project does not involve any ecological sensitive area such as natural reserves, scenic spot and basic farmland conservation area.

(2) After construction and operation of this project, it will enhance the connectivity of all function block landscapes along the line, keep the smooth input/out operation between the function blocks, ensure the high efficiency operation of city, enhance the stability of urban landscape ecological system and ensure the healthy development of city.

(3) According to the landscape aesthetics analysis and analog survey analysis, if fully considered the unique historic city property of Zhengzhou city and land use pattern

and adopted the design with blending method and hidden method, it can keep the coordination of ground buildings such as station entrance/exit and ventilation pavilions with ambient environment.

(4) The construction of rail transit has remarkable advantages in saving of land resource and energy, and in favor for integration and modification of Zhengzhou land resources, relief of regional land utilization pressure and improvement of land utilization efficiency.

5.6.5.2 Suggestion

(1) The arrangement of ventilation pavilion and station entrance/exit of this project shall, in the principle of protecting traditional landscape and respecting the local features, focus on the harmony and unity between Zhengzhou ecological construction and modern landscape. Under the conditions of meeting the construction access and ventilation requirements, it shall strive to merge into the ambient urban functions and coordinate with ambient building styles and landscapes. It is possible to plant surrounding dense multiple-layer vegetation such as shrub and grass so as to enclose the hardness space of building into soft space with the mediation effect of vegetation and therefore integrate the building space of station entrance/exit with ambient environment, increase the landscape ecological function and create a harmonious ecological environment of human and nature. Especially the areas near Memorial Tower for February 7th Strike, Zhengzhou Confucius Temple, Zhengzhou Shang City Ruins, and 3 historic and cultural blocks of Shuyuan Street, Confucius Temple-Chenghuang Temple, Dehua Street-Datong Road, which have the Zhengzhou feature and represents the historic and cultural connotation of Zhengzhou, the design of entrance, ventilation pavilion and cooling tower shall ensure the integration with surrounding environment; the low rise type ventilation pavilion and the ground buildings integrated in ambient environment are preferably designed.

(2) Properly fulfill the planning of permanent land use and temporary land use during project design phase so as to minimize the occupation of green land and the impact of rail engineering construction on along-line urban green land system. For the green land occupied by the project, the employer shall carefully execute various application and approval processes, organize the construction strictly according to approved the land use range, fulfill necessary recovery and compensation for occupied green lands and recovery their ecological functions as soon as possible.

(3) The project shall strengthen the greening and ecological construction in yard during construction process, focus on the protection of ecological environment in this region, reasonably plan the land use along the line, reserve the greening land and intensify the greening design in full land use range. Protect the vegetation in the land acquisition and along-line range during construction period, minimize the damage of forest, grassland and scrub around the temporary land use and operation area.

(4) For the construction site in the section from Zhengzhou west railway station to Longgang Station, it is necessary to, besides removal of construction waste soil and leveling of construction site, pay more attention to the consistent with surrounding ecological functions such as planting of turf. For construction site in the section between International Sports Center Station and Xinjia'an Station, restore occupied municipal land such as road during construction period; plant proper urban greening

vegetation and remain original urban greening belt and forest coverage rate.

(5) During operation period, the car depot & integrated base and substation will be completely afforested and the greening tree category shall meets the requirements of coordination with ambient landscape, improvement of ecological balance, rehabilitation and optimization of along-line environment. The greening tree category shall be mainly of local indigenous plant so as to form stable community structure with surrounding plants and prevent the biological invasion and impact on the stability and biological diversity of regional ecological system.

(6) The construction unit shall, in combination with Zhengzhou climate and according to the regional rainfall features, prepare the construction organization plan of earthwork and avoid large scale earthwork construction in rainy season; during earthwork construction, it is necessary to take necessary sole and water conversation measures and implement the road surface drainage works simultaneously so as to prevent the formation of runoff of surface during rainy season which may directly flush and lead to collapse of vertical excavation face or bottom ponding. The construction waste slag shall be timely removed and the subgrade face filled shall be timely compacted and properly protected; during construction in rainy season, it is necessary to ensure smooth drainage system at construction site.

5.7 Ambient air influence predictive assessment and measures of ambient air protection

5.7.1 Air pollution source

5.7.1.1 Air pollution source during construction period

The air pollutant emission during construction period mainly comes from the raise dust generated by construction excavation, material placing, earthwork transport and construction materials such as yellow sand and cement, and fuel exhaust emitted by construction machinery and heavy transport vehicles during operation period. The main pollutants include raise dust, smoke, sulfur dioxide (SO2) and nitrogen oxides (NOX).

5.7.1.2 Air pollution source during operation period

After completion of this project, the EMUs for train have no locomotive exhaust emission. The air pollutant emitted only includes a few exhaust gas emitted by the diesel locomotive for car depot & integrated base, which is of mobile source. The main pollutants include NO2, SO2 and flues, of which the exhaust pollutants emission is low with minor air environment impact

The exhaust of underground station ventilation pavilion may lead to certain odor impact. The exhaust odor from ventilation pavilion during initial operation period may be large, which is mainly due to the volatilization of various harmful gases from composite materials and devices used by the subway project. As the time goes on, this

part of gas will gradually reduce, it is hard to feel the odor at the area more than 15m downwind from the exhaust pavilion. In addition, the analog survey indicates there is basically no odor feeling for the ventilation pavilion at sides of road.

The passenger transport volume of rail transit is large and it can substitute for many ground road traffic after put into service and therefore significantly reduce the automobile exhaust pollutants emission. At initial phase, the reduction volumes of bus exhaust pollutants emissions of COand NOx are separately of 111.6 and 30.9t/a and these reductions will be more at short term and long term. The rail transit is more rapid and comfortable than the bus, and can reduce the bus exhaust pollutants emissions as well as inhalable particle concentration in air so that it benefits for the improvement of environment air quality in Zhengzhou city.

5.7.2 Predictive assessment

5.7.2.1 Air environment predictive assessment during construction period

(1) Raise dust production mechanism

The possible drift distance of dust particles under the effect of wind or handling and vehicle movement will be affected by the initial speed, particle diameter and atmosphere turbulence intensity; the theoretical drift distance is the function of particle diameter and average wind speed. In case of wind speed of 4 - 5m/s, the drift distance for the dust participle of about 100μm diameter is 7 - 9m; for the dust particles of 30 - 100μm, the drift distance may be up to hundreds meters according to atmosphere turbulence intensity; for the dust particles of less diameter, its drift distance will be ever further.

The raise dust emission in construction site in positive relation to the ground dust quantity, flow of transport vehicles, traveling speed, deadweight and wind speed, i.e. the more the ground dust quantity, the higher the traveling speed, the larger the load, the higher the wind speed, and then the more the raise dust emission is..

During demolition of housing, various fine particles will form the raise dust under the demolition external forces, and the cleaning of construction site, deposition and transportation of building wastes will also lead to raise dust pollution. The raise dust quantity from housing demolition relates to the demolition method, protection measures (if any) and present climate conditions;

The construction of ground stations and car depots of this project will veritably form many construction exposed surfaces. The construction exposed surfaces is very easy to produce raise dust under dry and windy climate conditions. In addition, the slag and spoil from this project construction are mainly of clay silt, which has large viscosity under high moisture and therefore is hard to produce raise dust. However, the fine soil layer with small diameter will form after the surface dried and the fine dust will drift into the air due to human activities such as handling, movement and vehicle traveling or when the wind speed reaches related startup value, and then form the raise dust.

The raise dust generated during vehicle transportation mainly includes following three aspects:

The vehicle stirs the ground dust when driving in construction area and forms the raise dust;

During loading and transport process of dregs and soils, if not tightly and properly covered, the dregs and soils may scatter on the road during high speed traveling and jolting and then form the raise dust after rolled by the vehicles. According to the analog survey for Zhengzhou dregs and soils transport vehicles, the average scattering amount of dregs and soils for each vehicle is more than 500g.

When the transport vehicle travels out of construction site, the wheels and chassis normally will carry certain number of soils due to contact with the dregs and soils. The carrying soils will scatter on the road and therefore form the raise dust. According to the survey, the average soil carrying amount of each vehicle driving out of the site is more than 5000g.

The soils of access roads mainly scatter on the road surface of 1.2m wide and 1200m away from the construction site. The average surface dust amount is 190.2g/m^2 and it is 39 times of that of road surface not affected by the construction. If the construction dregs and soils are deposited at the road side with vehicle passing, the average surface dust amount is 319.3g/m^2 and it is 67 times of that of road surface not affected by the construction.

(2) Impact analysis

Sine most of the construction sites are near the traffic roads, the construction machines and transport vehicles with the fuel as power source emit certain amount of exhaust near the construction site. Although the total amount of exhaust emission in the region increases, it will not impose remarkable impact on ambient air environment as long as to strengthen the servicing of devices and vehicles, ensure no emission of soot not completely combusted and strictly comply with the regulations on motor vehicles in Zhengzhou city.

The excavation and drilling on dry ground surface may generate the fine dust; in addition, after the original vegetation is destroyed during construction period, the ground surface is exposed with water evaporated and forms the dry and loose particles, and it will generate the raise dust in case of large wind or backfilling. A part of fine dust floats in the air and the other part drifts to nearby ground and building surface with the wind. The fine dust pollution during construction has large harness. If the fine dust floating in the air is inhaled by the construction staff or surrounding residents, it will lead to various respiratory diseases, and may also heavily impact the healthy because the fine dust carries large amount of pathogenic bacteria; the flying fine dust will also reduce the visibility and may lead to traffic accident; the fine dust drifting on various buildings and tree leaves may impact the landscape.

The impact duration of secondary raise dust from transport vehicle is the longest and the impact degree will significantly increase for the damage of road surface and mud explosion in construction site. It is predicted that the raise dust quantity depends on road surface dust deposition amount under constant vehicle speed and weight. The larger the dust deposition amount, the heavy the secondary raise dust. Since the transported construction materials in this project are mainly of underground deep spoil with certain humidity, so the raise dust generated by the construction transport

vehicles in this project will only influence the residents near the construction site, especially the residents in first row of buildings.

5.7.2.2 Air environment predictive assessment during operation period

In combination with the features of this project, the subway train adopts electric traction without fuel exhaust emission. The air pollution source is mainly of the odors emitted from exhaust pavilion. So the ambient air impact assessment of this project is mainly for the impact of gas emission from subway exhaust pavilion on nearby resident living environment.

(I) Main job contents

The main job contents of ambient air impact assessment include:

(1) Briefly analyze the impact of odor emission from underground station ventilation pavilion.

(2) Predict and calculate the total air pollutant volume emitted by integrated base track cars.

(3) Predict the reduction of automobile exhaust pollutants emission due to substation for bus traffic by rail transit after put into service.

(II) Assessment method

(1) With analog method, predict and briefly analyze the impact of odors emitted from ventilation pavilion on ambient environment;

(2) Adopt pollutant emission factor method to calculate the pollutant emissions from integrated base shunting locomotive and reduction of automobile exhaust pollutants emission due to substation for bus traffic by rail transit after put into service

(III) Environment impact analysis of odors emitted from ventilation pavilion

(1) Cause analysis of ventilation pavilion exhaust odor

The gas emitted from subway station exhaust pavilion, not exposed to sunlight for long term in underground station, will breed the mould in dark and damp environment and emit stale odor; the power system during vehicle operation will increase the ambient air temperature in underground space and the vehicle passing and access of passengers will bring in large amount of dust and therefore increase the dust content of air; the CO2 exhaled by the crowd will increase the CO2 concentration in air; the high voltage electric spark between vehicle pantograph and contact devices will generate ozone in the air; the sweat volatilization and various composite materials sued for internal decoration engineering of underground stations will also give out harmful gas, and so on. According to the odor survey of existing subway station exhaust pavilion in domestic, the stale odor is the main component of exhaust odor in underground station ventilation pavilion, even if at the initial operation phase.

(2) Analog monitoring and analysis of emission from ventilation pavilion

A. Analog survey location

Shanghai M8 line Xiangnan Road was built in 2007 and has been normally operated for more than one year till now. The vehicles is of type C car for EMUs with variable voltage variable frequency regulation and control receiving the power from the catenary.; there are 263 pairs of trains at day time and 12 pairs in night time; there are an air supply duct and an exhaust duct separately arranged at ends of stations, and the station public area air treatment system is made up from the supply/exhaust duct in station and the air supply/exhaust fan in them, silencers and combination air valves so as to ensure the minimum fresh air operation in air conditioning reason in public areas, full fresh air conditioning operation and ventilation operation during non-air conditioning season.

B. Monitoring overview

a. Monitoring factor: according to exhaust characteristics of subway ventilation pavilion, determine the monitoring factors as follows: odor concentration, volatile gas (including 59 indexes such as Benzene) and particles.

b. Monitoring time and frequency: in April 17th in 2009, Shanghai Environment Monitoring Center conducted related monitoring for the gas emitted from exhaust pavilion at Xizangnan Road station of Shanghai rail transit No.8 (M8) line. It took four times samplings and analysis for two factors of odor concentration and volatile gas at each measurement point, and conducted once monitoring for the particles, and also the synchronous meteorological observation.

c. Layout of monitoring points: there are four monitoring points. 0# measurement point mainly reflects the source intensity and it is located in pipeline of ventilation pavilion; 1# and 2# points mainly reflect the attenuation rules after emitted into the environment and are located at downwind 2m and 10m from the outlet; 3 position is close to the road and mainly reflects the environment background conditions. Take the samples simultaneously at 4 monitoring points and the specific positions of monitoring points are as follows:

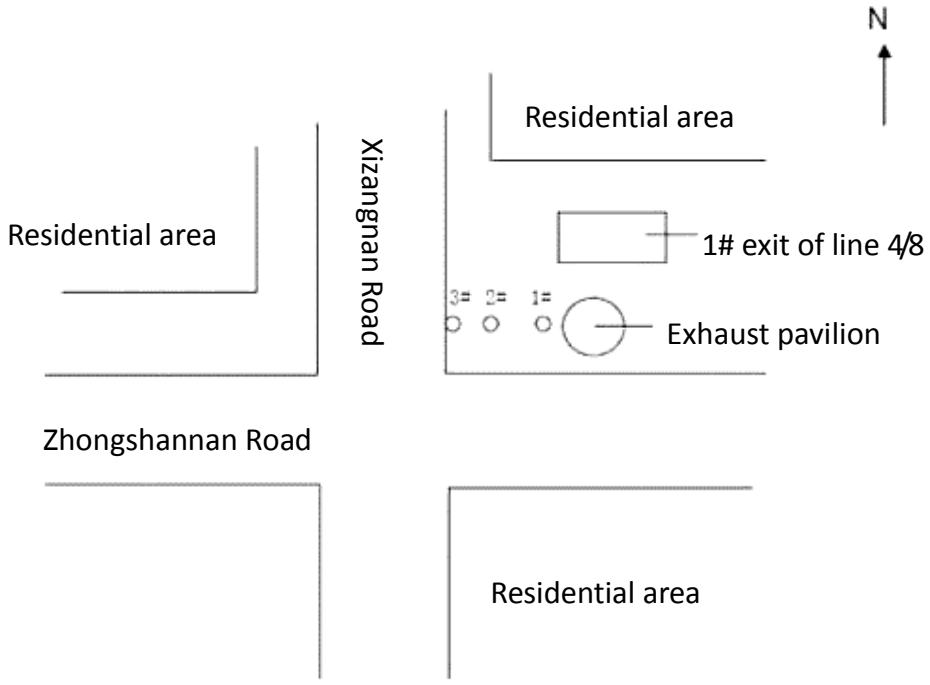
0# monitoring point: in internal pipeline of ventilation pavilion;

1# monitoring point: 2m down wind at outlet of ventilation pavilion;

2# monitoring point: 10m down wind at outlet of ventilation pavilion;

3 monitoring point: 15m down wind at outlet of ventilation pavilion;

The specific positions of monitoring points are as follows:



1# measurement point is located at 2m downwind from 1# exit exhaust pavilion;

2# measurement point is located at 10m downwind from 1# exit exhaust pavilion;

3 measurement point is located at 15m downwind from 1# exit exhaust pavilion;

Figue 5.7-1 Schematic diagram of measurement points locations

C. Monitoring result analysis

Since the odor concentration and volatile gas have no related environment air quality standard, the monitoring makes reference to the monitoring concentration limits in GB16297-1996 “Integrated Emission Standard of Air Pollutants” and GB14554-93 “Emission standards for odor pollutants” for related analysis. In 59 indexes of volatile gas monitored, only 4 items of benzene, toluene, dimethylbenzene and chlorobenzene have related standards in B16297-1996 “Integrated Emission Standard of Air Pollutants”. The monitoring statistics results refer to table 5.7-1, 5.7-2 and 5.7-3.

Table 5.7-1 Statistics table for monitoring results of volatile gas (mg/m^3)

Monitoring point location	1st				2nd				3rd				4th			
	Benzene	Toluene	Dimethylbenzene	Chlorobenzene	Benzene	Toluene	Dimethylbenzene	Chlorobenzene	Benzene	Toluene	Dimethylbenzene	Chlorobenzene	Benzene	Toluene	Dimethylbenzene	Chlorobenzene
In internal pipeline of ventilation pavilion	ND	0.0525	ND	ND	ND	0.145	ND	ND	ND	0.0425	ND	ND	ND	0.0600	ND	ND
2m down wind at outlet of ventilation pavilion	0.0019	0.0152	0.0064	ND	0.0026	0.007	ND	ND	0.0021	0.0103	0.0052	ND	0.0014	0.0115	0.0019	ND
10m down wind at outlet of ventilation pavilion	0.0017	0.0095	0.0028	ND	0.0021	0.0064	0.0064	ND	0.0019	0.0072	0.0069	ND	0.0016	0.0092	0.0019	ND
15m down wind at outlet of ventilation pavilion	0.0015	0.0136	0.0033	ND	0.0021	0.0063	0.0027	ND	0.0023	0.0055	0.0019	ND	0.0013	0.0146	0.0017	ND
Class 2 value in Integrated Emission Standards of Air Pollutants	0.40	2.4	1.2	0.40	0.40	2.4	1.2	0.40	0.40	2.4	1.2	0.40	0.40	2.4	1.2	0.40

Table 5.7-2 Statistical table of monitoring results of odor concentration (dimensionless)

Monitoring point location	1st	2nd	3rd	4th
In internal pipeline of ventilation pavilion	30	30	73	30
Downwind 2m from the outlet of ventilation pavilion	32	23	32	68
Downwind 10m from outlet of ventilation pavilion	62	26	28	26
Downwind 15m from outlet of ventilation pavilion	Less than 10	24	49	28
Class II value in “Emission standards for odor pollutants”	20	20	20	20

Table 5.7-3 Statistics table for monitoring results of particles (mg/m^3)

Monitoring point location	1st
In internal pipeline of ventilation pavilion	Without monitoring conditions
Downwind 2m from the outlet of ventilation pavilion	0.317
Downwind 10m from outlet of ventilation pavilion	0.559
Downwind 15m from outlet of ventilation pavilion	0.471
Class 2 value in Integrated Emission Standards of Air Pollutants	1.0

D. Brief analysis of monitoring results

a. Volatile gas

a. The monitoring results show the concentrations of 4 items in volatile gas with related standard (benzene, toluene, dimethylbenzene and chlorobenzene) are less than the concentration limits for secondary monitoring in “Integrated Emission Standard of Air Pollutants” (benzene of 0.40mg/m3, toluene of 2.4mg/m3, dimethylbenzene of 1.2mg/m3 and chlorobenzene of 0.40mg/m3);

b. The monitoring data indicate, the concentration of volatile gas materials emitted by ventilation pavilion is basically equivalent to that of ambient environment, so it can consider that there is no pollution of this category of materials.

b. Particle concentration

a. The monitoring results show the concentration value of particles at each measurement point is lower than the secondary monitoring concentration limit requirement (1.0mg/m3) in GB16297-1996 “Integrated Emission Standard of Air Pollutants”;

b. The monitoring data indicate, the concentration of particle materials emitted by ventilation pavilion is basically equivalent to that of ambient environment. Since the subway environment control system has complete dedusting system with certain vibration reduction effect for the particles of external environment, so it can consider there is no pollution of this category of materials.

c. Odor concentration

a. The monitoring results show the odor concentration at each monitoring point has exceeded the monitoring concentration reference limits in Emission standards for odor pollutants;

b. The monitoring data have no evident rule. In 4 groups of sample data, the odor concentration in the internal pipeline of ventilation pavilion is slightly higher than that at downwind 15m from the outlet of ventilation pavilion. It means, after the ambient air enters the subway environment, the odor concentration in exhaust slightly increases due to human body odor and mildew smell in underground space; however, the data at downwind 2m and 10m from outlet of ventilation pavilion show that the subway exhaust pavilion is not the unique odor source for ambient air and the road traffic exhaust is also one of the sources; the proportion of odor concentration in gas emitted by subway exhaust pavilion is not high so that there is no evident attenuation rule in various groups of data.

The survey of residents around Shanghai rail transit No.2 and No.8 lines, at initial phase after subway construction, there is strong odor feeling in downwind 0-10m range from exhaust pavilion and it has certain impact on residential environment. However, as the times go on , the exhaust odor of ventilation pavilion significantly reduces. The survey form indicates that there is odor threshold or no odor at downwind 10-15m from exhaust odor from Shanghai subway line 2 ventilation pavilion and the areas more than 15m away can not feel the ventilation pavilion odor.

In addition, the analog survey shows the odor is hardly sensed for the ventilation pavilion at road side

(3) Impact analysis of exhaust odor of ventilation pavilion during operation period

According to the station plan in feasibility study design, carry out field survey for ambient environment of all ventilation pavilions of the project, and finally determine there are environment sensitive spots at 14 ventilation pavilion areas in 13 stations and 50m range of 1 sectional ventilation pavilion 50m. The impact analysis results of subway exhaust pavilion exhaust odor on sensitive spots refer to table 5.7-4.

Table 5.7-4 extent of sensitive point affected by Wind Pavilion off-flavors

Station	Wind Pavilion location	Sensitive point Name	Distance (m)	Sensitive point overview	The degree of influence	Note
Xinliu Road Station	West Wind Pavilion：Northwest side of the intersection of Sanqun Road and Changxing Road	Building 1 of Yuhua ninth city	30	Each floor has 19 households, a total of 26 floors, a total of about 494 households facing	15m away，not affected	The wind pavilion backs sensitive point
Shamen Road Station	North wind Pavilion：North side of northwest exit, Shamen Road Station, west side of Changxing Road	Hualian family member courtyard's, Buildings 3, 4 and 5	19m	a total of about 252 households facing	15m away，not affected	The wind pavilion backs sensitive point
	South wind Pavilion,：North side of southwest exit, Shamen Road Station, west side of Changxing Road	Cityorth Shore District, 1 # and 4#building	19m	a total of about 40 households facing	Closer to the piston air pavilion, with a slight impact at the initial stage	The wind pavilion backs sensitive point
Xinglongpu Road Station	North wind Pavilion,：West side of Northwest exit, Xinglongpu Road Station	City bus company, family member courtyard , 1 # and 2# building	23	a total of about 42 households facing	After the 1 # building is demolished by engineering, Building 2# will be 23m from the wind pavilion, without effect	The 1 # building is an entrance and the location of the air pavilion.
	South wind Pavilion：West side of Southwest exit, Xinglongpu Road Station	Projects under construction (Chang Jian.Yufeng)	48	a total of about 136 households facing	15m away，not affected	The wind pavilion backs sensitive point
Dongfeng Road Station	North wind Pavilion,：North side of Northwest exit, Dongfeng Road Station, west side of Nanyang Road	Nanyang Road, No. 219 Courtyard, 4 #,6 # Building	15	a total of about 84 households facing	After the 6 # building is demolished by engineering, the 4 # building with be 15m from the air pavilion, basically unaffected	The 6 # building is an entrance and the location of the air pavilion.
		Sunshine Holiday district, 3#, 2 # Building	6	a total of about 84 households facing	Building 3 is closer to air pavilion, with greater odor impact at the initial stage	The wind pavilion backs sensitive point
	South wind Pavilion,：South side of Southeast exit, Dongfeng Road Station, east side of Nanyang Road	Fun district, Southern District, fun district building 46, 61,Liangji, family member courtyard 2	23	a total of about 81 households facing	15m away，not affected	The wind pavilion backs sensitive point
Agricultural Road Station	Northwest wind Pavilion,：Northwest exit of Dongfeng Road and Agricultural Road	Nanyang xincun street agency Xincun District 3#	20	a total of about 30 households facing	After the Nanyang New Village neighborhood office is demolished by engineering, the new village community's 3 # building will be 15m from the air pavilion, basically unaffected	Nanyang New Village neighborhood office's entrances and the air pavilion's location
		Ronghua District 3#,2#	12（2#） 21（3#）	a total of about 48 households facing	The2 # building is too near to the piston air pavilion, with greater odor impact at the early stage; the 3 # building will have little impact	The wind pavilion backs sensitive point
	Southwest wind Pavilion：South side of Southeast exit, Agricultural Road Station	Nanyang Road, No. 266 Courtyard, 3 #Building	15	a total of about 30 households facing	15m away，not affected	The wind pavilion backs sensitive point
		Nanyang Road, No. 268 Courtyard, 1 #Building	10	a total of about 24 households facing	The distance of the piston air pavilion is too close, with greater odor impact at the initial stage.	It is suggested that the location of the piston air pavilion be adjusted
Huanghe Road Station	North wind Pavilion,：East side of Northeast exit, Huanghe Road Station	Zhengzhou Textile staff apartments, 29 #, 30 # Building	4（30#）	4 floors，a total of about 500 peple	After the 29 # building is demolished by engineering, 30 # will be the nearest.	Proposed demolition
	North wind Pavilion,：East side of Northeast exit, Huanghe Road Station	Zhengzhou Textile staff apartments, 18 # to 20 # buildings	16	a total of about 64 households facing	15m away，not affected	Proposed demolition
	Southwest wind Pavilion：South side of Southwest exit, Huanghe Road Station	Garden community, 5 # building	13	a total of about 42 households facing	The distance of the exhaust pavilion is nearer, with space around	It is intended to adjust the position, without impact after the

Station	Wind Pavilion location	Sensitive point Name	Distance (m)	Sensitive point overview	The degree of influence	Note
						adjustment
	Southwest wind Pavilion：South side of Southwest exit, Huanghe Road Station	Garden community, 6 # building	37	a total of about42 households facing	15m away，not affected	The wind pavilion backs sensitive point
Jinshui Road Station	Northeast wind Pavilion,：East side of Northeast exit, Jinshui Road Station, east side of Nanyang Road	Film Bureau, family member courtyard, 6 #,	10	a total of about 32 households facing	The distance of the piston air pavilion is too close, with greater odor impact at the initial stage.	It is intended to adjust the position, without impact after the adjustment
	Northeast wind Pavilion,：East side of Northeast exit, Jinshui Road Station, east side of Nanyang Road	Film Bureau, family member courtyard, 5 #,	45	a total of about 32 households facing	15m away，not affected	The wind pavilion backs sensitive point
	Northeast wind Pavilion,：East side of Northeast exit, Jinshui Road Station, east side of Nanyang Road	Zhengzhou City Library	32	Seat 400	15m away，not affected	The wind pavilion backs sensitive point
	Southeast wind Pavilion：South side of Northeast exit, Jinshui Road Station, east side of Nanyang Roa	Chengzhongyang District 1 # building	31	a total of about 108 households facing	15m away，not affected	The wind pavilion backs sensitive point
	Southwest wind Pavilion：West side of Northwest exit, Jinshui Road Station, west side of Nanyang Road	Nanyang Road, No. 326, courtyard, 1 #building	39	a total of about 70 households facing	15m away，not affected	The wind pavilion backs sensitive point
Taikang Road Station	North wind Pavilion,：West side of Southwest exit, Taikang Road Station	West Cai district, 2 #, 3 #	44	a total of about 140 households facing	15m away，not affected	The wind pavilion backs sensitive point
	North wind Pavilion,：West side of Southwest exit, Taikang Road Station	Ming Gong Road No. 245Courtyard	20	a total of about 83 households facing	15m away，not affected	The wind pavilion backs sensitive point
Erqi square Station	Northwest wind Pavilion：East side of Northwest exit, Erqi square Station, west side of Minzhu Road	Huigang New Town 3 # Building	10	a total of about 280 households facing	The distance of the piston air pavilion is too close, with greater odor impact at the initial stage.	It is intended to adjust the position, without impact after the adjustment
	Northwest wind Pavilion：East side of Northwest exit, Erqi square Station, west side of Minzhu Road	Small building mosques	41	religion	15m away，not affected	The wind pavilion backs sensitive point
Shunchengjie Station	Southeast wind Pavilion：East side of Northeast exit, Shunchengjie Station	Hongxin Jia Yuan 1 # building	35	a total of about 84 households facing	15m away，not affected	The wind pavilion backs sensitive point
	Southeast wind Pavilion：East side of Northeast exit, Shunchengjie Station	Xidan apartments, two buildings	36（3#） 30（3#）	a total of about 138 households facing	15m away，not affected	The wind pavilion backs sensitive point
Chengdong Road Station	Northwest wind Pavilion：Northwest exit of Chengdong Road Station, North side of Dongdajie road	Shangcheng Garden 1#	53	a total of about 42 households facing	15m away，not affected	The wind pavilion backs sensitive point
	Northeast wind Pavilion：Northeast exit of Chengdong Road Station, North side of Dongdajie road	Dongguandongli No.96Courtyard 1#、2#	16	a total of about 60 households facing	15m away，not affected	The wind pavilion backs sensitive point
	Northeast wind Pavilion：Northeast exit of Chengdong Road Station, North side of Dongdajie road	Dongguandongli No.96Courtyard 6#、	28	a total of about 30 households facing	15m away，not affected	The wind pavilion backs sensitive point

(IV) Prediction and analysis of exhaust pollutant emissions in car depot and the parking lots shunting locomotive

The traction type of this project is of electric locomotive, so there is no exhaust emission of locomotive. In design, the car depot & the parking lots is equipped with 2 shunting locomotives (diesel locomotive for line inspection & repair and locomotive rescue). The shunting locomotive emits small amount of exhaust pollutants. According to emission coefficient method, the emission prediction of exhaust pollutants for Hongjiaozhou car depot & the parking lots shunting locomotive refer to table 5.7-5.

Table 5.7-5 Prediction results of pollutant emission from car depot & the parking lots shunting locomotive

Unit	Diesel consumption	Flue	SO2	NOX
kg/d	140	2.12	0.44	2.66
t/a	51	0.78	0.16	0.98

The car depot & the parking lots shunting diesel locomotive is of mobile source with small amount of exhaust pollutant emission and therefore minor impact on ambient environment air.

(V) Reduction of automobile exhaust pollutant emission from substitution for bus transport

The rail transit construction can relieve the traffic congestion of Zhengzhou urban road transport. The rail transit transport reduces the ground traffic vehicles and therefore the pollution of vehicle exhausts on urban environment air, and benefits for the improvement of urban ambient air quality conditions.

After put into service of rail transit, it can effectively reduce the exhaust emission. Taken the bus for example, calculate with the average of 35 persons transported in an hour for each bus, covert the rail transmit traffic volume into bus vehicle quantity, and then figure out the automobile exhaust pollutant emission reduction from substitution for bus traffic by the rail transit according to daily turnover volume (see table 5.7-6). Refer to table 5.7-7.

Table 5.7-6 Passenger flow prediction of Zhengzhou subway line 3

design period	Daily total passenger transport volume (10,000 persons/km)	Passenger traffic intensity (10,000 persons/km)	Peak high profile （10,000 persons/h）	Average traveling distance (km)
initial stag（2023）	42.38	1.35	2.23	7.94
Short term （2030）	86.92	2.77	2.90	6.79
Long term（2045）	117.47	3.75	4.05	6.96

Table 5.7-7 Automobile exhaust pollutant emission reduction from substitution for bus traffic by the rail transit rail transit

Pollutant	Unit	Automobile exhaust pollutant emission reduction from substitution for bus traffic		
		Initial phase	Short term	Long term
CO	kg/d	305.7	521.1	352.7
	t/a	111.6	190.2	128.7
NOX	kg/d	84.8	124.2	117.5
	t/a	30.9	45.3	42.9

As shown in table 5.7-7, after operation of rail transit, the Automobile exhaust pollutant emission reduction amounts of CO and CHX from substitution for bus traffic at initial phase are separately of 111.6 and 30.9t/a .and these reductions will be more at short term and long term. So the rail transit construction not only changes the traffic structures, increases the passenger transport volume, relieves the ground traffic congestion and more rapid and comfortable than bus, but also it reduces the exhaust pollution emission of bus transport and benefits the improvement of Zhengzhou urban environment air quality. The rail transit is one of effective approach to solve the urban traffic pollution.

5.7.3 Control measures for environment air pollution

5.7.3.1 Control measures for air environment pollution during construction period

Most of the construction sites of this project are located in commercial area and other areas with dense residents, so they are sensitive to the raise dust. To this end, it is necessary to take practicable measures to control the dust generated during construction period of this project so as to control the dust pollution in construction sites and near the transport road along the line.

(1) The employer and construction unit shall assign the persons in charge of raise dust control and determine their responsibility range.

(2) The construction site shall set the hard enclosures of no less than 2.5m high; the main roads must be hardened and kept clean. Assign special person to be responsible for the cleaning works of construction site to timely sprinkle and clean to reduce the raise dust.

(3) During demolition and excavation of dry soil surface, properly spray water and keep the operation surface at certain humidity.

(4) The garbage and spoils shall be timely cleared (the wastes and spoils generated from housing demolition shall be completely cleared in 3 days after the demolition). The spoil deposits and bare soil for more than 2 days shall be covered with dust cloth or hardened to remove the dust.

(5) When the air pollution index is higher than 100 or in case of dry climate with gale of grade 4 and above, prohibit explosion, demolition, earthwork and manual dry sweeping. When the air pollution index is between 80 and 100, clean once every 4h

and the sprinkling and wiping shall be alternatively conducted. When the air pollution index is larger than 100, the cleaning frequency shall intensify.

(6) The office area and living area at construction site shall be afforested and rehabilitated. The water boiler and cooking stoves shall use clean fuel.

(7) The vehicle transporting the garbage, spoil and sandstone must obtain the "Transport permit for spoil and sandstone vehicles".

(8) The earth-moving trucks shall be completely sealed without spillage. They loading shall ensure the materials will not scatter during transport. If any scattering, they shall be timely cleared to reduce pollution.

(9) Set up the car washing platform at inside of construction site gate. The ground of car washing and access road must be hardened; frequently clean the muds on transport vehicles and chassis; clean the wheels or muds when the construction vehicles get out of the site so as to reduce the soil carried on the wheels.

(10) Properly plan the traveling route and time for construction vehicles and avoid the traveling at crowded area and residential areas. For the areas with higher environment requirements, the transport shall be done at night time according to actual conditions so as to reduce the dust impact on the crowed.

5.7.3.2 Control measures of air environment pollution during operation period

(I) Suggestion for control measures for odor impact of ventilation pavilion

(1) It is proposed in the report that the buildings at the sensitive points within 10 meters to the ventilation pavilions shall be relocated; The positions of the ventilation pavilions within 15 meters to the sensitive point shall be adjusted. It can be guaranteed that the position of the ventilation pavilion can be 15 meters to the sensitive points after taking the measures.

(2) To more effectively relieve the odor impact, plant ardors around the ventilation pavilions and set the air outlet opposite to sensitive spots.

(3) The underground stations shall use the decoration materials complying with national environment standards, especially not use the materials containing PCBs, so that it can be in favor for protection of personal health and also relieve the impact of ventilation pavilion exhaust odor on ambient environment at initial operation phase.

5.7.4 Summary

(1) In this design program, 8 sensitive spots at Dongfeng Road Station, Nongye Road Station, Huanghe Road Station and Shuncheng Street Station conflict with the land use of ventilation pavilion or the distance is less than 10m, and they are planned to be demolished; in addition, the distance from ventilation pavilions at Shuncheng Street Station and Taikang Road Station to the sensitive spot is less than 15m, and the odors emitted from ventilation pavilion will impact the resident livings to some extent; in combination with the control measures listed in noise topic, the environment

assessment suggests to adjust the locations of 8 ventilation pavilions with the distance of less than 15m from sensitive spots. To effectively relieve the odor impact, it is necessary to plant arbors around ventilation pavilion and make the outlet opposite to the sensitive spots such as residential building. The underground stations shall adopt decoration materials complying with national environment standard so that it can be in favor of protection of health of the crowd and also relieve the impact of ventilation pavilion exhaust odor during initial operation period on ambient environment.

(2) After operation of rail transit, the reduction volumes of exhaust pollutants emissions of CO and NO_X by the bus substituted by the subway at initial phase are separately of 111.6 and 30.9t/a and these reductions will be more at short term and long term. The rail transit is more rapid and comfortable than the bus, and can reduce the bus exhaust pollutants emissions as well as inhalable particle concentration in air so that it benefits for the improvement of environment air quality in Zhengzhou city.

(3) The diesel locomotive employed is of mobile source with small exhaust pollutant emission and minor air environment impact integrated base.

(4) The crowed buildings such as school, hospital and centralized residential house shall be not built in 15m range around the ventilation pavilion.

(5) Since the rail transit adopts electric traction, there is no fuel exhaust emission during vehicle operation, and the impact of piston ventilation pavilion odor is slight at initial phase and no impact during operation period.

5.8 Electromagnetic impact predictive assessment and protection measures

5.8.1 Electromagnetic source

The impact of this project on electromagnetic environment mainly includes: random ignition interference generated from the discharge gap due to poor contact between vibration or sliding plate and catenary when the EMUs travels on access line of vehicle integrated base; electromagnetic interference resulted from electromagnetic induction of substation due to high voltage or large current. The existing environment assessment indicates that the electromagnetic interference only imposes slight impact in certain distance with the civil television reception without any impact on human health.

5.8.2 Predictive assessment

5.8.2.1 Assessment job contents and job emphasis

The impact assessment contents of electromagnetic environment include the impact of electromagnetic radiation generated from train operation on the resident television reception near ground section, car depot and specific repair section; impact of power

frequency electric and magnetic fields generated by main substation and the impact of radio interference generated on ambient electromagnetic environment.

5.8.2.2 Electromagnetic pollution source characteristics and impact assessment

(I) Electromagnetic radiation generated by train traveling and impact

(1) Characteristics of electromagnetic pollutant source generated by the train traveling

Zhengzhou subway line 3 phase I adopts flexible overhead category for supply with the 1500V DC voltage and full compensation simple chain suspension. So it can adopt Guangzhou transit line 1 ground line electromagnetic radiation measurement as analog source intensity.

Figure 5.8-1 provides the electromagnetic radiation frequency characteristics and distance characteristics of Guangzhou rail transit No.1. This figure is drafted according to the average value which will not be exceeded by 80% measurements at each frequency point and different distance.

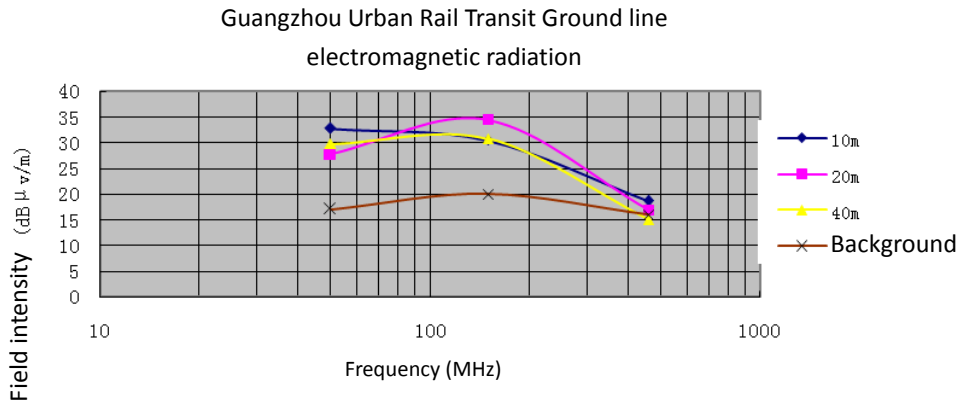


Figure 5.8-1 Actual measurement results at different distances and frequencies of Guangzhou rail transit ground line

The figure 5.8-1 shows out the variation trend of electromagnetic radiation intensity with the frequency and distance of measurement point to line distance when the rail transit trains pass. The electromagnetic radiations at 50MHz and 150MHz frequency points when vehicle passes are about 10dB higher than the background, while those at 490MHz at different distance points are close to the background. According to figure 5.8-1, table 5.8-1 provides the interference field strength values at different frequencies and distances.

Table 5.8-1 Interference field strengths of different frequencies and distances (dBμv/m)

Frequency (MHz) Distance (m)	50	170	500	900
10	32.7	31	19	17
20	27.9	34	17	15
40	2	31	15	14

(2) Prediction on Influences of Electromagnetic Pollution due to Train Operation:

The No. 3 Zhengzhou subway line is totally underground line, and the electromagnetic interference caused by train operation will not influence the receptive effect of TV signals by surrounding residents. The train climbs up to the ground only at the depot and parking lot. However, there are no environmental sensitive points around the depots and parking lots, therefore the whole project of No. 3 line will not influence the signal receptive quality of surrounding residents.

(II) Impact of electromagnetic radiation generated by main substation

The impacts generated by subway main substation mainly include the interference by owner frequency electric field, magnetic field and radio, and the effect may be tested by analog with similar type of substations built and put into service.

(1) Analog monitoring object and overview:

The analog monitoring object is selected as Shanghai rail transit line 1 north extension “Lingshi Road main substation”. The substation is of 110kV ground substation for households with the high voltage incoming line of 110kV and low voltage outgoing line of 35kV and 10kV. All incoming lines and outgoing lines are laid with underground buried method, main transformers and other electric devices are built indoors.

(2) Reference standard:

DL/T988-2005 Methods of measurement of power frequency electric field and magnetic field from high voltage overhead power transmission lines and substation

HJ/T24-1998 Technical regulations on environmental impact assessment of electromagnetic radiation produced by 500 kV ultrahigh voltage transmission and transfer power engineering

GB7349-2002 Methods of measurement of radio interference from high voltage overhead power transmission lines and substations

GB15707-1995 Limits of radio interference from AC high voltage overhead power transmission lines

(3) Analog monitoring contents:

Power frequency electric field and power frequency magnetic field.

(4) Instrument used:

Adopt PMM8053A low-frequency electromagnetic field gauge for power frequency electromagnetic field measurement. All instruments are calibrated as qualified in RPC National Institute of Metrology.

(5) Monitoring method:

The PMM8053A low frequency electromagnetic measurement instrument is 1.5m from the ground surface. The power frequency electric field measures the vertical components and the power frequency induction strength measures the composite component of horizontal component and vertical component. The detailed measurement points and results are as follows:

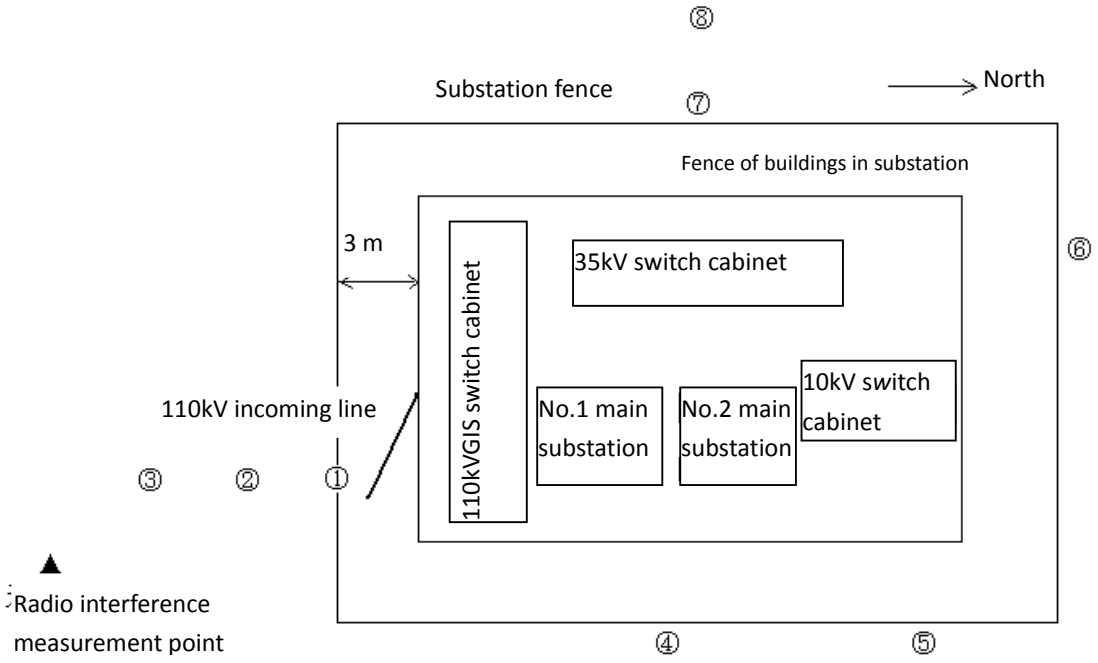


Figure 5.8-2 Distribution diagram for monitoring of Lingshi Road main substation

Table 5.8-3 Monitoring results of power frequency electromagnetic field

Measurement point No.	Position description	Vertical component of power frequency electric field (V/m)	Power frequency magnetic induction strength (μT)
1	south side high voltage incoming line terminal fence position	0.22	0.27
2	5m from measurement point 1	0.3	0.05
3	10m from measurement point 1	0.9	0.07

4	Fence at each side of substation	0.1	0.07
5	Fence at each side of substation	0.1	0.08
6	Fence at each side of substation	0.08	0.05
7	Fence at each side of substation	0.1	0.05
8	5m from measurement point 7	0.09	0.02

According to above analog monitoring results, 110kV Lingshi Road main substation has a small electromagnetic leak because it is built indoors and the incoming and outgoing lines are laid underground. The maximum value of vertical component of power frequency electric field out of the fencing wall is 0.9V/m and the maximum power frequency magnetic induction intensity is 0.27μT, which are equivalent to the background value of normal regions and far lower than the recommended limit requirements of power frequency electric field intensity of 4kV/m and power frequency induction intensity of 100μT in HJ/T24-1998 Technical Regulations on Environmental Impact Assessment of Electromagnetic Radiation Produced by 500 kV Ultrahigh Voltage Transmission and Transfer Power Engineering.

(III) Assessment conclusion

According to analog prediction analysis, the monitoring points for TV at present status can receive 5 TV channels with normal antenna, in which 4 channels can meet the signal to noise rate of 35dB. After construction, under the impact of vehicle passing, only 2 channels can meet the signal to noise rate requirements. Since the cable TV network connection rate in televiewsensitive spots of this project is high, it is predicted that the radio interference generated by construction of this project will not generate obvious impact on televiewquality of nearby residents. There is no sensitive spot in 200m range of the car depot, testing line and parking depot of this project, so it has no impact on the televiewof nearby residents

A main substation and a switching station are newly built in Zhengzhou subway 3 line. By analogy monitoring, after construction and put into service of Boxue Road main substation and Erqi Square switching station, the generated power frequency electric field and magnetic field comply with the limits of power frequency electric field of 4kV/m and power frequency magnetic field of 0.1mT recommended in HJ453-2008 Technical Guidelines for Environment Impact - Urban Rail Transit.

5.8.3 Electromagnetic pollution control measures

5.8.3.1 Measures for impact on television reception

The CCTV facilities have been basically configured along the line of Zhengzhou subway Line 3 phase I project. The districts along the line have been uniformly installed with CCTV devices by the government with the wired TV network connection rate of more than 90%. Only a few rural residents do not have access to cabled TV due to economic reason, and watch TV with antenna. However, the whole No. 3 line is underground line, and has no influences on TV viewing by such rural residents. There are no sensitive points such as residents around the trial running line

of the depot at East Hanghai Road, thus no measures need be taken on such influence in the project.

Recommend to intensify the routine maintenance on catenary so as to reduce the off-line rate and the electromagnetic disturbance during train operation.

5.8.3.2 Measures for impact on main substation

According to survey of present status, the location of Boxue Road main substation currently is of a freight depot with logistics companies and warehouse and without any sensitive spot around; there is no sensitive facility such as high voltage line over the location.

According to above analog analysis, although the power frequency electric field and magnetic field and radio interference generated by main substation complies with the national standard requirements, more and more persons begin to worry about that the electric and magnetic fields generated by the substation may impact the personal healthy with the social advance and strengthening of environmental protection consciousness, and then oppose the construction of substation close the residential area. The complaints of these issues have been the social hotspot. In the view of human orientation and establishment of harmonious society, to reduce the worrying of the public for electromagnetic impact and therefore the environment complaints due to electromagnetic radiations, recommend to reasonably lay out the main substation and properly plan the land around the main substation to keep the fencing wall of main substation away from residential area as possible, and the least distance from residential area shall be more than 50m.

5.9 Solid waste impact assessment and measures of disposal and protection

5.9.1 Solid waste pollution sources

The solid wastes of this project during construction period mainly come from the spoil generated from stations and tunnel construction; the solid wastes during operation period mainly include the domestic garbage from station passengers and staff, solid waster from car depot & integrated base mechanical processing and maintenance works and staff domestic garbage, train passenger left wastes in depot, and small amount of domestic garbage discarded by the passenger, and waste oil and dregs from sewage treatment plant in car depot & integrated base, clothes wiping the oil in each procedures, waste transformer oil and EMUs battery regularly replaced.

5.9.2 Predictive assessment

5.9.2.1 Solid waste impact predictive assessment during construction period

(I) solid waste properties

The solid wastes from this project mainly include engineering spoils, construction wastes and construction staff domestic garbage.

The engineering spoils are mainly of the spoils generated from excavation and tunneling of stations and tunnels during construction process.

The spoils generated from this project are mostly of clay silt with high viscosity in case of high moisture and less organic content.

The construction staff domestic garbage is of normal domestic garbage, and the quantity is less.

(II) Environment impact due to solid waste treatment

The solid wastes produced during project construction, if not properly disposed, will obstruct traffic and pollute environment.

During transport of spoils, if the vehicle is not properly cleaned, the muds and soils may scatter along the road and therefore pollute the streets and roads and impair the urban appearance; the traveling of spoils transport vehicles on urban roads will increase the vehicle flow in the regions along the line and may lead to traffic congestion.

If the spoils are deposited and dumped randomly, it may lead that large amount of silts carrying the cement at construction site flushes into the nearby rain pipeline during rainstorm period and therefore the silting up of pipeline. The high turbidity sewage may lead to water loss and soil erosion if flowing into receiving river channel via rain pipeline, and it may also lead to seasonal ground water logging in rainstorm season near the construction sites.

5.9.2.2 Solid waste impact predictive assessment during operation period

The solid wastes after subway operation mainly include: domestic garbage generated by station waiting passengers and working staff, of which the main components are of drink containers, paper towel, fruit skins, ticket remnant and dusts; wastes sweeping from the passenger car in car depot & integrated base, routine domestic garbage generated by production staff; waste battery generated by the vehicle.

(I) Discharge amount of solid wastes and treatment conditions

(1) Discharge amount of domestic garbage

According to analog survey, the station passenger waste amount is about 50-100kg/d; the domestic garbage generated by the production and office personnel is calculated as 0.4kg/d per person, so the prediction of solid waste discharge amount of solid wastes after operation of rail transit is shown in table 5.9-1.

Table 5.9-1 Discharge amount of solid waste during operation period (initial phase)

Source		Discharge amount of domestic garbage (t/a)
Production and office personnel along the line		165.7
Passenger garbage	station	18.3-36.5(each) 384.3-766.5(entire line)
total		568.3－968.7

As shown in table 5.9-1: the solid wastes generated after subway operation are of nontoxic domestic garbage and the total amount is 568.3-968.7t/a. The discharge amount is small and they are distributed in the stations, car depot & integrated base and other locations along the line. All wastes shall be collected and stored at specific locations and delivered to local environment sanitation department for uniform treatment. From this, the solid wastes generated after subway operations have minor environment impact on ambient environment.

(2) Hazard solid waste disposal

The hazardous solid wastes of this project are mainly of waste soil and slag generated in car depot & integrated base sewage treatment plant, clothes wiping the oil at each procedure, waste transformer oil and EMUs batteries regularly replaced, the domestic substation equipment has banned the use of PCB-containing compounds related material, the project will not produce the pollution caused by PCBs materials. The above hazardous waste shall be disposed by the agency with qualification for hazardous waste treatment. The assessment recommends that after line 3 puts into operation, Zhengzhou Rail Transit Co., Ltd. shall enter into agreement with the unit with qualification for hazardous waste treatment and deliver the hazardous wastes to them for treatment. The battery for EMUs is mainly of alkaline (Ni-Cd) battery. Each EMUs train has 2 battery banks and their service life is 36 months. All batteries are of maintenance free chargeable type. According to statistics, it is predicted that the vehicle integrated base will replace more than 1000 batteries every year on average. The replaced batteries are deposited in car depot and regularly treated by the manufacturers or agency with qualification for hazardous waste treatment (once – twice every year). So the batteries used by car depot and integrated base EMUs will not impose solid waste hazard on ambient environment.

5.9.3 Disposal measures

5.9.3.1 Disposal measures of construction period solid waste

The solid wastes during construction period are normally of spoils generated during construction period. The total spoils quantity in stations and open cut sections of this project is 2.368 million m^3, and total spoils quantity in shield section is 0.473 million m3; the car depot and parking depot are mainly of filling with the spoil quantity of about 0.513 million $m^{3.}$

The construction wastes in Zhengzhou are mainly disposed with landfill method. The landfill location is at the gullies in southwest hilly area. There are 4 planned construction building disposal locations at present, separately of Houzhai, Honghuasi, Xiaoliucun and Shawolicun. The basic conditions of all disposal fields are shown in table 5.9-2.

Table 5.9-2 Basic conditions of waste disposal fields during construction period of Zhengzhou rail transit 3 line

Name	Land use area (Mu)	Capacity (10,000m3)	Land use time limit	Approval procedure execution	Reclamation measures	Present status
Houzhai	60	137	2011-2028	In transaction	Plant cherry after filled up	
Honghuasi	40	80	2010-2025	In transaction	Plant poplar, cherry and grape after filled up	
Xiaoliucun	40	64	2012-2025	In transaction	Plant apple, cherry, grape after filled up	
Shawolicun	60	120	2011-2012	In transaction	Plant fruit trees after filled up	
Total	200	401	/	/	/	

The total capacity of above 4 construction waste disposal fields is about 4 million m3, and can meet the demand for spoils from 3 line. However, if other spoil group is to be selected when 3 line construction commences due to the construction time sequence problems, it shall strictly comply with related requirements of Zhengzhou city to acquire the permit. The specific approval procedures are as follows:

Approval Procedures for Construction Wastes Disposal in Zhengzhou City

1. Application

The unit disposing the construction wastes on construction site in urban buildup area shall assign person (applicant) to urban management department of area under administration to get the application for approval of construction wastes disposal in Zhengzhou city and related certification data, and complete the form according to the requirements. The applicant shall provide the construction project planning permit of the planning competent authority.

2. Acceptance

The urban administrative department of administrative service center in the area under administration registers and accept at the service window.

3. Initial review

The responsible person for initial review is responsible for the review of written materials, informing the applicant of related rights, conducting field survey and providing the initial comments to the section chief for review.

4. Review

Carry out full review for the permit of this project; put forward the permit or refusal comment; submit to the supervised director for approval.

5. Approval

The approval responsible person is responsible for the signature and approval of the decision, and issuance of urban construction waste disposal permit.

By site survey, the 4 disposal fields are more than 4km away from the water sources, and currently of natural gully without water passing by, and with stable geological conditions. The assessment considers the location is proper. Since the locations suitable for landfill of mucks in Zhengzhou city are located in southwest gully area, while there are threw ate source protection zones of Changzhuang reservoir, Jianggang reservoir and south-to-north water diversion middle section main canal in this area, the assessment requires the construction unit to keep the spoil field away from the water source protection zone according to related requirements in Water Pollution Prevention and Control Law.

The spoils generated from 3 line are planned to transport to above 5 spoil fields for disposal. Following environment protection measures shall be taken for transportation, and also the spoil deposition fields of construction sites and the spoil fields:

Timely clear the generated dregs and spoils and maintain the environment tidy of construction site and surroundings; set up enclosures and bulletin board and harden the site entrance/exit according to related regulations; set up the vehicle washing and cleaning facilities complying with the requirements and assign full-time cleaner, and the vehicle in the construction site can drive out of the site only after cleaned by the washing and cleaning facilities; regularly sprinkle the construction site for dust falling and cover the exposed muds.

Part of construction sections may generate liquidified shield soil, which shall be aired for some time at construction sit, and then cleared and transported with special vehicles; they shall be mixed with dry soils with certain proportion after transported to the disposal field before landfilling.

The retaining wall shall be set on construction site to avoid the spoil flowing out during rainy season.

5.9.3.2 Solid waste disposal measures during operation period

(1) The waste oil produced by oily waste water treatment system, oily rags of various working procedures, and waste transformer oil undergo harmless treatment by the organization with relevant qualifications.

(2) The batteries regularly replaced in car depot are of hazard wastes, and shall be

reclaimed by manufacturers or qualified agency. The storage room of batteries shall be treated for anti-seepage to avoid percolation.

(3) The sludge produced at the depots shall be collected, buried and disposed regularly by the domestic rubbish disposal plant located at Hongzhai Village in section 27.

5.9.4 Assessment summary

(1) The solid wastes during construction period are normally of spoils generated during construction period. The total spoils quantity in stations and open cut sections of this project is 2.3680 million $m^{3,}$ and total spoils quantity in shield section is 473,000 m^3, and the total spoils quantity of car depot is 513,000 m^3. The spoils generated from line 3 are planned to transport to ERqi Qu and LongHu Zhen depot spoil field for excavation and backfilling treatment.

(2) The solid wastes during operation period are mainly of station and car depot domestic garbage. According to analog survey data, it is predicted the total discharge amount of solid wastes during operation period of this project is 568.3 – 968.7t/a. The wastes at each station are collected by environment sanitation workers and collectively delivered to urban garbage treatment field for treatment, so there is only slight impact on environment.

(3) The waste oil and dreg from sewage treatment plant in car depot & the parking lotsduring operation period, clothes wiping the oil in each procedures, waste transformer oil are of hazardous wastes, and shall be entrusted to the agency with related qualification for harmless treatment; the battery regularly replaced shall be reclaimed by the manufacturers and the anti-seepage treatment shall be conducted in battery deposition room to avoid leakage. So the soil wastes have little impact on ambient environment by the solid waster generated after operation of rail transit.

(4) Explicitly prohibits the procurement of equipment containing polychlorinated biphenyls material in transformers and other equipment in the design and tender documents.

5.10 Social environment influence assessment and measures of social environment protection

During construction period and operation period, the project construction will affect the people's livings of Zhengzhou city to certain extent. The positive effects include: the project construction will provide Zhengzhou city people with a more quick, convenient and environment protection public transit facilities for ease of trip of residents; the adverse impacts include: during construction period, the fences will impose adverse impact on living and traffic of the people along the line, but the impact is temporary and controllable, and relieved by measures. So, the positive effects of construction of line 3 are far higher than the positive effect in long term. This chapter will consider the line direction and construction methods of subway line 3 project and the factors such as traffic organization and land utilization, present environment status and station design, and focus on the impact analysis on social environment by subway line 3 project from the positive and negative aspects.

5.10.1 Analysis of social environment impact

5.10.1.1 Positive effect

This positive effects of this project on the society mainly concentrates in operation period, and mainly include following aspects: (1) Improvement of urban traffic after put-into-operation of rail transit 3 line; (2) Saving of land development along the line for the utilization of rail transit; (3) Vast business opportunity for the stores along the line from large passenger flow after put-into-operation of rail transit.

(I) Impact on urban traffic after put-into-operation of rail transit

3 line is mainly laid along the urban main rods of Zhengzhou city. The line passes Changxing Road, Nanyang Road, Jiefang Road, East and West Street, Zhengbian Road and Shangdu Road successively. After put into operation of rail transit 3 line, After put into service of rail transit 3 line, due to its advantages of rapid, convenient and economic, it will attract large amount of passenger flow to share part of passenger flow on roads, and part of public routes may be replaced and another part of buses may reduce their departure frequencies so as to reduce the road pressure and fundamentally improve the traffic of above areas. Prepare reasonable bus-rail integral program to facilitate the public to use 3 line project, enhance the public traffic resource utilization rate of Zhengzhou city and finally improve the urban traffic of Zhengzhou city.

(II) Impact of rail transit on land use variation along the line

(1) Impact analysis of project land use on urban land utilization

The total demolition area along project line is 10.2 hm2, permanent land use of 5.98hm2 and temporary land use of 30.08hm2. The temporary land use is temporarily

occupied during open cut construction method for underground stations. The expropriated collective lands are of vegetable plot, cultivated land, orchard and forest land at present. The expropriated state lands are of state construction land.

In term of related passenger capacity, and in comparison to the ground traffic facilities, the rail transit features less land use area, larger transport capacity, higher speed and operation stability; the construction of rail transit can significantly saves the tense construction land use and is good for the saving development of land in Zhengzhou so as to save the valuable land sources for urban development of Zhengzhou.

(2) Impact analysis of project on along-line land utilization

The construction of 3 line project will speed up and promote the implementation of land utilization planning along the line, speed up the urbanization development process along the line. Under the induction effect of rail transit, the land utilization property of zones to be developed will substantially change. The main change is that the farmland and forest land are converted into resident land, commercial land and education land. The conditions of planning areas along 3 line are shown in figure 5.10-1.

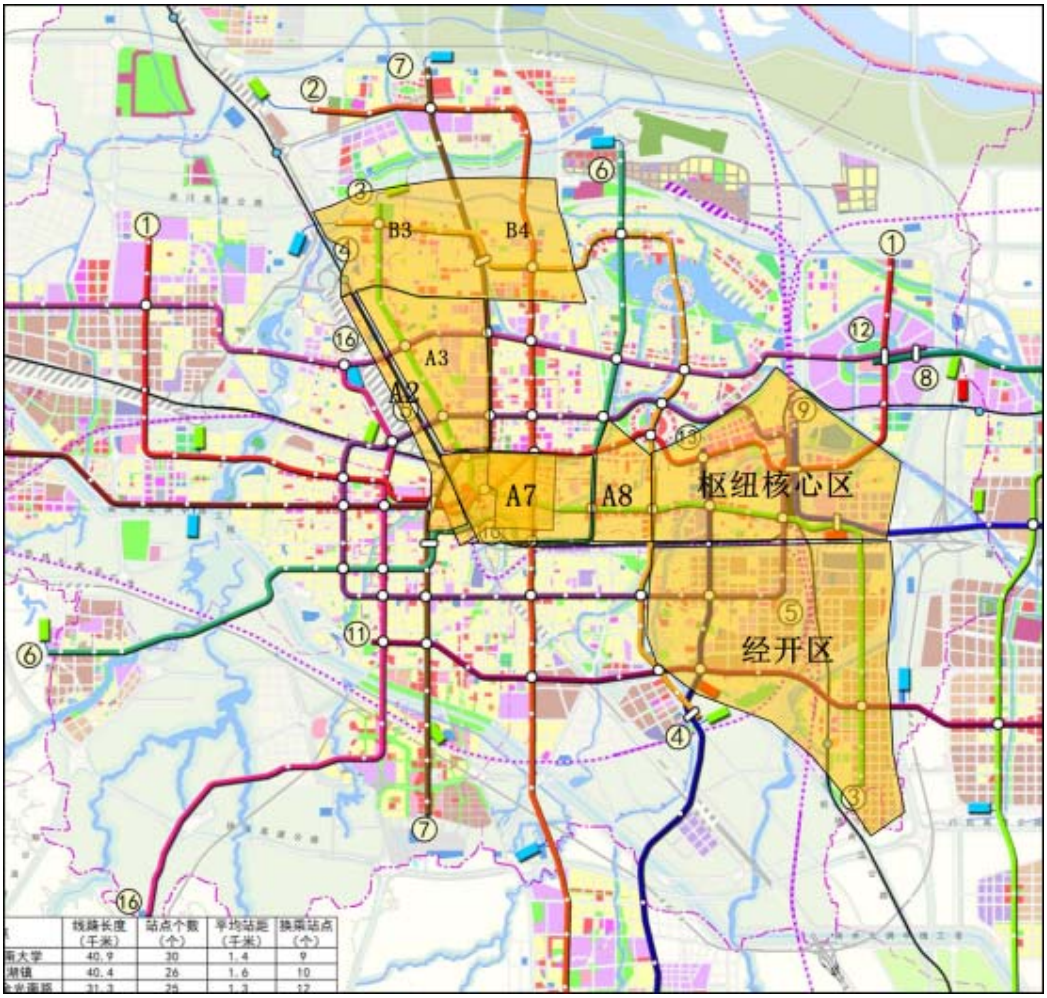


Figure 5.10-1 Conditions of planning zones along 3 line

The rain transit 3 line passes through zone B3, zone A3, zone A7 (focus of Erqi

Commercial Center and Shang City Ruins), zone A8, Zhengzhou Comprehensive Transportation Hub core area and economic development zone. Hereby describe the impact 3 line construction on around land development by taking zone A2 as example:

The planning range of zone A2 is shown in figure 5.10-2. The rail transit 3 line passes through the west of zone A2. It is currently of old town and mainly used for residence, railway and warehouse lands; and there are also many industry land. The land use proportions of four functions are separately of 26.63%, 20.24%, 10.67% and 8.67%. The public facility land use is dispersed and the public green land is seriously lack.

The land uses in zone presents obvious sectional different with Huanghe Road as the boundary. The land block at south of Huanghe Road is well developed mainly of residence, education, scientific research and commercial lands, and the public service facilities and municipal facilities such as education and medicals are complete; while the land block at north of Huanghe Road is mainly for warehouse, village construction land and industry land, and few residence land, and the resident living and service facilities are seriously deficient

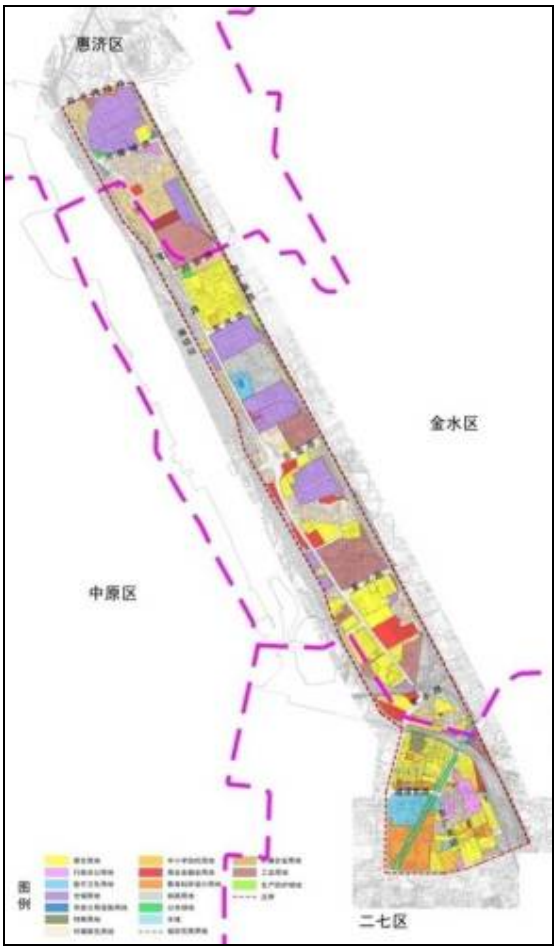


Figure 5.10-2 Planning range of zone A2

After construction of rail transit 3 line, the planning control emphasis in this zone lies in: highlight the concept of city management, adjust the land use structure, optimize

the land use pattern, increase the tertiary land use, support the integration of land use and utilization with traffic (especially the land use around rail transit yard), coordinate the relations among along-line large buildings, municipal infrastructures and rail transit, analyze the adjustment objective and measures of road network, regular bus connection and pedestrian distribution system, specify the rail car depot and station land use control. The high strength and high mixture land uses can be developed around the station. Designate the compact district for building complex at large scale rail transit transfer center, encourage the construction of complex and further improve the human settlement environment.

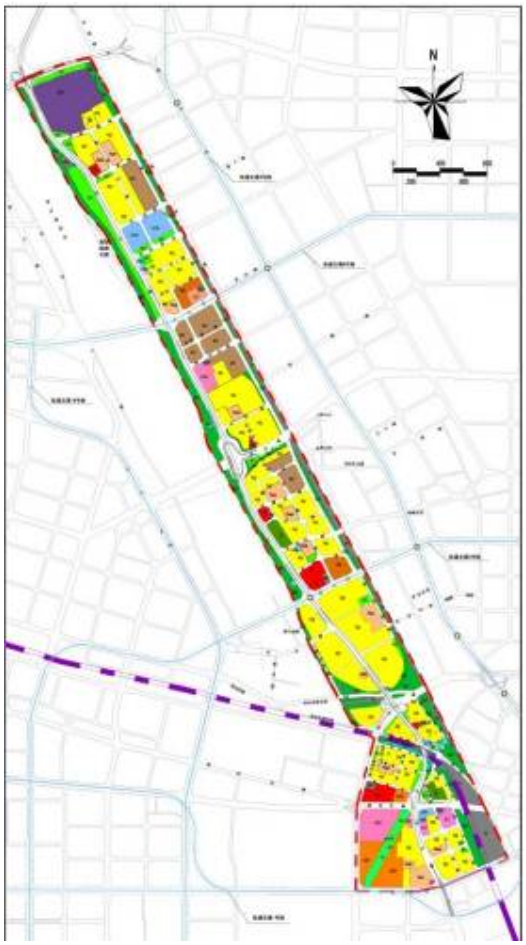


Figure 5.10-3 Planning map of zone A3

According to short-range planning of Zhengzhou rail transit, there are total lines of rail transit 1#, 3 and 5# lines pass through the planning zone. Total 7 stations are set in the planning zone, including 2 transfer stations. There are 3 BRT corridors planned in zone; at initial stage, the line passes through Nongye Road and a pair of bus stops are set at east of Nongye Road – Shakou Road overpass. A bus start/destination station is planned each at southeast of intersection of Jianshedong Road and Jingguangbei Road (8,100 m^2) and northwest of intersection of Nongye Road and Shakou Road (2,500m^2). There are 8 public parking depots in the section with the total area of 270,000 m^2, separately located at southeast of intersection of Jianshedong Road and Xizhonghe Road, southeast of intersection of Jinshui Road and Jianxin Road, southeast of intersection of Shakou Road and Jinshui Road, northwest of intersection of Huanghe

Road and Shakou Road, northeast of intersection of Damengzhaibei Road and Shakou Road, northeast of intersection of Qunban Road and Shakou Road, south of intersection of Tiexi Road and Dongfeng Road, southwest of intersection of Xinglongpu Road and Shakou Road.

The control detailed planning around stations of rail transit 3 line is in preparation, but has not completed.

(3) Protection measures for impact of the project on land use

The construction of 3 line project has positive and favorable effects on surrounding land utilization around 21 stations along the line, especially for Nanyang Road; with the construction of rail transit 3 line, Zhengzhou old town reconstruction plan and Nanyang Road expansion project, the land utilization and urban landscape along Nanyang Road will significantly change. When planning the land utilization functions in above areas, it shall consider together with the noise and vibration protection distance in this report for reasonable planning and therefore minimize the environment impact of project construction on existing residences and planned sensitive spots.

The control detailed planning along 3 line will be adjusted according to social development requirements. Normally once every 5 years. In each adjustment, it shall be submitted for approval according to the procedures in Urban and Rural Planning Law and Zhengzhou Planning Management Regulations; the planning approved can be used for instruction of urban construction. The planning adjustment procedures are shown in the figure below.

The detailed control procedures are shown in the figure below.

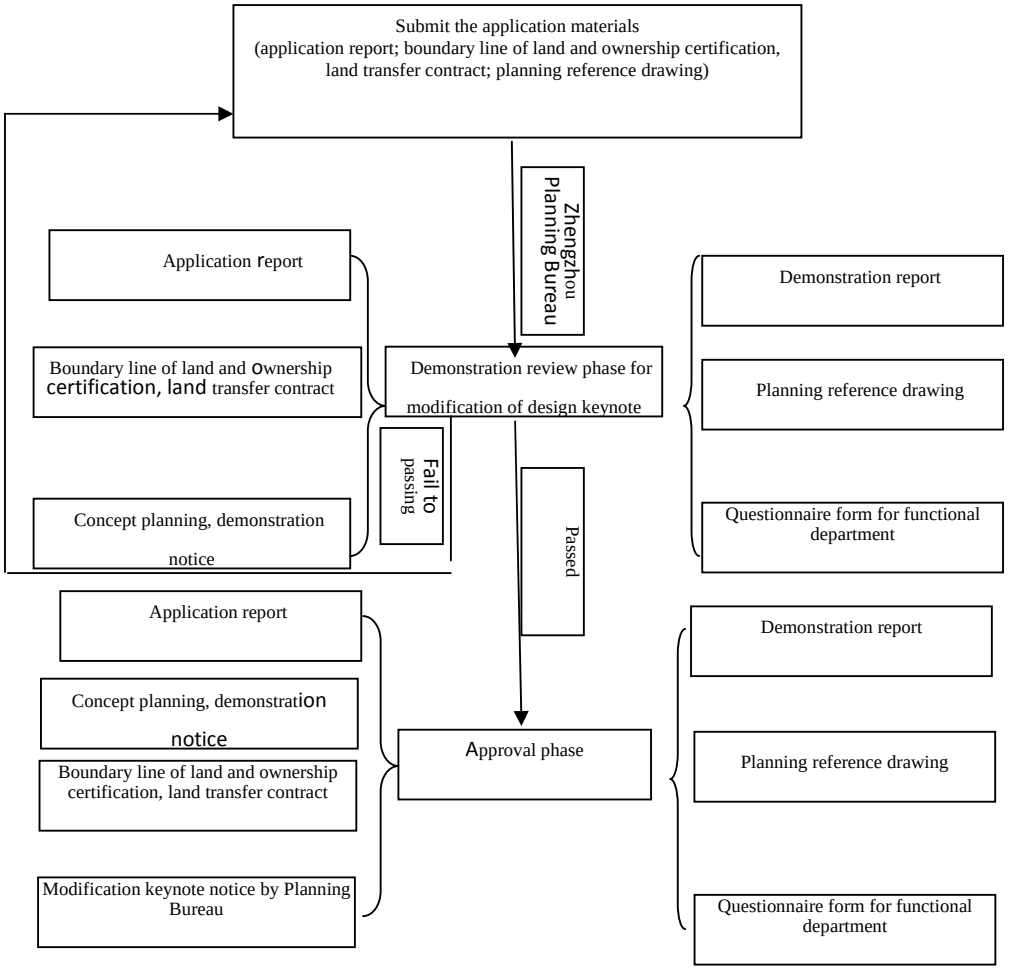


Figure 5.10-4 Control planning procedure for land utilization change

5.10.1.2 Negative Influences:

The negative influences caused by the project on the society are mainly concentrated in the construction period as follows: (1) influence of enclosure during construction period on urban traffic; (2) influence of enclosure during construction period on resident income; (3) influence of enclosure during construction period on residents' life. (4) Influences of underground vibration during construction period on stability of ground buildings.

(I) Influences of Enclosure during Construction Period on Urban Traffic

The major construction method for project section is shield tunnel method, and no influences will be caused on ground traffic. Except for Jinshui Road which adopts covered digging method, the other stations adopt open cut method, and influences will be caused on ground traffic during construction period.

(1) Influences of Construction of No. 1 Line under Construction on Urban Traffic

The project team surveyed the influences of station construction on ground traffic such as 27 square station, Tongbai Road Station, Minhang Road Station and Dongfeng

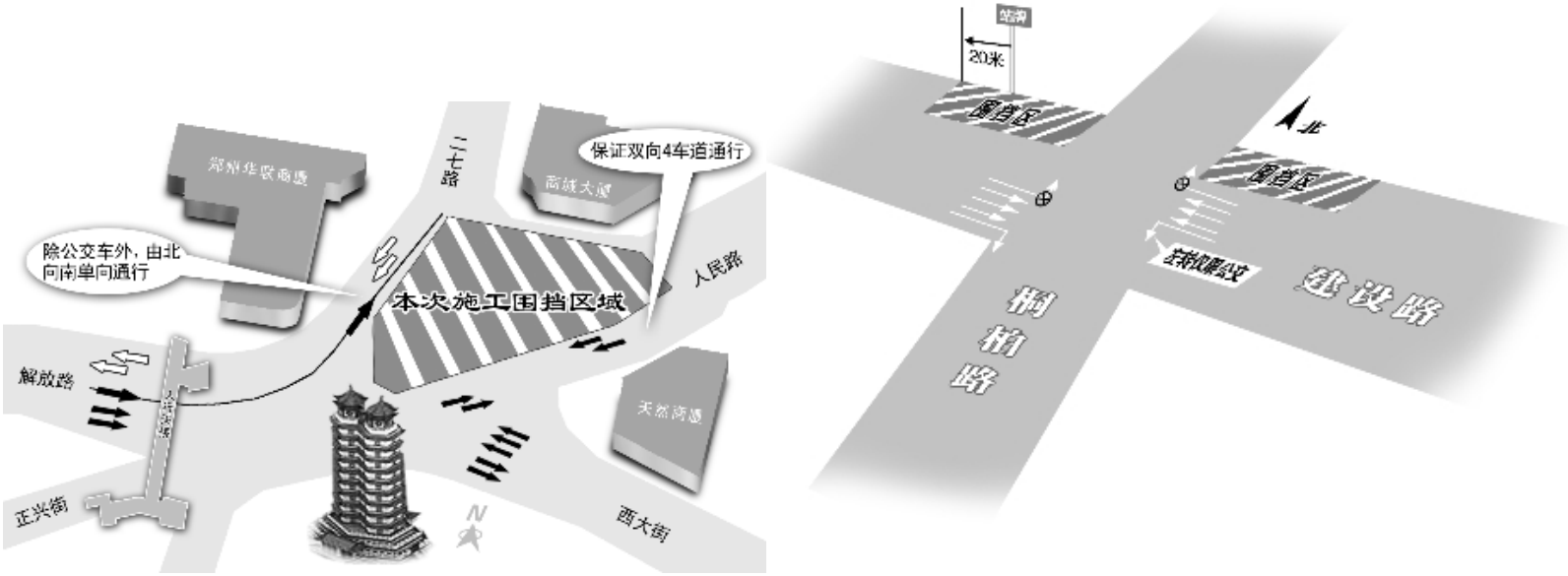
Road station etc. during project survey. See Table 5.10-1 for details. See Figure 5.10-5 for the traffic organization during construction period of 27 Square Station and Tongbai Road Station.

(2) Influences of No. 2 Line Project on Urban Traffic

See Table 5.10-2 for detailed influences of station construction of No. 3 line on ground traffic on the analogy of the influences of the stations built of No. 1 line on ground traffic.

Table 5.10-1 Traffic impact analysis of stations in construction of Zhengzhou rail transit 1and 2 line

No.	Name of station	Station position	Constructing method	Road occupation condition		Traffic volume conditions			Traffic for residences around the station	
				Total lane number	Occupied lane number	Traffic volume at peak time	Congestion condition	Traffic conditions of affected road around	Main residence or unit around	Impact degree on traffic
1	Erqi Square	Erqi Road, Renmin Road, Jiefang Road, West Street, Zhengxing Street crossing	open-cut method, local cover-excavation	Renmin Road 6 lanes	2	At peak time, 4100 vehicle/hour	Average speed of about 10km, seriously congested	Congested roads around	Erqi Hotel, Hualian Department Store, Tianran Department Store, Shangcheng Department Store and etc.	Large impact
2	Tongbai Road	Tongbai Road, Jianshe Road	open-cut method	Jianshe Road 8 lanes	3	At peak time, 3220 vehicle/hour	Average speed of about 20km, congested	Basically not affected	Lvcheng Shuma Building, Mianfang Road Sanmian Community, Minshengzhengquan Building, Meiliyuan Community	Obvious impact
3	Minhang Road Station	Jinshui Road, Minhang Road	open-cut method	Jinshui Road 8 lanes	3	At peak time, 2620 vehicle/hour	Average speed of about 30km, congested	Basically not affected	Pufa Square, Angang Building, State Development Bank Henan Branch, Minmen Shengshi	Little impact
4	Dongfeng Road Station	Huayuan Road, Dongfeng Road	open-cut method	Huayuan Road 8 lanes	3	Huayuan Road At peak time, 4450 vehicle/hour	Huayuan Road, average speed of about 30km, congested	Basically not affected	Bank of Communications Zhengzhou Branch, Provincial Administration for Industry and Commerce	Little impact



Erqi Square Station Tongbai Road Station

Figure 5.10-5 Traffic organization for part of stations during construction period

Table 5.10 -2 Traffic impact analysis of construction of stations for Zhengzhou rail transit 3 line

No.	Name of station	Station position	Constructing method	Analogy station in 1# and 2# lines	Predicted road occupation conditions		Traffic volume at peak time		Traffic for residences around the station	
					Total lane number	Occupied lane number	Current traffic volume at peak time (vehicle/hour)	Prediction congestion status	Main residence or unit around	Traffic impact prediction
1	Xinliu Road Station	Intersection of Changxing Road and Xinliu Road	open-cut method	1# line Minhang Road Station	Sanquan Road two-way 8 lanes, Changxing Road two-way 4 lanes	2	Sanquan Road 2448 Changxing Road 840	Smooth traffic	Henan Province Sports Center, Zhengzhou University Physical Culture School, Yuhua 9th City	Little impact
2	Shamen Road Station	Intersection of Changxing Road and Shamen Road	open-cut method	1# line Minhang Road Station	Changxing Road two-way 4 lanes Guoji Road two-way 2 lanes	2	Changxing Road 1150 Guoji Road 650	Smooth traffic	Hualian Family Area, Chengshi Bei'an Residence Community, Henan Shenghuang Industry, Zhengzhou Shunxing Construction Labor Company	Little impact
3	Xinglongpu Road Station	Intersection of Xinglongpu Road and Nanyang Road	open-cut method	1# line Tongbai Road station	Nanyang Road two-way 4 lanes Xinglongpu Road two-way 4 lanes	2	Nanyang Road 4000 Xinglongpu Road 1680	Congested at peak time	Zhengzhou Public Transportation Company Family Area, Changjian Yufeng gasoline station, Kairun Commercial Hotel, residence, glass wholesales market	Inconvenient traveling and large impact
4	Dongfeng Road Station	Intersection of Dongfeng Road and Nanyang Road	open-cut method	2# line Dongfeng Road Station	Dongfeng Road two-way 6 lanes Nanyang Road two-way 4 lanes	2	Dongfeng Road 3100 Nanyang Road 3500	Congested at peak time	Nanyang Road No.219 Yard, Food Machinery Plant Family Area, Tongle Community, Holiday Garden Community, Futian Building, Futian Lijing Garden Community	Inconvenient traveling and large impact
5	Nongye Road Station	Intersection of Nongye Road and Nanyang Road	open-cut method	1# line Tongbai Road station	Nongye Road two-way 8 lanes Nanyang Road two-way 4 lanes	2	Nongye Road 5650 Nanyang Road 4400	Congested at peak time	Xiaoyuzhai, Transport Company Family Area (Nanyang Road No.268) Zhongzhou Commercial Hotel, Nanyang New Town, Nanyang Xincun Community, Ronghua Community, Kaixuan Hotel	Inconvenient traveling and remarkable impact
6	Huanghe Road Station	Junction of Nanyang Road and Huanghe Road	open-cut method	1# line Tongbai Road station	Huanghe Road two-way 6 lanes Nanyang Road two-way 4 lanes	2	Huanghe Road 4150 Nanyang Road 5550	Seriously congested at peak time	Zhengzhou Textile Machinery Community, Zhengzhou Textile Machinery Apartment, Zhengzhou Textile Machinery Family Area, Huayuan Community	Inconvenient traveling and remarkable impact
7	Jinshui Road Station	Nanyang Road	cover-excavation method	1# line Tongbai Road station	Jinshui Road two-way 6 lanes Nanyang Road two-way 4 lanes	2	Jinshui Road 5600 Nanyang Road 3850	Seriously congested at peak time	Film Bureau Family Area, Zhengzhou City Library, Downtown Community Phase II, Nanyang Road No.326 (Zhengzhou National Oil Reserve Base Family Area), Jinshui Restaurant	Inconvenient traveling and remarkable impact
8	Taikang Road Station	Junction of Minggong Road and Taikang Road	open-cut method	1# line Tongbai Road station	Minggong Road two-way 4 lanes Xitangkang Road two-way 2 lanes	2	Minggong Road 5200 Xitaikang Road 2000	Seriously congested at peak time	Shengde Yike hotel, Minggong Road No. 245 (Xiqian Street 85# Yard 1#, 2# building), Xicai Community (Minggong Road 240# Yard)	Inconvenient traveling and remarkable impact
9	Erqi Square Station	Intersection of Jiefang Road, Minzhu Road and	open-cut method	1# line Erqi Square Station	Jiefang Road and Erqi Road two-way 4 lanes, others one-way 4 lanes	4	Jiefang Road 2890 Minzhu Road 2670 Zhengxing Street 2150	Congested at peak time	Huigang New Town, ICBC Jiefang Road branch, Asia hotel, Xiaolou Mosque	Inconvenient traveling and large impact
10	Shuncheng Street Station	East of crossing of West Street and Shuncheng Street	open-cut method	1# line Erqi Square Station	Shuncheng Street one-way 2 lanes Xitaikang Road two-way 6 lanes	2	Xitaikang Road 4000 Shuncheng Street 750	Congested at peak time	Yinzuo International, Hongxin Garden 1# building, Xiandai Xingyuan, Xidan Apartment, Huarong Assets Management Company	Inconvenient traveling and large impact
11	East Street Station	Intersection of East Street and Zijinshan Road	open-cut method	1# line Erqi Square Station	East Street two-way 4 lanes Zijinshan Road two-way 8 lanes	2	East Street 4000 Zijinshan Road 5000	Congested at peak time	Xiaolangdi hotel, Hongyu Garden, Ziyan Huating, Postal Building, Zhengzhou 1st People's Hospital, East Street 220# Yard, Shangcheng Licun (East Street 248# Yard),	Inconvenient traveling and large impact
12	Chengdong Road Station	Intersection of Chengdong Road and East Street	open-cut method	1# line Erqi Square Station	Two-way 6 lanes	2	East Street 4700 Chengdong Road 2600	Congested at peak time	Shangcheng Garden, Dongguandongli 96# Yard, Home Inn, China Union	Inconvenient traveling and large impact
13	Weilai Avenue Station	Intersection of Weilai Road and Zhengbian Road	open-cut method	2# line Dongfeng Road Station	Two-way 6 lanes	2	Zhengbian Road 4700 Weilai Avenue 3520	Smooth traffic	Zhongyuan Xintuo Building, Yutong Garden	Little impact

No.	Name of station	Station position	Constructing method	Analogy station in 1# and 2# lines	Predicted road occupation conditions		Traffic volume at peak time		Traffic for residences around the station	
					Total lane number	Occupied lane number	Current traffic volume at peak time (vehicle/hour)	Prediction congestion status	Main residence or unit around	Traffic impact prediction
14	Fengtainan Road Station	Intersection of Fengtainan Road and Zhengbian Road	open-cut method	2# line Dongfeng Road Station	Zhengbian Road two-way 6 lanes Yufeng Road two-way 2 lanes	2	Zhengbian Road 5900 Fengtainan Road Very few	Smooth traffic	Zhengzhou Traffic Police Detachment, Zhengzhou Huimin Middle School, Municipal Management Family Area	Little impact
15	Zhongzhou Avenue Station	Intersection of Zhongzhou Avenue and Zhengbian Road	open-cut method	2# line Dongfeng Road Station	Zhengbian Road two-way 8 lanes Zhongzhou Avenue two-way 10 lanes	2	Zhengbian Road 6400 Zhongzhou Avenue 9000	Smooth traffic	East Construction Material City, Jiangye Landmark	Little impact
16	Tongtai Road Station	Intersection of Tongtai Road and Shangdu Road	open-cut method	2# line Dongfeng Road Station	Shangdu Road two-way 6 lanes Tongtai Road two-way 6 lanes	2	Shangdu Road 5800 Tongtai Road 2800	Smooth traffic	Metro, New home furnishing construction material market, Zhongnanhaizhiyi Community	Little impact
17	Huanghedong Road Station	Intersection of Huanghedong Road and Shangdu Road	open-cut method	2# line Dongfeng Road Station	Two-way 8 lanes	2	Shangdu Road 5000 Huanghedong Road 4500	Smooth traffic	Commercial agencies such as logistics distribution center	Little impact
18	Nongyedong Road Station	Intersection of Nongyedong Road and Shangdu Road	open-cut method	2# line Dongfeng Road Station	Nongyedong Road two-way 8 lanes Shangdu Road two-way 8 lanes	2	Nongyedong Road 1500 Shangdu Road 2800	Smooth traffic	Yaxing International Square, Kinhom, Henan Province Collective Construction Material market	Little impact
19	Zhongxing Road Station	Intersection of Zhongxing Road and Shangdu Road	open-cut method	2# line Dongfeng Road Station	Zhongxing Road two-way 4 lanes Shangdu Road two-way 6 lanes	2	Zhongxing Road 1480 Shangdu Road 6000	Smooth traffic		Little impact
20	Boxue Road Station	Intersection of Boxue Road and Shangdu Road	open-cut method	1# line Minhang Road Station	Boxue Road two-way 4 lanes Shangdu Road two-way 6 lanes	2	Boxue Road 2600 Shangdu Road 7800	Smooth traffic		Little impact
21	Hanghai East Road Station	Intersection of Hanghai East Road and Chenyang Road	open-cut method	1# line Minhang Road Station	Two-way 6 lanes	2	Nonhaidong Road 2800 Jingkai 7 street not opened	Smooth traffic		Little impact

As shown in table 5.10-2, during construction of stations in Huiji District such as Xinliu Road Station and Shamen Road Station, although the open-cut method is used, the Huiji District Changxing Road is wide and the traffic flow is small, and the station construction only occupies part of road, so the residual road can still meet the traffic demand. In light of above facts, it has no remarkable impact on traffic. The Xinlongpu Station in Huiji District is on narrow Nanyang Road, but the Beihuan Road is wide with small traffic volume, and the construction does not occupy the narrow Nanyang Road, so it has little traffic impact.

The stations in Nanyang Road including Dongfeng Road, Nongye Road and Huanghe Road Jinshui Road are in old town of Zhengzhou with dense population and seriously congested traffic at present. Except Jinshui Road Station, other stations adopt open-cut construction method, so it intensifies the congestion of Nanyang Road during construction period.

The Taikang Road Station is located on current narrow Minggong Road with many buildings, dense population and complicated road conditions; it also connects with Zhengzhou Railway Station and commercial centers like Erqi Square with large visitor flows, so it is very congested. The Taikang Road Station adopts open-cut construction method and it has large traffic impact on Minggong Road during construction period.

Erqi Square Station is a station in construction of 1# line. Through field survey, due to scientific traffic strike control for surrounding Zhengxing Street, Renmin Road, Erqi Road, Jiefang Road and West Street and the circular corridors in large shopping malls around Erqi Square Station for ease of pedestrian traveling, although this station construction adopts open-cut method, the construction enclosure is arranged at the triangular location of each intersection, and in combination with practical measures, it has little traffic impact during construction period.

Jiefang Road and East and West Street are of Zhengzhou Commercial Center with dense human traffic and developed road network, the Shuncheng Street Station, East Street and Chengdong Road Station in this area may be affected during construction period; but the roads in this area is wider than Nanyang Road, so the impact is slightly less than that of Nanyang Road and Minggong Road.

The Weilai Avenue Station, Fengtainan Road Station, Zhongzhou Avenue Station, Tongtai Road Station, Huanghedong Road Station, Nongyedong Road Station, Zhongxing Road Station and Boxue Road Station in Zhengdong New District are on the Zhengbian Road and Shangdu Road. This area is of new development area with 8 lanes road and 5m wide green belts between lanes and both sides of walkway; although it adopts open-cut construction method, the construction area is basically located in walkway and green belts, and the construction of stations basically do not occupy existing road, so it has little impact on ground traffic. By above analysis, in the stations with open-cut construction method, the traffic impact of Taikang Road Station by construction activities is the most serious, then followed by Dongfeng Road, Nongye Road and Huanghe Road Station on Nanyang Road Station.

For Jinshui Road Station with cover-excavation construction method, due to current narrow road and large traffic volume, it can still ensure two-way 4 lanes traffic after adopting cover-excavation construction method; it has little traffic impact during

construction period.

(II) Impact on resident incoming after enclosing during construction period

The impacts of 3 line project on resident incoming mainly include: impact of part of farmland occupation at car depot, parking depot and access section of open cut on resident incoming; after open cut and semi-covered station, the resulted traffic blocking and cutoff will impact part of commercial tenants at both sides of open cut and semi-covered excavation station; the surrounding construction demolition around the station will affect the operation incoming of relocated merchants.

(1) Impact on residents of farmland occupation

According to field survey, the economic loss of residents due to land occupation of 3 line refers to table 5.10-3.

Table 5.10-3 Expropriated collective land for parking depot and car depot

	Vegetable Field	Arable Land	Fruit Garden	Woodland	Other Land	Total	Number of Households Influenced	Number of People Influenced
I. Parking Lot	82	96	0	0	35	213	148	477
Laoyechen Village	34	96	0	0	23	153	108	345
Gucheng Village	48	0	0	0	12	60	40	132
II. Depot	0	115	112	287	59	573	91	290
Dawang Zhuang	0	44	44	110	22	220	35	118
Shanwang Village	0	36	36	90	18	180	29	91
	0	35	32	87	19	173	27	81
Total	82	211	112	287	94	786	239	767

Calculated based on 10,000 yuan/Mu for vegetable plot, 5,000 yuan/Mu for cultivated land, 50,000 yuan/Mu for orchard and 40,000 yuan/Mu for forest land, the impact of land occupation on peasant incoming is about 26.335 million yuan/year as about 34.400 yuan/year/household.

(2) Impact analysis on commercial tenants around the station by station construction

During project survey, the project group surveys the impact on commercial operations by construction of Minhang Road Station of 1# line. The details refer to table 5.10-4.

By analog with the survey of 1# line, the detailed economic loss of commercial units from station construction along 3 line refers to table 5.10-5.

Table 5.10-4 Commercial impact of Zhengzhou rail transit 1# line station construction

Position	Name of store	Type of store	Scale	Station construction method	Current road conditions			Operation revenue loss of store (%)	Cause
					Current road width	Traffic flow	Traffic congestion conditions		
Minhang Road Station	Youle Hot Pot	Catering	Small scale	open-cut method	4 lanes	At peak time, 2140 vehicles/hour	Relative congested	Reduction of about 20%	No parking position; less customer
	Fuzhi Department Store	Service	Small scale	open-cut method	4 lanes	At peak time, 2140 vehicles/hour	Relative congested	Reduction of about 20%	Less bus, and less pedestrian
	Hongshan Guarantee Company	Service	Small scale	open-cut method	4 lanes	At peak time, 2140 vehicles/hour	Relative congested	Reduction of 30%	Less bus, and less pedestrian
	Maiduo Pie	Catering	Small scale	open-cut method	4 lanes	At peak time, 2140 vehicles/hour	Relative congested	Reduction of 50%	Less bus, and less pedestrian
	Dances with Wolves dress	Clothes	Small scale	open-cut method	4 lanes	At peak time, 2140 vehicles/hour	Relative congested	Reduction of 50%	Less bus, and less pedestrian
	Holiland cake	Catering	Small scale	open-cut method	4 lanes	At peak time, 2140 vehicles/hour	Relative congested	Reduction of 30%	Less bus, and less pedestrian
	Hongwei Refrigeration	Service	Small scale	open-cut method	4 lanes	At peak time, 2140 vehicles/hour	Relative congested	Reduction of about 20%	No parking position; less customer
	Peng Crackling Cake Shop	Catering	Small scale	open-cut method	4 lanes	At peak time, 2140 vehicles/hour	Relative congested	Reduction of about 20%	No parking position; less customer
	Tiedage Shangyao Store	Catering	Small scale	open-cut method	4 lanes	At peak time, 2140 vehicles/hour	Relative congested	Reduction of about 20%	No parking position; less customer

Table 5.10-5 Commercial impact of 3 line station construction

Position	Name of store	Type of store	Scale	Station construction method	Current road conditions			Road conditions after construction		Store operating revenue loss (%)	Cause analysis
					Existing road width	Traffic flow	Traffic congestion	Road width	Traffic flow		
Xinglongpu Road Station	China Postal Office, Hengyuan drugstore, Tiedage Shanyao, Zuoyoujian supermarket, Jun'an real estate agent, Xiaoji sanxian, Nanyang Cooking pot, Liangxin Glasses Wholesales Market, China sports lottery, Guangming Glasses, Xingguang rest house, Mingshida Glasses, Piaoxiangdao Cake, Tianshi Dentistry, China Lianneng and etc.; total about 50 stores	catering Service	small scale	open-cut method	Nanyang Road two-way 4 lanes Xinglongpu Road two-way 4 lanes	Nanyang Road 3210	Congested at peak time	2 lanes	At peak time, 1200 vehicles/hour	10%	Less passing vehicles and pedestrians
Dongfeng Road Station	Zhengzhou Bank, Construction Bank	Public institute	Medium scale	open-cut method	Dongfeng Road two-way 6 lanes Nanyang Road two-way 4 lanes	Dongfeng Road 3680 Nanyang Road 3340	Congested at peak time	2 lanes	At peak time, 1200 vehicles/hour	10%	Less passing vehicles and pedestrians
	Green Tree Inn, Weilai Yiju Hotel	Public institute									
	Fuzhi department store, Xiaozhubanna children's wear, Nixingwosu Hairdressing, Jumenglai home textiles, Aidengbao dress, Meilian House Property, Jindapeng Aviation Ticket Business, Shunfeng Cigaratte and Wine Store, Unlocking and Stamp making, Mifei Children's Shoes, Bimu Photo-Text Quick-Print, Mingyang Real Estate Agent, Jinde Pipe, Juewei Duck-neck, Hunan Rice and Beef Noodles, Kangjia Stewed Noodles Store, Hardware and Electric Equipment, Lanzhou Hand-pulled Noodles with Beef	Department store, Dress, Service, catering	small scale								
Nongye Road Station	Dadixiang Kitchen, Dayu Medicine	Catering service	Medium scale	open-cut method	Nongye Road two-way 8 lanes Nanyang Road two-way 4 lanes	Nongye Road 3440 Nanyang Road 3560	Congested at peak time	2 lanes	At peak time, 3000 vehicles/hour	10%	Less pedestrian and passing vehicles; bus stop relocation
	Jinshui District Insulation Material Plant, Nanyang New Town Subdistrict Office	Enterprise and public institution									
	Yanghe River Blue Classic Wine Store, Ruice Design, Bosideng Dress, Hongshan Guarantee Company, DESIGNICE Dress, Wallace Fast-food, Qipai Men's Wear	catering	small scale								
	Damengzhai Kaixuan Hotel	Service	Large scale								
Huanghe Road Station	Hengtian Incorporated Company	Enterprise	Large scale	open-cut method	Huanghe Road two-way 6 lanes Nanyang Road two-way 4 lanes	Huanghe Road 3720 Nanyang Road 3610	Seriously congested at peak time	2 lanes	At peak time, 3000 vehicles/hour	Part of stores are demolished; impact on rest stores for reduction by about 30%	Part of vehicles has to bypass Significant reduction of bus, passing vehicles and pedestrians
	Zhengzhou Textile Machinery Guest House	Enterprise	Medium scale								
	Tianneng Battery, Hongzhi Yanjiu, Huahuaniu Dairy, Boai beef balls soup, Lixing Stationery Store, Yilanxuan Dress, Hongyun Hardware and Electric Equipment, Xiangla Chanzui Fish, Household Appliances Refrigration Maintenance, Jinling Beauty Club, Animal Husbandry Grocery, Nanyang Road Marketplace, Shumeijie Dress, Dongtian Liquor Tobacco Store	catering, Service, department store, dress	small scale								
Jinshui Road Station	Jinshui Hotel, Home Inn	Catering Service	Medium scale	open-cut method	Jinshui Road two-way 6 lanes Nanyang Road two-way 4 lanes	Jinshui Road 3980 Nanyang Road 3650	Seriously congested at peak time	6 lanes	3600 vechiles/hour	50 stores demolished; large impact	Part of vehicles has to bypass Significant reduction of bus, passing vehicles and pedestrians
	Zhengzhou Kangning Medical Equipment Co., Ltd., Kangzhong Medical Instruments, Baiyitianyi Medical Dress, Donglixiang Chinese Chestnut, Shiqiao KTV, Five-star Medical Instruments Supply Station, China Mobile Number Seletion and Payment Office	Service Creation, catering	small scale								
Taikang Road	Sanxing Stainless Steel, Electric Materials,	Special appliance sasles,	small scale	open-cut method	Minggong Road	Minggong Road	Seriously	4 lanes	At peak time,	10 stores	Part of vehicles has to

Station	Zhengzhou Donghai Plastics, Zhengzhou Erqi Electric Heating Instrument Sales Agent, Defu Frequency Converter Zhengzhou Office, Electric Construction Equipment, Railway Standard Parts, various packing belts, Guangdong Fry Food	catering			two-way 4 lanes Xitaikang Road two-way 2 lanes	3450 Kangtai Road 3170	congested at peak time		3000 vehicles/hour	demolished; other impact by 10%.	bypass Significant reduction of bus, passing vehicles and pedestrians
Shuncheng Street Station	Amashi Dress Store, Hongdou House Dress Store, Fengshaotian Training School, Chengliren Zudao, Survey and Design Institute Office, Xinyu Properties	Service, Service	small scale	open-cut method	Shuncheng Street one-way 2 lanes Xitaikang Road two-way 6 lanes	West Street 3790 Shuncheng Street 3330	Seriously congested at peak time	6 lanes	At peak time, 1500 vehicles/hour	Demolish 11 stores; other revenue reduction by 30%	Less vehicles and pedestrains
East Street Station	Yongxin Cupboard marketplace	Service	small scale	open-cut method	East Street two-way 4 lanes Zijinshan Road two-way 8 lanes	East Street 3560 Zinjinshan 3410	Seriously congested at peak time	2 lanes	2500 vehicles/hour	Revenue reduction by about 10%	Less pedestrian
Chengdong Road Station	Home Inn	Service	Medium scale	open-cut method	two-way 6 lanes	East Street 3280 Chengdong Road 2950	Seriously congested at peak time	2 lanes	At peak time, 2280 vehicles/hour	Large impact	Almost all are relocated; large impact
	Shishang Hotel, Yifei Dress Store, Dongfang Cigarette and Wine Shop, Fujian Flavor Snack Bar, Tiedage Shanyao Store, Gongting Walnut Cake Store, Shuangeng Shoes	Dress, catering, retails	small scale								
Weilai Avenue Station	Huari Furniture City Franchised store, Electronics Store	Retails	small scale	open-cut method	Two-way 6 lanes	Zhengbian Road 3150 Weilai Avenue 3520	Congested at peak time	2 lanes	At peak time, 2080 vehicles/hour	Revenue reduction by about 50%	Less pedestrian
Zhongzhou Avenue Station	Huashi Paint, Zinjinghua Paint, Duomei Wallpaper, Hanning Wallpaper, Hyayuan Decoration, Jinbaolai Furniture, Hongfa Sone, Shengshi IronArt, Fangao Gypsm Art Workshop, Xindalu Smart Home experiement hall	Decoration	Small scale	open-cut method	Zhengbian Road two-way 8 lanes Zhongzhou Avenue two-way 10 lanes	Zhengbian Road 2860 Zhongzhou Avenue 4640	Congested at peak time	2 lanes	At peak time, 680 vehicles/hour	No impact	With parking position

As shown in table 5.10-5, during construction of Xinliu Road Station, Shamen Road Station and Xinglongpu Road Station in Huiji District, since there are few commercial facilities with wide road, the traffic is basically not affected; For Dongfeng Road Station, Nongye Road Station, Huanghe Road Station, Jinshui Road Station and Taikang Road Station along Nanyang Road and Minggong Road, the stores at both sides of road are mostly at the first floor of residential building or at the outer side of residential building near the road, and the buildings are old, in combination with the narrow space of Nanyang Road and Minggong Road, it imposes many difficulties on the layout of rail transit station entrance and ventilation pavilion; so the commercial tenant quantity to be resettlement during construction period is large and their incomings are affected; for the stations on Jiefang Road, there are many stores on east and west streets, but the roads in this area are broad and the demolition amount is small, so the affected amount by demolition is less; for the stations along Zhengbian Road and Shangdu Road, there are few stores with the minimum demolition works; the space at both sides of station is broad and the store business type is simple and concentrated, so the construction impact is small. The incomes of merchants around above stations will decrease 20%-30% in comparison to present status.

For 260 merchants to be demolished along the line, compensate according to market price and provide 6 months close-down compensation reward. For 988 store employees, offer one-off 6 months minimum wage compensation for actual employees registered in business license.

For other affected merchants, after 3 line operation, the passenger flow volume around the stations will considerably increase due to the radiation effect of rail transit and it will sustainably and long-term increase the above merchants' incoming affected during construction period. As a result, although the income during construction period decreases, the construction period is far less than operation period and the incomes of merchants generally increase in integrated consideration of construction period and operation period.

(III) Impact on resident livings during construction period

The impact on resident livings by line 3 project mainly occurs during construction period. It includes the inconvenient traveling of residents or enterprise or public service units around the station during construction period and extension of traveling time for going to work and getting off work. The relocation and placement will affect the resident livings. At same time, the noise and vibration interference due to operation of construction machinery, deposition and transport construction raise dust, sewage, muddy water, construction wastes and construction materials during construction period will impact the resident livings. The main resident areas or enterprises or public service units affected along the line refer to able 5.10-6.

Table 5.10-6 Impact analysis of resident livings

Position	Name of residential area and organization	Influenced factor	Influence period	Influence degree
Xinliu Road Station	Yuhua 9th City 1#	noise, vibration, traveling	Construction period	Low
Shamen Road Station	Chengshi Bei'an Community 1# building	noise, vibration, traveling	Construction period	Large
	Changxing Building	noise, vibration, traveling	Construction period	
	Huiji District Changxing Road Subdistrict Office	noise, vibration, traveling	Construction period	
	Changxing Road 2# Yard 13, 10# building	noise, vibration, traveling	Construction period	
	Baiwen Garden 1#, 2#, 6#, 7# building	noise, vibration, traveling	Construction period	
Xinglongpu Road Station	Zhengzhou Public Transportation Company Family Area	noise, vibration, traveling, demolition	Construction period	Large
	Huarun Chengshi Zhiyin (Xinyu Yayuan) Community 1#, 5# building	noise, vibration, traveling	Construction period	
	Changjian Yufeng (in construction)	Traveling	Construction period	
Dongfeng Road Station	Sunshine Holiday Community 3# Building Sunshine Holiday Community 2# Building	noise, vibration, demolition	Construction period	Large
	Tongle Community 46# building Tongle Community 61# building Food Machinery Plant Family Area 2# Building	noise, vibration, traveling, demolition	Construction period	Large
	Tongle Community North Area 1#, 2#, 3#, 4#, 5# building	noise, vibration, traveling, demolition	Construction period	Very large
	Futian Lijing Garden Community 39#, 40# building	noise, vibration, traveling	Construction period	small
Nongye Road Station	Ronghua Family Area 3#, 4#	noise, vibration, traveling	Construction period	Large
	Zhengzhou Ceramics Factory Family Area 1#, 3# building, Nanyang Road No.62	noise, vibration, traveling	Construction period	Large
	Nanyang Road 68# Yard Zhengtie Nanyang New Town Community 1#, 2#, 3#, 10#, 41# building	noise, vibration, traveling	Construction period	Large
	Xiaoyuzhai (Nanyang Road 266# Yard) 3#, 5# building	noise, vibration, traveling, demolition	Construction period	Large
Huanghe Road Station	Nanyang Road the 1st Primary School	noise, vibration, traveling	Construction period	Large
	Zhengzhou Textile Machinery Staff Apartment 18# - 20# building	noise, vibration, traveling, demolition	Construction period	Large
	Nanyang Road 296# Yard (Nanyang Renjia) 1#, 2#, 3#	noise, vibration, traveling	Construction period	Moderate
	Nanyang Road 300# Yard 2# building	noise, vibration, traveling	Construction period	Large

	Zhengzhou Textile Machinery Co., Ltd. Family Area 6#, 5#, 4#, north 3#, north 2# building	noise, vibration, traveling, demolition	Construction period	Large
	Huayuan Community (Nanyang Road No.300)5# building	noise, vibration, traveling, demolition	Construction period	Moderate
Jinshui Road Station	Film Bureau Family Area 6#, 7# building (Nanyang Road No.7)	noise, vibration, traveling	Construction period	Large
	Tingdao foreign language training	noise, vibration, traveling	Construction period	Large
	Zhengzhou City Library	noise, vibration	Construction period	Large
	Zhengzhou National Oil Reserve Base Family Area 1# building	noise, vibration, traveling, demolition	Construction period	Large
	Downtown Community Phase II 1# building	noise, vibration, traveling	Construction period	Small
Taikang Road Station	Xicai Community (Minggong Road 240# Yard)2#, 3# building	noise, vibration, traveling, demolition	Construction period	Large
	Minggong Road No.245 (Xiqian Street 85# Yard 1#, 2# building)	noise, vibration, traveling, demolition	Construction period	Large
	Huarun Yuefu (in construction)	noise, vibration	Construction period	Small
Erqi Square Station	Huigang New Town 1#, 2#, 3# building	noise, vibration, traveling	Construction period	Small
	Xiaolou Mosque, Female Mosque	noise, vibration, traveling	Construction period	Large
Shuncheng Street Station	Hongxin Garden 1# building	noise, vibration, traveling	Construction period	Small
	Xidan Apartment 2# Building	noise, vibration, traveling	Construction period	Small
	Xiandai Xingyuan 1#	noise, vibration, traveling	Construction period	Small
	Yinzuo International	noise, vibration, traveling	Construction period	Small
East Street Station	Changjiang Chengzhongcheng	noise, vibration, traveling	Construction period	Small
	Hongyu Garden 1#, 2#, 3# building	noise, vibration, traveling	Construction period	Small
	East Street 220# Yard	noise, vibration, traveling	Construction period	Small
	Ziyan Huating 1#, 2# building	noise, vibration, traveling	Construction period	Small
	The First People's Hospital of Zhengzhou	noise, vibration, traveling	Construction period	Small
Chengdong Road Station	Dongguandongli 96# Yard 1# building	noise, vibration, traveling	Construction period	Large
	Shangcheng Garden 1# building	noise, vibration, traveling	Construction period	Small
Fengtainan Road Station	Zhengzhou Huimin Middle School	noise, vibration, traveling	Construction period	Moderately small
	Zhengzhou City Public Security Bureau SWAT Detachment	noise, vibration, traveling	Construction period	Moderately small

In addition, Jinshui Road Station, Taikang Road Station, Erqi Square Station, Shuncheng Street Station and Weilai Avenue Station are located in existing urban arterial roads with dense pipeline under the roads, and above stations adopt open cut construction method and semi-covered excavation construction method, so it will veritably affect part of underground pipelines and the water and gas supply and communication of residents around the stations, and make them inconvenient.

(IV) Underground vibration impact on ground building stability during construction period

Since the project adopts the construction methods of open cut and covered cut and shield method and auxiliary construction methods, the improper selection of construction methods will be liable to uneven settlement, ground collapse or uplift. It will impose certain impact on the stability of ground buildings along the line of project, and therefore the cracking or collapse of ground building along the project line.

The list of ground buildings of which the stability may be affected due to engineering construction refers to table 5.10-7.

Table 5.10-7 Investigation of structures (buildings) along rail transit No.3 in Zhengzhou

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
1	Nanyang road	右 K2+752-783	Xiaoji huimian	Frame	The depth of pile foundation is 8.5m	About 23.5m from the wast of the center line	2000 ㎡	
2		K2+750-775	Nanyangzai dashaguo	Brick concrete	Natural foundation	About 15m from the east of the center line	850 ㎡	
3		K2+776-822	Xinyu yayuan 3#	Bottom frame + brick concrete	The depth of pile foundation is 10.5m	About 22m from the east of the center line	4529 ㎡	
4		K2+833-843	Xinyu yayuan 11#	Brick concrete	Natural foundation	About 20m from the east of the center line	1048 ㎡	
5		右 K2+792-885	City bus company, family member courtyard	Brick concrete	Depth of raft foundation 1.8m	About 20m from the wast of the center line	1 号:3209 ㎡ 2 号:3209 ㎡ 3 号:2915 ㎡ 4 号:2143 ㎡	
6		K2+879-923	Zhengzhou yanjing dashijie	Bottom frame + brick concrete	Natural foundation	About 17m from the east of the center line	1800 ㎡	
7		右 K2+899-922	Zhengzhoukaoya	Brick concrete	No data	About 25m from the east of the center line	578 ㎡	
8		K3+43-60	Henan zhubao, family member courtyard	Brick concrete	No data	About 18m from the east of the center line	1454 ㎡	
9		K3+70-121	Zhongji urban spring	Frame	The depth of pile foundation is 16m	About 31m from the east of the center line	19904 ㎡	
10		右 K3+178-312	Grain transport community, 3 #,5 # ,10#Building	3#、5#：Brick concrete 10#：Frame	Natural foundation	About 20m from the east of the center line	3 号楼：1999 ㎡ 5 号楼：1769 ㎡ 10 号楼 3680 ㎡	
11	Nanyang road	K3+175-191 K3+231-249	Building No.2 and No.7 of City-state of Jianye Yihao	Frame	The depth of pile foundation is 14m	About 35m from the east of the center line	2 号：7828 ㎡ 7 号：7972 ㎡	
12		K3+271-313	Office building	Brick concrete	Natural foundation	About 18m from the east of the center line	2600 ㎡	
13		K3+335-395	Yard No.149 of Family residential building of Zhengzhou Tractor Plant	Brick concrete	Natural foundation	About 16m from the east of the center line	2842 ㎡	
14		K3+400-460 K3+470-530	Family residential building of Zhengzhou Tractor Plant	Brick concrete	Natural foundation	About 18m from the east of the center line	1706 ㎡	
15		K3+610-622	Tianxiu Homeland	Bottom frame + brick concrete	Natural foundation	About 42m from the east of the center line	20000 ㎡	
16		K3+558-588	Liuzhai Office Building of Huiji District	Frame	The depth of pile foundation is 12.5m	About 21m from the east of the center line	2767 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
17		右 K3+597-607	Family residential building of Huiji District Education Office	Brick concrete	No data	About 19m from the wast of the center line	8276.52 ㎡	
18		右 K3+615-750	Building No.1 and No.2 of Yuhua Wenhui	Brick concrete	Natural foundation	About 24m from the wast of the center line	共 36566 ㎡	
19		K3+722-769	Dongfang Hospital	Bottom frame + brick concrete	No data	About 24m from the east of the center line	14700 ㎡	
20		K3+770-876	Bojin Shopping Mall	Frame	The depth of pile foundation is 12m	About 17m from the east of the center line	39000 ㎡	
21	Nanyang road	K3+900-934	Office building of Nanyang Road Sub-branch of ICBC	Frame	The depth of pile foundation is 13m	About 30m from the east of the center line	4072 ㎡	
22		右 K3+898- 右 K4+30	Building No.1, No.2, No.3, and No.4 of Yuhua Wenqing Community	Frame	Natural foundation	About 22m from the wast of the center line	1 号楼：5631 ㎡ 2 号楼：5308 ㎡ 3 号楼：5755 ㎡ 4 号楼：5643 ㎡	
23		K4+38-158	Frontage shop of Liuzhai Vallage	Brick concrete	No data	About 16m from the east of the center line	371 ㎡+1526 ㎡	
24		右 K4+49-59	Family residential building of Zhengzhou Brewery	Brick concrete	No data	About 24m from the east of the center line	1969 ㎡	
25		右 K4+181-191	Family residential building of Zhengzhou Brewery	No data	No data	About 25m from the wast of the center line	10128 ㎡	
26		K4+223-241	Nanyang Road sub-branch of Zhengzhou Branch of Unicom	Frame	The depth of pile foundation is 20m	About 23m from the east of the center line	4400 ㎡	
27		右 K4+211-260	Chuangye homeland	No data	No data	About 22m from the east of the center line	5773 ㎡	
28		K4+252-272	Business office of Nanyang Road	Brick concrete	No data	About 22m from the east of the center line	1500 ㎡	
29		右 K4+275-355	Commercial residential building	No data	Natural foundation	About 26m from the wast of the center line	6453 ㎡	
30		右 K4+361-392	Zhengzhou Songtao Hotel Co. Ltd	Brick concrete	No data	About 23m from the wast of the center line	4955 ㎡	
31	Nanyang road	K4+283-361	Building No.1, No.2, No.3 of Tongle Community	Brick concrete	No data	About 21m from the wast of the center line	1 号：1500 ㎡ 2 号：1500 ㎡ 3 号：800 ㎡	
32		右 K4+417-463	Rest house of Qixing Company	Brick concrete	No data	About 19m from the wast of the center line	1565 ㎡	
33		K4+498-543	Residential building of Municipal CCB	No data	No data	About 18m from the east of the center line	2290 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
34		K4+366-420	Building No.4 of Tongle Community	Brick concrete	No data	About 22m from the east of the center line	4900 ㎡	
35		右 K4+452-463	Residential building No.1 of Woolen Mill	Brick concrete	Depth of strip foundation 1.8m	About 36m from the wast of the center line	5200 ㎡	
36		K4+551-569	Residential building of Municipal CCB	No data	No data	About 24m from the east of the center line	1678 ㎡	
37		K4+581-623	Green Tree Inn	Frame	Natural foundation	About 24m from the east of the center line	4300 ㎡	
38		K4+633-695	Shengdi Mansion	Frame	The depth of pile foundation is 28m	About 28m from the east of the center line	20480 ㎡	
39		K4+713-776	Xiangyang Building	Brick concrete	pile	About 20m from the east of the center line	4878 ㎡	
40		右 K4+771-819	Building No.2 of family residential building of Feima Group	Brick concrete	No data	About 21m from the east of the center line	5118 ㎡	
41	Nanyang road	右 K4+840-883	Building No.1 of Kaiyuan Community	Brick concrete	No data	About 20m from the wast of the center line	3578 ㎡	
42		K4+784-878	Family residential building of Henan Institute of Engineering	Brick concrete	Strip foundation	About 22m from the east of the center line	2659 ㎡+2050 ㎡	
43		K4+912-996	Family residential building of Daqiao Bureau	Brick concrete	No data	About 21m from the east of the center line	6067 ㎡	
44		右 K4+498-509	Building No.1 of Futian Lijing Garden Residence Community	Bottom frame + brick concrete	The depth of pile foundation is 10m	About 86m from the wast of the center line	8024 ㎡	
45		右 K4+496-510	Building No.3 of Futian Lijing Garden Residence Community	Bottom frame	The depth of pile foundation is 10m	About 231m from the wast of the center line	12795 ㎡	
46		右 K4+496-510	Building No.2 of Futian Lijing Garden Residence Community	Bottom frame + brick concrete	The depth of pile foundation is 10m	About 139m from the wast of the center line	7594 ㎡	
47		右 K4+506-550	Building No.36 of Futian Lijing Garden	Frame	The depth of pile foundation is 10m	About 32m from the wast of the center line	19142 ㎡	
48		右 K4+570-635	Building No.37 of Futian Lijing Garden	Bottom frame + brick concrete	The depth of pile foundation is 10.5m	About 35m from the wast of the center line	6302 ㎡	
49		右 K4+680-758	Building No.38 of Futian Lijing Garden	Bottom frame + brick concrete	The depth of pile foundation is 10.5m	About 24m from the wast of the center line	11703 ㎡	
50		右 K4+923- 右 K5+11	Family residential building of building No.1 of Henan Prospecting Machinery Institute	Bottom frame + brick concrete	pile	About 21m from the wast of the center line	4783 ㎡	
51	Nanyang road	K5+15-92	Building No.15, No.16 of Jiatianxia	Frame	The depth of pile foundation is 15m	About 35m from the east of the center line	15 号：8000 ㎡ 16 号：7800 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
52		右 K5+16-72	Frontage complex building	Frame	pile	About 22m from the wast of the center line	2560 ㎡	
53		右 K5+78-133	Complex building	Brick concrete	pile	About 27m from the wast of the center line	4870 ㎡	
54		K5+106-140	Family residential building of Feima Group	Brick concrete	No data	About 20m from the east of the center line	2680 ㎡	
55		K5+148-233	Family residential building of Zhengzhou Boiler Factory	Bottom frame + brick concrete	Natural foundation	About 20m from the east of the center line	7210 ㎡	
56		K5+255-295	Building No.3, No.6 of Meat Processing Plant Family Residential Building	Brick concrete	No data	About 16m from the east of the center line	3 号：3492 ㎡ 6 号：3522 ㎡	
57		右 K5+147-288	Frontage building	3 层：Brick concrete 2 层：Frame	Natural foundation	About 18m from the wast of the center line	3 层：2679 ㎡ 2 层：1120 ㎡	
58		右 K5+310-330	Family residential building of Malleable Plant	Brick concrete	No data	About 25m from the wast of the center line	2250 ㎡	企业破产
59		K5+312-372	Longing Homeland	Brick concrete	Natural foundation	About 20m from the east of the center line	6500 ㎡	
60		右 K5+333-398	Yongle Electrical Apparatus	No data	pile	About 26m from the wast of the center line	4514 ㎡	
61	Nanyang road	K5+380-445	Family Residential Building of Meat Processing Plant	Brick concrete	No data	About 19m from the east of the center line	3480 ㎡+3390 ㎡+2820 ㎡	
62		右 K5+377-420	Family Residential Building of Malleable Plant	Brick concrete	No data	About 20m from the wast of the center line	5580 ㎡	
63		右 K5+458-506	Intermixing Building of Commerce and Residence	Brick concrete	No data	About 16m from the wast of the center line	2656 ㎡	
64		右 K5+518-547	Residential building of Zhengzhou Diet Company	Brick concrete	The depth of pile foundation is 10m	About 17m from the wast of the center line	不详	
65		右 K5+552-602	Frontage House of Zhengzhou Vegetable Co. Ltd	Brick concrete	Natural foundation	About 22m from the wast of the center line	410 ㎡	
66		K5+468-578	Xincun Community of Nanyang Road	Brick concrete	No data	About 23m from the east of the center line	1 号：5192 ㎡ 2、3 号：1819 ㎡	
67		K5+674-690	Kaixuan Express Hotel	Brick concrete	No data	About 46m from the east of the center line	5580 ㎡	
68		右 K5+610-645	Temporary Office Building of Nanyang New Village Office	Brick concrete	No data	About 25m from the east of the center line	3-4 层：1010 ㎡	
69		右 K5+658-690	Dadi KTV	Brick concrete	Natural foundation	About 88m from the wast of the center line	1300 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
70		右 K5+658-672	Xinqingyue Commercial Club	Frame	Natural foundation	About 45m from the wast of the center line	3500 ㎡	
71	Nanyang road	右 K5+656-681	Fragrant Kitchen Hotel	Brick concrete	Natural foundation	About 38m from the wast of the center line	400 ㎡	
72		K5+755-775	Zhongzhou Express Hotel	No data	No data	About 31m from the east of the center line	5930 ㎡	业主拒绝提供信息
73		右 K5+735-780	Electric Power Installation Co. Ltd of Zhengzhou Xianghe Group	Brick concrete	Natural foundation	About 22m from the wast of the center line	3768 ㎡	
74		K5+782-875	Family residential building of Chinaware Plant	Brick concrete	No data	About 18m from the east of the center line	1 号：2375 ㎡ 2 号：1975 ㎡	
75		右 K5+790-817	Mengzhai Business Building of Zhengzhou Power Supply Company	Bottom frame + brick concrete	Natural foundation	About 20m from the wast of the center line	1986 ㎡	
76		右 K5+829-864	Family residential building of Electromechanical Company	Brick concrete	No data	About 24m from the wast of the center line	2943 ㎡	公司破产
77		右 K5+876-952	Family residential building of Zhengzhou Traffic Company	Brick concrete	No data	About 18m from the wast of the center line	1 号：3011 ㎡ 2 号：617 ㎡	
78		K5+936-950	Commercial residential building	Brick concrete	No data	About 19m from the east of the center line	2204 ㎡	
79		K5+974-K6+21	Henan geological and mining mansion	Frame	The depth of pile foundation is 24m	About 27m from the east of the center line	17000 ㎡	
80		右 K5+957- 右 K6+4	Complex production building of Post Office	Brick concrete	No data	About 18m from the wast of the center line	2299 ㎡	
81	Nanyang road	K6+31-71	Residential Building #3, Housing Office of Nanyang Road, Housing Administration of Jinshui, Zhengzhou	Brick concrete	Natural foundation	About 20m from the east of the center line	2735 ㎡+429 ㎡	
82		右 K6+19-71	Dormitory Building of Post Office	Brick concrete	No data	About 17m from the wast of the center line	7 层：1335 ㎡ 5 层：1267 ㎡	
83		K6+76-112	Business Building, Xiaoduzhuang	Frame	The depth of pile foundation is 12m	About 23m from the east of the center line	9700 ㎡	
84		右 K6+91-133	Residential Building of Productive Material Service Company	Brick concrete	No data	About 18m from the west of the center line	2125 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
85		右 K6+142-158	Commercial residential building	Brick concrete	No data	About 21m from the west of the center line	2013 ㎡	
86		右 K6+171-187	Residential building of the Refrigeration Factory	Brick concrete	No data	About 18m from the west of the center line	不详	
87		K6+150-189	Xingecheng Night club	Brick concrete	No data	About 21m from the east of the center line	2391 ㎡	
88		右 K6+193-236	Residential Building of Construction Material Company	Brick concrete	No data	About 20m from the west of the center line	2200 ㎡	
89		右 K6+260-286	Residential Building of The Foodstuff Office, Minggong Road	Brick concrete	No data	About 19m from the west of the center line	1380 ㎡	
90		K6+236-286	Bright Pearls at Sea Bath center	Frame	Natural foundation	About 19m from the east of the center line	4700 ㎡	
91	Nanyang road	K6+293-336	Residential Building of Food and Beverage Company, Zhengzhou	Brick concrete	Natural foundation	About 19m from the east of the center line	2600 ㎡	
92		K6+361-392	Home Inns	No data	No data	About 25m from the east of the center line	3825 ㎡	
93		右 K6+360-411	Comprehensive Building of Vegetable Company Limited, Zhengzhou	Frame	Natural foundation	About 27m from the west of the center line	5400 ㎡	
94		K6+425-492	Zhengzhou Yuanyuan Property Company	Brick concrete	Natural foundation	About 29m from the east of the center line	24315 ㎡	
95		K6+507-539	Building #2, Tea Corporation, Henan Province	Brick concrete	Natural foundation	About 27m from the east of the center line	2155 ㎡	
96		K6+756-802	Residential building, Zhengzhou Textile Machinery Company	Brick concrete	Natural foundation	About 19m from the east of the center line	2430 ㎡	
97		右 K6+630-790	Two-floored store house, Zhengzhou Textile Machinery Company	Brick concrete	Natural foundation	About 18m from the east of the center line	3100 ㎡	
98		K6+625-669	Teaching Building	Frame	Depth of raft foundation 6m	About 24m from the east of the center line	2042 ㎡	
99		K6+681-750	Comprehensive building	Frame	Depth of raft foundation 6m	About 22m from the east of the center line	2660 ㎡	
100		右 K6+790-921	Third-floor store house, Zhengzhou Textile Machinery Company	Brick concrete	No data	About 21m from the west of the center line	961 ㎡+1137 ㎡+1552 ㎡	
101	Nanyang road	K6+852-876	Hospital of Zhengzhou Textile	Brick concrete	Natural foundation	About 28m from the east of the	4022 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
			Machinery Company			center line		
102		K6+894-988	Employee dormitory building of Zhengzhou Textile Machinery Company	Brick concrete	Natural foundation	About 23m from the east of the center line	6930 ㎡	
103		右 K6+927-右 K7+5	Residential building of Zhengzhou Textile Machinery Company	Brick concrete	Natural foundation	About 21m from the west of the center line	4097 ㎡	
104		K7+3-60	Residential building of Zhengzhou Textile Machinery Company, No, 29, Nanyang Road	Brick concrete	Natural foundation	About 23m from the east of the center line	2077 ㎡	
105		右 K7+32-44	Building #3, Nanyang Family Community	Frame	The depth of pile foundation is 20m	About 24m from the west of the center line	不详	
106		右 K7+61-106	Building #1 and 2, Nanyang Family Community	Frame	The depth of pile foundation is 6m	About 22m from the west of the center line	不详	
107		K7+93-130	No.1 Elementary school, Nanyang Road, Jinshui District, Zhengzhou	Brick concrete	strip foundation	About 20m from the east of the center line	1698 ㎡	
108		K7+270-668	Residential building of Zhengzhou Textile Machinery Company, Nanyang Road	Brick concrete	Natural foundation	About 23m from the east of the center line	17500 ㎡	
109		右 K7+287-305	Residential building, Storage and Transportation Company	Brick concrete	No data	About 21m from the west of the center line	1546 ㎡	
110		右 K7+407-447	Communication Hub Building, Customer Service Center, Henan Mobile Company	Frame	No data	About 20m from the west of the center line	13000 ㎡	
111	Nanyang road	右 K7+464-498	Residential building, China Construction Bank	No data	No data	About 19m from the west of the center line	3255 ㎡	
112		右 K7+498-540	Securities Building	No data	No data	About 19m from the west of the center line	总 6821 ㎡	
113		右 K7+562-607	Office building	Brick concrete	No data	About 21m from the west of the center line	2029 ㎡	
114		右 K7+619-685	Office building	Bottom frame + brick concrete	Natural foundation	About 18m from the west of the center line	1716 ㎡	
115		K7+708-752	Huishang Building	No data	No data	About 23m from the east of the center line	6706 ㎡	
116		右 K7+713-792	Zhongheng Bense (a community)	Frame	The depth of pile foundation is 15m	About 38m from the west of the center line	35000 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
117		K7+781-839	Building #16 Hongyihua HongKong Town	Brick concrete	The depth of pile foundation is 17m	About 33m from the east of the center line	20907 ㎡	
118		K7+884-918	Residential Building of Material Recycling Company	Brick concrete	Natural foundation	About 19m from the east of the center line	1161 ㎡	
119		K7+920-953	Residential building of the foodstuff office	Brick concrete	No data	About 23m from the east of the center line	2257 ㎡	
120		K7+957-右 K8+6	Concord mansion	Frame	The depth of pile foundation is 19.5m	About 22m from the east of the center line	4869 ㎡	
121	Nanyang road	右 K7+862-991	Residential building, Storage and Transportation Company	Brick concrete	No data	About 18m from the west of the center line	2890 ㎡	
122		K8+9-36	Jinjiang Inn	Brick concrete	No data	About 23m from the east of the center line	2412 ㎡	业主无资料
123		右 K8+24-102	Office building and residential buildings, Fruit Company	Brick concrete	No data	About 19m from the west of the center line	1434 ㎡	
124		右 K8+91-147	Residential buildings # 2,1 and 3, Yousheng Road	Bottom frame + brick concrete	Natural foundation	About 28m from the east of the center line	9960 ㎡	
125		K8+182-215	Zhengzhou Theater and Film Company	Bottom frame + brick concrete	No data	About 22m from the east of the center line	1769 ㎡	
126		K8+215-228	Zhengzhou Theater and Film Company	Brick concrete	No data	About 22m from the east of the center line	1257 ㎡	
127		K8+228-238	Art Creation Institute, Sub-No.5, No. 6, Nanyang Road, Zhengzhou	Brick concrete	No data	About 22m from the east of the center line	1074 ㎡	
128		右 K8+240-286	Tower A, SoHo Plaza, Qinghuayuan Community	Frame	pile	About 37m from the west of the center line	29454 ㎡	
129		K8+254-298	Zhengzhou Library	Frame	The depth of pile foundation is 9m	About 48m from the east of the center line	9589 ㎡	
130		K8+337-351	Building 3, No.2, Nanyang Road	Brick concrete	Natural foundation	About 20m from the east of the center line	1997 ㎡	
131	Nanyang road	右 K8+316-347	Zhengzhou Branch of Commercial and Industrial Bank of China	Brick concrete	No data	About 21m from the west of the center line	1749 ㎡	
132		K8+386-418	Five-star Medical Device Company, Zhengzhou	Brick concrete	Natural foundation	About 21m from the east of the center line	1800 ㎡	
133	Minggong road	K8+361-377	Electric Appliance Sale and Maintenance Center, Zhengbaiwen	Bottom frame + brick concrete	pile	About 37m from the east of the center line	8970 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
134		右 K8+367-391	Jinshui Hotel	Brick concrete	Natural foundation	About 20m from the west of the center line	9678 ㎡	
135		K8+418-453	Residential Building, Salt Company	Brick concrete	Natural foundation	About 30m from the east of the center line	4600 ㎡	
136		K8+646-695	Zhengzhou Acrobatics Stadium	Brick concrete	Natural foundation	About 57m from the east of the center line	4000 ㎡	
137		右 K8+840-859	Henan Zongheng Construction Company Limited	Brick concrete	Natural foundation	About 22m from the west of the center line	1698 ㎡	
138		右 K8+885-906	Jinxiuyuan Community	Frame	pile	About 22m from the west of the center line	8486 ㎡	
139		右 K8+907-937	Shuhe Hotel	Brick concrete	No data	About 22m from the west of the center line	2362 ㎡	
140		右 K8+942- 右 K9+3	Jinmingyuan Communnity	Bottom frame + brick concrete	The depth of pile foundation is 13m	About 22m from the west of the center line	4500 ㎡	
141	Minggong roa	K8+876-891	Residential Building, The People's Park	Brick concrete	Natural foundation	About 24m from the east of the center line	5000 ㎡	
142		K9+3-12	Residential Building, The People's Park	Brick concrete	No data	About 24m from the east of the center line	1339 ㎡	
143		K9+17-25	Residential Building, Native Fresh-food Company, Zhengzhou	Brick concrete	No data	About 22m from the east of the center line	1179 ㎡	
144	West taikang road	K9+32-63	Residential Buillding of Apparel Factory	No data	No data	About 20m from the east of the center line	4444 ㎡	
145	Minggong road	右 K9+25-92	Jinmingyuan Communnity	Bottom frame + brick concrete	The depth of pile foundation is 13m	About 21m from the west of the center line	7000 ㎡	
146	Nanyang road	右 K9+103-153	Bilding #15, Zhengzhou Mingxiang Property Company Limited	Brick concrete	The depth of pile foundation is 11m	About 19m from the west of the center line	4370 ㎡	
147		右 K9+162-204	Comprehensive building, Zhengzhou Mingxiang Property Company Limited	Brick concrete	The depth of pile foundation is 10m	About 32m from the west of the center line	5796 ㎡	
148		K9+147-173	Tower A, Jinfeng Ji'an International	Frame	The depth of pile foundation is 16.5m	About 33m from the east of the center line	18000 ㎡	
149		右 K9+268-303	North Unit of Residential Building, Shangjie Aluminum Factory	Brick concrete	No data	About 19m from the west of the center line	1242 ㎡	
150		右 K9+207-251-	Zhengzhou Chenguang Property Company Limited	Frame	The depth of pile foundation is 12m	About 21m from the west of the center line	23814 ㎡	
151	Minggong road	K9+300	Phase-1 Yuefu Community,	No data	No data		--	在建

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
	Jiefang road		Huarun					
152		右 K9+316-359	Building 5, Minggong Road	Brick concrete	No data	About 19m from the west of the center line	2438 ㎡	
153		右 K9+647-659	Residential Building of China Electronics Company	Brick concrete	No data	About 19m from the west of the center line	1155 ㎡	
154		右 K9+672-706	Housing on the street, Catholic Church	Brick concrete	Natural foundation	About 18m from the west of the center line	3000 ㎡	
155		K9+726-831	Building 2, Huigangxincheng Comminity	Frame	The depth of pile foundation is 16m	About 44m from the east of the center line	10 万㎡	
156	Xidajie	K10+11-33	Xiaolou Mosque, Zhenghzou	Frame	Natural foundation	About 31m from the north of the Jiefang road , About 23m from the east of the minzhu road	4000 ㎡	
157		K10+55-84	Branch of Commercial and Industrial Bank of China, Jiefang Road	Frame	Natural foundation	About 16m from the north of the center line	3000 ㎡	
158		右 K10+467-486	Building for office machineries	Frame	pile	About 42m from the south of the center line	8211 ㎡	
159		右 K10+625-641	Branch of Communication Bank, Western Street	Brick concrete	No data	About 31m from the south of the center line	4279 ㎡	
160		右 K10+390-454	Asia Building	Frame	No data	About 43m from the south of the center line	25000 ㎡	
161		K10+503-598	Comprehensive building, Shangfu road, Zhengzhou	Frame	The depth of pile foundation is 35m	About 25m from the north of the center line	40000 ㎡	
162		右 K10+520-598	Baolonghuating Community	Frame	The depth of pile foundation is 9m	About 23m from the south of the center line	37236 ㎡	
163		右 K10+653-665	Jiaoyao Club	Frame	No data	About 18m from the south of the center line	1750 ㎡	
164		K10+644-711	Furongyuan Community	Brick concrete	No data	About 20m from the north of the center line	6168 ㎡	
165		右 K10+668-677	5-floored Building of Housing Bureau of Guancheng District	Brick concrete	No data	About 22m from the south of the center line	845 ㎡	
166		右 K10+680-714	Office Building of Zhengzhou Bank	Brick concrete	No data	About 19m from the south of the center line	1537 ㎡	
167		右 K10+721-761	Jindinghuafu Community	Frame	pile	About 38m from the south of the center line	11000 ㎡	
168		K10+722-766	Fuzhun Mansion	Brick concrete	No data	About 20m from the north of the center line	6769 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
169		右 K10+812-861	Modern Star Community	Frame	Depth of raft foundation 4.3m	About 33m from the south of the center line	14438 ㎡	
170		K10+813-892	Wangbang Building	Frame	pile	About 38m from the north of the center line	80900 ㎡	
171	Xidajie	右 K10+883-929	China Huarong Assets Management Company Limited	Frame	No data	About 33m from the south of the center line	8900 ㎡	
172		K10+910-975	Fengxinjiayuan Community	Frame	No data	About 20m from the north of the center line	不详	
173		右 K10+943- 右 K11+14	Yinzuo International	Frame	No data	About 23m from the south of the center line	23840 ㎡	
174		K10+991-K11+26	Jinyu Commercial Building	Frame	--	About 19m from the north of the center line	7670 ㎡	
175		K11+26-49	Commercial building, Western Street, Zhengzhou	Frame	Natural foundation The depth of pile foundation is 12m	About 19m from the north of the center line	2000 ㎡	
176		右 K11+27-70	Residential building, No.3 Middle School, Zhengzhou	Frame	The depth of pile foundation is 26m	About 27m from the south of the center line	18000 ㎡	
177		K11+57-138	Comprehensive Building, minzu Community, Guancheng Hui District	Frame	pile	About 23m from the north of the center line	7930 ㎡	
178		右 K11+76-123	Enterprise center, Western Street	Frame	Natural foundation	About 23m from the south of the center line	9397 ㎡	
179		K11+148-178	Office building, Zhengzhou Branch of Chain Life Insurance Corporation	Frame	The depth of pile foundation is 9.4m	About 24m from the north of the center line	3771 ㎡	
180		K11+188-230	Residential and Commercial Building, Times China Park	Frame	pile	About 27m from the north of the center line	11000 ㎡	
181	Xidajie Dongdajie	右 K11+165-209	Zhongkai City Lights	Brick concrete	No data	About 22m from the south of the center line	3005 ㎡	
182		右 K11+219-282	Zhengzhou Songyuan Property Development Company Limited	Frame	The depth of pile foundation is 11m	About 38m from the south of the center line	32000 ㎡	
183	Xidajie Dongdajie	K11+242-270	High-rise residential and commercial building, Zhengzhou Branch of Chain Life Insurance Corporation	Frame	The depth of pile foundation is 15.5m	About 27m from the north of the center line	15039 ㎡	
184		K11+367-429	Tower A, Yard 39, Zhongkai City Lights	Frame	No data	About 22m from the north of the center line	10000 ㎡	
185		右 K11+333-434	Zhongkai City Lights	Brick concrete	No data	About 22m from the south of the	不详	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
						center line		
186		K11+453-526	Fuhua Building	Frame	The depth of pile foundation is 11m	About 28m from the north of the center line	50000 ㎡	
187		K11+542-579	Shoe Building, Zhenngzhou	Frame	The depth of pile foundation is 13m	About 33m from the north of the center line	14010 ㎡	
188		K11+589-641	Property Consulting Form, Guancheng District, Zhengzhou	Frame	raft foundation	About 24m from the north of the center line	5231 ㎡	
189		右 K11+692-774	Tower A, B and C, Yuhong Park	Frame	The depth of pile foundation is 13.1m	About 33m from the south of the center line	86000 ㎡	
190		K11+713-749	Xiaolangdi Hetel	Frame	The depth of pile foundation is 20m	About 24m from the north of the center line	10300 ㎡	
191	Dongdajie	右 K11+458-554 右 K11+968- 右 K12+94	Changjiang Town-in-Town Community	No data	No data	About 21m from the south of the center line	25000 ㎡	
192		K11+921-968	Office Building of State Taxation Bureau, Guangcheng District, Zhengzhou	Frame	No data	About 27m from the north of the center line	5516 ㎡	
193		K12+36-45	Emergency Building, No.1 People's Hospital, Zhengzhou	steel	The depth of pile foundation is 6m	About 27m from the north of the center line	2700 ㎡	
194		K12+57-92	Changjiang Square	Frame	pile	About 24m from the north of the center line	30000 ㎡	
195		K12+129-184	Educational center of Guancheng District	Brick concrete	Natural foundation	About 25m from the north of the center line	5825 ㎡	
196		右 K12+158-251	Jingcuiyuan Community	Frame	Natural foundation	About 20m from the south of the center line	1329 ㎡	
197		K12+188-203	Store houses	Brick concrete	No data	About 22m from the north of the center line	1003 ㎡	
198	Dongdajie	K12+221-320	Building 1, Community 1, Zhigong Road	Brick concrete	pile	About 22m from the north of the center line	4121 ㎡	
199		右 K12+272-491	The 2nd floor store	Brick concrete	No data	About 21m from the south of the center line	5302 ㎡	
200		K12+391-485	The 2nd floor store	Brick concrete	No data	About 21m from the north of the center line	1871 ㎡	
201		右 K12+639-664	Building of Road Machine Company, East City	Frame	The depth of pile foundation is 12m	About 40m from the south of the center line	4840 ㎡	
202		右 K12+721-775	Fangyuan Budget Inn	Brick concrete	No data	About 17m from the south of the center line	8200 ㎡	
203		K12+703-763	Home Inn	Brick concrete	pile	About 22m from the north of the	8000 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
						center line		
204	Zhengbian road	K12+791-844	Shop Front	Brick concrete	No data	About 18m from the north of the center line	1244 ㎡	
205		右 K12+809-845	Guangcheng Branch, Bank of Agriculture, Zhengzhou City	Bottom frame + brick concrete	strip foundation	About 18m from the south of the center line	1500 ㎡	
206		右 K12+852-874	Residential Building, East Avenue Sub-district Office, Guangcheng District	No data	pile	About 21m from the south of the center line	2100 ㎡	
207		K12+852-904	Rural Credit Cooperative of the City	Brick concrete	No data	About 18m from the north of the center line	1520 ㎡	
208		右 K12+930- 右 K!3+116	Great Wall Cambridge Garden	Brick concrete	The depth of pile foundation is 17m	About 22m from the south of the center line	17 号:35000 ㎡ 18 号:30000 ㎡ 19 号:1860 ㎡	
209		K12+981-K13+60	Family Dormitory Building of Knitwear Mill	Brick concrete	pile	About 17m from the north of the center line	3478 ㎡	
210		K13+69-121	Family Dormitory Building of Yutong	Brick concrete	Brick concrete	About 17m from the north of the center line	3200 ㎡	
211	Zhengbian road	K13+145-163	Xiaoji Braised Noodles with Three Delicacies	Bottom frame + brick concrete	Natural foundation	About 27m from the north of the center line	2470 ㎡	
212		K13+167-214	No. 1 Building, Yutong Garden	Brick concrete	strip foundation	About 25m from the north of the center line	4100 ㎡	
213	Zhengbian road	右 K13+166-211	Huajian Apartment	Frame	Natural foundation	About 33m from the south of the center line	14110 ㎡	
214		K13+227-397	No. 1, 2, 3 Building, Family Dormitory of Underwear Factory	Brick concrete	Natural foundation	About 18m from the north of the center line	1 号：1963 ㎡ 2 号：3300 ㎡ 3 号：2959 ㎡	
215		右 K13+234-294	Block C, Langui District	Brick concrete + Brick concrete	The depth of pile foundation is 17.3m	About 29m from the south of the center line	29679 ㎡	
216		右 K13+324-376	Ophthalmology and Otolaryngology Hospital	Brick concrete	Natural foundation	About 20m from the south of the center line	4563 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
217		右 K13+384-416	Dormitory Building of Zhengzhou China Resource Gas Co., Ltd.	Brick concrete	No data	About 24m from the south of the center line	1699 ㎡	
218		右 K13+427-450	Zhengzhou China Resource Gas LLC and Business Office	Brick concrete	No data	About 21m from the south of the center line	1521 ㎡	
219		K13+407-460	Hengtai International Building	steel	raft foundation	About 33m from the north of the center line	79000 ㎡	
220		右 K13+510-563	Family Dormitory Building of Dongfeng Business Office of Zhengzhou Power Supply Company	Brick concrete + Brick concrete	Natural foundation	About 22m from the south of the center line	3008 ㎡	
221	Zhengbian road	右 K13+570-637	Zhengzhou Xianghe Group Electronics Engineering Co., Ltd.	Brick concrete	Natural foundation	About 20m from the south of the center line	6738 ㎡	
222		K13+509-724	Residential Building of Yutong Company	No data	No data	About 17m from the north of the center line	不详	已拆迁
223		右 K13+786-798	Zhengbian Road Household Appliance Branch of Zhengzhou Xinghua Joint Enterprise Head Office	Brick concrete	No data	About 40m from the south of the center line	10000 ㎡	
224		右 K13+873-898	Sale Agency of Xiuquan Furniture, Zhengzhou City	steel	Natural foundation	About 70m from the south of the center line	3600 ㎡	
225		右 K13+881-968	Huari Home Furnishing	Frame	Natural foundation	About 29m from the south of the center line	6000 ㎡	
226		K13+902-946	Zhongyuan Trust Co., Ltd.	Frame	The depth of pile foundation is 25m	About 55m from the north of the center line	10000 ㎡	
227		右 K13+976- 右 K14+381	Zhongbo Home Furnishing Famous Store Street	steel	Natural foundation	About 33m from the south of the center line	不详	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
228		K14+256-426	Zhongbo Auto Square	Brick concrete	Natural foundation	About 53m from the north of the center line	总 14668 ㎡	
229		右 K14+587-734	Phoenix City	Frame	Natural foundation	About 50m from the south of the center line	131000 ㎡	
230		K14+744-759	Teaching Building of Zhengzhou Huimin Middle School	Brick concrete	The depth of pile foundation is 15m	About 52m from the north of the center line	2700 ㎡	
231	Zhengbian road	K14+738-757-	Zhengzhou Huimin Middle School	Brick concrete	Natural foundation	About 31m from the north of the center line	700 ㎡	
232		K14+785-842	Shop Front of Patrol Detachment, Zhengzhou Bureau of Public Security	Brick concrete	No data	About 33m from the north of the center line	1150 ㎡	
233		右 K14+956- 右 K15+61	Shenglong Phoenix City	Frame	Natural foundation The depth of pile foundation is 15m	About 39m from the south of the center line	496000 ㎡	
234		K15+53-125	Complex Building of the Procuratorate of Henan Province	Frame	No data	About 51m from the north of the center line	59000 ㎡	
235		K15+183-210 K15+398-446	Yingxie Stores	Brick concrete	Natural foundation	About 42m from the north of the center line	3 层：2388 ㎡ 2 层：1215 ㎡	
236		K15+205-244	Dingfeng of Yingxie Square	Frame	The depth of pile foundation is 18m	About 86m from the north of the center line	36000 ㎡	
237		K15+269-386	Yingxie Square	Frame	The depth of pile foundation is 18m	About 49m from the north of the center line	总 83000 ㎡	
238		K15+509-709	Jianye Zhidi Square	Frame	The depth of pile foundation is 20m	About 45m from the north of the center line	45000 ㎡	
239		右 K15+658-779	Zhengzhou Building Material World Eastern Building Materials	steel	Natural foundation	About 39m from the south of the center line	20000 ㎡	
240		K15+709-773	Aimei Hotel	Frame	The depth of pile foundation is 40m	About 49m from the north of the center line	60000 ㎡	
		K15+890	Zhongzhou Avenue overpass	Frame	The depth of pile foundation is 40m	About 16m from the south-north of the center line		施工时注意
241	Shangdu road	右 K15+996- 右 K16+87	Zhengzhou Red Star Macalline (phase I)	Frame	The depth of pile foundation is 15m	About 89m from the south of the center line	100000 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
242		右 K16+99-189	Red Star Macalline International Square	Frame	The depth of pile foundation is 15m	About 59m from the south of the center line	170000 ㎡	
243		K16+8-199	Shilipu Commercial Building	Brick concrete	No data	About 67m from the north of the center line	不详	
244		K16+246-361	Zhongnanhaizhiyin residential zone 10# building	Frame	The depth of pile foundation is 20m	About 59m from the north of the center line	29144 ㎡	
245		右 K16+411-452	Zhengzhou Yuanda Lexus Automobile Sales Service Co., Ltd.	Frame	The depth of pile foundation is 3.6m	About 59m from the south of the center line	9600 ㎡	
246		K16+378-468	Zhongnanhaizhiyin residential zone 4# building	Frame	The depth of pile foundation is 20m	About 60m from the north of the center line	11203 ㎡	
247		右 K16+450	Jianye Wudong Building	Frame	The depth of pile foundation is 15m	不详	161224 ㎡	在建
248		右 K16+463-472	Zhengzhou Weida 4S Store	steel	Natural foundation	About 66m from the south of the center line	5000 ㎡	
249		右 K16+472-492	Zhengzhou Weijia Yuantong Buick 4S store	Frame	Natural foundation	About 66m from the south of the center line	9800 ㎡	
250		K16+417-491	Zhongnanhaizhiyin residential zone 3# building	Frame	The depth of pile foundation is 20m	About 93m from the north of the center line	11185 ㎡	
251	Shangdu road	K16+567-822	Shangdu World Trade Center	Frame	The depth of pile foundation is 18m	About 73m from the north of the center line	187005 ㎡	
252		右 K16+549-681	New Furniture Marketplace	Frame	Natural foundation	About 93m from the south of the center line	53100 ㎡	
253		右 K16+642-672	KFC	steel	Natural foundation	About 53m from the south of the center line	317 ㎡	
254		右 K16+900- 右 K17+7	Zhengzhou Manyuan Rosewood Market	Frame	raft foundation	About 75m from the south of the center line	34458 ㎡	
255		K16+822-K17+35	Shilipu village placement 2# area	Frame	The depth of pile foundation is 17m	About 58m from the north of the center line	108000 ㎡	
256		右 K17+100	Complex building at hub station of Shangdu Road of Zhengzhou Public Traffic Company	Frame	The depth of pile foundation is 20m	不能确定	15331 ㎡	在建
257		K17+149-186	Henan Zhongdu Integrated Chinese and Western Medicines Skin Disease Hosptal	Frame	Natural foundation	About 67m from the north of the center line	12000 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
258		K17+192-254	Guancheng Chinese Medicine Hospital	Brick concrete	Natural foundation	About 43m from the north of the center line	11000 ㎡	
259		右 K17+600	Caixin Shengdiyana office building A, B	Frame	--	不能确定	A：4293 ㎡ B：2181 ㎡	在建
260		右 K17+700	Caixin Building	Frame	The depth of pile foundation is 12m	不能确定	21327 ㎡	在建
261	Shangdu road	右 K17+730	Caixin Shengdiyana No.4 and 5 buildings	Frame	The depth of pile foundation is 12m	不能确定	4 号：39872 ㎡ 5 号：23596 ㎡	在建
262		K17+811-843	Jiayang Square	Frame	pile	pile	30000 ㎡	
263		K17+852-893	Henan Seed Control Station	Frame	The depth of pile foundation is 7.1m	About 82m from the north of the center line	3110 ㎡	
264		K17+903-986	Jiangnan Xintiandi International Electro-mechanical City	Brick concrete	Natural foundation	About 64m from the north of the center line	30000 ㎡	
265		右 K17+841-882 右 K17+961-994	Henan Xinhua Bookstore Tianyi Building	Frame	The depth of pile foundation is 17m	About 66m from the south of the center line	29035 ㎡	
266		K17+640-K18+845	Zhengdong building material and home furnishing town	Frame	Natural foundation	About 55-76m from the north of the center line	总 280000 ㎡	
267		右 K18+690-714	Jiangnan Xin Tiandi	Frame	The depth of pile foundation is 18m	About 53m from the south of the center line	31000 ㎡	
268		右 K18+735	Zhengdong Shangdu Trade Marketplace	No data	No data	不能确定	不详	未建
269		K18+932-K19+26	Henan Jindi Real Estate Co., Ltd. Complex Building	Frame	The depth of pile foundation is 20m	About 61m from the north of the center line	13800 ㎡	
270		K19+46-92	Public Security Bureau Criminal Investigation Technical Scientific & Research Building	Frame	The depth of pile foundation is 13m	About 54m from the north of the center line	16787 ㎡	
271	Shangdu road	K19+145-294	Zhengshang Dongfang Hotel No.1 and No.2 buildings	shear	The depth of pile foundation is 17.4m	About 64m from the north of the center line	1 号：21223 ㎡ 2 号：12922 ㎡	
272		右 K19+170-206	International Enterprise Center	Frame	pile	中心线南约 77 米	42920 ㎡	
273	Changxing road	右 K0+150-256	Tianjun Huating phase II	Frame	The depth of pile foundation is 15m	About 18m from the west of the center line	1 号:29525 ㎡ 2 号:17855 ㎡ 3 号:18094 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
							5 号:12908 ㎡	
274		K0+210-339	Henan Track and Field Scientific & Research Complex Building	Frame	Natural foundation	About 56m from the east of the center line	17020 ㎡	
275		右 K0+638-649	Sanquan Food Plant Family Building	Brick concrete	Natural foundation	About 22m from the west of the center line	5000 ㎡	
276		K0+813-830	Fuwa Meijing 1# building	Brick concrete	The depth of pile foundation is 11m	About 51m from the east of the center line	1193 ㎡	
277		K0+829-890	Fuwa Meijing 2# building	Bottom frame + brick concrete	The depth of pile foundation is 11m	About 32m from the east of the center line	5400 ㎡	
278		K0+946-966	Taili Residential zone 1# building	Brick concrete	Natural foundation	About 31m from the east of the center line	2300 ㎡	
279		右 K1+4-426	Wuhuan Building	Frame	The depth of pile foundation is 21m	About 17m from the west of the center line	13079 ㎡	
280		K0+991-K1+92	Changxing Residential Zone No.5, No.9, No.10, No.11 Residential Building	Frame	pile	About 34m from the east of the center line	11 号：1871 ㎡	
281	Changxing road	K1+243-267	Henan Yinjiang Commercial Complex Building	Frame	The depth of pile foundation is 15m	About 34m from the east of the center line	10000 ㎡	
282		右 K1+245-275	Complex building No.2 building	Brick concrete	The depth of pile foundation is 12m	About 18m from the west of the center line	7380 ㎡	
283		右 K1+328-356	Comprehensive workshop No.3 building	Frame	The depth of pile foundation is 4m	About 20m from the west of the center line	3500 ㎡	
284		右 K1+377-426	Zhengzhou Hualian residential zone 4# building	Brick concrete	No data	About 22m from the west of the center line	2646 ㎡	
285		K1+404-423	Waste transfer station	Frame	Natural foundation	About 26m from the east of the center line	889 ㎡	
286		K1+427-462	Zhengzhou comprehensive investment area office building	Brick concrete	Natural foundation	About 26m from the east of the center line	1500 ㎡	
287		K1+490-527	Qingtian Building	Frame	pile	About 27m from the east of the center line	3600 ㎡	
288		右 K1+462-475	City North Shore Three-storey Building	Brick concrete	The depth of pile foundation is 1m	About 21m from the west of the center line	400 ㎡	

No.	Name of road	Pile No.	Name of ownership unit	Type of building	Depth of foundation (pile foundation)	Distance to the center line	Construction area	Important note
289		右 K1+470-481	City North Shore No.5 Building	Brick concrete	The depth of pile foundation is 2.2m	About 31m from the west of the center line	2200 ㎡	
290		右 K1+483-507	City North Shore No.4 Building	Brick concrete	The depth of pile foundation is 2m	About 24m from the west of the center line	4800 ㎡	
291	Changxing road	K1+605-695	Baiwen Yuhong Garden No.6 Building	Bottom frame + brick concrete	Natural foundation	About 31m from the east of the center line	6500 ㎡	
292		右 K1+646-770	Changxing Building	Bottom frame + brick concrete	Natural foundation	About 19m from the west of the center line	15000 ㎡	
293	Nanyang road	右 K1+806-848	Zhengzhou Huiji District Chinese Medicine Tumor Hospital	Brick concrete	The depth of pile foundation is 10m	About 39m from the west of the center line	7400 ㎡	
294		K1+900-K2+180	Electromechanical market	Frame	Natural foundation	About 16m from the west of the center line	30000 ㎡	
		K2+151-544	Overpass	Brick concrete	The depth of pile foundation is 30m			桩基多，施工时注意
295		K2+622-650	Laoyachen credit cooperatives Nanyang Road branch	Brick concrete	No data	About 19m from the east of the center line	1603 ㎡	
296		K2+699-722	Zhengzhou Chenguang Real Estate Co., Ltd.	Frame	The depth of pile foundation is 12m	About 22m from the east of the center line	23814 ㎡	
297		K2+546-580	Xianghe residential zone No.9 building	Frame	The depth of pile foundation is 13m	About 26m from the east of the center line	16252 ㎡	
298		K2+592-608	Xianghe residential zone No.8 building	Frame	The depth of pile foundation is 13m	About 26m from the east of the center line	8130 ㎡	
299		K2+450-500	Sanjiang Commercial	Frame	No data	About 48m from the east of the center line	5600 ㎡	

5.10.2 Social environment protection measures

5.10.2.1 Protection measures for urban traffic impact

(I) Principles Guaranteeing Smooth Traffic

(1) Meeting the basic traffic demand of road traffic

According to the construction methods and fencing requirements of stations in the first phase of rail transit No.3, and on the premise of analyzing the impact of regional traffic, overall traffic dispersion and diverging, the traffic organization shall fully consider the basic traffic conditions of roads and intersections. If a lane is occupied, a temporary lane shall be provided to guarantee the smooth and safe road traffic.

(2) Utilizing limited road space and giving priority to public transport facilities

There are many bus routes along this line. It is suggested to properly optimize these routes. During the organization process, the affected bus stop shall be relocated to the nearest location.

(3) People first, utilizing limited road space and giving priority to pedestrian facilities

Due to the different construction processes of various stations, roads will be occupied which will bring inconvenience to units and residents along this line. To create a harmonized social environment, the sidewalk and street crossing system shall be improved at first during the traffic organization process.

(4) Reserving certain space for the relocation of municipal pipelines

During the subway construction process, the municipal pipelines may have to be relocated, so certain space shall be reserved as their working face.

(I I) Traffic dispersion experiences of 1# Line

According to the experience of Zhengzhou rail transit 1# line, prepare complete traffic dispersion program during construction in old town with large traffic flow.

● Dongming Road Station:

Huanghe Road and Jingwu Road, one-way traffic

This station is located on Jinshui Road between Jingyi Road and Dongming Road and the station position is close to north of Jinshui Road. The phase I construction period is of 17 months. The construction area of station will occupy part of bicycle and sideway of Jinshui Road.

During construction period, Jinshui Road changes from two-way 8 lanes into 6 lanes. In the construction location, set 4 through lanes in west to east direction. In this direction, the left and right turning are forbidden; set4 2 through lanes and 1 right turn lane in south to north direction which does not allow left turning. Set 3 through lanes

in north-to-south direction where does not allow right and left turning; the section of Jinshui Road – Jingyi Road does not allow left turning; it is of 2 right turn lanes in north-to-south direction prohibiting left turning.

In addition, the section of Dongming Road to Jinshui Road crossing east entrance prohibits left turning; the section from Dongming Road to Jinshui Road crossing west entrance prohibits right turning; the flow from west to east shall turn right for bypassing at Chengdong Road crossing in advance (or at Weilai Road crossing afterward); open the isolation barrier at Yufeng Road - Jinshui Road crossing to allow the east-to-west vehicles on Jinshui Road to turn left at Yufeng Road.

To relieve the traffic pressure on Jinshui Road, the traffic police department plans to widen the Jinger Road (Dongming Road to Weilai Road) to disperse the flow; the Jingwu Road (Huayuan Road to Dongming Road) is of one-way traffic from east to west and the Huanghe Road (Jingqi Road to Weilai Road) is of one-way traffic from west to east.

● Zhengzhou Gymnasium Station：

Renmin Road, one way traffic from south to north

This station is near the T-junction of Renmin Road and Guangchenghou Street. The phase I construction period is of 17 months; the station construction area will occupy the motor vehicle lane of Renmin Road.

During construction period, part of commercial building of Renmin Road side will be demolished; it will change from two-way 6 lanes into one-way 4 lanes (3 through lanes at east side and 1 lane at west side for bus lane); the east half of Renmin Road (Erqi Square to Zijinshan overpass) can travel from south to north and the west half (Zijinshan overpass to Xili Road) can travel from north to south; the bus can travel in both directions of Renmin Road. The Xili Road and Duling Street are of one-way traffic, and form the one-way “rotary island” with Renmin Road; the social vehicles can bypass in one way.

● Zhengzhou University Station:

Zhongyuan Road - Xinghuabei Street; prohibit left turning at intersection

This station is at T-junction of Zhongyuan Road and Xinghuabei Street. The phase I construction period is of 10 months. The construction site will occupy the motor lane of Zhongyuandong Road and the green belts at both sides.

Zhongyuandong Road ensures the traveling of two-way 6 lanes. At east entrance of Zhengzhou University Station construction location (Zhongyuandong Road - Xinghuabei Street T-junction), set 3 through motor lanes which prohibits left turning, and the vehicle will pass along the north side of enclosure; at west entrance, set 3 motor lanes including 2 through lanes and 1 through and right-turn lane; at south entrance, set two-way 2 lanes which only allow right turning; the intersection of Zhongyuan Road and Xinghuabei Street prohibits left turning.

●Zhongyuandong Road Station:

Ensure two-way 6 lanes traffic.

This station is located between Zhongyuan Road and Daxue Road crossing. The phase I construction period is of 2 months. The construction area will occupy 13m wide motor lane and green belts at both sides of Zhongyuandong Road, and the recreation square at southeast corner of crossing.

During construction period, Zhongyuandong Road ensures two-way 6 lanes traffic. Set 2 through lanes and 1 right turn lane at east entrance. The vehicles bypass along the north side of enclosure, which prohibits left turning (including the bus). The vehicles from west entrance bypass the south side of enclosure when entering the construction enclosure area; set 2 through lanes and 1 right turn lane, which prohibits left turning (including bus). The Daxuebei Road ensures two-way 4 lanes traffic. At north entrance, set 2 through lanes and 2 right turn lanes, and the through vehicles bypass the west side of center part of construction enclosure. At south entrance, set 2 through lanes and 1 right turn lane. The through vehicles bypass along the east side of center part of construction enclosure. Prohibit left turning in south-to-north direction (including bus).

● Bishagang Station:

Ensure bi-way 6 through lanes of Jianshexi Road

This station is located at the intersection of Jiangshexi Road and Baihua Road, and the north side of Jianshexi Road. The phase I construction period is of 10 months. The construction area will occupy 20m wide motor lane at north of Jianshexi Road and related green belts, with the land use area of 8570m2; the enclosing period is of 12 months.

During construction period, the Jianshexi Road ensures two-way 6 lanes traffic. At east entrance, set 2 through lanes and 1 through and right turn lane. A through lane and a through and right turn lane bypass the north side of construction enclosure. A through lane bypasses along the south side of construction enclosure. At west entrance, set 3 through lanes, which are expanded as 3 through lanes and 1 right turn lane at nearby intersection part to bypass along the south side of construction enclosure. Baihua Road is of two-way 2 lanes traffic. Set isolation barriers in the middle of south side of construction enclosure. Prohibit left turning at the south entrance and north entrance, and only the right turning is allowed.

● Qinling Road Station:

Bi-way 4 through lanes

The Qinling Road Station is at intersection of Jianshexi Road and Qinling Road and north of Jianshexi Road center line. The phase I construction period is of 3 months. The temporary covering system fendering pile and temporary covering system for construction station are at the south of Jianshexi Road center line.

During construction period, Jianshexi Road ensures two-way 4 lanes traffic. At east entrance, set 2 through lanes and 1 right turn lane. The through lane passes along the construction enclosure (north side). At west entrance, set a straight lane and 1 straight

and right turn lane. The Qinling Station ensures two-way 4 lanes traffic. At north entrance, set 1 through and left turn lane, 1 through and right turn lane. At south entrance, set a left turn lane, 2 through lanes and 2 right turn lanes.

Erqi Square Station:

The road network for Erqi Square Station is dense with crowded vehicles and persons. Except that the measures to limit the vehicle floor direction at Zhengxing Street, Jiefang Road, Erqi Road, Renmin Road and West Street (specific measures refer to figure 5.10-5), the pedestrian bridges are built overhead of main road sections around Erqi Square Station and form an annular corridor so that they connect various shopping malls in space and form an spatial pedestrian gallery on ground and in space (see figure 5.10-6).

Figure 5.10-6 Erqi Square circular corridor

Construction notice board:

According to prepared traffic dispersion program, set the construction notice boards at the crossings in advance to enable the driver preparing in advance and avoid failure of route change when approaching to the construction site. For example, a notice board of Zhengzhou subway 1# line Zijinshan Road is shown in figure 5.10-7.

Figure 5.10-7 Notice board for Zijinshan Road subway construction

(III) Protective Measures of Impacts on Traffic by Line No.3

According to the layout characteristics of the first phase of rail transit No.3 and the traffic organization experience in the construction of lines No.1 and No.2, the following three measures shall be taken to guarantee the smooth traffic along the entire line:

1. Consider specific measures for each station according to its location and surrounding environment;

2. Regional organization can be considered if the traffic organization of a single station is difficult to realize;

3. For the relatively congested Nanyang Road, Minggong Road, Jiefang Road, and West Street-East Street, some stations can be constructed at first to avoid the impact to traffic by the simultaneous construction of all stations.

(1) Measures taken for the construction of stations

Based on the road conditions and surrounding environment, stations along this line can be classified into two types according to the difficulty in traffic guide and the impact to surrounding traffic. Typical stations are selected to explain:

Table 5.10-8 Classification according to the difficulty in traffic guide and construction measures

NO.	TYPE	CHARACTERISTICS	STATION	MEASURES TAKEN
1	Mild impact section	The station is arranged along the road, the surrounding has traffic guide conditions, and there is no need to demolish or only a few to	Xinliu Road Station and Shamen Road Station on Changxing Road; Chengdong Road Station, Weilai Road Station, Fengtainan Road Station and Zhongzhou Road Station on	Cover construction at sections crossing the intersection and fully fencing open-cut construction for stations at both sides, traffic guide to one

		guarantee the smooth traffic	Zhengbian Road section; Tongtai Road Station, Huanghe East Road Station, Nongye East Road Station, Zhongxing Road Station and Boxue Road Station on Shangdu Road section; as well as Hanghai East Road Station on Chenyang Road.	side of the trunk road or fencing two sides.
2	Severe impact section	The current road is narrow, the traffic flow is large, there are a lot of pipelines, and the surrounding demolition is difficult	Xinglonglu Road Station, Dongfeng Road Station, Nongye Road Station, Huanghe Road Station and Jinshui Road Station on Nanyang Road section; Taikang Road Station on Minggong Road; Erqi Square Station on Jiefang Road; Shuncheng Street Station on West Street; East Street Station on East Street.	Cover construction at sections crossing the intersection and fully fencing open-cut construction for stations at both sides, necessary demolition at the same time, traffic limitation, keep one driveway and one non-motor vehicle lane at either direction, and regional traffic organization.

Mild impact section: The station is arranged along the road, the surrounding has traffic guide conditions, and there is no need to demolish or only a few to guarantee the smooth traffic

According to the relations between the red line width, current road width and station width, roads, greenbelts, plots (including houses which must be demolished) shall be utilized for traffic organization if open cut condition is available. For stations crossing the intersection, cover construction shall be adopted to the section crossing the intersection and open cut shall be adopted at both sides, the traffic shall be guide to one side of the trunk road or two sides shall be fenced. The treatment measures of this type of station are explained by taking Weilai Road Station as the example.

The main body of the station is located at the intersection between Weilai Road and Zhengbian Road. The traffic in this intersection is relatively congested. On the premise of guaranteeing the moving the BRT stops to the north for 40m, the construction conditions are relatively good. The station can be constructed by fencing in four phases.

The construction of this station in the first phase only has one construction site. The main structure crossing the intersection is constructed by the cover excavation method. Pipelines affected above the main structure are relocated to the east and west of the cover plate. Vehicles have to pass round the edge of the fences, and the construction site will be occupied for 3 months. The construction in the second phase has two sites. The central site of Zhengbian Road at both sides of the intersection will be fenced to construct the main structure of the station. Pipelines being affected will be relocated

to the south and north of the station, and the construction site will be occupied for 10 months. The construction in the third phase has two sites, there are two entrances and exits at the south, and the construction site will be occupied for 4 months. The construction in the fourth phase has two sites, there are two entrances and exits at the north, and the construction site will be occupied for 4 months.

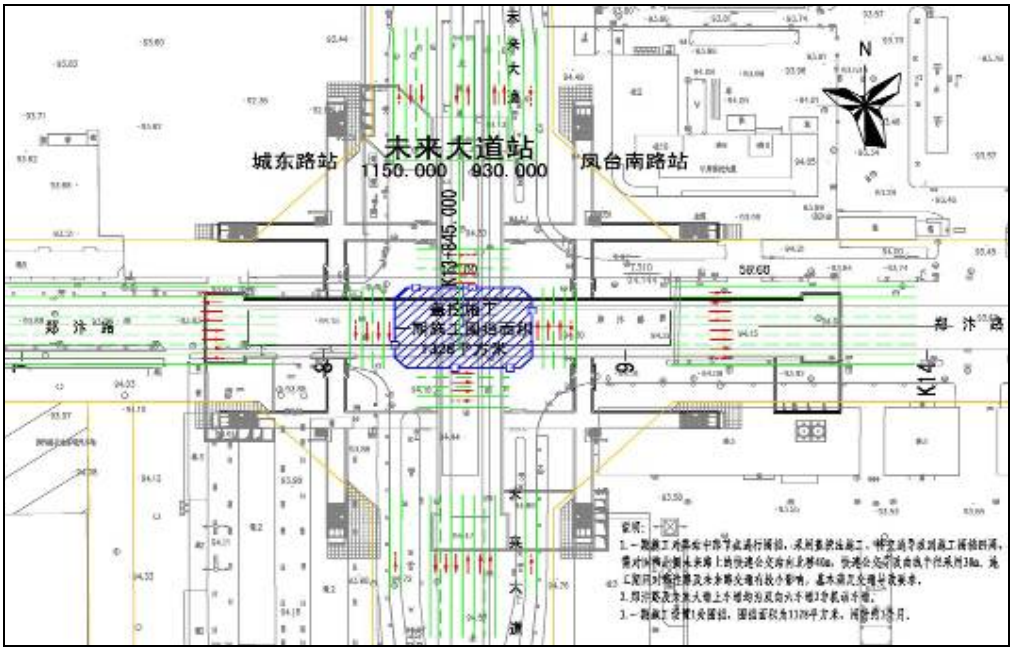


Fig.5.10-8 Traffic organization and construction fencing of the first phase on Weilai Road

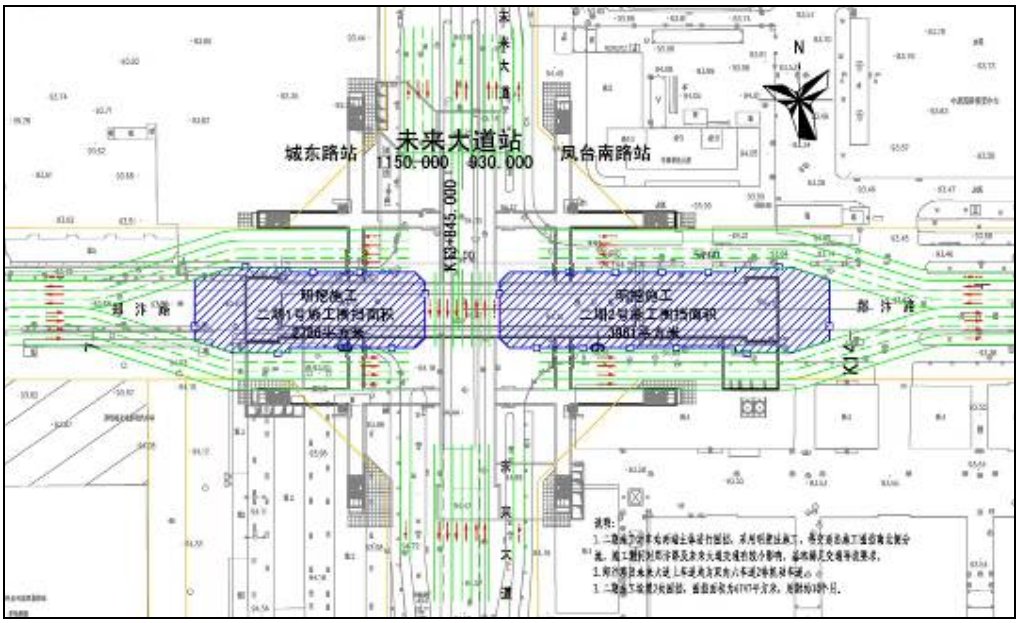


Fig.5.10-9 Traffic organization and construction fencing of the Secondphase on Weilai Road

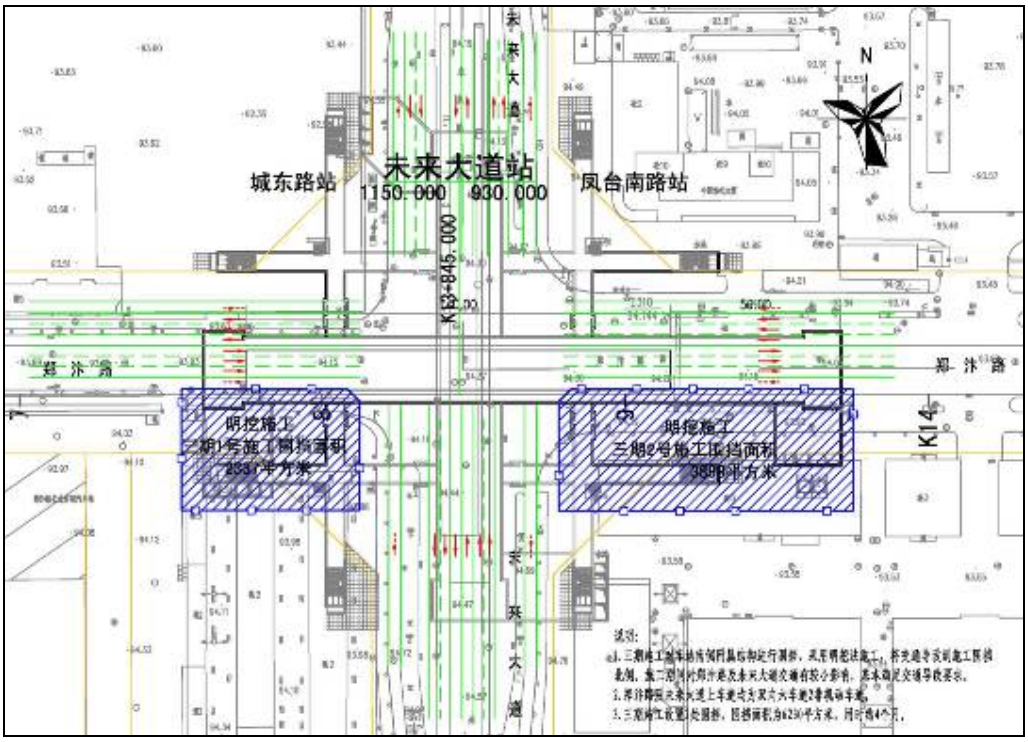


Fig.5.10-10 Traffic organization and construction fencing of the Third phase on Weilai Road

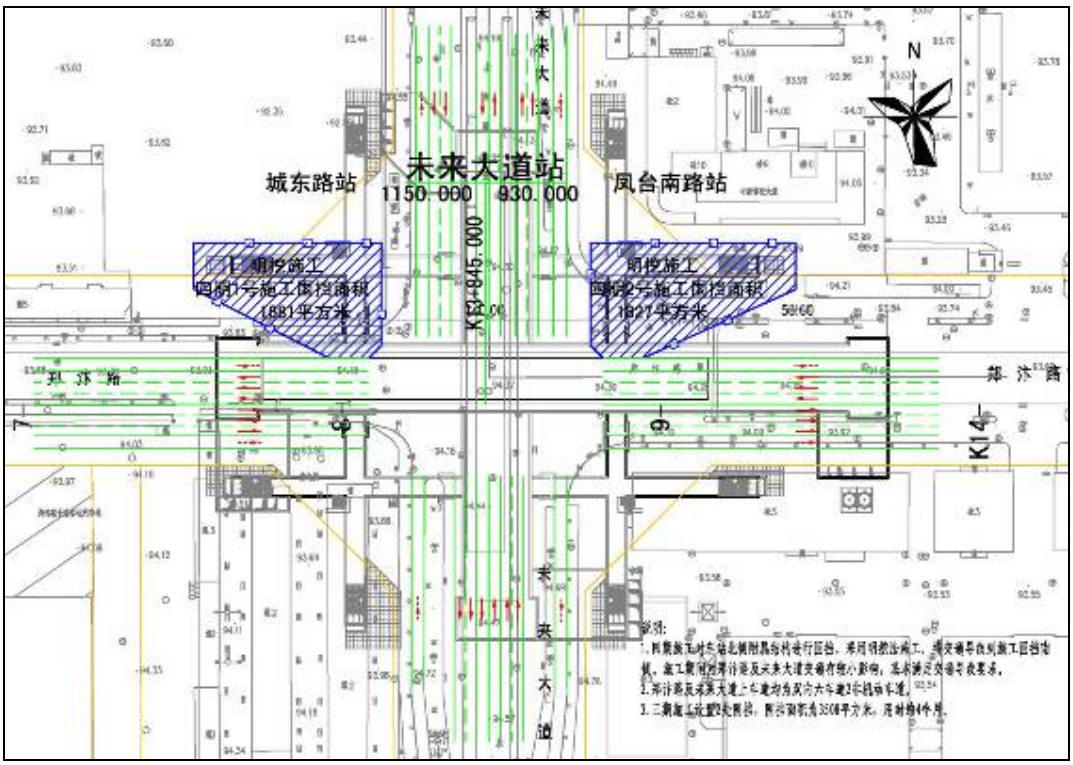


Fig.5.10-11 Traffic organization and construction fencing of the Fourth phase on Weilai Road

Severe impact section: The current road is narrow, the traffic flow is large, there are

a lot of pipelines, and the surrounding demolition is difficult. Treatment measures: cover construction at sections crossing the intersection and fully fencing open-cut construction for stations at both sides, necessary demolition at the same time, traffic limitation, keep one driveway and one non-motor vehicle lane at either direction, and regional traffic organization. The treatment measures of this type of station are explained by taking Dongfeng Road Station as the example.

Dongfeng Road Station is located at the intersection between Dongfeng Road and Nanyang Road. It is arranged in the south-north direction along Nanyang Road. It is a station with two underground floors. The entrance and exit are located at both sides of Nanyang Road. Nanyang Road is an important traffic artery in the south-north direction connecting the old town of Zhengzhou. The traffic on this road is heavy. Dongfeng Road is the important traffic corridor in the east-west direction connecting the old town and the eastern area. It extends to the east new zone at the east and to the high-tech zone at the west. The traffic volume at the surroundings is large. Currently, there are many passing bus routes. There are many bus routes overlapping with the rail transit.

The northeast corner and southeast corner of this station is the mixed 6-storey residential buildings in Tongle community, the southwest corer is the 11-storey Futian high-rise and Futian Lijing Garden, and the northwest corner is the mixed 6-storey residential buildings in Jiari Huayuan housing estate.

The east station has two underground floors. The main structure crossing the intersection is constructed by the cover excavation method. This station is located at the intersection between Dongfeng Road and Nanyang Road. The traffic is congested. The demolition of buildings in four quadrants is difficult. The construction of this station will be fenced in four phases.

During the first phase construction, the crossroads of this station will be fenced, cover excavation method will be used, and traffic will be diverted to both sides of the fencing. During the construction period, the impact on traffic on Nanyang Road and Dongfeng Road, and this can basically meet the traffic organization requirements. Pipelines affected above the main structure will be relocated to the south and north of the cover plate. Vehicles have to pass round the edge of the fences, and the construction site will be occupied for 4 months. During the second phase construction, buildings in the place of accessory structures shall be demolished before construction. Nanyang Road at both sides of the crossroads will be fenced to construct the main structure at both sides of the station. Pipelines being affected will be relocated to the east and west of the station, and the construction site will be occupied for 12 months. The third phase construction has three sites, the entrance and exit and the wind pavilion at the east side will be fenced, and the construction site will be occupied for 5 months. During the fourth phase construction, the entrance and exit and the wind pavilion at the west side will be constructed, and the construction site will be occupied for 6 months.

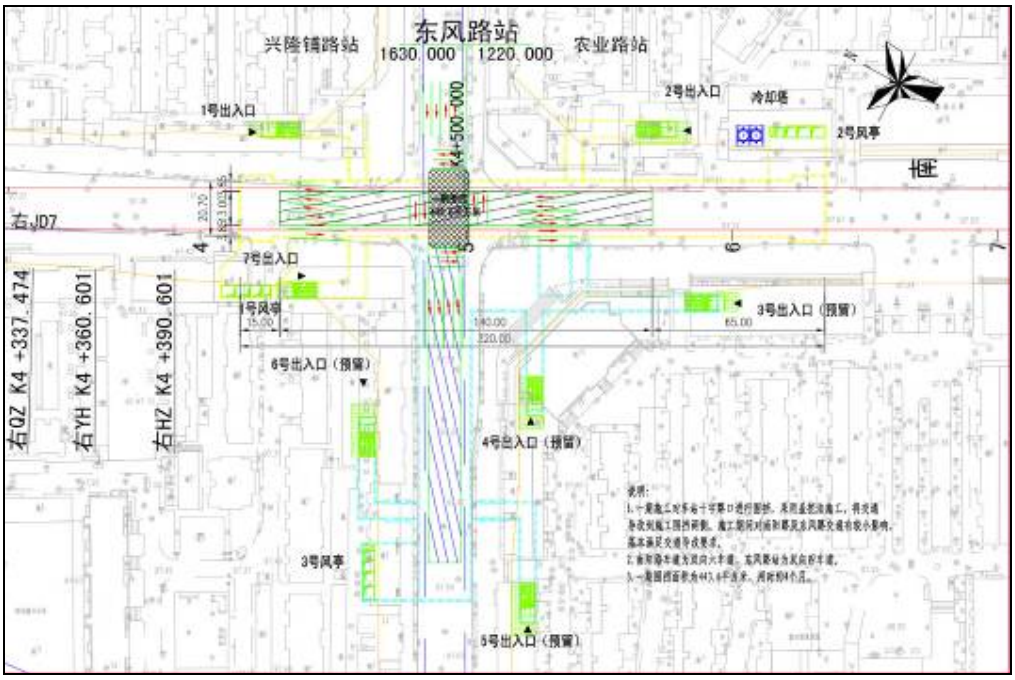


Fig.5.10-12 Traffic organization and construction fencing of the first phase on Dongfeng Road

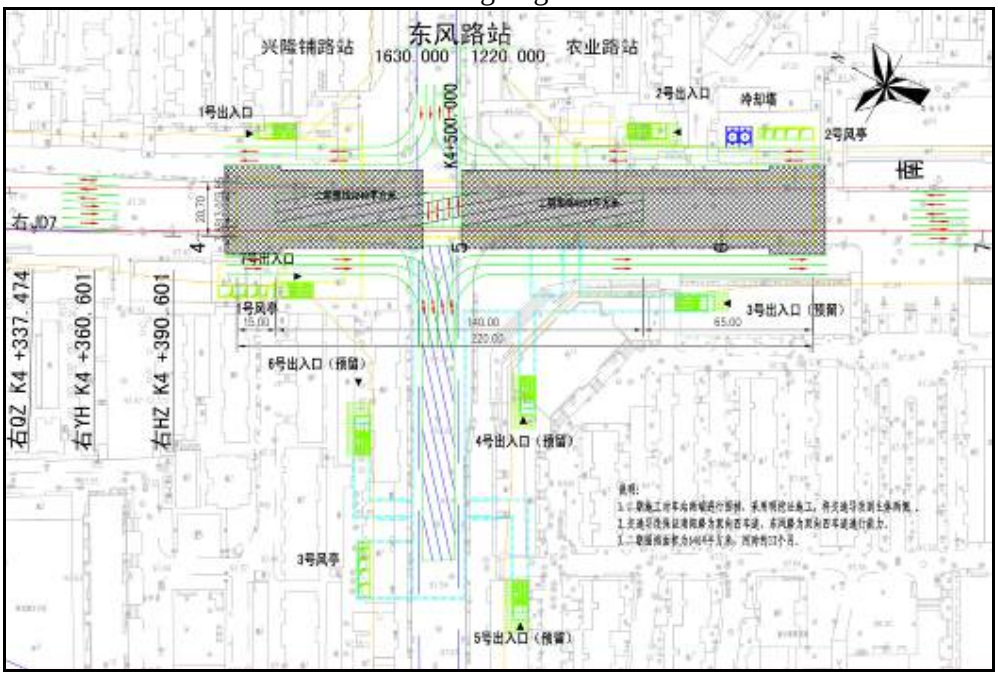


Fig.5.10-13 Traffic organization and construction fencing of the Second phase on Dongfeng Road

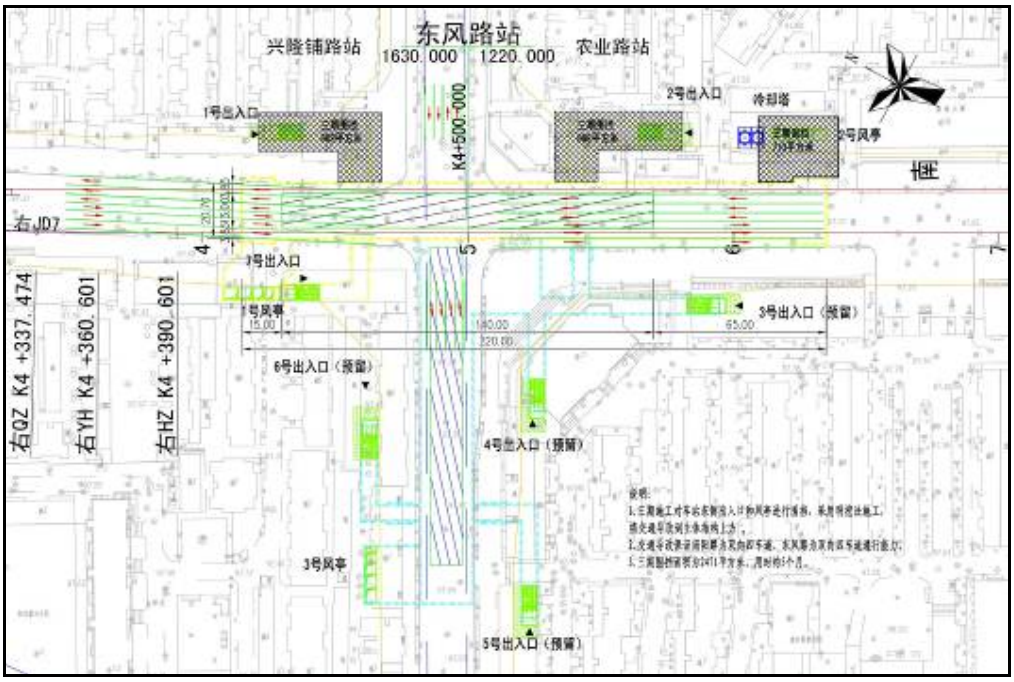


Fig.5.10-14 Traffic organization and construction fencing of the Tird phase on Dongfeng Road

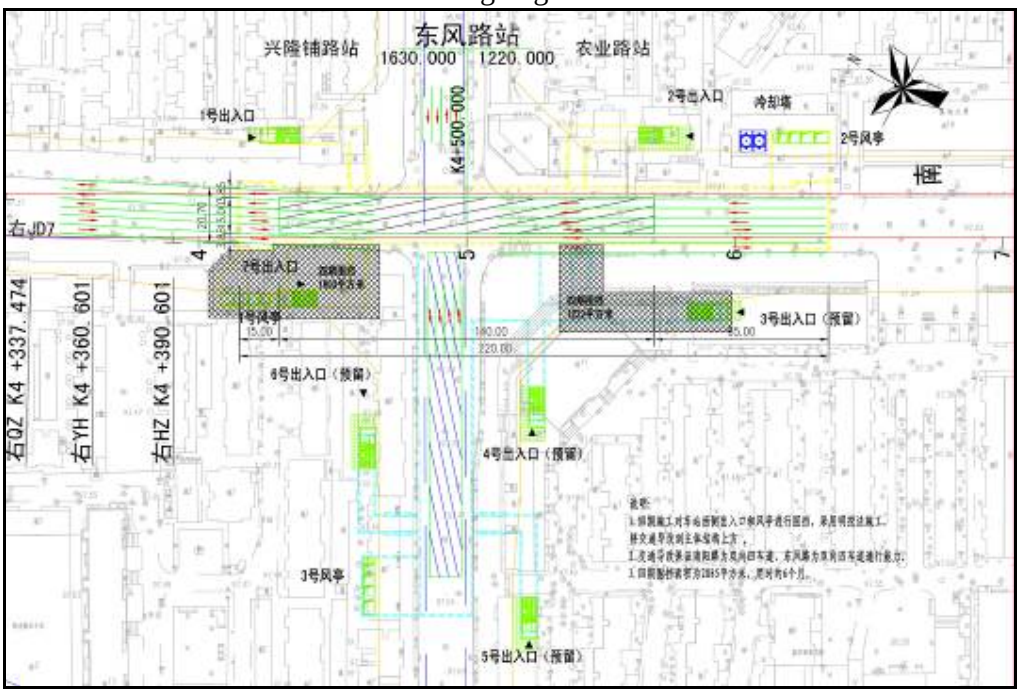


Fig.5.10-14 Traffic organization and construction fencing of the Fourth phase on Dongfeng Road

(2) Traffic organization measures in important sections

The first phase of rail transit No.3 in Zhengzhou mainly travels under Nanyang Road, Minggong Road, Jiefang Road, and West Street-East Street. The ground transportation of these four roads is relatively congested. Regional organization can be conducted

for important sections after the construction of the first phase of line No.3 to guarantee smooth traffic.

Table 5.10-9 Comparison of traffic conditions before and after regional traffic organization

NO.	STATION	LOCATION OF THE STATION	NUMBER OF LANES		DEMOLITION AMOUNT		AFFECTING TIME
			No regional guide	Regional guide	No regional guide	Regional guide	
1	Xinglongpu Road Station	Nanyang Road	4 driveway + 2 non-motor vehicle lanes		11 one-storey houses 4 two-storey buildings 1 four-storey buildings 1 five-storey building 2 six-storey buildings 1 seven-storey building		18 months
2	Dongfeng road station	Nanyang Road	4 driveway + 2 non-motor vehicle lanes	2 driveway + 2 non-motor vehicle lanes	16 one-storey houses 4 two-storey buildings 1 threer-storey buildings 3 six-storey building 4 seven-storey buildings 1 eight-storey building	7 one-storey houses 4 two-storey buildings 1 three-storey buildings 3 six-storey building 2 seven-storey buildings 1 eight-storey building	16 months

NO.	STATION	LOCATION OF THE STATION	NUMBER OF LANES		DEMOLITION AMOUNT		AFFECTING TIME
			No regional guide	Regional guide	No regional guide	Regional guide	
3	Agriculture road station	Nanyang Road	4 driveway + 2 non-motor vehicle lanes	2 driveway + 2 non-motor vehicle lanes	6 one-storey houses 3 two-storey buildings 1 three-storey buildings 1 four-storey building 2 five-storey buildings 3 six-storey building	2 one-storey houses 2 two-storey buildings 1 fiver-storey buildings	13 months
4	Huanghe road station	Nanyang Road	4 driveway + 2 non-motor vehicle lanes	2 driveway + 2 non-motor vehicle lanes	13 one-storey houses 5 two-storey buildings 7 three-storey buildings 1 four-storey building 3 six-storey buildings 1 seven-storey building	8one-storey houses 2 two-storey buildings 4 three-storey buildings 1 four-storey building 1 six-storey buildings	15 months
5	Jinshui road station	Nanyang Road	4 driveway + 2	2 driveway + 2	18 one-storey houses	14 one-storey houses	15 months

NO.	STATION	LOCATION OF THE STATION	NUMBER OF LANES		DEMOLITION AMOUNT		AFFECTING TIME
			No regional guide	Regional guide	No regional guide	Regional guide	
			non-motor vehicle lanes	non-motor vehicle lanes	8 two-storey buildings 4 three-storey buildings 5 four-storey building 4 five-storey buildings 3 six-storey buildings 1 seven-storey building 1 twelve-storey building	4 two-storey buildings 2 threer-storey buildings 2 four-storey building 2 five-storey buildings 1six-storey building 1 twelve-storey building	
6	Taikang road station	Minggong road	4 driveway + 2 non-motor vehicle lanes	2 driveway + 2 non-motor vehicle lanes	15 one-storey houses 14 two-storey buildings 6 three-storey buildings 1 four-storey building 1 six-storey buildings	7 one-storey houses 1four-storey buildings 1six-storey buildings	13 months

NO.	STATION	LOCATION OF THE STATION	NUMBER OF LANES		DEMOLITION AMOUNT		AFFECTING TIME
			No regional guide	Regional guide	No regional guide	Regional guide	
7	Erqi square sation	Jiefang road	4 driveway + 2 non-motor vehicle lanes	2 driveway + 2 non-motor vehicle lanes	1 one-storey houses	1 one-storey houses	18 months
8	Shuncheng jie station	Xidajie	4 driveway + 2 non-motor vehicle lanes	2 driveway + 2 non-motor vehicle lanes	1 one-storey houses 6 two-storey buildings 1 six-storey buildings 2 seven-storey building	2 two-storey buildings	13 months
9	Dongdajie station	Dongdajie	4 driveway + 2 non-motor vehicle lanes	2 driveway + 2 non-motor vehicle lanes	4 one-storey houses 7 two-storey buildings 1 three-storey buildings 1 eight-storey building	4 one-storey houses 6 two-storey buildings	18 months

Nanyang Road section

Nanyang Road is an important artery in south-west direction connecting the new and old towns of Zhengzhou. It has heavy traffic. Currently, this road has four lanes in two directions and two non-motor vehicle lanes, and some places have two isolation belts. The width of the red line is 50m, except Xinglongpu Road intersection, Dongfeng Road intersection and Nongye Road intersection which width is 56m. Nanyang Road is located in the old town. The west of this road is Beijing-Guangzhou Expressway and railway. There are a few adjacent roads in the east-west direction. Therefore, traffic in the south-north direction is mainly concentrated on Nanyang Road.

There are five stations in the south-north direction along Nanyang Road, which are Xinglongpu Road Station on Xinglongpu Road, Dongfeng Road Station on Dongfang Road, Nongye Road Station on Nongye Road, Huanghe Road Station on Huanghe Road, and Jinshui Road Station on Jinshui Road. All of these stations are arranged in the south-west direction along Nanyang Road.

The planned red line width of Nanyang Road is 50m, but the current road width is less than 30m. The width of the standard section of the station is about 22m which will occupy most of the main road. Furthermore, there are many buildings at the surrounding. So the construction method of this station will be greatly affected. To guarantee smooth traffic, the cover excavation method will be adopted to the section crossing the intersection, and full fencing and open-cut will be adopted to both sides of the station. Meanwhile, necessary demolition is required. A driveway and a non-motor vehicle lane will be kept in each direction. Regional traffic organization will be conducted at the same time to guarantee smooth traffic.

During the peak period, regional organization will be used to ease the traffic on the premise of station traffic organization in Xinglongpu Road Station, Dongfeng Road Station, Nongye Road Station, Huanghe Road Station and Jinshui Road Station.

Minggong Road section

Minggong Road is an urban trunk road and an important traffic artery connecting the new and old towns and Erqi business district in Zhengzhou in the south-north direction. The traffic on this road is heavy.

There is one station on Minggong Road in the south-north direction, which is Taikang Road Station at the intersection between west Taikang Road and Minggong Road.

The planned red line width of Minggong Road is 45m, the current road width is about 23m, and the current road width at the intersection is about 30m. The current road has four driveways and two non-motor vehicle lanes in two directions. The width of the standard section of the station is about 22m which will occupy most of the main road. Furthermore, there are many buildings at the surrounding. So the construction method of this station will be greatly affected.

To guarantee smooth traffic, the station will be fully fenced and open-cut. Meanwhile, necessary demolition is required. A driveway and a non-motor vehicle lane will be kept in each direction. Regional traffic organization will be conducted at the same time to guarantee smooth traffic.

During the peak period, regional organization will be used to ease the traffic on the premise of station traffic organization in Taikang Road Station.

Jiefang Road section

Jiefang Road is an urban trunk road and an important traffic artery connecting the east and west of Erqi business district. The traffic on this road is heavy.

There is one station on Jiefang Road in the east-west direction, which is Erqi Square Station at the intersection of Jiefang Road and Renming road.

The planned red line width of Jiefang Road varies between 48 and 55m, and the current road width is about 22m. The current road has four driveways and two non-motor vehicle lanes in two directions. The width of the standard section of the station is about 22m which will occupy most of the main road. Furthermore, there are many buildings at the surrounding. So the construction method of this station will be greatly affected.

To guarantee smooth traffic, the station will be fully fenced and open-cut. Meanwhile, necessary demolition is required. A driveway and a non-motor vehicle lane will be kept in each direction. Regional traffic organization will be conducted at the same time to guarantee smooth traffic.

During the peak period, regional organization will be used to ease the traffic on the premise of station traffic organization in Erqi Square Station.

West Street-East Street section

West Street-East Street is an urban trunk road and an important traffic artery connecting Erqi district and the new district in the east-west direction. The traffic on this road is heavy.

There are two stations in the West Street-East Street in the east-west direction, which are Shuncheng Street Station at the intersection between West Street and South-North Shuncheng Street, and East Street Station at the intersection between East Street and Zijingshan Road.

The planned red line width of West Street-East Street is 45m, and the current road width is less than 30m. The current road has four driveways and two non-motor vehicle lanes in two directions. The width of the standard section of the station is about 22m which will occupy most of the main road. Furthermore, there are many buildings at the surrounding. So the construction method of this station will be greatly affected.

To guarantee smooth traffic, the station will be fully fenced and open-cut. Meanwhile, necessary demolition is required. A driveway and a non-motor vehicle lane will be kept in each direction. Regional traffic organization will be conducted at the same time to guarantee smooth traffic.

During the peak period, regional organization will be used to ease the traffic on the premise of station traffic organization in Shuncheng Street Station and East Street

Station.

After taking the measures of staggering the construction time of the same congested section, proper fencing in different phases and regional traffic organization, the impacts on traffic by various stations of line No.3 are listed in table 5.10-10.

Table 5.10-10 Traffic impact analysis of station construction of 3 line

No.	Name of station	Position of station	Construction method	Measures	Remark
1	Xinliu Road Station, Shamen Road Station, Xinglongpu Road Station	Huiji District	open-cut method	/	Low traffic volume, little traffic impact on construction
2	Dongfeng Road Station, Huanghe Road Station, Nongye Road Station	Nanyang Road	open-cut method	(1) Elaborately arrange the construction site to minimize the road occupation;	Low traffic volume, no impact on ground traffic
3	Jinshui Road Station	Nanyang Road Jinshui Road	cover-excavation method	(1) Elaborately arrange the construction site to minimize the road occupation; (2) Speed up the construction progress and reduce the road occupation time.	cover-excavation method has little impact on ground traffic
4	Erqi Square Station	Minggong Road West Street	open-cut method	Make full use of existing construction field during 1# line construction; in light of the successful experience of 1# line, elaborately design the traffic flow direction, construct the loop corridors and set construction area at crossing triangular zone	From practical experiences of 1# line, little impact
4	Taikang Road Station, Shuncheng Street Station, East Street Station, Chengdong Road Station	East Street, Zhengbian Road	open-cut method	(1) Prepare traffic dispersion program and enable the vehicle bypassing in advance; (2) Elaborately arrange the construction site to minimize the road occupation; (3) Set special lanes at both sides of field to minimize the traffic obstruction. (4) Speed up the construction progress and reduce the road occupation time. (5) Give priority to smoothness of bus route.	Dense road network; bypass in advance; select the land occupation during construction period according to actual communication conditions
5	Weilai Avenue Station, Fengtainan Road Station, Zhongzhou Avenue Station, Tongtai Road Station, Huanghedong Road Station,	Shangdu Road	open-cut method	/	Wide road; the lands occupied by construction are mainly of sidewalk and road green land; it does no occupy the

	Nongyedong Road Station, Zhongxing Road Station, Boxue Road Station, Hanghai East Road Station				lane; no impact during construction period

As shown in table 5.10-10, during construction of stations in Huiji District including Xinliu Road Station, Shamen Road Station and Xinglongpu Road Station, since it has little impact on traffic, the measures taken mainly include reasonably arranging the station construction field and reducing the road occupation. For Dongfeng Road, Huanghe Road Station and Nongye Road Station using open-cut method construction in old town, since the traffic flow is large at present, the measures taken include properly arranging the construction field, enabling less or no road occupation and reducing the construction period; For Jinshui Road Station with cover-excavation construction method, it has little impact on the traffic; for Taikang Road Station, Shuncheng Street Road Station, East Street Station and Chengdong Road Station in downtown area, since the ground traffic flow is large and the road area occupied is large, the measures taken mainly include: preparation of traffic dispersion program to enable bypassing of vehicle in advance; elaborate arrangement of construction filed for less road occupation; setup of special lanes at both sides of field to reduce the traffic obstruction; speed up the construction progress and reduce the land occupation period; give priority to the smoothness of bus route. Among others, during the construction of stations along Nanyang Road with most serious traffic impact, recommend use of semi-cover-excavation construction method if conditions permit.

For the impact on urban traffic by construction of Zhengzhou Rail Transit 3 Line, except preparation of reasonable traffic dispersion program, it shall set up real time notice to provide the enclosure information to the residents and it shall inform the residents in advance if any necessary bypassing.

(IV) Ground and underground traffic integration program

The network optimized adjustment methods of bus line along the track mainly include: newly built, cancel, adjust (including adjustment of direction, cut-down and extension, and adjustment of line orientation and functions such as change of bus model and timetable). The main conclusions of specific programs are described as follows.

The connection methods of rail transit include: walk, conventional bus, bicycle, taxi, car and external traffic mode. At present, only the optimized adjustment principles and methods are put forward in feasible study phase. The detailed implementation program is to be deepened by public traffic planning and operation departments at next stage. The common methods include:

Bus connection

Realize the transfer of bus line and rail transit through the station; so the adjustment of stations, including bus start/destination station and midway bus stop are the key points to be considered for connection. The attentions for these two facilities at different areas are different. Under the conditions of well-developed bus route, the optimization of middle bus top is the concerned key point of connection; in peripheral areas, especially the terminal station, due to incomplete line, the connection of bus

passenger flow shall be handled by adding the bus start/destination stations and open up new conventional line or regional minibus.

Bicycle connection

The bicycle parking depot is the parking facility necessary for the bicycle passenger flow to transfer to the urban rain transit. Considered the climate, geographic features and traveling structure features in Zhengzhou, the setting scale of bicycle parking depot shall be reasonable with possible various methods.

Car connection

Similar to bicycle connection passenger flow, the car connection passenger flow has to depend on “P + R” Parking depot in connection; the land occupation for single car is large, so special layout of “P + R” Parking depot is mostly limited by land supply conditions; the common station, especially in central area, does not has the setting conditions. So the land supply capacity is the key factor to be considered for arrangement principle of “P+R” Parking depot.

Taxi connection facilities

The taxi connection passenger flow mainly enables the transfers with the rail transit through temporary bus stop and passenger waiting area. The land occupation of these two facilities are small and normally can be solved in road redline, so the dependency on supply is less than that of bicycle and car parking depot.

5.10.2.2 Protection measures for impact on urban resident incoming and livings

(I) Mitigation measures for negative affects

(1) For the economic loss of local farmer due to farmland occupation by car depot, parking depot and line route, it shall be compensated according to national and Zhengzhou municipal government compensation standard with the basic principle of not affecting the economic income of the farmers whose land is occupied.

(2) Under the impact of station construction, the incomes of small-scale merchants around the stations such as Xinglongpu Road Station, Dongfeng Road Station, Nongye Road Station, Huanghe Road Station, Jinshui Road Station, Taikang Road Station, Shuncheng Street Station, East Street Station, Chengdong Road Station, Weilai Road Station and Zhongzhou Avenue Station during construction period decreases in different degrees. However, after put into operation of 3 line, the passenger flows around the stations will significantly increase due to the radiation effect of rail transit and it will sustainably and long-term increase the above merchants’ incoming affected during construction period. As a result, although the income during construction period decreases, the construction period is far less than operation period and the incomes of merchants generally increase in integrated consideration of construction period and operation period. For the merchants to be relocated and related employees for station construction, they shall be properly compensated according to national and Zhengzhou local standards in the relocation and placement process. The compensation shall base on the principle of not impairing the interest of merchants and related employees.

(3) For 260 merchants to be demolished along the line, compensate according to market price and provide 6 months close-down compensation reward. For 988 store employees, offer one-off 6 months minimum wage compensation for actual employees registered in business license.

(4) For the construction of stations in old district with dense residents, enterprises and public service unit, it shall reduce the construction noise and vibration impact by setting up construction enclosure, properly arranging the machinery in construction site, prohibiting pile driving operation at night time, and relieve the impact of raise dust by sprinkling and dedusting in construction site and covering the construction materials.

(5) Before construction, it is necessary to conduct various preparation works and detailed survey for the road and various underground pipelines such as power supply, communication, water supply and drainage pipeline involved in the line, coordinate with related department to determine the removal and relocation program in advance and fulfill various emergency preparation works so as not to impact the normal supply and operation of water, electricity, gas and communication facilities in the areas along the line and ensure the normal society livings.

(6) The electricity and water consumption during construction period are large. The construction unit shall communicate with related department in advance to determine the pipeline and line connection programs, and properly connect the temporary pipeline and line. For the section with inadequate supply capacity, it shall modify the pipeline in advance so as to avoid temporary power cutoff and water cutoff or affecting normal water and power supply of regions nearby.

(7) In addition, for other impacts on resident livings during construction period, it shall persuade the resident or shorten the enclosure and construction period as possible.

It shall persuade the residents: After put into operation of 3 line, the passenger flows around the stations will significantly increase due to the radiation effect of rail transit and it will sustainably and long-term increase the small-scale merchants' incoming affected during construction period. As a result, although the income during construction period decreases, the construction period is far less than operation period and the incomes of merchants generally increase in integrated consideration of construction period and operation period.

(II)Improvement measures for positive effects

(1) Design of station wheelchair access

To ensure safe, convenient and rapid utilization of the traffic facilities by the people with various demands such as blind people, disabilities, office staff and the people with many luggage, Zhengzhou rail transit 3 line stations design the wheelchair access according to Code of Accessibility Design, such as sidewalk for the blind, accessible elevator and staircase, which can separately meet the requirements for the disables and the blind to ride the rail transit. The staircase provides a good luggage transport access for the people carrying many luggages. The design principle is to ensure minimize transfer line and save the traveling time of office staff.

(2) Consideration of proportion of men and women toilet positions

According to related social survey and social feedback reports, due to different physiological characteristics of male and female, the time consumption in toilet for male and female has remarkable difference. According to the statistics, the average time consumption in toilet of male is only 1/5 of that of the female. Based on above reasons, improvement of toilet position design in 3 line stations to increase the toilet position numbers of the male and the female with the female toilet position increment larger than that for the male can reduce or avoid the lining-up for toilet of the female (the female toilet position increase will considerably shorten the lining-up time of the female) so that it can not only facilitate the female, but also enhance the satisfaction of the male waiting for the female.

(3) Reasonable consideration of low-incoming group during determination of ticket fare

In entire social group in Zhengzhou city, the low-incoming group is a special group accounting for a large portion. The definition of ticket fare for Zhengzhou rail transit 3 line shall consider the traffic of low-incoming group in Zhengzhou city. It shall prepare reasonable ticket fare satisfying most of people for different hierarchies and different incoming levels of low-incoming groups, and positively affect the society.

5.10.2.3 Protection measures for impact on ground building stability

To avoid the cracking or collapse of ground buildings along the project line due to engineering construction, it shall properly fulfill all aspects of preparation and prevention works.

First, the departments shall get familiar to the project conditions and record the possible affected buildings on ground along the project line, and take proper anti-vibration measures. The second, if any ground building cracking or collapse along the line during construction period occurs, it shall be immediately complaint or reported to related departments. The corresponding department shall provide the solution according to actual conditions in two weeks and ensure the normal livings of residents are not affected.

5.10.3 Assessment summary

(I) Impact assessment of the project on social environment

Whether in construction period or operation period, this project will affect the livings of Zhengzhou citizens in different degrees and from various aspects. The positive effects lie in that the project construction will provide Zhengzhou people a more rapid, convenient and environment protection public transit facility and Zhengzhou rail transit 3 line during operation period will become a more convenient, safe, comfortable and economic communication mean for the residents along the line; at same time, the project construction works and enclosure will inevitably bring forward adverse impact on the people along the line; however the adverse impact is controllable and temporary as long as implemented related relief measures in the report.

The positive effects mainly lies in: the rail transit construction improves the urban traffic to provide a more effective and low price choice for traveling of citizens; it brings forward favorable impact for change of land utilization along the line, promote the urbanization process, enhance the development strength along line; the construction of rail transit also significantly saves the traffic land use and provides valuable land sources for urban development of Zhengzhou

The adverse impacts are mainly in construction period and include followings: the station enclosure impacts the local urban traffic; station construction enclosure imposes temporary impact on incoming of surrounding merchants; the construction enclosure leads to inconvenient livings of nearby residents and increases their traveling time; noise and vibration disturbance due to construction machinery operation, construction raise dust, sewage, muddy water, deposition and transport of construction garbage and construction materials will affect the living quality of residents; the ground settlement and vibration affect the ground building stability during construction period.

(II) Protection measures for social environment impact by the project

For the impact on traffic, take proper protection measures including traffic dispersion program, money compensation and mental compensation, and related report and complaint procedures.

The specific protection measures for impact on urban traffic environment impact by the project are as follows: the traffic dispersion program for 3 line complies with the principle of “Compensate a road for each road Occupation”. The traffic pressure during the construction period can be reduced by taking the measures of fencing in different phases, regional traffic organization and necessary demolition.During construction of stations in Huiji District including Xinliu Road Station, Shamen Road Station and Xinglongpu Road Station, since the vehicle flow and passenger flow is small and the road is wide, the construction enclosure duration in traffic dispersion measures are short and the construction can be completed in short term. So its traffic impact is not much in long term. For Dongfeng Road Station, Nongye Road Station and Huanghe Road Station of Nanyang Road and Taikang Road Station of Minggong Road, the vehicle and passenger flows are dense and the roads are crowed. To avoid large impact of traffic by enclosure during construction period, the construction enclosure range in traffic dispersion measures are small and the enclosure duration is long. It is preferable to use cover-excavation construction method for Taikang Road.

For the impact on urban traffic by construction of Zhengzhou Rail Transit 3 Line, except preparation of reasonable traffic dispersion program, it shall set up real time notice to provide the enclosure information to the residents and it shall inform the residents in advance if any necessary bypassing.

(III) Protection measures for impact on urban resident incoming and livings by the project

(1) Mitigation measures for negative effects

For the economic loss of local farmer due to farmland occupation by car depot, parking depot and line route, it shall be compensated according to national and

Zhengzhou municipal government compensation standard with the basic principle of not affecting the economic income of the farmers whose land is occupied

Under the impact of station construction, the incomes of small-scale merchants around the stations such as Xinglongpu Road Station, Dongfeng Road Station, Nongye Road Station, Huanghe Road Station, Jinshui Road Station, Taikang Road Station, Shuncheng Street Station, East Street Station, Chengdong Road Station, Weilai Road Station and Zhongzhou Avenue Station during construction period decreases in different degrees. However, after put into operation of 3 line, the passenger flows around the stations will significantly increase due to the radiation effect of rail transit and it will sustainably and long-term increase the above merchants' incoming affected during construction period. As a result, although the income during construction period decreases, the construction period is far less than operation period and the incomes of merchants generally increase in integrated consideration of construction period and operation period. For the merchants to be relocated and related employees for station construction, they shall be properly compensated according to national and Zhengzhou local standards in the relocation and placement process. The compensation shall base on the principle of not impairing the interest of merchants and related employees.

For 260 merchants to be demolished along the line, compensate according to market price and provide 6 months close-down compensation reward. For 988 store employees, offer one-off 6 months minimum wage compensation for actual employees registered in business license.

For the construction of stations in old district with dense residents, enterprises and public service unit, it shall reduce the construction noise and vibration impact by setting up construction enclosure, properly arranging the machinery in construction site, prohibiting pile driving operation at night time, and relieve the impact of raise dust by sprinkling and dedusting in construction site and covering the construction materials.

Before construction, it is necessary to conduct various preparation works and detailed survey for the road and various underground pipelines such as power supply, communication, water supply and drainage pipeline involved in the line, coordinate with related department to determine the removal and relocation program in advance and fulfill various emergency preparation works so as not to impact the normal supply and operation of water, electricity, gas and communication facilities in the areas along the line and ensure the normal society livings.

The electricity and water consumption during construction period are large. The construction unit shall communicate with related department in advance to determine the pipeline and line connection programs, and properly connect the temporary pipeline and line. For the section with inadequate supply capacity, it shall modify the pipeline in advance so as to avoid temporary power cutoff and water cutoff or affecting normal water and power supply of regions nearby.

In addition, for other impacts on resident livings during construction period, it shall persuade the resident or shorten the enclosure and construction period as possible.

It shall persuade the residents: After put into operation of 3 line, the passenger flows

around the stations will significantly increase due to the radiation effect of rail transit and it will sustainably and long-term increase the small-scale merchants' incoming affected during construction period. As a result, although the income during construction period decreases, the construction period is far less than operation period and the incomes of merchants generally increase in integrated consideration of construction period and operation period.

(2) Boosting Measures for Positive Influences

(I) Impact of station wheelchair access

To ensure safe, convenient and rapid utilization of the traffic facilities by the people with various demands such as blind people, disabilities, office staff and the people with many luggage, Zhengzhou rail transit line 3 stations design the wheelchair access according to Code of Accessibility Design, such as sidewalk for the blind, accessible elevator and staircase, which can separately meet the requirements for the disables and the blind to ride the rail transit. The staircase provides a good luggage transport access for the people carrying many luggages. The design principle is to ensure minimize transfer line and save the traveling time of office staff.

(II) Impact of increase of men and women toilet positions

According to related social survey and social feedback reports, due to different physiological characteristics of male and female, the time consumption in toilet for male and female has remarkable difference. According to the statistics, the average time consumption in toilet of male is only 1/5 of that of the female. Based on above reasons, improvement of toilet position design in line 3 stations to increase the toilet position numbers of the male and the female with the female toilet position increment larger than that for the male can reduce or avoid the lining-up for toilet of the female (the female toilet position increase will considerably shorten the lining-up time of the female) so that it can not only facilitate the female, but also enhance the satisfaction of the male waiting for the female.

(III) Impact of ticket fare rationality on low-incoming group

In entire social group in Zhengzhou city, the low-incoming group is a special group accounting for a large portion. The definition of ticket fare for Zhengzhou rail transit line 3 shall consider the traffic of low-incoming group in Zhengzhou city. It shall prepare reasonable ticket fare satisfying most of people for different hierarchies and different incoming levels of low-incoming groups, and positively affect the society.

(IV) Protection measures for impact on ground building stability

Firstly, prepare detailed stability protection program for each buildings which may be affected by the project; secondly, fulfill the settlement observation and vibration speed monitoring for ground buildings along the line which may be affected by the project; in addition, if any ground building cracking or collapse along the line during construction period occurs, it shall be immediately complaint or reported to Tack Company. The Tack Company shall provide the solution according to actual conditions in two weeks and ensure the normal livings of residents are not affected.

5.11 Impact on physical culture resources and protection measures

5.11.1 Along-line cultural relics

5.11.1.1 Identification of along-line cultural relics

The protection objectives of along-line cultural relics of this project are mainly of culture relics, old and valuable trees. According to field survey, the cultural relics protection sites along 3 line include Zhengzhou Shang Dynasty Relics, Minggong Road Pottery Workshop ruins, February 7th Memorial Tower, Penggong Temple and Octagonal tomb. The detailed list of physical cultural heritages refers to table 5.11-1.

Table 5.11-1 Cultural relics along Zhengzhou rail transit 3 line

Name	Level	Present status	Relation with this project position			
			Section or station	Pile No.	Position	Distance (m)
Zhengzhou Shang Dynasty Relics	National major cultural relics protection unit	Underground ruins; only wall reserved; well protected	East Street - Chengdong Road section	K12+500 - K12+579	Left side	31
					Right side	6
Minggong Road Pottery Workshop ruins	Not classified	Minggong Road 14th middle school in construction; the cultural relics have been relocated	Jinshui Road - Taikang Road section, close to northwest entrance of Taikang Road Station	K9+060 - K9+150	Right side	33
Memorial Tower for February 7th Strike	National major cultural relics protection unit	Well protected	Erqi Square - Shuncheng Road section	K10+317 - K10+348	Right side	3
Penggong Temple	Municipal cultural relics protection unit	In People's Park west gate, well protected	Jinshui Road Station - Taikang Road Station section	K10+850 - K10+900	Left side	79
Octagonal tomb	Not classified	Current as Huigang New Town, demolished	Taikang road - Erqi Square section	K9+900 - K9+920	Left side	35
Zhengzhou Confucius Temple	Henan province culture relics protection unit	In good conditions at present	East Street - Chengdong Road section	K12+340 - K12+400	Left side	82

As shown from above table, the two ruins not classified of Minggong Road Pottery

Workshop and Octagonal tomb along the line are not at original location. This report mainly describes the cultural relics protection units including Zhengzhou Shang Dynasty Relics, Memorial Tower for February 7th Strike, Penggong Temple and Zhengzhou Confucius Temple. The photo for current status is shown in figure 5.11-1.

Memorial Tower for February 7th Strike

Zhengzhou Confucius Temple

Zhengzhou Shang Dynasty Relics

Penggong Temple

Figure 5.11-1 Present status of cultural relics ruins along the line

5.11.1.2 Basic conditions of cultural heritage protection and the position relations with this project

(I) Zhengzhou Shang Dynasty Relics

Zhengzhou Shang Dynasty Relics is located in Zhengzhou Guancheng District old town, including Guancheng District, Jinshui District and Erqi District. The relics was found in autumn of 1950. The distribution of Shang Dynasty ancient cultural relics is east to Fenghuangtai, west to Xishakou, north to Huayuan Road and south to Erligang with the area of 25km2. Since 1951, it emphasized the exploration of Shang Dynasty Townsite and totally dug 24 exploratory trenches surrounding the walls; a lot of important relics have been founded which provided important reference for fully understanding of the intension and years of Shang Dynasty townsite and determination of Zhengzhou Shang City status. The Zhengzhou Shanghai City is of nearly rectangular; the north wall is about 1692m long and the west wall is about 1700m long, the lengths of both south wall and east wall are of 1870m; the perimeter is near 7km. it is considered as Bodu resided by Chengtang emperor.

On March 4 in 1961, the State Council publicized the Zhengzhou Shang Dynasty Relics as National major cultural relics protection unit.

Protection arrange of Zhengzhou Shang Dynasty Relics

The area at south of Sunhe Road, north of Dongli Road, west of Shang Dynasty Wall and east of Zijinshan Road; the area from west of Chengdong Road to outside of east wall; the area at east of Nanguan Street, north of Xionger River and north to wall; the playground area of Zhengzhou 6th middle school (the Huis middle school); Henan Province Chinese Medicine Research Institute Affiliated Hospital Family Area; the area at south of MVR Yellow River Conservancy Commission the first dormitory area, west of east wall, north of Chengbei Road and east of Henan Province Chinese Medicine Research Institute Family Area; the area in front of Henan Province Chinese Medicine Research Institute office building; the east half area of Yellow River Conservancy Commission Scientific Research Institute of Water Resources (south of Shunhe Road, west of Zijinshan Road, north of Henan Art School west yard and east of Gongyi Street); Henan Art School west yard area (south of Yellow River Conservancy Commission Scientific Research Institute of Water Resources, west of Zijinshan Road, north of Dongli Road, east of Henan Province Acrobatics Puppet Theatre); the area within 20m range at both sides of Zhengzhou Shang City wall; area in 20m range of outer wall body of Zhengzhou Shang City.

Construction control zone of Zhengzhou Shang Dynasty Relics

The area within the Zhengzhou Shanghai Dynasty Wall (excluding the cultural relics protection range); the area of 200m from the boundary of self-protection range of Zhengzhou Shang Dynasty wall; copper smelting ruins and bone workshop ruins out of Shang City north area, i.e. the area at west of Huayuan Road, east of Jingwu Road, north of Jinshui Road and south of Weisan Road; Pottery Workshop ruins at west of Shangcheng west wall, i.e. the area in Zhengzhou 14th middle school; People's Park tombs area, north Erqi Road tombs area and Zhangzhainan Street; bronze ware cellaring ruins, i.e. the area at south of 10m from north side of Longhai Road, east of Nancangxili, north of Nancang Street and west of provincial freight transport 1st company; cigarette plant tombs area, i.e. Zhengzhou Cigarettes Factory field (north of Xionger River, west of Zhengzhou Light Automobile Factory, north of Longhai Road and east of Yanchang street); Yangzhuang tombs area, i.e. the area at south of Fenghuan Road, east of Chengdong Road, west of Huozhanbei Street and north of Yangzhuangnan Street; the areas of 50m from both sides of Shang city outer wall, i.e. the areas going south from Fenghuangtai at southeast of Zhengzhou Shang City, till the municipal service company Xinzheng Road Family Area through provincial water conservation warehouse and then turning to northwest, through Zhengzhou 5th middle school, Buchang Street Huayuan Xincun, Yinji Shopping mall till Dongfanghong theatre, and the extension of outer wall ruins.

Current protection status

The Zhengzhou Shang City ruins and palace foundation site have not been effectively protected; for the entire wall, only the southeast wall is 8m higher than the ground and well protected; however, there are many temporary buildings on walls and surroundings due to historic reasons; most of these buildings or structures are in the cultural relics protection range such as Shang City wall body. Moreover, there are

related buildings in Zhengzhou Shang city construction control zone, of which the style does not agree to that of Shang City.

Position relation with 3 line

The section of Shuncheng Street Station to Tongtai Road Station of 3 line is fully located in the protection range of Zhengzhou Shang Dynasty Relics. The ruins are located underground, and separately of 31m and 6m from the left side and right side of southeast wall above the ground. The detailed position relation refers to figure 5.11-2.

Figure 5.11-2 Position relation of Zhengzhou Shang Dynasty Relics with rail transit

(II) Zhengzhou Confucius Temple

Zhengzhou Confucius Temple is located at north of Zhengzhou Guancheng District East Street and in former Zhengzhou Bearing Factory yard.

The Confucius Temple is facing south. According to records in Republic of China Zheng County Annals, Zhengzhou Confucius Temple was built in Yongping Years of Donghan Dynasty Ming Emperor (in 58-75) with large scale. The original Lingxing Gate and Pan Pool are destroyed in “Cultural Revolution” period, and there are two buildings of Dacheng Hall and Ji Gate, and many wing rooms. In 2005, Zhengzhou People’s Government invested to rebuild and recover the Confucius Temple. The Recovered Confucius Temple land use is about 9.300 m2, and consists of Lingxing Gate, East and West Memorial Archway, Dacheng Gate, Minghuan Temple, Xixian Temple, Dacheng Hall, Zujing Pavilion, East and West Rooms and Stele Gallery. The Coloured Glaze art in Dacheng Hall can be called as the masterpiece in existing

historic building arts.

On June 20 in 1963, Henan Province People's Commission publicized the Confucius Temple as one of the first batch of Henan Province Cultural Relics Protection Units.

(1)Protection range of Zhengzhou Confucius Temple

The area 50m west from Xishan Wall of Dacheng Hall, 62m east from Dongshan Wall of Dacheng Hall, 116m south to Threshold Wall of Dacheng Hall to north boundary of East Street, and 100m north from Rear Eave Wall of Dacheng Hall.

(2)Construction control zone of Zhengzhou Confucius Temple

100m north of protection range boundary; 100m east to protection range boundary; 120m west to protection range boundary to Zhigong Road; 100m south to protection range boundary.

(3)Position relation with 3 line

3 line is not in the protection range of Zhengzhou Confucius Temple; the rail transit 3 line passes through Confucius Temple construction control zone in underground mode, but there is no ground building in construction building zone. The details refer to figure 5.11-3.

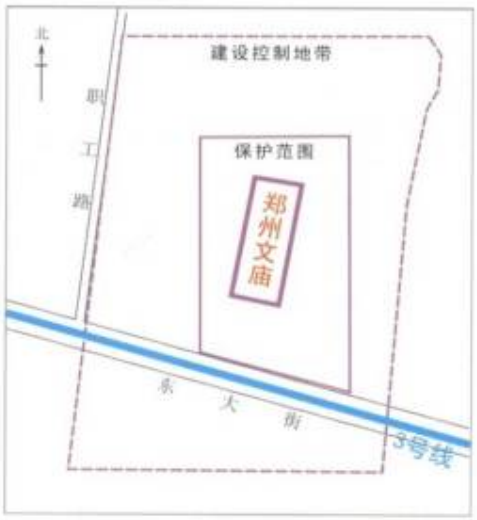


Figure 5.11-3 Position relation of 3 line and Zhengzhou Confucius Temple

(III) Memorial Tower for February 7th Strike

February 7th Memorial Tower is located at south of Zhengzhou Center Erqi District Erqi Square.

February 7th Memorial Tower was built in memory of Wang Shengyou and Si Wende, the railway strike worker leaders killed by Zhili Clique. In 1951, Zhengzhou People's Government expanded the former site of Xiguan Changchun Bridge as Erqi Square with a hexagon wooden spire in the middle. In July 1 to September 29 in 1971, knock down the wooden spire and rebuild as reinforced concrete pentagon conjoined twin

towers; it was total 14 floors and 63m height, and a bright red five-pointed star is mounted on top of bell tower; the historic relics, figures, literal data and memorial articles for Jinghan Railway Worker Strike are displayed in the tower. February 7th Memorial Tower has been the symbol and logo of Zhengzhou.

On Nov. 21 of 1986, Henan Province People's Government publicized February 7th Memorial Tower as Henan Province Cultural Relics Protection Unit. On May 25 of 2006, State Council of People's Republic of China publicized it as one of the 6th batch of national major cultural relics protection units.

(1)Protection range of February 7th Memorial Tower

50m east from Tower east boundary to Asia Shopping Hall west wall; 46m west from Tower west boundary to Erqi Hotel east wall boundary; 95m south from Tower south gate to Youyi Commercial Building north door; 80m north from Tower north door vertically to left-east side of south door of Shangcheng Department Store.

(2)Construction control zone of February 7th Memorial Tower

100m east from protection range boundary to South and North Xiejie; 70m west from protection range boundary to Erqi Hotel west street; 100m south from protection range to Yuanling Street, 80m north from protection range to Zhenghong Building north street.

Execution of planning: February 7th Memorial Tower is located at urban center with high-rise building around, developed commercial environment, crowed traffic and large traffic volume. The vision corridor has been destroyed and the Zhengzhou landmark and symbol peculiarity have been seriously impaired.

(3)Position relations with 3 line

3 line passes side through Memorial Tower for February 7th Strike underground; the line is within the protection range for Erqi Tower and it is only 3m from the tower body at the nearest part. Erqi Square Station is the transfer station of 1 and 3lines and there is no ground building such as entrance and ventilation pavilion; the entrance and ventilation pavilion are fully built in construction control zone.

(IV) Penggong Temple

Penggong Temple is located at east of Zhengzhou Erqi District Minggong Road north section, and in current People's Park. It was built on October 10 in 1925 in memory of Peng Xiangqian, so it is called as "Penggong Temple".

Now the "Penggong Temple" only leaves a gate, 5 halls and 6 hexagon pavilions, and was included in People's Park in 1957. On June 3 of 2009, Zhengzhou People's Government publicized Penggong Temple as Municipal Cultural Relics Protection Unit; the protection range and construction control zone have not determined at present.

The rail transit 3 line has not set the station at west gate of People's Park and 3 track is about 79m from Penggong Temple.

(V) Other possible underground buried areas

Zhengzhou Shang Dynasty Relics is of underground ruins. Besides it, the possible buried areas along 3 line include: ancient ruins distributed in high-tech industry development zone, ancient tombs and ancient cultural ruins distributed from Nanyang Road (Dashiqiao) to Henan Province Sports Center. The detailed positions refer to figure 5.11-4.

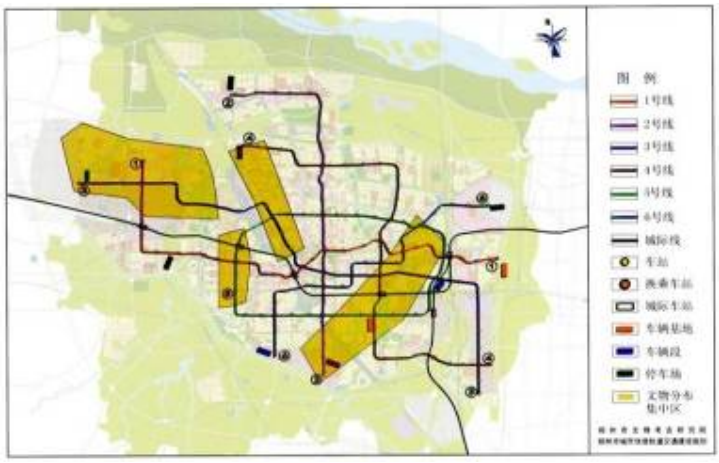


Table 5.11-4 Schematic diagram of centralized areas for distribution of cultural relics for Zhengzhou rail transit network

(VI) Old trees and famous wood species

There is an ancient locust tree in Hugong Temple at south gate of People's Park and 200m from 3line.

5.11.2 Impact analysis of along-line physical culture resources

5.11.2.1 Impact identification on along-line physical culture resources

(1) Impact identification on cultural relics protection site during construction period

The construction phase mainly includes the works of land acquisition which may lead to vanishing or damage of ruins body (above ground or underground), device transport, debugging and grooving; the pile foundation and shield construction activities may generate waste gas, electromagnetic radiation, flying dust, noise, construction garbage, vibration and collapse, damage of aquifer, and damage of buried cultural relics during tunneling of shield machine.

(2) Impact identification on cultural relics protection units during operation period

It will generate the impact such as waste gas, electromagnetic radiation, flying dust, noise and vibration during operation phase. The occurrence of construction project body will block off the vision corridor of cultural heritage, and therefore vanish or reduce the peculiarity and impose impact on ecologic landscape.

5.11. 2.2 Requirements proposed by Cultural Relics Protection Units for 3 line construction and execution

(1) According to related regulations on construction control area of historic and culture sites to be protected in articles 18 and 19 in Law of the People's Republic of China on the Protection of Cultural Relics, for the engineering construction involving construction control area, the engineering design plan shall be agreed by cultural relics administrative department and then submitted to urban construction planning department for approval according to regulations in law of cultural relics.

(2) In the answer of State Administration of Cultural Heritage to route selection for Construction Project of Zhengzhou Urban Rail Transit: 1. This project shall be kept from the axis of memorial tower when passing underground of Zhengzhou Memorial Tower for February 7th Strike, and bypass from other foundation as possible. 2. The program shall include scientific and accurate project construction and operation, and vibration analysis report for Zhengzhou Shang Dynasty Relics (wall ruins) and Zhengzhou February 7th Strike Memorial Tower and necessary vibration reduction measures. 3. Henan Provincial Cultural Relic Bureau shall organize special archaeological excavation unit for archaeological investigation and exploration for the ground building areas to be built such as station and ventilation port of this project, and the incurred costs shall be assumed by the construction unit. 4. The stations and ventilation ports project newly built in construction control zone of Zhengzhou Memorial Tower for February 7th Strike shall be otherwise submitted for approval according to the procedures. The ground building construction projects involving Zhengzhou Shang Dynasty Relics shall be otherwise submitted for approval with related procedure according to the archaeological excavation results and management requirements for Zhengzhou Shang Dynasty Relics construction control zone after the archaeological excavation completed.

(3) In the review comments of Ministry of Environment Protection for Report on Environment Impact of Zhengzhou Rail Transit Construction Planning (2013-2019), it proposes: 1. Increase the buried depth of line passing underground of Zhengzhou Shang Dynasty Relics and Zhengzhou Memorial Tower for February 7th Strike for 3 line phase I project, optimize the line position program near Zhengzhou Confucius Temple based on scientific verification an avoid adverse impact on environment sensitive objects.

(4) Execution: 3 line bypasses the axis of Memorial Tower for February 7th Strike and there is no ground building such as entrance, ventilation pavilion and cooling tower in its protection range. The report for ground building in construction control zone to cultural relics management department is in transaction. There is no ground building in Shang Dynasty Ruins wall protection range; the archaeological exploration works for buried depth of Shang Dynasty ruins is in progress. 3 The protection range of Zhengzhou Confucius Temple has been bypassed during routing of 3 line and it passes through from its construction control zone range, so it meets the requirements in answer of Ministry of Environment Protection to line network planning environment assessment.

5.11.3 Cultural relics protection measures

5.11.3.1Memorial Tower for February 7th Strike

(1) Protection requirements for Memorial Tower for February 7th Strike

According to Protection Program for Zhengzhou Rail Transit Project Passing through side of February 7th Memorial Tower reviewed and approved in March of 2010, the Erqi Tower deformation control standards in construction period of short-term 1# line Erqi Square Station and long-term 3 line shield section are determined as follows: maximum settlement amount of foundation of no more than 20mm and the foundation inclination of no more than 0. 001.

(2) Protection measures

The protection program for Zhengzhou rail transit project passing through side of February 7th Memorial Tower consists of pre-reinforcement protection measures before construction and process control measures for 1# line station construction and 3 line shield section construction. The details are as follows:

Arrange a row of 800mm-diameter bored piles along axis direction of 3 line, partly of broken line with the total length of 62m; the pile bottom is at 4m under 3 line shield tunnel and enters (33) silty clay layer (permeability coefficient of 0.08m/d); it will restrain the soil body deformation during 1# line pit foundation construction and isolate the ground settlement channel during 3 shield construction, as shown in figure5.11-5.

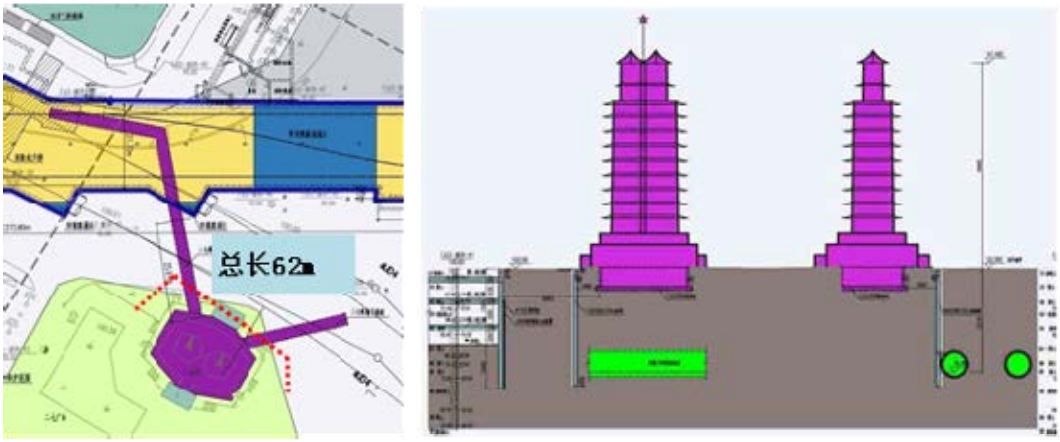


Figure 5.11-5 Protection program for Memorial Tower for February 7th Strike

When the shield machine excavates to 50m position from February 7th Memorial Tower, strictly fulfill the shielding construction management, especially the management of shielding working level to ensure good conditions of equipment; adopt earth pressure balance mode; control the shield driving posture, excavated earth volume for each loop and synchronous grouting amount and carry out secondary grouting supplement and balanced excavation; carefully study the shield excavation parameters and optimize the parameters such as grouting mixing ratio, pressure, shield pushing force and speed according to special geology of Zhengzhou; ensure

smoothly and stably passing through side of February 7th Memorial Tower. Keep the ground settlement at minimum level and meet the requirements for ground cultural relics protection.

The tracks in 50m range from protection range of February 7th Memorial Tower adopt steel spring floating slab to reduce the vibration impact on February 7th Memorial Tower during operation period.

(3) Analysis of settlement monitoring of 1 line during construction period

Carry out settlement monitoring at 1 line pit foundation construction phase; the monitoring results refer to table 5.11-2. It can be seen that the settlement values of each points of Erqi Tower are in the allowable range, so that it verifies that the protection measures for Erqi Tower is effective.

Table 5.11-2 Monitoring data for building settlement (Erqi Tower) of Erqi Square Station 1# line Construction period

Number of measuring points	itial value	The cumulative amount of change（mm）										controlling value（mm）	Conclusion
		3-15	3-29	4-10	4-12	4-14	4-17	11-12	12-2	1-2	6-2		
JCJ-45	100.9782	0.0	0.2	0.1	0.2	-0.2	0.1	0.9	0.9	0.9	1.0	15mm	Normal
JCJ-46	100.9181	0.0	0.2	0.3	0.4	0.9	0.5	0.5	1.5	1.3	1.3	15mm	Normal
JCJ-47	101.2679	0.0	0.1	0.5	0.4	0.5	0.3	0.2	1.2	1.6	1.6	15mm	Normal
JCJ-48	101.1165	0.0	-0.5	-1.1	-1.8	-2.8	-3.0	-3.2	-3.2	-3.4	-3.3	15mm	Normal
JCJ-49	101.1266	0.0	1.4	1.9	2.4	2.5	2.2	2.2	2.1	2.1	2.2	15mm	Normal

(4) Protection requirements for Erqi Square Station in this report

Require the rail transit 3 line away from the axis of memorial tower and passing through from the outer side of tower foundation, and the depth shall meet the requirements of no less than 15 specified by cultural relics protection department.

During construction, adopt underground diaphragm wall protection before exaction of underground station; intensity the protection near February 7th Memorial Tower. The tunnel construction adopts shield method; timely adjust the pressure during excavation to avoid displacement of tunnel. After construction of tunnel, the related government departments shall take strict limit measures to prohibit excavation of pit foundation with forced drainage method and heavily exploiting of underwater above the underground tunnel and 500m range at both sides so as to avoid instability of tunnel, and intensify the ground settlement monitoring near February 7th Memorial Tower. Thus the impact of rail transit project on cultural heritage during construction period will be minimized so as to fulfill maximum protection of cultural relics (body).

The 3 station entrance is located at west side of Erqi Road and in front of Hualian Department Store and it is not in protection range of Erqi Tower. To avoid impact on Erqi Tower landscape, it is planned to adopt uncovered entrance. The design of this kind of entrance is very simple, i.e. no upper cover underground, and only mounting the safeguard fencing around the entrance with the height below 1.5m. The design of outdoor steps and handrails is kept uniform with the landscape of entire Erqi Square. There is no ventilation pavilion in protection range of February 7th Memorial Tower; the building styles of entrance and ventilation pavilion in its control zone shall keep uniform with February 7th Memorial Tower.

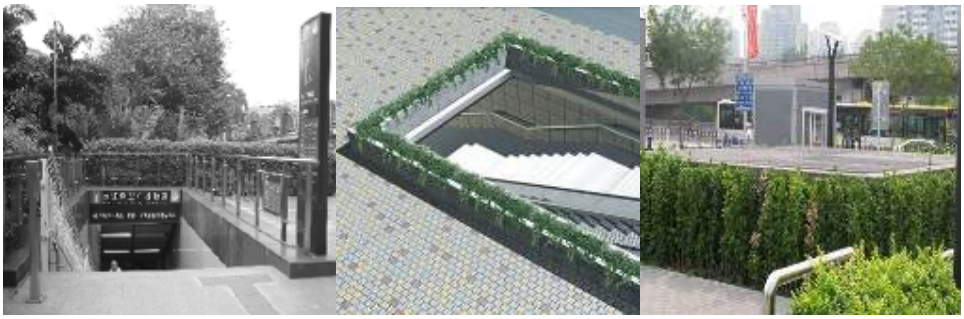


Figure 5.11-6 Schematic diagram of coverless entrances

5.11.3.2 Zhengzhou Shang Dynasty Relics

When rail 3 line passing under Shang City Ruins, it shall adopt steel spring floating slab ballast bed for vibration reduction. This rail system features favorable damping performance and can eliminate the solid sound. The natural vibration frequency can be very low (5-8Hz) with favorable vibration reduction performance. The maximum vibration reduction can be up to 20dB and it has remarkable vibration effect at low frequency range.

The new construction, expansion and reconstruction are prohibited in key protection range, which must be approved by cultural relics department and the building height must be lower than 9m. the construction materials, colors, types, technologies and greening shall consider the coordination with ancient capital environment and related

protection planning for Zhengzhou Shang City Ruins. Furthermore, the depth of underground wall of Zhengzhou Shang City is about 8 to 13m according to the archaeological exploration, so recommend the subway buried depth as 15 to 20m.

5.11.3.3 Zhengzhou Confucius Temple

The rail transit 3 line passes through underground of Confucius Temple protection range and it mainly impose impact on Confucius Temple Lingxing Gate (stone memorial gateway). Due to close straight line distance, according to provisions in Code for Industrial Vibration Proof for Historic Buildings, the culture relics protection site of masonry structure shall be kept 40m away from the line to meet the code requirements. The 3 line is about 82m from Lingxing Gate, so it is necessary to set steel spring floating slabs in 50m tracks at both sides of Confucius Temple protection range to reduce the vibration impact by 3 line during operation period.

The nearby section of Zhengzhou Confucius Temple is passed through with shield construction method and the construction distance meets the construction safety requirements without need of any measures.

5.11.3.4 Penggong Temple

The rail transit 3 line passes through under west gate of People's Park and set a station (Jinshui River north side) at People's Park northwest corner, i.e. the intersection of Jinshui Road and Nanyang Road (Minggong Road). The design of station, ventilation pavilion and cooling tower shall be coordinated with the Shang Dynasty Cultural Display zone of People's Park and Jinshui River Waterfront Park landscape.

5.11.3.5 Protection measures for physical culture resources

(I) Handling procedure of physical culture resources detected during construction period

According to Law of the People's Republic of China on the Protection of Cultural Relics (2002.10.28) Article 32 "In the course of construction of a project or agricultural production, all units and individuals that discover cultural relics shall keep the scene intact and immediately report to the local administrative department for cultural relics; after receiving the report, the department shall, except under special circumstances, rush to the scene within 24 hours and put forth its proposals on the handling of the matter within seven days. The administrative department for cultural relics may report to the local peoples government; requesting it to inform the public security organ of the matter and to seek its assistance in keeping the scene intact; and where important cultural relics are discovered, the matter shall immediately be reported to the administrative department for cultural relics under the State Council, which shall put forth its proposal on the handling of the matter within 15 days after receiving the report. The cultural relics discovered in such a manner as mentioned in the preceding paragraph belong to the State, and no unit or individual may plunder, privately divide or conceal them." and Regulations on Protection of Cultural Relics in Henan Province Article 26 "In the course of construction of a project or agricultural production, all units and individuals that discover cultural relics shall keep the scene intact and immediately report to the local administrative department for cultural relics; after receiving the report, the department shall rush to the scene within 24 hours and

put forth its proposals on the handling of the matter within seven days. The administrative department for cultural relics may report to the local people's government; requesting it to inform the public security organ of the matter and to seek its assistance in keeping the scene intact." This practice code for environment protection puts forth following management requirements for the culture relics detected during construction period: of practice implementation:

If the culture relics are found during construction period, it shall immediately stop the construction and keep the scene intact without conducting any action without authority, and immediately report to the local administrative department for cultural relics.

After the administrative department for cultural relics puts forth the handling comments, the construction unit shall prepare the construction program of culture relics section according to the handling comments issued by culture relics department, and begin construction only after approved by culture relics department. Before archaeological excavation completes, no unit and individual may continue construction or conduct production activity in archaeological excavation area.

No unit or individual may plunder, privately divide or conceal the culture relies found.

The detailed control procedures of culture relics found during construction period refer to figure 5.11-7.

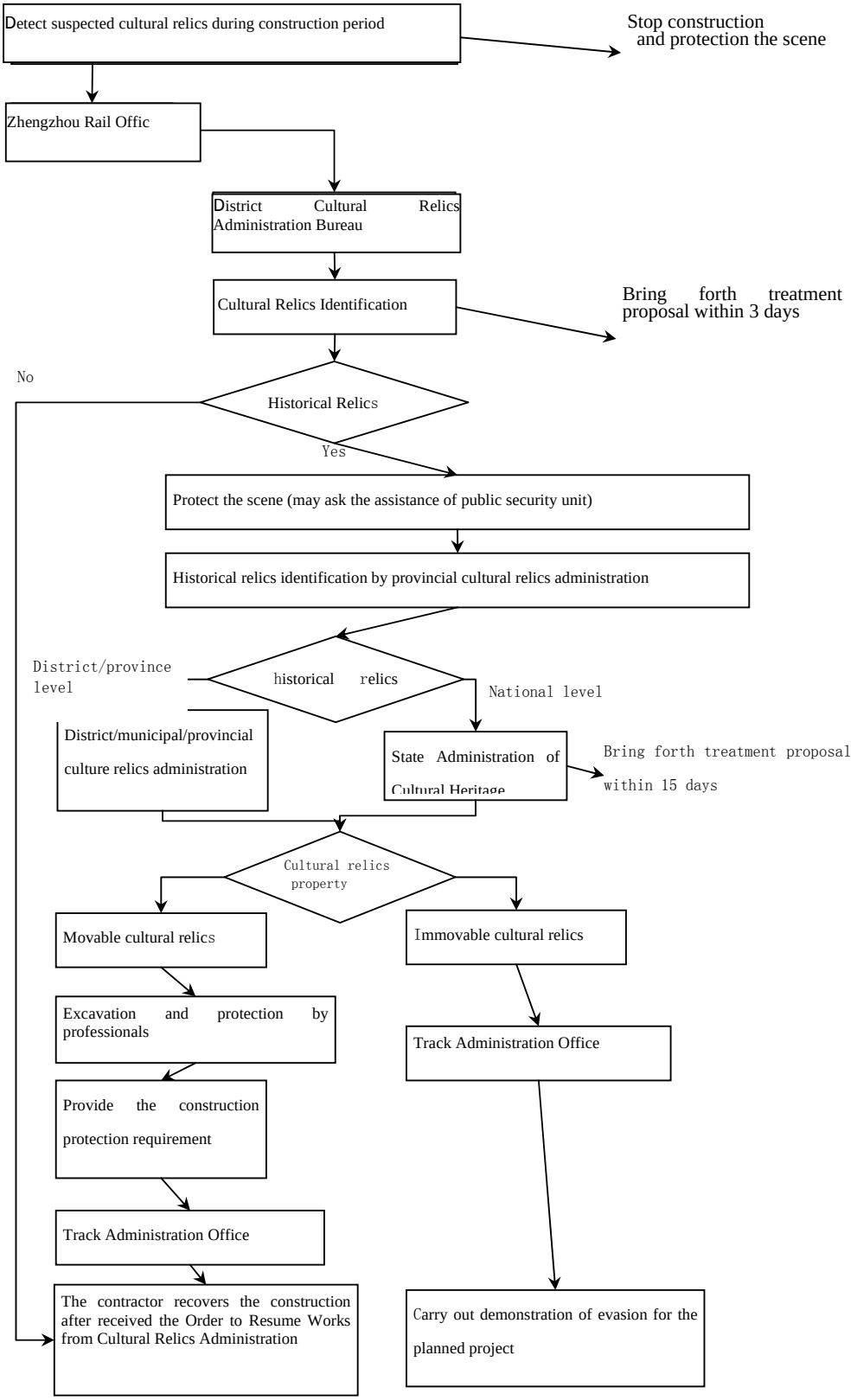


Figure 5.11-7 Diagram of control procedure for culture relics found during construction period

5.11.3.6 Management Measures during Construction Period

Establish vibration monitoring mechanism, and strengthen long-term tracing and monitoring of the possible influences of vibration on subway operation period after project implementation;

Strengthen the environmental management within the aforesaid sensitive sections during construction period; Establish construction enclosures, strengthen water sprinkling and dust reduction, and implement traffic evacuation etc.; The establishment of the construction site shall evade the protective areas of various sensitive factors, and the construction sewage and dregs shall be discharged and piled on an organized way, and cleared and transported in time to guarantee project construction will not cause adverse influences on various protected factors.

5.11.4 Assessment summary

There are four physical cultural heritages identified in this project, separately of Memorial Tower for February 7th Strike, Zhengzhou Shang Dynasty Relics, Zhengzhou Confucius Temple and Penggong Temple, in which the distance of line to Memorial Tower for February 7th Strike body is only 3m; there is no ground buildings such as entrance, ventilation pavilion or cooling tower in protection range in protection range and there is an entrance in construction control zone; the line passes through underground of Shang Dynasty Ruins and there is no ground building in its protection range and construction control range; the line passes through underground the construction control range of Zhengzhou Confucius Temple without any ground building; the Penggong Temple is located at west gate of People’s Park and the line passes through underground with far distance.

The protection measures provide in the assessment are as follows: carry out pre-reinforcement before construction at Memorial Tower for February 7th Strike; adopt shelter pile measures during 3 line shield construction and mount steel spring floating slabs in 50m range at both sides of protection range, and intensify the settlement monitoring during construction period; during design of stations near the cultural relics including Erqi Square Station, Chengdong Road Station and Taikang Road Station, the design of entrances, ventilation pavilions and cooling towers shall be kept uniform separately with People’s Park Shang Dynasty Cultural Display Area and Jinshui River Waterfront Park landscape, Memorial Tower for February 7th Strike and Dehua Commercial Center and Shang Dynasty ruins landscape.

Since Zhengzhou is one of national famous historical and cultural cities and listed in eight ancient capital cities, the general style design for stations and ventilation pavilion of rapid rail transit of complete city shall have the visual image of city culture and coordinate with the heavy culture connotation of Zhengzhou.

6 Analysis of cumulative impact

6.1 The Definition of Analysis Area of Cumulative Impact

According to the technical requirement of cumulative analysis and combining the features of linear project of city rail traffic, the cumulative analysis is defined to the space and temporal summation of the environmental impact of Line No.3 project of Zhengzhou rail traffic, existing projects along the line, uncompleted construction projects and planned projects.

The current items to be given priority during the assessment: BRT route, the long-distance bus station and Subway #1. Project that will be carried out simultaneously with this one: Subway #2 project; the constructional projects that can be reasonably foreseen include Projects Subway #4 and #5 included in the near-term planning (the constructional planning from 2013 to 2019) The accumulative impact of the above existing project, the in-progress project, and those constructional projects that will be reasonably foreseen in the future will be comprehensively analyzed and assessed in this project.

This chapter discusses the accumulative impact of the valued environmental components (VECs) on on historic relics during construction, and on traffic, noise, vibration and smelling pavilion during the operation.

Subway #1 has been put into operated since December 28 2013, 16 stations of Subway #2 is under construction and the feasibility study for Subway #4 has yet to begin at present. Therefore the assessment on accumulative impact during the construction of the project will be focused on those brought by inter-regional construction at Subway #2, construction of the whole Subway #5 and Subway #3. Analysis on accumulative impact of all projects for Subways #1 ~5 and accesses to public transport facilities during operation The time sequence to build Subways #2 to 5 is shown in Table 6.1-1 according to Zhengzhou Urban Rail-Transit Building Planning.

Table 6.1-1 Construction sequence of Lines No.2 to No.5 projects

No.	Name	Construction period
1	Line No.2 project	2011-2015
2	Line No.3 project	2014-2018
3	Line No.4 project	2015-2019
4	Line No.5 project	2013-2017

6.2 Analysis of Cumulative Impact

6.2.1 Analysis of Cumulative Impact during the Construction Period

6.2.1.1 Cumulative Impact on Cultural Relics Protection during the Construction Period

The Memory Tower for “Feb. 7th” is located at the most prosperous Seven Feb. Square in Zhengzhou. This tower is a national heritage and the landmark of Zhengzhou. Seven Feb. Square Station is a two-storey underground island platform station, and is also the transfer station of Line No.1 and Line No.3. The shortest distance from the foundation pit of Seven Feb. Square Station of Line No.1 to the foundation of the Memory Tower for “Feb. 7th” is 23.6 m; the shortest central distance from the right line of Line No.3 to the masonry door of the Memory Tower for “Feb. 7th” is 3 m, and the shortest distance to the raft foundation is 10.7 m; the shortest central distance from the left line to the masonry door of the tower is 18 m, and the shortest distance to the raft foundation is 25.8 m; the depth of foundation pit of Seven Feb. Square Station of Line No.1 is 17.3 m; the buried depth of rail surface of Line No.3 is about 23.7 m, as shown in Fig.6.2-1.

(1) Numerical Simulation Computation and Analysis on Impact of Excavation of Foundation Pits at Subway #1

In the numerical analysis, a molar-Coulomb ideal elastic-plastic constitutive model is used for the earth body. = Through calculation, prior to reinforcement, the maximal settlement of Erqi Tower is 10 mm, less than 20 mm and its foundation tilt is 0.0003. The impact of excavation of Foundation Pits at Subway #1 on Erqi Tower does not exceed the deformation limit. After reinforcement, the maximal settlement of Erqi Tower is 4.2mm, less than 20 mm and its foundation tilt is 0.0002. After reinforcement the impact of excavation of Foundation Pit #1 on Erqi Tower does not exceed the deformation limit. it is concluded that prior to reinforcement Erqi tower baseplate's maximal settlement is 10 mm and its tilt is 0.0003, and after reinforcement, they are 5 mm and 0.0002, respectively, none of them beyond the deformation limit.

(2) Numerical Simulation Computation and Analysis on Impact of Shielding Tunneling of Subway #3

In the numerical analysis, a molar-Coulomb ideal elastic-plastic constitutive model is used for the earth body. = After calculation, prior to reinforcement Erqi tower baseplate's maximal settlement is -22 mm beyond the limit of 20 mm, its minimal settlement is -7 mm and its tilt is 0.0006 within the limit of 0.001; After reinforcement Erqi tower baseplate's maximal settlement is -15 mm within the limit of 20 mm, its minimal settlement is -8 mm and its local tilt is 0.0003 within the limit of 0.001. It is concluded from this that prior to reinforcement Erqi tower baseplate's maximal settlement is -22 mm and its tilt is 0.0006; After reinforcement Erqi tower baseplate's maximal settlement is -15 mm and its tilt is 0.0003, none of them exceeding the allowed maximal foundation settlement of 20mm and the maximal allowed tilt of 0.001.

(3) Conclusion from comprehensive consideration of the impact of foundation pit construction at Subway #1 and shield tunneling at Subway #3

It is known from comprehensively assessing overall impact of foundation pit construction at Subway #1 and shield tunneling at Subway #3, i.e. superpose in linear way the above-described conclusions for impact of foundation pits at Subway #2 and shield tunneling at Subway #3 respectively, that after reinforcement Erqi Tower's maximal settlement is 19.2 mm within the limit of 20 mm and its foundation tilt is 0.0005, within the limit of 0.001.

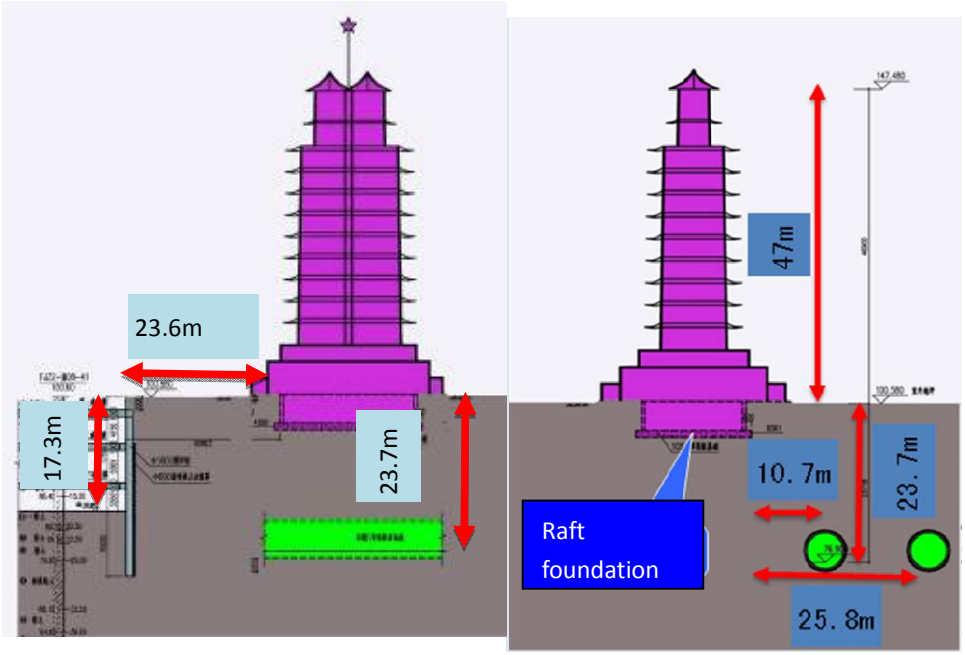


Fig.6.2-1 Profile relationship between the Memory Tower for “Feb. 7th” and the foundation pit of Line No.1 station and Line No.3

6.2.2 Analysis of Cumulative Impact during the Operation Period

6.2.2.1 Analysis of Cumulative Impact on Traffic during the Operation Period

After the subway is put into operation, massive passengers will be attracted to travel by subways thanks to its quickness and convenience. Safety-related hidden hazards may be present at subway stations, especially at the transfer stations and those located at the down-town areas because the heavy passenger flow that concentrates around stations at the peak hours will cause temporary congestion or jam at some local stations and is hard to evacuate quickly in case of emergency.

The subway, upon operation, will be connected seamlessly with the high-speed railway station, the train station and the long-distance bus station to form an integrated traffic network by connecting it with different public transport systems at proper positions including the public transport stops, BRT and the parking lots in order to divert passenger flow and save time and cost for passengers.

6.2.2.2 Analysis of Cumulative Impact of Noise during the Operation Period

During the operation period, if the noise sensitive point is located at the common range of wind pavilion and cooling tower corresponding to two transfer stations, the noise impact generated by the subway environmental control equipment will have cumulative impact. Concrete analysis is listed in table 6.2-1.

Table 6.2-4 Cumulative impact on sensitive point by air-conditioning noise (unit: dB)

Name of station	Name of sensitive point	Current value		Contribution value of wind pavilion of Line No.3		Cumulative noise value of Line No.3 and other lines		Standard value	
		Day	Night	Day	Night	Day	Night	Day	Night
Huanghe Road Station (Line No.5)	Building No.5 in Huayuan Community	57.2	51.2	57.4	52.2	60.3	55.3	55	45
	Building No.6 in Huayuan Community	58.2	52.2	58.2	52.3	61.2	55.3	55	45

Various sensitive points will be affected by the noise of environmental control equipments for subway Line No.3 or Line No.5, and the noise values in day and at night are from 57.4 to 58.2 dB and from52.2 to 52.36dB, separately. Huanghe Road Station is a transfer station, and it also affected by the noise from environmental control equipments for subway Line No.3 and Line No.5. Therefore, the superposition noise value of various sensitive points in day and at night are from 60.3 to 61.2 dB and from 55.3 dB, separately. Compared with the corresponding standards, the noise at building No.6 in Huayuan Community and building No.5 in Huayuan Community exceeds the standard both in day and at night,.

6.2.2.3 Analysis of Cumulative Impact of Vibration during the Operation Period

At transfer stations, the vibration caused by the increasing of passing times of subway will have cumulative impact on sensitive points on the ground. Cumulative analysis of environmental vibration generated by Xinliu Road Station, Huanghe Road Station, Seven Feb. Square Station, Dongdajie Station, Future Road Station, Zhongzhou Road Station and Zhongxing Road Station is listed in Table 6.2-2.

Table 6.2-2 Cumulative impact on sensitive points by environmental vibration (unit: dB)

Name	Name of sensitive point	Combined action lines	Line No.3 alone Z10		combined action of Line No.3 and other lines cumulative Z10		Standard value		Remarks
			Day	Night	Day	Night	Day	Night	
Xinliu Road Station	Buildings No.1 to No.3 in Yuhuang 9th City	3, Line No.4	63.1	62.4	66.2	65.4	70	67	Line No.3 is above Line No.4
Huanghe Road Station	First Primary School on Nanyang Road	3, Line No.5	70.6	70.5	73.6	73.5	75	72	Line No.3 is above Line No.5
	Buildings No.1, No.2 and No.3 in No.296 yard on Nanyang Road		68.9	68.7	71.9	71.7	75	72	
	Building No.5 in Huayuan Community (No.300 Nanyang Road)		69.9	69.4	72.9	72.4	75	72	
Dongdajie Station	Ziyanhuating Housing Estate	3, Line No.2	67	66.5	70	69.5	75	72	Line No.3 is above Line No.2
	Yuhonghuayuan Housing Estate		67	66	70	69	75	72	

Various sensitive points are affected by the vibrations of subway Lines No.1, No.2, No.3, No.4 and No.5. The vibration values at day and night varies from 63.1 to 70.6dB and from 62.4to 70.5dB, separately. Transfer stations will also be affected by the vibration of other railways. Therefore, the superposition vibration values of various sensitive points at day and night vary from 66.2 to 72.9 dB and from 65.4 to 73.9 dB, separately. Compared with corresponding standards, the vibration values of buildings the First Primary School on Nanyang Road, and building No.5 in Huayuan Community (No.300 Nanyang Road) at night exceed the standard.

6.2.2.4 Analysis of Cumulative Impact by Air Pollution during the Operation Period

The ambient air is mainly affected by the smell from the wind pavilion. The influence degree of peculiar smell is related to the ambient temperature, passenger flow volume and atmospheric diffusion conditions. Sensitive points which may be affected by cumulative air impact during the operation period are listed in table 6.2-3.

Table 6.2-3 Cumulative impact of sensitive points by ambient air during the operation period

Name of station	Name of sensitive point	Combined action of wind pavilion	Accumulative result (bad-smelling gas concentration)	Standard value	Influence degree
Xinliu Road Station	Yuhua 9th City Housing Estate	West wind pavilion	<10	20	The distance from the wind pavilion to the sensitive point is long, so the cumulative impact is small
Huanghe Road Station	Zhengfangji Community	Southeast wind pavilion	<10	20	Combined wind pavilion and small cumulative impact
Dongdajie Station	Zhengzhou Post Office Building	Southeast cooling tower	<10	20	

It can be seen from Table 6.2-3 that many transfer stations have the same wind pavilion. So the cumulative impact on sensitive point by wind pavilion is small. The distances from Yuhua 9th City Housing Estate near Xinliu Road Station to wind pavilions at both sides are small. They are separated by green land or road. So the cumulative impact by wind pavilion is small.

6.3 Mitigation Measures of Cumulative Impacts of this Project

6.3.1 Mitigation Measures of Cumulative Impacts during the Construction Period

6.3.1.1 Mitigation Measures for Cumulative Impact by Continuous Construction near the Memory Tower for “Feb. 7th”

The protection scheme of the Memory Tower for “Feb. 7th” when the rail transit project of Zhengzhou side penetrating the tower includes pre-reinforced protective measure before construction and control measure during the shield construction of Line No.3.

(1) Various enforceable reinforcing protection schemes are proposed in view of the deformation control standards, combining with similar successful engineering experience in China as well as the geological conditions of the Seven Feb. Square. And then, numerical simulation and finite element calculation are conducted for various schemes before reinforcement. On the premise of meeting the deformation requirements, the optimal scheme is proposed combining with economy, technology, pipeline modification and correction, and other factors.

(2) A row of bored piles with the diameter of 800 mm are provided along the axis direction of Line No.3. The pile tops are connected into a whole by the 0.8m×1.0m crown beam. The pile bottom goes deep into 4 m below the shield tunnel of Line No.3, and enters into the (33) silty clay layer (permeability coefficient of 0.08m/d). Meanwhile, grouting pipes are embedded near the tower foundation. Information construction is adopted to the construction of foundation pit of Line No.1 and to the shield tunneling of Line No.3. Grouting reinforcement is prepared at any time according to the monitored deformation data.

(3)The impact of foundation pit construction at Subway #1 and the reinforcement process on Erqi Tower will not be in excess of the deformation control limit because following factors have been considered in construction of the foundation pits: the water-retaining effect of the chemical churning piles outside the pits, the shear strength of the fending piles inside the pits and strength of the concrete support inside the pits to prevent water/mug ingress and water loss in formations, monitoring frequently data concerning uneven settlement of Erqi Tower in real time. The above-mentioned measured have been carried out during construction of Subway #1 and the data from monitoring has shown the requirement had been met.

(4)Within 50 meters from Erqi Tower, the shield tunneling, especially the operation, will be under strict control to ensure equipment in good condition. The earth-pressing balance mode will be applied, the shield tunneling excavation position, earth cut from each cycle and the volume of synchronous grouting shall be under control, and secondary grouting will done to achieve tunneling in balance. The tunneling parameters of the shield tunneling machine will be studied in detail and parameters

such as grouting ratio, pressure, thrust force and speed of the machine will be optimized based on specific geologies in Zhengzhou to ensure the shield tunneling machine passes below Erqi Tower in continuous and steady way in order to achieve minimal ground settlement and meet the requirement on protection of historical relics.

6.3.2 Mitigation Measures of Cumulative Impact during the Operation Period

6.3.2.1 Measure to mitigate the accumulative impact on traffic

1. Based on the demand from traffic development, considering the land development mode along the subway route, the characteristics of connecting passenger flow, land condition, road network condition and the traffic condition, specific studies have been done on some topics concerning the integrated traffic plan in order to build a well-developed integration traffic network to meet the demand of resident traveling as quick as possible. Based on these results from studies, various station's accessing functions are defined and spatial arrangement of different types of connecting facilities are planned as a whole. There will be mainly five ways and means:

(1) Pedestrian access

Walk will be the final form for all accessing ways. The walk accessing system shall be first considered for all stations. A continuous, safe and comfortable pedestrian system shall be provided through squares, crossing-street facilities and foot paths based on the passenger flow to be accessed, considering road building and rebuilding. The barrier-free facilities shall be provided for and attached to the pedestrian system and be constructed together with the urban facilities.

(2) Cycling access

In view of the accessing features at difference areas along the subway route where most are residential areas, the cycling access is inevitable and planning of parking lots along the entire route shall be focused on whether it is convenient to access to residential areas. The accessing facilities shall be designed and distributed based on whether the land supply is possible and reasonable, and land will be reserved in view of the change in long/near term demand. The parking space will be reduced through parking space landscaping, sharing it with public buildings, three-dimensional parking, reducing space for a single cars. For the cycling accessing facilities, passengers will be encourage to use it more frequently. Specific bicycle parking space will be arranged to reduce the time percentage of bicycles using roads as much as possible.

(3) Access to bus stops

At the old urban areas where there are more public transports, the spatial position, the manners and the spatial size of the intermediate stops will be optimized by analyzing

the bus flow route, defining the main passenger flow direction and centering arrangement of the entrance and exit of railway transit. At other areas where the public transport is developing, public transports shall be planned and developed in consideration of the subway stations along its route. Bus stops shall be optimized and adjusted to proper positions while consideration shall be given to the intersections are coordinated as a whole to meet the requirement to connect subways efficiently.

(4) Taxi access

The regulations on design and arrangement of taxi facilities shall be complied and road and general traffic conditions at different areas shall be taken into consideration. Taxies are allowed to pull over the road around the subway route to take or drop passengers, for instant stopping and leaving. At the peripheral areas towards the south and the north, where conditions permit, taxi waiting space or taxi-beckoning stops will be set, and the passenger-waiting space will be set at the hub station, flexibly.

(5) Car access

Car access shall be planned and arranged in compliance with the criteria of "P+R" (Parking and Transfer), based on the station land condition, the road network conditions and the traffic condition, and considering the whole picture of the railway network. In the process of preparing the detailed regional planning, focus shall be on reserving parking space around the remote subway stations.

The above-mentioned access space for public transport will be controlled and reserved as the accessing land by the planning bureau to avoid being used by other projects. During the project construction, the Subway planning company and the commission for communication will take the lead to organize the public transport companies and the gardening &landscaping organizations to build respective facilities to be accessed to the subway stations as per the planning.

Example: Erqi Square Station - the transfer station between Subways #1 and #3.

(1) Traffic around the station

The station is located at the intersection of Jiefang Road and Zhengxing Street and arranged in transmeridional way along Jiefang Road. Passengers can transfer between Subway #1 and #3. There are totally 5 entrances/exits for Subways #1 and #3 which are distributed on four sides of the intersection between Jiefang Road and Zhengxing Street. The station stand at the center of the old urban area where it is well-developed, densely populated, the most prosperous commercially and highly-concentrated with urban functions.

At present, Bus Line No. 6, 603, 28, B17 have stops on Jiefang Road (stop name: Erqi

Square bus stop) which are closer to the subway entrance/exit while Bus Line No. 105 (south), 806, K906, 95, 32, 21, K6, K903, 93, 517 and 906 have stops at Zhengxing Street (stop name: Erqi Square bus stop) that intersects Jiefang Road, which also are closer to the subway entrance/exit.

(2) Passenger flow features

The passenger flow is dominantly mixed including travellers and commuters. The passengers walking to the station are distributed over the commercial space around it. Since railway transit stations concentrate there, most passengers from other stations also walk inside it and so there will be no bicycle parking space. passengers coming to it by public transports are by passing-by buses and the train station.

(3) Improve the integrated traffic network

Consideration is mainly given to access to the station on foot, by public transport, by bicycle, taxi, and private cars.

The pedestrian system: Since the on-foot passenger flow comes from every direction around the station, squares are to be built around every entrance/exit of the subway and to be connected with established roads, and the established roads with footpath width less than 3 m will be rebuilt. Develop and improve sound planar crossing-street facilities and crossing-street facilities for transferring bus stops to provide a safe and comfortable on-foot system for on-foot and transferring passengers to the station.

The public transport facilities: 2 bue stops on the west street will be reserved. 2 bus stops on Shuncheng Street will be relocated in order to minimize the distance from new stops to the subway entrance/exit, thus reducing the transferring time.

The bicycle parking space: based on the demand from bicycle access and the organizational requirement, the first measure is to build more cycling roads and the second measure is to build 2 bicycle parking lots somewhere around the subway entrance/exit on the western street in order to reduce the frequency of bicycles crossing street effectively and lower traffic interference. The total area of both bicycle parking lots is 500 square meters including No.1 bicycle parking lot of 200 m2 to be located on the north side of the western street to serve the passenger flow on the north side of the station and No.2 bicycle parking lot of 300 m3 to be located on the south side of the western street to serve the passenger flow on the south side of the station;

Taxi: Taxies are allowed to pull over the road around the subway entrance/exit for instance stopping and leaving to provide convenience to transferring passengers on the condition that the Zhengzhou rules concerning taxi management are met.

2. Organize passenger flow effectively and efficiently Understand how the passenger flow changes dynamically and take some measures to manage passenger flow (e.g. restrict traffic flow and direction at the peak hours).

3. Optimize the emergency response plan The organization responsible for operating the railway transit shall prepare emergency plans to address possible situation due to high passenger flow at the peak hours to incorporate relevant organizations, establish the interactive mechanism and carry out periodical drill.

6.3.2.2 Mitigation Measures of Sensitive Points Affecting by 2 Wind Pavilions at the Same Time

The noise in buildings No.6 and No.5 in Huayuan Community exceeds the standard. Measures taken for them in this report include: (1) lengthening the silencer to more than 3 m which will reduce the noise of the wind pavilion by 10dB; (2) setting the main vents at the backward direction of the sensitive point. After taking the above measures, the predicted value of noise at these two sensitive points can meet the standard requirement.

6.3.2.3 Mitigation Measures of Cumulative Impact by the Vibration of 2 Subway Lines at the Same Time

Sensitive points near the transfer station may be affected by two (or more) subway lines. The influence of shallow buried subway line to the sensitive point is much larger. Therefore, conservative vibration prevention measures shall be taken for both lines. The standard in “Residential, cultural and education areas” is taken as the limit value, and vibration prevention measures are proposed. For sensitive points with strict standards like residential area, school and hospital within 20 m, the mitigation measure of “steel spring floating slab” shall be adopted, and for “office buildings and commercial buildings” within 40 m, the mitigation measure of “elastic monolithic track bed” shall be adopted. The mitigation measure of “elastic monolithic track bed” will be adopted to building No.5 in Huayuan Community (No.300 Nanyang Road). The mitigation measure of “fastener” will be adopted to First Primary School on Nanyang Road.

6.4 Summary

(1) Cumulative Impact on Cultural Relics Protection during the Construction Period: It is known from comprehensively assessing overall impact of foundation pit construction at Subway #1 and shield tunneling at Subway #3, i.e. superpose in linear way the above-described conclusions for impact of foundation pits at Subway #2 and shield tunneling at Subway #3 respectively, that after reinforcement Erqi Tower's maximal settlement is 19.2 mm within the limit of 20 mm and its foundation tilt is 0.0005, within the limit of 0.001.

A row of bored piles with the diameter of 800 mm are provided along the axis direction of Line No.3. The pile tops are connected into a whole by the 0.8m×1.0m crown beam. The pile bottom goes deep into 4 m below the shield tunnel of Line No.3, and enters into the (33) silty clay layer (permeability coefficient of 0.08m/d). Meanwhile, grouting pipes are embedded near the tower foundation. Information construction is adopted to the construction of foundation pit of Line No.1 and to the shield tunneling of Line No.3. Grouting reinforcement is prepared at any time according to the monitored deformation data.

The cumulative impacts by Line No.3 during the operation period mainly include: the impact on the same sensitive point by wind pavilions at both sides of the subway at the same time; the impact of noises from two subways on one same sensitive point; the impact of the same sensitive point by the vibration of two subway lines; and the impact on the Traffic ..

The cumulative impact of noise during the operation period can be mitigated by properly arranging the position of wind pavilion and cooling tower, selecting low noise equipment, lengthening the silencer, and other measures; the cumulative impact of vibration during the operation period can be mitigated by using the steel spring floating slab, and other damping measures.

The traffic access space will be controlled and reserved by the planning bureau to avoid being used by other projects. During the project construction, the Subway planning company and the commission for communication will take the lead to organize the public transport companies and the gardening &landscaping organizations to build respective facilities to be accessed to the subway stations as per the planning in order to realize 5 accessing ways; Organize passenger flow effectively and efficiently. Understand how the passenger flow changes dynamically and take some measures to manage passenger flow (e.g. restrict traffic flow and direction at the peak hours); Optimize the emergency response plans. The organization responsible for operating the railway transit shall prepare emergency plans to address possible situation due to high passenger flow at the peak hours to incorporate relevant organizations, establish the interactive mechanism and carry out periodical drill.

7 Analysis of alteranative schemes

First-stage project of Zhengzhou Rail Traffic Line No. 3 highlights line trend and comparison and selection of alternative scheme for station location during the feasibility study and design phase. Comparison and selection of alternative scheme of underground station construction scheme is taken into account during the construction stage.

7.1 Analysis of Zero Scheme

Line No. 3 project of Zhengzhou Rail Traffic is urgent and necessary to the development of Zhengzhou and is mostly represented in following aspects.

Table 7.1 Comparison and selection of project scheme and zero scheme

Category	Project implementation scheme	Zero scheme
Advantages	1. It will effectively change the jamming situation of the east-west traffic corridor in Zhengzhou, ease the downtown traffic pressure, and greatly improve the travel convenience of residents; 2. It will greatly improve the development, influence, cohesion, creativity, driving force and radiation force of regional central city of Zhengzhou; 3. It has great significance in strengthening the urban space, traffic integration, industrial layout, spatial layout optimization, regional resources integration, strengthening competitive industries, speeding up the aggregation of population and industry, and promoting the coordinated regional development; 4. It is the inevitable choice in improving the urban environment of Zhengzhou, implementing sustainable development, and promoting social and economic development; 5. It is the active demand of supporting facilities for major projects along the line;	1. Maintain the existing environment without any environmental impact caused by the construction; 2. Not change the land utilization value (no land occupancy); 3. No immigrant settlement problem;
Disadvantages	1. Occupy the land resources and generate certain water loss and soil erosion; 2. The vegetation is destroyed and the dust nuisance is generated during the construction period; 3. Noise and vibration impact; 4. Project construction and immigrant settlement will bring short term adverse impact to the environment; 5. Increase certain environmental pollution such as more solid waste, etc.	1. Urban traffic of Zhengzhou is very crowd now; 2. The urban traffic shows the "demand exceeds supply" phenomena.
Comprehensive analysis	View from the social development and environment aspects, the project development scheme is superior to the zero scheme	

It is shown from table 7.1-1 that the construction will not only solve the phenomena

of urban traffic congestion in Zhengzhou, but also is favorable to the development of urban economy. Furthermore, the construction of rail traffic can reduce the emission of carbon dioxide by cars and thus protect the environment. Therefore the construction scheme is superior to the zero scheme view from any aspect.

7.2 Comparison and Selection of the Route Selection Technology of the Project

7.2.1 The Principles of Route Selection

(1) The trend of the line and the allocation of stations shall be based on the "Master City Plan of Zhengzhou", "Planning of Zhengzhou Rail Transit Network", "Construction Program of Zhengzhou Express Rail Traffic", and other master planning. The trend of the line and the allocation of stations shall be studied and selected by combining with the land development and the engineering construction conditions along the line to give full play to the high efficiency and backbone effect of passenger transport.

(2) Allocation of stations shall be close to the distribution points of main passenger flow and various traffic hubs in order to attract the passenger flow maximally and provide convenience for passengers. Meanwhile, united consideration shall be given to the development plan of real estates along the line to drive the real estate development and improve the land efficiency.

(3) Besides considering the transfer to other lines in the network, the connection with other public transportation modes shall also be handled for stations. The type of transfer station, the transfer mode and scale shall be properly selected according to the future passenger requirements to create better transfer conditions for passengers.

(4) Auxiliary lines and other lines shall be properly provided according to the requirement of train operation and organization.

(5) The influences of other intersected subway lines, underground structures, pile foundation, municipal pipelines, rivers, and other control factors shall be comprehensively considered. These intersections shall be avoided as far as possible.

(6) Cultural relics and environment along the line shall be protected.

(7) The buried depth of subway shall be properly determined according to the present situation and planning along the line.

(8) Dynamic slope shall be adopted as far as possible for underground sections, especially the sections constructed by shield method to save the energy.

7.2.2 Comparison and Selection of Typical Lines

In the feasibility research stage, the alternative scheme research is made to the trend

of lines at the north of the North Ring, the line scheme from Jinshui Road Station to Seven Feb. Square Station, and the line scheme of down-traversing the planned National Highway No.107 Interchange.

7.2.2.1 Comparison and Selection of Line Trend at the North of the North Ring

This section is located at the starting section of Line No.3. After passing the North Ring Interchange along Nanyang road, Line No.3 goes further to the north in two routes: along Changxing Road and along Jiangshan Road, as shown in Fig.7.2-1.

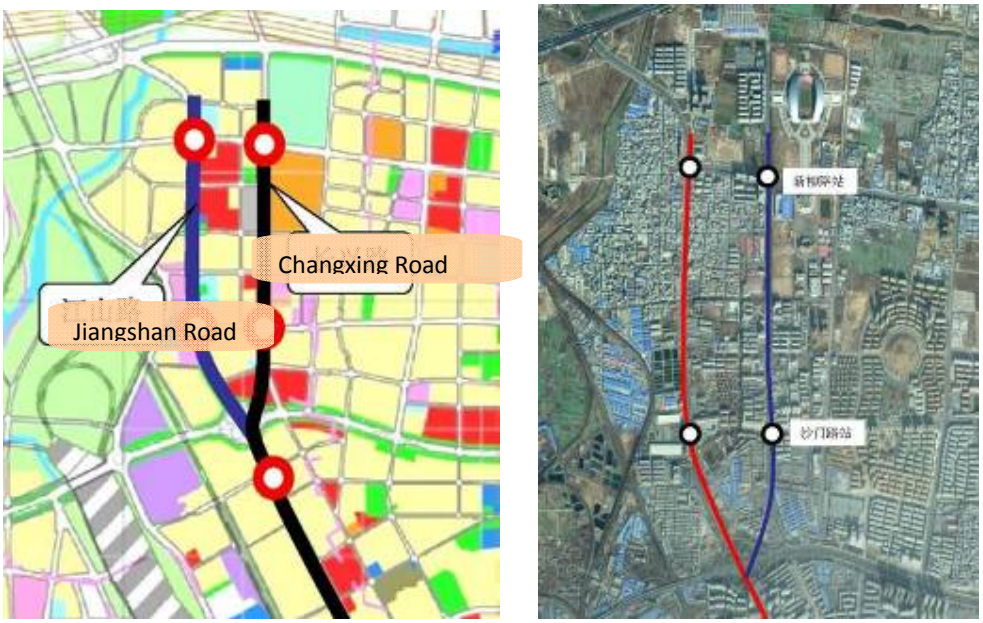


Fig.7.2-1 Schematic view of comparison and selection of line trend at the north of the North Ring

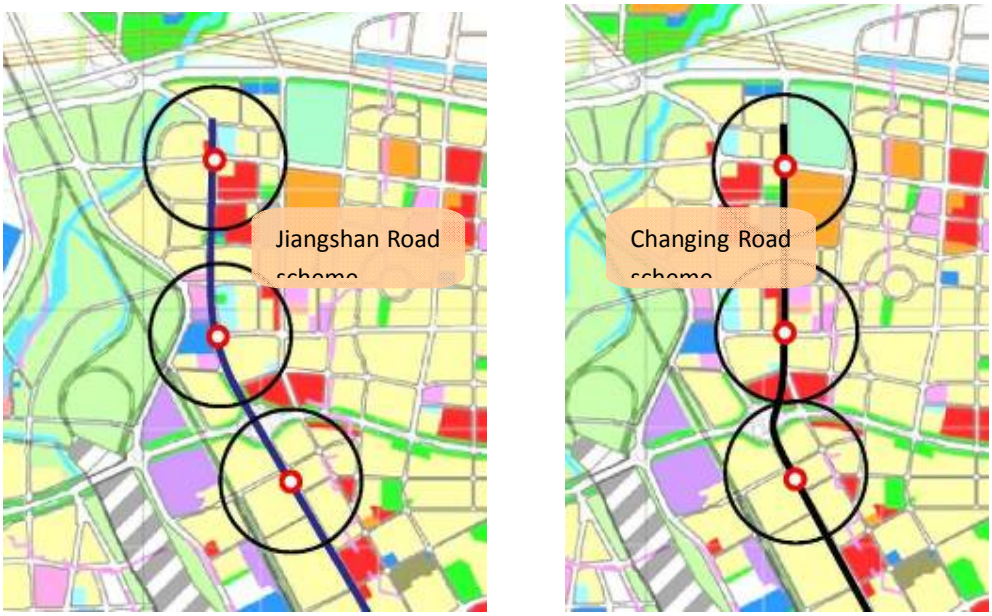


Fig.7.2-2 Schematic view of passenger flow coverage along the line at the north of the North Ring

(I) Alternative Scheme (Jiangshan Road Scheme)

Line trend: after passing round the pile foundation of North Ring Interchange, the line goes further north, and will pass through the space between two existing housing estates. The housing estate at the west has buildings of 6 storeys, while the housing estate at the east has buildings of 30 storeys. The minimum space between buildings of these two estates is only 30m, as shown in Fig.7.2-3 to Fig.7.2-5.

Fig.7.2-3 Line diagram of Jiangshan Road scheme

Fig.7.2-4 North extension line plan of Jiangshan Road scheme

Fig.7.2-5 Photo of current status of north extension of Jiangshan Road

(II) Recommended Scheme (Changxing Road Scheme)

Line trend: after passing round the pile foundation of North Ring Interchange, the line goes north and down-traversing the plot at the northeast corner of the North Ring Interchange. The future line goes further north along Changxing Road, down-traversing Jialu River, enters into Huiji District, and goes further north along Qinghuayuan Road. Stations will be built in the planned Binhe Road intersection, Kaiyuan Road intersection and Dahe Road intersection. The Kaiyuan Road Station is a transfer station with subway Line No.2, as shown in Fig.7.2-6 to Fig.7.2-8.

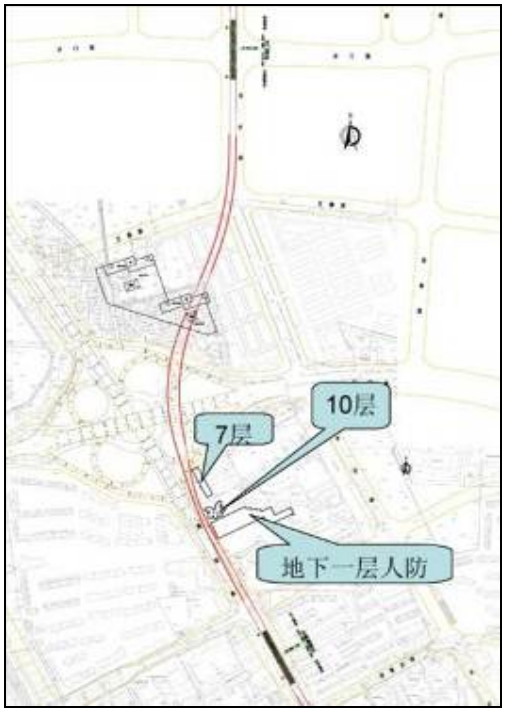


Fig.7.2-6 Line diagram of Changxing Road scheme

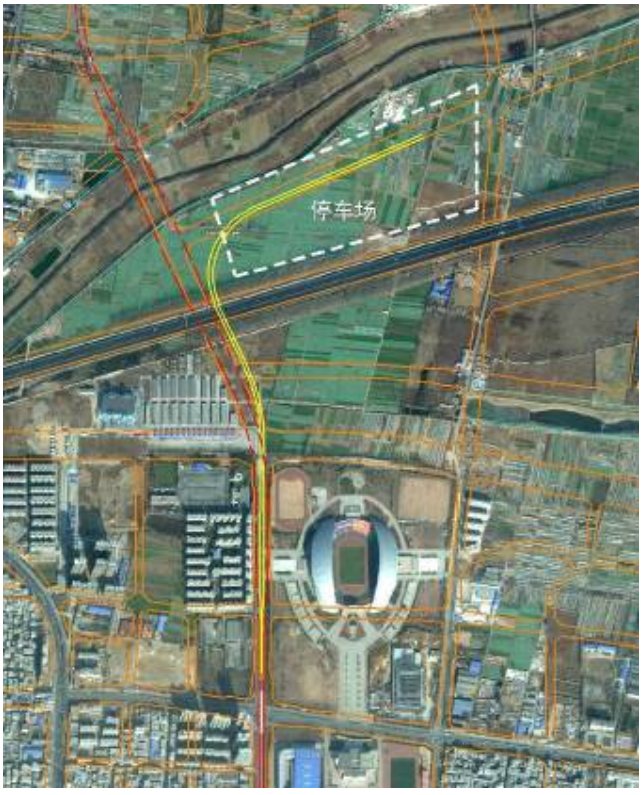


Fig.7.2-7 North extension line plan of Changxing Road scheme

Fig.7.2-8 Photo of current status of north extension of Changxing Road

(III) Comparison of Line Schemes

These two schemes are compared and analyzed from four aspects of engineering technology, social impact, environmental impact and finance in this report, as listed in table 7.2-1.

Table 7.2-1 Comparison selection of line trend at the north of the North Ring

Review of Scheme Factors of Comparison		Recommended Scheme (Changxing Road Scheme)	Alternative Scheme (Jiangshan Road Scheme)	Advantages and Disadvantages
Engineering Technology	The difficulty of construction	Down-traversing the plot at the northeast corner, and the distance from this line to the 10 storeys residential building and the first underground air defense rooms is far, and the closest place is about 3m. The construction difficulty and risk are low.	Down-traversing a commercial podium (6 storeys) and a high-rise apartment building (28 storeys) of this project. In addition, the distance from Line No.3 to a 10 storeys residential building and a first underground air defense room in Xianghehuayuan Housing Estate at the northeast corner of the North Ring Interchange is close (less than 1m at the closest). The construction risk and difficulty are large.	Recommended scheme is superior
	Operating conditions of the line	Two curves with the minimum radius of R=400m	The line is straight, and there is one curve with the minimum radius of R=600m	Alternative scheme is superior
	Geological conditions	There are collapsible soil layer and liquefied soil layer, which will have adverse effect on this project.	There are collapsible soil layer and liquefied soil layer, which will have adverse effect on this project.	Equivalence
	Construction risk	Construction is made under existing roads and the construction risk is small.	Down-traversing existing housing estates together with the in and out lines, so there are many lines, a small space, and large construction risk.	Recommended scheme is superior
Social impact	Conformance with the planning	This line is laid within the road red lines, and it is well cooperated with the planning.	This line is laid within the road red lines, and it is well cooperated with the planning.	Equivalence
	Impact of traffic	This area has a small traffic flow, so the impact to the traffic is small.	This area has a small traffic flow, so the impact to the traffic is small.	Equivalence
	Amount of demolition	The plot at the northeast of Nanyang Interchange is green space and market warehouses, so the amount of demolition is small	The housing estate at the west is residential buildings of 6 storeys, and that at the east is residential buildings of 30 storeys, and both of them shall be demolished.	Recommended scheme is superior
	Land utilization	The line along Changxing Road is mainly residential area, land used for universities and schools, sport sites, some commercial and financial sites, and administrative offices. The down-traversing plot is undergoing urban village reconstruction, so the passage of Line No.3 can be reserved.	The line of Jiangshan Road is mainly residential area, commercial sites and administrative offices.	Equivalence
	Impact of the land acquisition	The construction of stations will temporarily occupy a small amount of green space	The construction will temporarily occupy a small amount of green space	Equivalence
	Attraction to passenger flow	The line along Changxing Road is a large tract of developed plot, especially the east of Changxing Road which has a large amount of residential buildings which will have a greater passenger flow demand	Railway is not far away from the west of Jiangshan Road, so the development hinterland is limited, and the coverage area of passenger flow is small	Recommended scheme is superior
	Transfer convenience	The future line will go further north, down-traversing Jialu River, enters into Huiji District, and goes further north along Qinghuayuan Road. Stations will be built in the planned Binhe Road intersection, Kaiyuan Road intersection and Dahe Road intersection. The Kaiyuan Road Station is a transfer station with subway Line No.2	The transfer conditions are poor due to the obstruction of Beijing-Guangzhou Railway at the west.	Recommended scheme is superior
	Impact of cultural relics	No cultural relics	No cultural relics	Equivalence
Environmental impact	Vibration	Under the existing road, close to buildings at both sides, and the impact of vibration is relatively large	Down-traversing three residential buildings, large impact of vibration	Recommended scheme is superior
	Noise	Under road, down-traversing one residential building, small impact of secondary structure noise	Down-traversing three residential buildings, impact of secondary structure noise	Recommended scheme is superior
	Ground water	The running tunnel basically passes through the lower of the central area and the traffic trunks. The soil layers passed through are mostly silt and fine sand strata, which have poor self-stability. The strata are rich in groundwater. The lower part of some tunnels has entered into the confined water. The lithology distribution is uneven. The engineering geological conditions are general. They belong to soft soil layer with high underground water level.	The running tunnel basically passes through the lower of the central area and the traffic trunks. The soil layers passed through are mostly silt and fine sand strata, which have poor self-stability. The strata are rich in groundwater. The lower part of some tunnels has entered into the confined water. The lithology distribution is uneven. The engineering geological conditions are general. They belong to soft soil layer with high underground water level.	Equivalence
	Landscape	The open cut station has certain impact on the landscape during the construction period, but it has no impact on the landscape during the operation period.	The open cut station has certain impact on the landscape during the construction period, but it has no impact on the landscape during the operation period.	Equivalence
	Vegetation	The temporary land occupation will affect a few green spaces, which can be resorted after the construction	he temporary land occupation will affect a few green spaces, which can be resorted after the construction	Equivalence
Finance	Engineering cost	Although there are two curves, the construction difficulty is small and the investment is relatively small.	The line is straight, but the construction difficulty is large and the investment is large.	Recommended scheme is superior

It can be seen from table 7.2-1 that although the alternative line is straight, it has to pass through the narrow passage between two housing estates, which have large construction difficulty and high construction risk. From the engineering technology point of view, the recommended scheme is relatively better. Both schemes will down-traversing existing roads without conflicting with the planning. But affected by the Beijing-Guangzhou Railway at the west, the recommended scheme will attract more passengers. Furthermore, the plot at the northeast of Nanyang Interchange is under reconstruction, which can reserve spaces for Line No.3. From the long-term planning point of view, the recommended scheme will go further north, down-traversing Lianyungang--Khorgos Expressway and Jialu River. Stations will be built in the planned Binhe Road intersection, Kaiyuan Road intersection and Dahe Road intersection. The Kaiyuan Road Station is a transfer station with subway Line No.2, so the transfer conditions are good. From the social impact point of view, the recommended scheme is relatively better. From the environmental impact point of view, the recommended scheme will not down-traversing existing housing estate, so the impact of vibration on residents is small. From the finance point of view, the recommended scheme is better due to the reducing of construction difficulty. To sum up, this report argues that the recommended scheme is relatively better.

7.2.2.2 Comparison Selection of Line from Jinshui Road Station to Seven Feb. Square Station

This section is located in the Seven Feb. business circle with dense surrounding buildings and busy traffic. It is one of the section with the most control factors, the largest implementation difficulty and the highest engineering risk on Line No.3. This line scheme shall be studied in emphasis, as shown in following figure.

Fig.7.2-9 Schematic diagram of comparison selection schemes of line trend and passenger attraction from Jinshui Road Station to Seven Feb. Square Station

(I) Alternative Scheme (detour scheme at the west of Minggong Road)

Line trend: a station will be built in Dashiqiao for Line No.3, the line will bypass the pile foundation of the interchange, go along the planned road at the west of Minggong

Road, and Xichenzhuang Station will be built after reaching to the backstreet of Xichenzhuang; and then, the line will curve off in R-320m to Jiefang Road, reach to Seven Feb. Square along the north of the planned interchange, and transfer with Line No.1.

(II) Recommended Scheme (scheme along Minggong Road)

Line trend: a station will be built in Dashiqiao for Line No.3, the line will bypass the pile foundation of the interchange, go along Minggong Road, and a station will be built at the intersection between Minggong road and Taikang Road; and then, the line will curve off in R-310m and passing through the plot of Huigangxincheng, bypass the pile foundation of Jiefang Road Interchange, and then bend to Jiefang Road, and reach to Seven Feb. Square, and transfer with Line No.1.

(III) Comparison Selection of Line Schemes

The routes of this line are compared and selected by considering the current status, planning, route conditions, passenger attraction, and other factors, as listed in table 7.2-2.

Table 7.2-2 Comparison selection of line schemes

Review of scheme Factors of comparison		Recommended scheme	Alternative scheme1	Advantages and disadvantages
Engineering Technology	The difficulty of construction	Down-traversing Huigangxincheng (28 storeys under construction), a few buildings, and small construction difficulty.	Down-traversing seven buildings of 6 to 7 storeys at the north of Jiefang Road, and many low buildings of 1 to 2 storeys. The total affected floor area is 146,600 m2, the area of house demolition is 8,955 m2. The implementation of this project has great difficulty.	Recommended scheme is superior
	Operating conditions of the line	Continuously adopting one R-310m and two R-350m curves, the line type is poor.	Continuously adopting one R-310m and two R-350m curves, the line type is poor.	Equivalence
	Geological conditions	There are collapsible soil layer and liquefied soil layer, which will have adverse effect on this project.	There are collapsible soil layer and liquefied soil layer, which will have adverse effect on this project.	Equivalence
	Construction risk	Down-traversing buildings of 28 storeys which are still under construction, so the construction has certain risks, but the mass of the down-traversing buildings is large	Down-traversing many buildings which have poor structure, so the construction has certain risks.	Recommended scheme is superior
Social impact	Conformance with the planning	Goes along existing roads without occupying other plots, good compliance with the road planning	Down-traversing the plot between Minggong Road and Jiefang Road, which will affect the development plan of this plot	Recommended scheme is superior
	Impact of traffic	Stations are constructed by the open cut method, which will have certain influence on traffic	Stations are constructed by the open cut method, which will have certain influence on traffic	Equivalence
	Amount of demolition	Small demolition amount	Down-traversing seven buildings of 6 to 7 storeys at the north of Jiefang Road, and many low buildings of 1 to 2 storeys. The total affected floor area is 146,600 m2, the area of house demolition is 8,955 m2. The demolition amount is large	Recommended scheme is superior
	Land utilization	Basically has no impact on the land use along the line	Basically has no impact on the land use along the line	Equivalence
	Impact of the land acquisition	Stations mainly occupy the land for traffic	Stations mainly occupy the land for traffic	Equivalence
	Attraction to passenger flow	Located in downtown sections, which will attract more passengers	Located in downtown sections, which will attract more passengers	Equivalence
	Transfer convenience	Convenient transfer, and fixed location of Seven Feb. Square Station and Jinshui Road Station	Convenient transfer, and fixed location of Seven Feb. Square Station and Jinshui Road Station	Equivalence
	Impact of cultural relics	Minimum structure clear distance of 21.1 m with the Memory Tower for “Feb. 7th”	Minimum structure clear distance of 12.5 m with the Memory Tower for “Feb. 7th”	Alternative scheme is superior
Environmental impact	Vibration	Down-traversing Huigangxincheng, and buildings in this housing estate are of frame structure, so the vibration of subway will have little influence on them	Down-traversing seven buildings of 6 to 7 storeys at the north of Jiefang Road, and many low buildings of 1 to 2 storeys. Buildings in the old housing estate are of brick-concrete structure, and the vibration resistance ability is poor, so the vibration of subway will have large influence on them	Recommended scheme is relatively better
	Noise	Down-traversing Huigangxincheng, so they will be affected by secondary structural noise	Down-traversing seven buildings of 6 to 7 storeys at the north of Jiefang Road, and many low buildings of 1 to 2 storeys, so the scope of influence by secondary structural noise is large	Recommended scheme is relatively better
	Ground water	The running tunnel basically passes through the lower of the central area and the traffic trunks. The soil layers passed through are mostly silt and fine sand strata, which have poor self-stability. The strata are rich in groundwater. The lower part of some tunnels has entered into the confined water. The lithology distribution is uneven. The engineering geological conditions are general. They belong to soft soil layer with high underground water level.	The running tunnel basically passes through the lower of the central area and the traffic trunks. The soil layers passed through are mostly silt and fine sand strata, which have poor self-stability. The strata are rich in groundwater. The lower part of some tunnels has entered into the confined water. The lithology distribution is uneven. The engineering geological conditions are general. They belong to soft soil layer with high underground water level.	Equivalence
	Landscape	The open cut station has certain impact on the landscape during the construction period, but it has no impact on the landscape during the operation period.	The open cut station has certain impact on the landscape during the construction period, but it has no impact on the landscape during the operation period.	Equivalence
	Vegetation	The temporary land occupation will affect a few green spaces, which can be resorted after the construction	The temporary land occupation will affect a few green spaces, which can be resorted after the construction	Equivalence
Finance	Engineering cost	The line is straight, the demolition amount is small, and the engineering cost is low	The demolition amount is large and the engineering cost is high	

While the positions of Jinshui Road Station and Seven Feb. Square Station are fixed at both ends of this line, the scheme along Minggong Road is the straighter and the demolition amount is small. However this scheme is restricted by the Huigangxincheng under construction and the Memory Tower for “Feb. 7th”. Vibration and secondary structural noise will affect them during the operation period. The detour scheme at the west of Minggong Road is slightly far away from the Memory Tower for “Feb. 7th”, but the vibration during the operation period will still affect them. Furthermore, this line will down-traversing seven buildings of 6 to 7 storeys at the north of Jiefang Road, and many low buildings of 1 to 2 storeys. The demolition amount is large, and the social impact is great. Besides, buildings in the old housing estate are of brick-concrete structure, and the vibration resistance ability is poor, so the vibration and secondary structural noise will have large influence on them. The engineering cost of demolition is large, too. Based on the above analysis, this report suggests the use of the recommended scheme, which is the Minggong Road scheme.

7.2.2.3 Comparison Selection of Line Schemes Down-Traversing the Planned National Highway No.107 Interchange

According to the road planning of Zhengzhou, a large interchange will be built at the intersection between National Highway No.107 and Shangdu Road. This interchange has not been built, and the current intersection is level crossing. By considering the present situation, this line is compared and selected, as shown in the following figure.

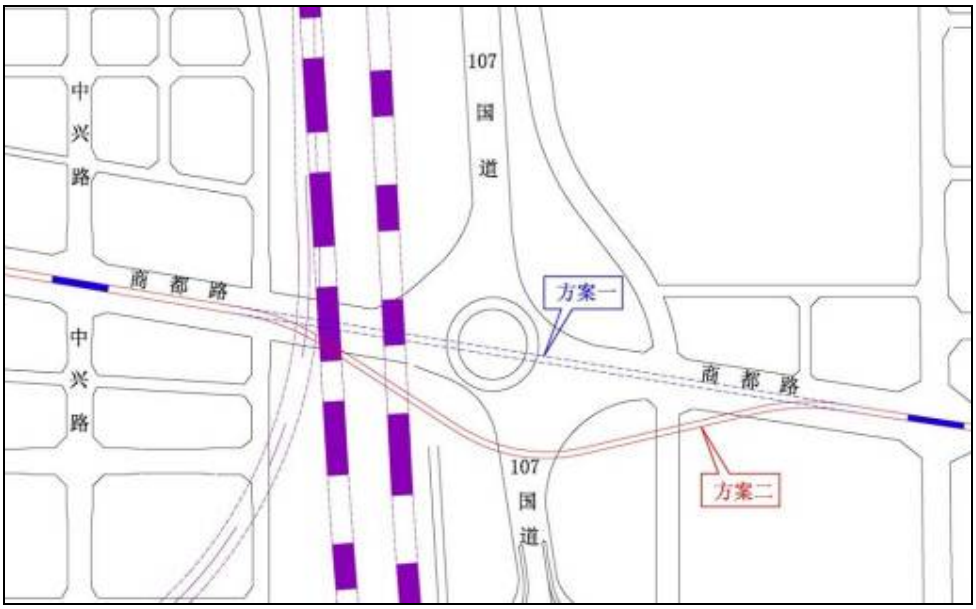


Fig.7.2-11 Schematic diagram of comparison selection schemes down-traversing the planned National Highway No.107 Interchange

(I) Alternative Scheme (Scheme II)

In this scheme, the line detours the intersection between the national highway and Shangdu Road. This line firstly detours to the south of the interchange, and returns to Shangdu Road after passing the interchange.

(II) Recommended Scheme (Scheme I)

In this scheme, the line is directly down-traversing the intersection between the national highway and Shangdu Road.

(III) Comparison Selection of Line Schemes

Table 7.2-3 Comparison selection of line schemes down-traversing the planned National Highway No.107 Interchange

Review of Scheme Factors of Comparison		Recommended Scheme	Alternative Scheme	Advantages and disadvantages
Engineering Technology	The difficulty of construction	Down-traversing the National Highway No.107 Interchange which has not yet been built, so the construction difficulty is small	No need to down-traversing the National Highway No.107 Interchange, the project is large, and the construction degree is relatively large	Recommended scheme is superior
	Operating conditions of the line	The length of the line is short and the line condition is good	The line is curved, and the line condition is poor	Recommended scheme is superior
	Geological conditions	The geological conditions is suitable	The geological conditions is suitable	Equivalence
	Construction risk	The construction risk is small	The construction risk is small	Equivalence
Social impact	Conformance with the planning	Not avoid the planned interchange	Avoid the planned interchange	Alternative scheme is superior
	Impact of traffic	Down-traversing the interchange, which will affect the arrangement of bridge span, but this interchange has not yet been built	Obliquely-traversing high-speed rail, which will have large influence to the high-speed rail	Recommended scheme is superior
	Amount of demolition	No demolition	No demolition	Equivalence
	Land utilization	Not changing the land use function	Not changing the land use function	Equivalence
	Impact of the land acquisition	Occupying some land for traffic	Occupying some land for traffic	Equivalence
	Attraction to passenger flow	Fixed position at both ends, which will attract more passengers	Fixed position at both ends, which will attract more passengers	Equivalence
	Transfer convenience	Convenient	Convenient	Equivalence
	Impact of cultural relics	No cultural relics	No cultural relics	Equivalence
Environmental impact	Vibration	No sensitive points at its surroundings	No sensitive points at its surroundings	Equivalence
	Noise	No sensitive points at its surroundings	No sensitive points at its surroundings	Equivalence
	Ground water	The upper soil layer belongs to class I surrounding rock, the lithology distribution is uniform, the engineering geological	The upper soil layer belongs to class I surrounding rock, the lithology distribution is	Equivalence

		conditions are good, and it is easy to control	uniform, the engineering geological conditions are good, and it is easy to control	
	Landscape	The open cut station has certain impact on the landscape during the construction period, but it has no impact on the landscape during the operation period.	The open cut station has certain impact on the landscape during the construction period, but it has no impact on the landscape during the operation period.	Equivalence
	Vegetation	The temporary land occupation will affect a few green spaces, which can be resorted after the construction	The temporary land occupation will affect a few green spaces, which can be resorted after the construction	Equivalence
Finance	Engineering cost	Low	High	Recommended scheme is superior

It can be seen from the above table that there are no residential areas, cultural relics near this line which will restrict the trend of this line. Therefore, the advantages and disadvantages of the comparative schemes are mainly considered from the aspects of engineering and economy. The recommend scheme is straight, its influence on existing railway is small, and the engineering cost is low. There will be interchange at this intersection, which requires the proper consideration of the positions of piers during the design process to connect with Line No.3. The alternative scheme is curved and obliquely-traversing the high-speed rail, so the engineering cost is high. Therefore, this report suggests the use of the recommended scheme.

7.2.3 Comparison Selection of Positions of Key Stations

7.2.3.1 Comparison Selection of Schemes for Jinshui Road Station

This section is located at the central area of Zhengzhou with dense buildings at its surroundings and prosper businesses. Both Jinshui Road and Nanyang Road are urban trunk roads. The road red lines are 60 m and 50 m, separately. Jinshui Road is one of the few urban expressways in Zhengzhou. It is the main channel linking the east and west, and the traffic flow is huge.

The intersection between Nanyang Road and Jinshui Road is a large interchange, which has three elevated layers. The ground layer is mainly composed by sidewalk, non-motor vehicle land, motor vehicle land and bus lane; the second elevated layer is the direct connection of the east and west of Jinshui Road, and the third elevated layer is the direct connection of Nanyang Road and Minggong Road. Ramps are provided at all four quadrants at the surrounding of the interchange for vehicles to turn around.

The maximum radius of the ramp bridge is 100 m, and the minimum radius is 26 m. All ramp bridges are made of reinforced concrete box girder, and the maximum span is 25 m. Both the main bridge and the ramp bridge are of bored pile foundation. Each pier of the ramp bridge is a pile foundation with the diameter of 1.5 m. Both ends of the 50m span of the main bridge have two pile foundations with the diameter of 1.5 m.

Other piers of the main bridge are of two pile foundations with the diameter of 1.2 m. Pile foundations are densely covered under the interchange, which will restrict the selection of line schemes.

In addition, some low buildings of 1 to 5 storeys are located at the northeast corner near the Dashi Bridge Interchange. Jinshui Restaurant and low street shops are at the northwest corner. Street shops of less than 5 storeys are located at the southwest corner, which have the urgent need for development and reconstruction. Zhengzhou Acrobatic Hall and park are located at the southeast corner.

To provide better service for passengers and to reduce the impact on surrounding environment, 2 schemes are studied for this section.

The following figure is the schematic diagram for the comparison selection of the position of Jingshui Road Station.

Fig.7.2-12 Schematic diagram of comparison selection of Jinshui Road Stations

Alternative Scheme (scheme I)

In the alternative scheme, the station is located at the north of Dashiqiao Interchange. It is at about 300 m from Jinshui Road. After that, the left and right lines will down-traversing the interchange and Jinshui River from the east and west of Dashiqiao, and then they will bend to Minggong Road.

(II) Recommended Scheme (scheme II)

The station is moved to the south about 270 m compared with the alternative scheme.

It is separated island platform station. This station is located at the interspace between the east and west of Dashiqiao Interchange, and is about 30 m from Jinshui Road. After that, the left and right lines will down-traversing the interchange and Jinshui River from the east and west of Dashiqiao, and then they will bend to Minggong Road.

(III) Comparison Selection of Schemes

Table 7.2-4 Comparison and selection of station schemes

Review of Scheme Factors of Comparison		Recommended Scheme	Alternative Scheme	Advantages and disadvantages
Engineering Technology	The difficulty of construction	Cover-excavation method construction, lots of pipelines, relatively far from Dashiqiao Interchange, and relative small construction difficulty	Cover-excavation method construction, lots of pipelines, many pile foundations under Dashiqiao, and large construction difficulty	Alternative scheme is superior
	Operating conditions of the line	Straight line, space between stations varies from 854 m to 1184 m	Straight line, space between stations varies from 1120 m to 935m	Equivalence
	Geological conditions	Suitable geological conditions	Suitable geological conditions	Equivalence
	Construction risk	A few controlling buildings at the surrounding of the station, and small risk	The net space between the station and the 12 storeys Jiutianshishang Hotel at the east of Dashiqiao is only about 6 m, so there is certain construction risk	Alternative scheme is superior
Social impact	Conformance with the planning	Laid along existing roads, and good compliance with the planning	Laid along existing roads, and good compliance with the planning	Equivalence
	Impact of traffic	The station is located at the middle of the road at the north of the interchange, which will have certain influence on vehicles from the south-west direction for accessing the interchange	The station is located at the vacant land at one side of the road, which has little interference to the passing of motor vehicles	Recommended scheme is superior
	Amount of demolition	The demolition of entrance, exit, and other structures of the station, the area is about 14500 m2. The demolition amount is small, the demolition cost is low,	The demolition area is about 16,700 m2	Alternative scheme is superior

		and the coordination difficulty is small		
	Land utilization	The use of surrounding land will be changed due to the demolition for the station construction	The use of surrounding land will be changed due to the demolition for the station construction	Equivalence
	Impact of the land acquisition	Some residential lands will be occupied	The land for traffic at the interspace in east-west direction of Dashiqiao will be occupied	Recommended scheme is superior
	Attraction to passenger flow	The station is located at about 300 m from the north of Jinshui Road, and the passenger service is poor	The station is close to Jinshui Road, the service for many passengers along Jinshui Road is good, and convenience for passengers.	Recommended scheme is superior
	Transfer convenience	Convenient transfer with surrounding public transport systems	Convenient transfer with surrounding public transport systems	Equivalence
	Impact of cultural relics	No cultural relics	No cultural relics	Equivalence
Environmental impact	Vibration	Close to surrounding low-rise residential buildings, and large impact of vibration	Near commercial and high-rise buildings, and small impact of vibration	Recommended scheme is superior
	Noise	The wind pavilion and cooling tower of the station are close to the residential buildings, the impact of noise is large	The station is mostly surrounded by commercial and service land, so the impact of noise to surrounding residents is small	Recommended scheme is superior
	Ground water	The station is constructed by the cover-excavation method, which has a large impact on groundwater	The station is constructed by the cover-excavation method, which has a large impact on groundwater	Equivalence
	Landscape	Influence on landscape during the construction period	Influence on landscape during the construction period	Equivalence
	Vegetation	Occupying the middle part of the road, and no influence on vegetation	Occupying one side of the road, and no influence on vegetation	Equivalence
Finance	Engineering cost	Slightly low	About 20 million Yuan more than scheme I	Alternative scheme is superior

According to the above analysis, Jinshui Road is the trunk road for east-west traffic of Zhengzhou. The passenger flow is large and it is very important. Therefore, the impact on the traffic of Jinshui Road during the construction and operation periods shall be considered in priority when selecting the position of station on Jinshui road. The recommended scheme has certain advantages both in passenger service and traffic influence. Its function is better. Although there are certain risks during the construction process and the engineering investment is slightly higher, certain engineering measures can be taken to guarantee the construction safety. Scheme II is recommended for this section with the principle of people oriented and function priority.

7.3 Comparison Selection of Construction Schemes

The construction method has a decisive influence on the determination of structural type and the cost of civil works. The selection of construction methods is restricted by engineering geological and hydrogeological conditions, environmental conditions (current status of above ground buildings and underground structures, widths of roads, traffic status, etc.), plane position of the line, buried depth of the tunnel, excavation width, and many other factors. Meanwhile, the selection of construction methods will directly affect the ground transportation, the normal life of urban residents, the construction period, the degree of difficulty of the project, the implementation of urban planning, the development and utilization of underground space, and the operation effect. Therefore, the determination of construction method shall be adjusted according to local conditions, and overall consideration is required. The section type and construction method with reliable technology, advanced level and reasonable economic shall be selected.

7.3.1 Comparison and Selection of Section Construction Schemes

The section type of the underground section is interrelated with the line, construction scheme and construction method. The section type is always different for different schemes. Common construction methods include mining method and shield method. The differences of them are listed in table 7.3-1.

Table 7.3-1 Comparison selection of section construction methods

Review of Scheme Factors of Comparison		Mining method	Shield method	Advantages and disadvantages
Engineering Technology	Construction difficulty	Passing through general strata, the construction technology is usually many and complicated, the construction difficulty is large, and the difficulty in passing through geological fault is larger	Relatively easy in passing through the geological fault, the construction method is mature, and the construction difficulty and risk are small	Shield method is better

	Construction risk	Passing through general strata, the construction technology is usually many and complicated, the construction difficulty is large	Relatively easy in passing through the geological fault, the construction method is mature, and the construction risk are small	Shield method is better
	Construction period	The quantity of working shafts and working surfaces are determined according to the time schedule. The construction period is flexible and easy to control	The quantity of shield machines are determined according to the time schedule. The construction period is restricted by the station conditions, but the automatic degree of the shield method is high, and the construction speed is fast	Shield method is better
	Engineering quality	Relatively good	Good	Shield method is better
	Ground settlement	Difficulty in controlling the ground settlement, and large land subsidence will be easily caused if the supporting is not in time	Relatively easy to control the ground settlement during the construction period, and it is safe and reliable	Shield method is better
	Geological conditions	Great construction difficulty and high risk for construction in sections with complicated geological conditions	The safety of construction can be guaranteed for strata with complicated geology, large water content and weak surrounding rock	Shield method is better
Social impact	Impact on ground traffic	Great influence on the safety of surrounding buildings	Good control of surrounding buildings and ground deformation during the construction by shield method, and the construction environment is good	Shield method is better
	Land occupation	Utilizing existing vacant land, land requisition and demolishing. The occupied land area is large due to the scattered construction sites	Utilizing existing vacant land, land requisition and demolishing. The occupied land area is due to the concentrated construction sites	Shield method is better
Environmental impact	Groundwater	Construction is likely to cause the loss of groundwater	Basically no impact on groundwater	Shield method is better
	Vibration	The impact of	The working surface	Mining

		vibration and noise is large if blasting operation is required during the construction process	has noise and vibration in a long term	method is better
Finance	Engineering cost	The expense is 89,000 Yuan for dual line in each linear meter and about 75,000 Yuan for medium weathered and slightly weathered rock.	The expense is between 95,000 Yuan to 100,000 Yuan for dual line in each linear meter	Mining method is better

It can be seen from Table 7.3-1 that from the engineering technology point of view, it is relatively easy to penetrate through the fault by the shield method, which has the advantages of mature method, high automatic degree and fast construction speed. Compared with the mining method, the construction difficulty is small, the construction period is flexible and easy to control. It is relatively easy to control the ground settlement if using the shield method and the construction risk is small. Concerning with the impact on social environment and natural environment, if compared with the mining method, the shield method has good control to surrounding buildings and ground deformation, the construction speed is fast, the construction environment is good, and it has no impact on groundwater and other environment. Besides, the geological features of Zhengzhou are suitable for the shield method. Therefore, the shield method is mainly adopted for constructing this section.

7.3.2 Comparison Selection of Station Construction Schemes

The construction methods of stations have decisive influence on the determination of the structural form and the engineering cost of civil works of rail transit. The selection of construction methods is restricted by engineering geological and hydrogeological conditions, environmental conditions (current status of above ground buildings and underground structures, widths of roads, traffic status, etc.), functional requirements of rail transit, plane position of the line, buried depth of the station, excavation depth, and many other factors. Meanwhile, the selection of construction methods will directly affect the ground transportation, the normal life of urban residents, the construction period, the degree of difficulty of the project, the implementation of urban planning, the development and utilization of underground space, and the operation effect. The construction methods of underground stations mainly include open cut method, undermining method and cover-excavation method. The advantages and disadvantages of these three methods are listed in table 7.3-2.

Table 7.3-2 Comparison selection of construction methods for underground stations

Review of Scheme Factors of Comparison		Open cut method	Cover-excavation method	Undermining method	Advantages and disadvantages
Engineering Technology	Construction difficulty	Small construction difficulty	Large construction difficulty	Large construction difficulty	Open cut method is better
	Construction risk	No	No	Large construction risk	The undermining method is bad
	Construction period	Short construction period	Relative long construction period	Long construction period	Open cut method is better
	Engineering quality	Good construction quality	Good	Relatively good	The undermining method is bad
	Ground settlement	Relatively small	Relatively small	Large	The undermining method is bad
	Geological conditions	Suitable for various geological conditions	Suitable for various geological conditions	Unsuitable for Quaternary soft soil layer	The undermining method is bad
	Impact on underground pipelines	Large, modification and correction of pipelines in the scope of the foundation pit	Modification and correction of some pipelines	No modification and correction is required	The undermining method is good
Social impact	Impact on ground traffic	Large (relatively small if constructing in the planned land use scope)	Relatively small impact on ground traffic	No impact on ground traffic	The undermining method is good
Environmental impact	Noise	Large influence scope of construction noise	Short influence time of noise	Not affected by construction noise	The undermining method is good
	Air	Easy to generate construction dust	Short influence time of construction dust	Not affected by construction dust	The undermining method is good
	Groundwater	Continuous wall or sealing curtain can be used to reduce the impact on groundwater	Continuous wall or sealing curtain can be used to reduce the impact on groundwater	Large impact on groundwater level	The undermining method is bad
	Ecology	Occupying urban green space and affecting the ecological environment	Restorable after being occupied and short influence time	No impact	The undermining method is good
Finance	Engineering cost	Lowest cost	Relatively low	Highest investment	Open cut method is better

It can be seen from the above analysis that the open cut order method with the advantages of simple, fast, economic and safe shall be considered in priority if there are enough construction sites on the ground, the road can be occupied for a long time by dispersing the traffic, and if the underground pipes can be relocated. Compared with the undermining method, both the open cut method and the cover-excavation method have obvious advantages in construction safety, difficulty, construction period, waterproof quality of the structure, and engineering cost of civil works. According to the environmental conditions, the traffic dispersing conditions, the underground pipeline modification and correction requirement, the geological conditions, the buried depth of the station, and other factors, and by drawing on the successful experience of domestic subway construction, it is suggested that the underground stations of this line shall be constructed by firstly selecting the open cut method. The segmented inverted edge construction method or open cut + local cover-excavation method can be adopted for traffic trunks which need dispersing the traffic or crossing intersections. The geology along Line No.3 is mainly alluvial plain, the groundwater level is high and the geology is poor. The construction difficulty is really large for the station of more than 20 m in width. Therefore, the undermining method is generally not considered for the main structure of the station. Therefore, the open cut method or cover-excavation method will be used for stations on rail transit Line No.3 according to the recommendation of surrounding environment. Jinshui Road is the trunk road for the east-west traffic in Zhengzhou. The adoption of cover-excavation method will have small impact on ground traffic. All other stations are constructed by the open cut method.

7.4 Conclusions

This report highlights the comparison and selection of alternative scheme in line trend, station location as well as the comparison and selection of alternative scheme in underground interval and underground station construction scheme.

(1) In the comparison and selection process, comprehensive comparison of line operation condition, construction hardness, civil work investment, passenger flow attraction and environmental impact have been taken into account. For the comparison selection of the line trend at the north of the North Ring, both schemes will down-traversing the existing road and have no conflict with the planning. But due to the influence of the Beijing-Guangzhou Railway at the west, the recommended scheme can attract more passengers. Furthermore, the plot at the northeast of Nanyang Interchange is under reconstruction, which can reserve spaces for Line No.3. From the long-term planning point of view, the recommended scheme will go further north, down-traversing Lianyungang--Khorgos Expressway and Jialu River. Stations will be built in the planned Binhe Road intersection, Kaiyuan Road intersection and Dahe Road intersection. The Kaiyuan Road Station is a transfer station with subway Line No.2, so the transfer conditions are good. From the social impact point of view, the recommended scheme is relatively better. From the environmental impact point of view, the recommended scheme will not down-traversing existing housing estate, so the impact of vibration on residents is small. From the finance point of view, the recommended scheme is better due to the reducing of construction difficulty. To sum up, this report argues that the recommended scheme is relatively better.

For the comparison selection of line scheme from Jinshui Road Station to Seven Feb. Square Station, while the positions of Jinshui Road Station and Seven Feb. Square Station are fixed at both ends of this line, the scheme along Minggong Road is the straighter and the demolition amount is small. However this scheme is restricted by the Huigangxincheng under construction and the Memory Tower for “Feb. 7th”. Vibration and secondary structural noise will affect them during the operation period. The detour scheme at the west of Minggong Road is slightly far away from the Memory Tower for “Feb. 7th”, but the vibration during the operation period will still affect them. Furthermore, this line will down-traversing seven buildings of 6 to 7 storeys at the north of Jiefang Road, and many low buildings of 1 to 2 storeys. The demolition amount is large, and the social impact is great. Besides, buildings in the old housing estate are of brick-concrete structure, and the vibration resistance ability is poor, so the vibration and secondary structural noise will have large influence on them. The engineering cost of demolition is large, too. Based on the above analysis, this report suggests the use of the recommended scheme, which is the Minggong Road scheme.

For the comparison selection of line schemes down-traversing the planed National Highway No.107 Interchange, the recommend scheme is straight, its influence on existing railway is small, and the engineering cost is low. There will be interchange at this intersection, which requires the proper consideration of the positions of piers during the design process to connect with Line No.3. The alternative scheme is curved and obliquely-traversing the high-speed rail, so the engineering cost is high. Therefore, this report suggests the use of the recommended scheme.

(2) In the comparison and selection of key stations, Jinshui Road is the trunk road for east-west traffic of Zhengzhou. The passenger flow is large and it is very important. Therefore, the impact on the traffic of Jinshui Road during the construction and operation periods shall be considered in priority when selecting the position of station on Jinshui road. The recommended scheme has certain advantages both in passenger service and traffic influence. Its function is better. Although there are certain risks during the construction process and the engineering investment is slightly higher, certain engineering measures can be taken to guarantee the construction safety. Scheme II is recommended for this section with the principle of people oriented and function priority.

(3) The interval construction scheme conducts the comparison and selection to the shield method and the mining method. It can be seen from the engineering technology that the shield method is relatively easy in passing through the geological fault, mature in construction method, high in automaticity and quick in construction, therefore it is smaller in construction hardness than the mining method, and is flexible in construction period, easy to control; The shield method is relatively easy in passing through the geological fault, mature in construction. Relatively in controlling the land subsidence and small in construction risk; From the aspect of impact to social environment and natural environment, the shield method construction is relatively good in controlling buildings around and the ground deformation, quick in construction, good in construction environment without any impact to environments such as underground water; In addition, the construction of this interval gives priority to the shield method taking the geologic characteristics of Zhengzhou into account.

(4) The station construction scheme conducts the comparison and selection to open deep excavation, covered excavation and subsurface excavation. The open deep excavation has larger environmental impact of ground traffic, land use, noise and dust than the covered excavation and subsurface excavation, however when the ground has adequate construction yard, the road can be occupied for long time by dispersing the traffic and the underground pipelines possess the modification and correction condition, construction method of the underground station should firstly consider the open excavation order method for its simplicity, quick speed, economy and safety. The open deep excavation has obvious advantages comparing to the subsurface excavation in construction safety, construction difficulty, and construction period, quality of structure waterproof and cost of civil work.

According to the environmental conditions, the traffic dispersing conditions, the underground pipeline modification and correction requirement, the geological conditions, the buried depth of the station, and other factors, and by drawing on the successful experience of domestic subway construction, it is suggested that the underground stations of this line shall be constructed by firstly selecting the open cut method. The segmented inverted edge construction method or open cut + local cover-excavation method can be adopted for traffic trunks which need dispersing the traffic or crossing intersections. The geology along Line No.3 is mainly alluvial plain, the groundwater level is high and the geology is poor. The construction difficulty is really large for the station of more than 20 m in width. Therefore, the undermining method is generally not considered for the main structure of the station. Therefore, the open cut method or cover-excavation method will be used for stations on rail transit Line No.3 according to the recommendation of surrounding environment. Jinshui Road is the trunk road for the east-west traffic in Zhengzhou. The adoption of cover-excavation method will have small impact on ground traffic. All other stations are constructed by the open cut method.

8. Environmental Risk Analysis and Mitigation Measures

Environmental risk analysis is intended to put forth preventive, emergency and mitigation measures against the impact on and damage to personal safety and environment caused by predictable emergencies (usually excluding manmade destruction and natural disaster) that occur during project construction and operation.

Urban rail transit project involves huge investment, complex techniques, extensive aspects involved and influenced by engineering construction, and high operational requirements, thus it is necessary to identify and assess risk throughout project construction, and put forth corresponding measures against major risk. The results of risk assessment vary in different project phases and from the perspective of different stakeholders. The risk analysis in the first phase of project is mainly to identify and assess risk from the perspective of project decision making to identify and assess major risk, analyze the overall risk level, put forth countermeasures against major risk to provide basis for decision making and approval of the project, and serve as the foundation for risk management in subsequent engineering design, construction and operation.

8.1 Risk Analysis and Mitigation Measures during Construction Period

8.1.1 Identification of Risk Source

Major risk source during construction period: Subway construction is characteristic of complex surrounding environment, various constructions, numerous underground pipelines, and high requirements for control of construction deformation; complex engineering geology and hydrological geology, and many uncertain factors; many structural forms, and crossed and varied construction methods, and high difficulty in construction and heavy pressure from construction period etc. Such characteristics are intensively embodied in high risk of subway construction, mainly during digging of base pit or interval tunnel of subway. Improper selection of construction methods and auxiliary methods such as open digging, hidden digging and shield tunnelling etc. tends to cause uneven settlement, ground collapse or bulging; Accidents such as collapse, roof fall, sand gushing water gushing, and water transmission etc. tend to happen during construction due to influences by multiple factors such as geological and hydrological factors etc.; Improper selection of construction methods and retaining program will cause breakage of adjacent underground pipelines or cracking, leaning or even collapse of surrounding constructions. For example, fire accident and explosion will be caused by breakage of gas pipelines; and damage of electrical wires and telecommunication cables will lead to power failure and suspension of telecommunication, or even electrical shock. Breakage of water supply and drainage

pipelines and sewage pipelines will cause suspension of water supply or accumulation of water in low-lying areas etc..

Major risk sources during operational period: According to survey of risk events during domestic and foreign subway operational period, the major risks and accidents during operational period come from social hazards such as arson or terrorist attack etc., and the accidents due to improper operation by staff and mechanical failure etc.. The aforesaid accidents have not only caused huge economic losses and tend to cause personal casualty and significant social influences.

8.1.2 Risk Analysis during Construction Period

8.1.2.1 Outline

Construction of urban rail transit in China has undergone rapid development in recent years, and various areas in the country are speeding up planning and implementation of subway construction. However, the increasingly denser subway routes have brought along with themselves continuous construction accidents. A lot of accidents in urban subway construction show that subway construction will not only influence and destruct the safety of the environment(ground buildings, traffic, underground constructions and underground pipelines etc.) in the area influenced by construct6ion, but also endanger production, construction and safety of people's life and property in serious cases, leading to serious economic losses. However, it is notable that inevitably certain secondary environmental disasters will be brought about to the surrounding environment upon occurrence of such accidents, or during remedy thereof. Thus it is necessary to carry out objective and fair assessment of the possible accidents and incidental environmental risk during project construction during environmental impact assessment for urban rail transit construction according to characteristics of project and the level of sensitivity of the ecological environment along the routes so as to take preventive measures for the areas greatly influenced thereby in time, which is of great significances for environmental safety in the areas influenced by construction.

8.1.2.2 Analogical Investigation of Environmental Risk Caused by Subway Construction Accident

As shown in the investigation data, accidents such as bursting of water supply pipelines and ground collapse frequently occur in many large and medium-sized cities in China along with the accelerating urban construction in recent years. Collapse accidents caused by subway construction frequently happen in such accidents, for ground collapse accidents caused by construction of underground rail transit(hereinafter referred to as subway) are especially striking. Construction of rail transit has stepped into rapid development in various large cities in China in recent years to solve traffic jam on the ground. The accidents that occur during such subway construction and the environmental problems caused thereby have aroused extensive attention from various social circles. See Table 8.1-1 for the important accidents in domestic subway construction in recent years:

Table 8.1-1 List of Important International Subway Accidents

Time	Site	Type and Cause of Accident	Loss
November 15, 2008	Fengqing Avenue along No. 1 Subway of Hangzhou	Ground collapse due to defects in construction methods, and problems in site selection of construction; There are requirement to hurry through project construction to meet “construction period”.	8 deaths; 13 persons disappeared, and 11 injured;
January 17, 2008	No. 5 Subway of Guangzhou	Water gushing during construction, ground collapse, and there are underground karst caverns;	/
March 28, 2007	Suzhou Street Station of No. 10 Subway of Beijing	Landslide due to complex geological conditions, and improper construction protective measures	6 deaths
August 2, 2009	Shajinqiao Station of No. 1 Subway of Xi’an	Landslide, poor geology, improper digging and support of base pit, insufficient site safety and protective measures	2 deaths
Desember 31, 2012	Jinqiao parking lots of No. 12 Subway of Shanghai	Casting concrete platform collapse due to improper digging and support of base pit, insufficient site safety and protective measures	5 deaths; 17 injured;
May 6, 2013	Hujiamiao to Tonghuamen section of No. 3 Subway of Xi’an	Landslide due to improper construction protective measures	6 deaths

Site of Accident in Subway Construction in Hangzhou

Site of Accident of No. 5 Subway in Guangzhou

Sit of Construction Accident of No. 10 Subway in Beijing

Site of Landslide Accident in No. 1 Subway in Xi’an

Site of Landslide Accident in No. 3 Subway in Xi’an

8.1.2.3 Environmental Impact due to Subway Construction Accident

Subway construction belongs to deep base-pit construction that involves complex engineering structure and huge engineering workload, thus sudden accidents may happen therein, and great impact will be caused on hydrological geology, surrounding construction and underground pipelines. Thus it is necessary to pay great attention to environmental protection project and implement effective measures during construction.

(1) Impact on Water Environment

According to statistical data, most of breakage of underground pipelines and ground collapse during subway construction occur in case of leakage of underground pipelines and mine tunneling method. As shown in the results of site investigation of the accident, the basic reason for ground collapse is stratum deformation caused by water and underground construction activities. Water sources can be divided into the original underground water in the stratum, and abrupt inrush of water due to breakage of pipelines. The accidents such as breakage of underground pipelines and ground collapse etc. will cause water and soil erosion in surrounding areas. In case water stoppage cannot be well solved during subway construction in stratum saturated with water, shifting sand or slurry will occur during construction, which will gush into base pit or tunnel suddenly and cause collapse, and the ground will be influenced in serious cases.

(2) Impact on Atmospheric Environment

As a lot of construction materials and various chemicals needed for construction are stored on the site of subway construction, certain impact will be caused on the surrounding atmospheric environment once fire accident happens on the site of subway construction. In addition, a huge quantity of firefighting water and the ashes of the substances produced during combustion or incomplete combustion will cause secondary pollution on the local surrounding underground water and ground water as well during fighting against the accident.

(3) Impact on flooding

The access line of Jialu River depot runs underneath Jialu River, and the main line transverses Jinshui River(at K8+550), Xiong'er River(at K12+900) and Qili River(at K17+300). The widths of aforesaid rivers run across by the line are 5m, 30m, 20m and 60 respectively, with the depths of river channel being 4m, 3m, 5m and 5m respectively. The anti-flood facilities of the aforesaid riverbeds have been carried out and designed according to the standard of withholding the greatest flood in 50 years, and the dyke will not be flooded by the greatest flood in 100 years. No influences will be caused on the stations of No. 3 line during the flood season.

8.1.2.4 Geological Risk Analysis

The stratum within the depth of 30m under the line(K0+0.000~K25+200) is mainly Holocene Series stratum of Q4 with a depth of 0-19.0m. The major stratums are as follows: the surface is artificial fill and complex earth etc., then dense-medium dense powdery earth, and soft plastic -plastic powdery clay mixed with powdery sand and fine sand. The major stratums between 19.0 to 30.0m are medium-dense to dense tight powdery sand, fine sand and medium sand stratums. The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. Except for the sand stratum and its interlayer with high bearing capacity and low compressibility, the other rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability. The area belongs to area with medium risk level of geological disaster. The major categories of geological disaster are ground collapse, ground fissure, ground precipitation and uneven ground settlement.

Thus shield tunneling method is adopted for construction of the line(K0+0.000~K25+200) , and open digging and covered excavation method are adopted for underground stations(Xinliu Road Station, Shamen Road Station, Xinglongpu Road Station, Dongfeng Road Station, Nongye Road Station, Huanghe Road Station, Jinshui Road Station, Taikang Road Station, Er'qi Square Station, Shuncheng Street Station, Dongdajie Station, Chengdong Road Station, Future Avenue Station, South Fengtai Road Station, Zhongzhou Avenue Station, Tongtai Road Station, East Huanghe Road Station, East Nongye Road Station, Zhongxing Road Station, Boxue Road Station, East Hanghai Road Station). Meanwhile, relevant engineering measures and prevention methods have been taken for disposal so as to avoid geological disasters(mainly instability of tunnel wall rock, instability of base-pit slope, watergushing in base pit and tunnel water surging etc.) caused by engineering construction.

8.1.2.5 Risk Analysis for Construction Methods

The major construction method adopted in subway construction in Zhengzhou is hidden digging (shield tunneling method), and those for subway station are open digging and cover excavation. Improper handling of any construction method adopted will cause serious environmental and safety accident. For example, there is a base pit constructed with open digging in the south section of No. 3 subway line of Guangzhou, which adopts the drilling pile as the retaining structure. Due to poor water stoppage between the piles, the slurry outside the retaining piles gushes into the base pit from among the piles suddenly, and cause ground collapse outside the base pit. Another case in point is as follows: Shield tunneling is adopted for construction of No. 4 Zhongshan Road on No. 1 subway line of Guangzhou. Due to water leakage in the cast-iron water supply pipes, part of the soil under the hard road surface was eroded, leading to hollow holes therein. Small stratum deformation causes breakage of water supply pipelines and erosion of a huge amount of water and soil, and ground collapse through passage of shield tunneling. Moreover, mine tunneling method is adopted for construction of the interval tunnel near Jingguan Bridge of No. 10 subway line of Beijing. Due to poor anti-deformation capacity of the joints of sewage pipelines, the sewage pipelines break and sewage and soil gush into the tunnel, and over 300 square meters of ground collapses due to interference by underground construction.

8.1.2.6 Risk Analysis for Running Across ther Municipal Projects

No.3 subway line runs across the bridge piles such as Beihuan and Nanyang Road approach bridge, Nanyang and Jinshui Road approach bridge, Zhongzhou Road and Shangdu Road approach bridge, the elevated bridge of Longhai railway line and Shiwu highspeed railway line etc.. Impact will be caused on the bearing capacity and deformation of piles, and foundation settlement due to stratum interference, and overturning of the above structure may happen in serious cases. Overall settlement and differential settlement of the rails, and unsmooth level of rails from front to back will be necessarily caused when shield tunneling runs across railway routes of Nachang Railway Station. Such problems will cause significant uncertain factors to safe railway operation.

8.1.3 Risk Classification evaluation

The onstruction risks are classified into 4 classes according to the possibilities and loss classes of urban rail transit underground engineering construction risks. The risk classification refers to table 8.1-2.

Table 8.1-2 Construction risk classes and handling

Class	Acceptance criteria	Handling measures	Control program	Response department
Class 1	Unacceptable	It must be highly focused, and take measures to prevent; otherwise the risk must be reduced to acceptable level.	Prepare control and alarm measures, or correct or adjust the program;	Headquarter high-level leader, and middle-level departments such as headquarter Safety Office, Engineering Division, Chief Engineer Office
Class 2	Unwilling to accept	It must strengthen the monitoring and take risk handling measures to reduce the risk level, and the cost of risk reduction shall not be higher than the loss after risk occurs.	Prepare preventive and monitoring measures	
Class III	Acceptable	No risk handling measure required, but require monitoring	Strengthen routine management and review	All parties on site (site owner representative, construction unit, supervision unit, design unit, monitoring unit)
Class IV	Neglectable	No risk handling measure required, but require routine monitoring	Routine management and review	Construction unit

The classification of open cut foundation pit risks are determined by four main factors of foundation pit depth, underground water conditions, surrounding interference degree of foundation pit and ambient sensitivity of foundation pit deformation. The open cut foundation pit risk classification considering depth impact will be regarded as basic classification of foundation pit risks, while the detailed risk classification, on basis of basic classification of foundation pit risks, will modify after considered necessary factors such as underground water impact, surrounding interference degree of foundation pit and ambient sensitivity of foundation pit deformation. After comprehensively considered various factors, determine in detail to classify the open cut foundation pit risk into several classes.

For risk classification of shielded tunnel, it is determined according to country rock category and poor geologic conditions of shielded tunnel, spatial state of shielded tunnel (gradient, earthing thickness, turning radius and spatial distance from neighboring tunnel), stratum interference extent and environment sensitivity for stratum deformation. The risk classification for tunnel country rock category, poor geologic conditions and impact on underground water is considered as fundamental classification of shielded tunnel; the detailed risk classification will be corrected after considered spatial state of shielded tunnel, stratum interference extent and environment sensitivity for stratum deformation on basis of fundamental classification.

The shielded tunnel risk will be classified into several classes in detail after integrally considered various factors.

8.1.4 Risk Preventive Measure during Construction Period

According to the general analysis of the accidents and cases during subway construction listed above, the following work shall be done well to avoid safety risk during construction, and reduce the environmental risk caused by construction accident:

8.1.4.1 Pre-Construction Investigation and Design of Risk Source

Firstly, subway lines shall avoid important risk source if possible, which calls for making definite the important risk sources for the route, the specific position and current situation, and the risk level. According to the practical conditions of No. 3 route, the following major problems shall be investigated and designed as required by project construction:

(1) Engineering rock and soil survey of wet-collapse stratum and liquefied stratum before line construction to find out scope of distribution, burial depth and thickness etc.;

(2) No. 3 line project runs across three overhead bridges at North Ring Road-Nanyang Road, Nanyang Road-Jinshui Road, and Zhongzhou Avenue-Shangdu Road, and bridges piles of Longhai Railway, and Shiwu High-Speed railway line etc.. The line runs under a great many houses, and multiple pipelines such as water supply, rainwater, sewage, fuel gas, thermal energy, electrical power and telecommunication etc. are distributed within the construction scope, and large-sized pipe galleries and pipe culverts are buried in some sections. It is necessary to carry out detailed and comprehensive survey of the bridge piles and foundations, house structure and foundation the line runs beneath, and the pipelines within the influence by the construction, and detailed construction organization and design according to the construction methods, construction order, and relative relations with the bridge foundation, house foundation and pipelines, and the types and characteristics of foundation and pipelines in the initial period of project construction to reduce the mutual adverse influences.

8.1.4.2 Engineering Measures for Risk Control

(I) Engineering Measures for Risk Control during Station Construction:

(1) Preventive Measures against Geological Risks

Appropriate enclosure program shall be determined according to the requirements for base pit and digging depth, and the engineering geological and hydraulic conditions on the site during open digging of base pits at each station on the line. Base-pit engineering bracing measures such as soil nail wall, slope protection pile and underground continuous wall etc., and engineering measures such as engineering water lowering, water stopping and recharging etc. are adopted during construction of base pit at the station. In case subsurface excavation method is adopted during

construction, it is hard to for a balance arch of natural stresses due to the thin earth covering the structural roof of the station, and poor self-stability capacity of the wall rock, therefore it is subject to collapse during digging.

Due to the dense distribution of surrounding buildings along the subway line, it is improper to adopt water lowering measure with well outside the base pits. The underground water level along No. 3 subway line ranges between 2.5m to 14.0m, and the depth of base pit is between 17 to 23m. Thus the base pit lies below the underground water level. In case water stopping measure is adopted, it is proposed to adopt bracing manner with drilling pouring pile plus waterproof curtain for the two-floor station, and underground continuous wall for three-floor station. In case well points are needed to lower the water, water lowering during base pit construction can only be carried out inside the pit, and it is strictly forbidden to lower the water outside the base pit, and it is necessary to establish a certain number of backfilling wells inside the water-lowering tunnel formed due to water lowering outside the base pit, and strengthen the monitoring over precipitation, deformation and movement of the surface and surrounding construction. The specific methods are as follows:

In case of no confined water within the project scope, the disposal measures shall be mainly water lowering, i.e. bury tube wells deep at the bottom of the base around the base pit. The underground water is pumped out through the submerged pump inside the tube well to reduce the underground water level 0.5 to 1.5m lower than the bottom of the base pit. Effective measures shall be taken during precipitation to lower the adverse influences on surrounding environment, and avoid large-area precipitation of the surrounding ground on the site and danger for the safety of the surrounding buildings.

In case there is confined water within the project scope, and “transitional layer” with a certain thickness between the digging depth of the base pit to the top of the confined aquifer, the upper submerged water may be isolated with the suspended vertical waterproof curtain. Then reduce pressure to lower the water level for the confined water in most cases to avoid hidden water-related dangers such as flowing sands and earth debris on the pit wall, and heave-piping at the bottom of the pit.

When the digging depth of base pit has approached or entered into the confined aquifer, water-lowering measures shall be taken to lower the confined water level to 2m below the digging depth of base pit, and the underground continuous wall or secant pile shall be taken as bracing structure. Bottom sealing of the base pit shall be taken if necessary to avoid water penetration and earth debris on the pit wall, and heave-piping at the bottom of the pit etc..

(2) Risk Prevention Measures for Pipeline Construction

① Disposal Measures for Existing Underground Pipelines:

As for the underground pipelines that influence the depth and engineering construction price of the station(for example, sewage pipelines with depth over 3 meters), it is proposed to relocate them outside the project scope at one time to lower the construction difficulty and risk, and save the overall project investment.

As for the underground pipelines with a small burial depth, characteristic of high

pressure and explosion, or high safety level and great difficulty in construction disposal that do not influence the burial depth of the station(for example, fuel gas pipeline), it is proposed to relocate them temporarily during the construction period to lower the engineering risk, and restore to the original place after the end of project. Generally, the underground pipelines vertically laid out along the station may be relocated temporarily.

As for the pipelines that involve great difficulty of relocation, and whose relocation restricts the construction period of subway, and those that cannot be relocated due to influence of the slope degree, such pipelines may be suspended for protection during construction period. Generally, steel arm or steel framework shall be put up for suspension protection. As for the concrete pipelines, they may be replaced with steel pipes for suspended protection. Generally, the underground pipelines that runs across the station(or exit and entrance passage) horizontally may be suspended for protection.

As for the underground pipelines that are close to the subway structural project with high requirements for own safety, or those that are subject to leakage, or may lead to construction risk, necessary protective measures shall be taken for them during construction. The specific disposal measure shall be formulated according to the opinion and requirements of the employer’s unit, and tracing, monitoring and measurement shall be carried out during construction period at the same time.

② Disposal Measures of Existing Ground Pipelines:

The ground pipelines are mainly electric and telecommunication pipelines, and shall be relocated outside the influenced scope of the project during project implementation, or elevated and buried along with pipeline network upgrading to guarantee construction and pipeline safety.

(II) Engineering Control Measures against Construction Risk of Interzone Tunnel

(1) Protection and Disposal Measures for Interzone Tunnel Running Across Houses on the Ground

No. 3 rail traffic line of Zhengzhou City runs beneath a great many houses, and house safety assessment shall be carried out, and the safety level of the buildings shall be classified before construction to guarantee safety of buildings. It is proposed to dismantle the buildings with a high risk, and then reconstruct or compensate them in other ways. In case it is qualified to carry out shield tunnel construction, adjustment of excavation and control of shield tunnel conditions shall be strengthened during shield tunnel construction, and carry out simultaneous filling and secondary supplementary filling, and carry out informationalized construction and management. The following major measures shall be taken during excavation of shield tunnel:

① Improve excavation control level, and adjust shield tunnel excavation parameter to guarantee soil stability of the excavated surface.

② Improve the water-tightness of the working surface; Improve the mobility and penetration parameter of the earth through infilling bentonite or foam agent into the earth cabin to prevent sprouting of spiral transmitter.

③ Improve the sealing properties of the shield end; Take multiple shield tunnel ends to prevent entry of the earth into the tunnel from the shield tunnel end; inject grease into the shield tunnel end and strengthen the waterproof properties of the shield tunnel end;

④ Take simultaneous filling and secondary supplementary filling during excavation to fill in the crevice inside the rings, and cause the pipelining to support the stratum as soon as possible and control the ground settlement.

⑤ Do well in construction monitoring, and adjust construction parameter in time according to monitoring results.

⑥ Carry out necessary reinforcement measures for the foundations of the houses run across by the shield tunnel before excavation.

(2) Risk control measures for foundation of bridges run across by inter-zone tunnel:

The whole line needs to run across part of the bridges spanning over rivers and overhead bridges. According to the foundation data grasped at present, the most of the bridge pile foundations have been avoided on plane surface through adjusting the plane location and line elevation of the inter-zone tunnel of the whole line.

In case of running across bridge pile foundation from the sides, generally optimal construction parameters may be adopted while strengthening the management of excavation parameters and status control, and carrying out simultaneous pressure grouting and necessary supplementary pressure grouting measure to guarantee its safety. In case of excessively large ground load, or close distance, compensatory filling may be adopted to duly reinforce the earth surrounding tunnel, or strengthen the pipe segment structure.

As for intrusion of bridge pile foundation into the tunnel structure, it is necessary to dismantle such pile foundations before arrival of the shield tunnel machine. It is possible to take pile foundation underpinning, or pile dismantlement for bridge reconstruction.

As the earth surrounding the tunnel may become loose due to passage of shield tunnel through pile foundation, and the friction resistance of pile foundation may decrease, grouting pipes shall be reserved in the tunnel to reinforce the surrounding soil. Meanwhile, high-pressure jet sprouting piles shall be established between the bridge pile foundation and the structure of the inter-zone tunnel for isolation.

(3) Risk control measures for inter-zone tunnel running beneath Jinshui River etc.

No. 3 rail traffic line of Zhengzhou runs across Jinshui River and Qili River etc., therefore on the one hand, simultaneous filling materials with light pollution for water resources shall be selected for tunnel construction, and on the other hand, the shield structure thrust force and filling pressure shall be controlled to avoid penetration of the slurry into river due to excessive pressure. In case the inter-zone tunnel runs across lake or river, the thickness of the covering earth shall be large than the diameter of the shield tunnel in principle, and anti-floatage shall meet the relevant requirement.

Carefully study engineering geological and hydrological geological conditions, and make definite the requirement of project construction for the properties and functions of the shield tunnel machine according to the characteristics of the project. Disposal of sudden accident shall be taken into consideration for allocation of shield tunnel machine; Put strict check over major excavation parameters, reduce pressure fluctuation, and adopt low-speed even promotion to avoid great interference with the soil.

(4) Risk Control Measure in case of Inter-zone Tunnel Running Beneath Railway

Zhengzhou boasts developed railway network, and the whole line needs to runs across the existing railways such as Longhai Railway and Shiwu High-Speed railway line etc.. The plane and vertical sections of the line have been optimized according to specific conditions to keep certain safe distance between the inter-zone tunnel and the line.

The major control factors are excessive railway deformation and pipeline transformation according to the experience on the existing urban subway shield tunnel running beneath the existing railway. The following measures shall be taken:

① Improve excavation control level, and adjust shield tunnel excavation parameter, and guarantee the soil stability of the excavated surface.

② Improve the watertightness of the dregs on the working surface. Improve the mobility and penetration parameter of the dregs through infilling bentonite or foam agent into the earth cabin to prevent sprouting of spiral transmitter.

③ Improve the sealing properties of the shield end; Take multiple shield tunnel ends to prevent entry of the earth into the tunnel from the shield tunnel end; inject grease into the shield tunnel end and strengthen the waterproof properties of the shield tunnel end;

④ Take simultaneous filling and secondary supplementary filling during excavation to fill in the crevice inside the rings, and cause the pipelining to support the stratum as soon as possible and control the ground settlement.

⑤ Carry out whole sectional filling and rotary grouting reinforcement for the areas run across by the shield tunnel;

⑥ Take reinforcement protective measures with a certain aim for important pipelines, and control its deformation through isolation zone formed through reinforcement;

⑦ Establish pressure-relief vent to prevent excessive movement of earth due to high-pressure filling;

(5) Inferior Geological Conditions

There are powdery earth and powdery clay on the line at K0+0.000~K25+200 with low strength and poor stability. It is proposed to adopt shield tunnel method for construction. And the stations shall be constructed by means of open digging and

covered digging method.

8.1.4.3 Adopt new construction techniques and technology

New prospecting equipment and comprehensive methods shall be adopted during construction to realize cooperation among various departments, and gradually find out specific conditions of urban underground facilities and establish 3-dimensional digital map of underground space. According to statistical data, most of the breakage of underground pipelines and ground collapse etc. caused during subway construction happen in case of leakage of underground pipelines and mine tunneling method. At present, domestic mine tunneling construction is still carried out mainly by means of manual excavation. Due to varied management capacity of the contractors and technical levels of the construction workers, or lack of clear knowledge about the stratum, underground water and pipelines, it is rather hard to properly carry out measures to control the underground water and stratum deformation. However, as open digging is visible and approachable during construction, it is easier to find abnormal conditions, and take emergency remedial measures in time and avoid accident. Shield tunneling depends on real-time monitoring of stratum and construction conditions by meters during construction, and can adjust construction parameters at any time. The shield tunneling machine can complete the prescribed construction operation automatically, and can strictly control stratum deformation and water stoppage.

The optimal subway structural forms and construction method shall be selected according to the specific engineering geological and hydrological geological conditions, and the status of underground pipelines. Open digging construction shall be adopted for the subway stations and distribution sections in front of or behind the subway stations if possible. Except for mine tunneling method for the sections with ground constructions, fewer underground pipelines and lower underground water level, and more stable stratum, shield tunneling shall be adopted for the other sections of the interval tunnel if possible. In case mine tunneling method must be adopted due to difficulty in grooming ground traffic or transfer of underground pipelines, the scale of subway station constructed with hidden digging shall be strictly controlled without lowering the service functions. Meanwhile, steady and reliable technical measures to stop water and consolidate stratum shall be adopted. In addition, relevant project parties shall closely cooperate with the owner of the underground pipelines to find out the relative positional relations between underground pipelines and subway tunnel, and leakage thereof. Construction shall be carried out after consolidation of the site in case of serious leakage.

Shield tunnel method is mainly adopted for construction of the project sections, which can effectively control stratum deformation and prevention of penetration of underground water, thus lower construction risk.

Supporting and water-stopping measures such as diaphragm wall, drilling hole pile plus water seal curtain etc. have been adopted for subway stations constructed by means of open digging and cover digging of the project to control drainage and extraction of underground water and prevent ground settlement.

8.1.4.4 Strengthen monitoring and measurement during construction

Strengthen monitoring and measurement during construction(including structural deformation of tunnel, ground settlement, and pipeline deformation etc.) to realize informational construction; Establish risk management mechanism and formulate risk control standard to improve the risk awareness, management and technical levels of the construction staffs. Generally speaking, there will be signs before occurrence of subway construction accident. For example, excessively large or rapid deformation of retaining structure, or sudden changes in ground settlement, or water leakage in tunnel etc.. In case such problems can be discovered and handled in time, and confined to the control standard all the time, the accident will be avoided as a result. Therefore monitoring and measurement are the eyes and ears of the construction staffs and managerial personnel. They can carry out actions with a certain aim to avoid risk in case they can obtain clear information. It can be found through careful analysis of the previous accident that most of such accidents were caused due to loose or improper monitoring.

Strict monitoring and monitoring measures shall be carried out against structural deformation of tunnel, ground settlement, structure deformation and settlement etc. when digging stations and sections that run across bridges and piles of Beihuan and Nanyang Road approach bridge, Nanyang and Jinshui Road approach bridge, Zhongzhou Road and Shangdu Road approach bridge, the elevated bridge of Longhai railway line, Shiwu highspeed railway line and residential buildings.

8.1.4.5 Establish environmental safety technical management system for subway construction

There are many practical cases on leaning of adjacent buildings, road collapse and breakage and dislocation of pipelines due to excessively large stratum movement due to underground project construction. Urban underground project is a risky project as well as a rather complex systematic project. Thus it is quite necessary to establish a set of perfect engineering construction environmental safety technical management system. To ensure the construction project of Zhengzhou Rail Transit Line 3 and construction personnel personal safety, avoid sudden major accidents and fulfill rapid and effective control and handling once accident happens, hereby prepare the risk management methods based on the principle of “prevention first, self-help in priority, uniform direction, works division” and it mainly includes construction risk identification, construction risk management system, construction risk early warning mechanism and construction risk emergency plan. For details see annex 2.

See table 8.1-3 and 8.1-4 for risk analysis and and prevention measures of the railway stations, tunnels along Line 3 project.

Table 8.1-3 Construction risks and measures of stations

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution
1	Xinliu Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	There are a DN219 gas pipe along Xinliu road with underground 2 meters depth.	Class II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
2	Shamen Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	There are a DN219 gas pipe along Changxin road with underground 3 meters depth.	Class class II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.

3	Xinlongpu Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	There are a DN250 gas pipe along Nanyang road with underground 2 -4 meters depth. a DN400 drinkable water pipe along Xinglongpu road with underground 2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
4	Dongfeng Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

				neighboring existing structures and buildings	No. 111 in Nanyang Road (TongLe Xiao Qu Nan Qu),The distance from the line is 6m.	Class IIclass II	The impact on foundation pit and the protection of surrounding buildings shall be specially considered. The design adopts drilling piles to prevent the water infiltration from surrounding soiles into the foundation pit and reinforce concrete support to reduce foundation pit deformation and prevent underwater level decrease outside of foundation pit so as to reduce the settlement of surrounding buildings and pipelines; it shall be closely monitored during construction and the grouting shall be done if necessary. Strictly control the ground settlement and horizontal displacement of bracing structures.
				Passing under municipal pipeline	There are a DN250 gas pipe along Nanyang road with underground 2-4 meters depth. a DN600 concrete drinkable water pipe along Nanyang road with underground 2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
5	Agriculture Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	There are a DN250 gas pipe along Nanyang road and a gas pipe at Agriculture Road station with underground 2-4 meters depth, a DN600 concrete drinkable water pipe along Nanyang road with underground 2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
6	Huanghe Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

				Passing under municipal pipeline	There are a electric cable at Agriculture Road station with a depth of 2 metres, a DN250 gas pipe along Nanyang road with underground 2-4 meters depth, a DN600 concrete drinkable water pipe along Nanyang road with underground 2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
7	Jinshui Road station	underground 2-floor separating island station	Cover cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of cover digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	underneath the jinshui river and jinshui overpass	Class CLASS IICLASS II	1.Generally optimal construction parameters may be adopted while strengthening the management of excavation parameters and status control, and carrying out simultaneous pressure grouting and necessary supplementary pressure grouting measure to guarantee its safety. In case of excessively large ground load, or close distance, compensatory filling may be adopted to duly reinforce the earth surrounding tunnel, or strengthen the pipe segment structure. 2.As for intrusion of bridge pile foundation into the tunnel structure, it is necessary to dismantle such pile foundations before arrival of the shield tunnel machine. It is possible to take pile foundation underpinning, or pile dismantlement for bridge reconstruction. 3. Grouting pipes shall be reserved in the tunnel to reinforce the surrounding soil. Meanwhile, high-pressure jet sprouting piles shall be established between the bridge pile foundation and the structure of the inter-zone tunnel for isolation.
8	Taikang Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

				Passing under municipal pipeline	double gas pipeline in the north side of taikang road d250, Distance from The north side of the midline is 10、12.5，Distance from The East side of the midline is 8.5 m.From west to east along taikang road D600, 8 meters depth.Minggong road ,D600,from south to north,about 4 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
9	Erqi Square station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a three-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 23 meters, and it is proposed to adopt continuous waterproof concrete walls for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				neighboring existing structures and buildings	distance from xiaolou qingzhen temple and qingzhen woman temple is about 6 meters.	Class IIclass II	1. Strength the construction monitoring for foundation pit bracing structure and traffic dispersion road surface. Strictly control the ground settlement and horizontal displacement of bracing structures. 2. Monitor the deformation of buildings besides foundation pit, ground surface and retaining structure and reserve grouting holes at buildings near the foundation pit; conduct grouting reinforcement if excess deformation of foundation is detected.

10	Shunchengjie station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				neighboring existing structures and buildings	distance from honhxinjiayuan number 1 building （7 floor，brick-concrete structure）	Class I	1. Strength the construction monitoring for foundation pit bracing structure and traffic dispersion road surface. Strictly control the ground settlement and horizontal displacement of bracing structures. 2. Monitor the deformation of buildings besides foundation pit, ground surface and retaining structure and reserve grouting holes at buildings near the foundation pit; conduct grouting reinforcement if excess deformation of foundation is detected.
				Passing under municipal pipeline	1、Gas pipeline from west to east along xiadajie D250,about 2-3 meters depth.from north to south along shuncheng street,about 2-3 meters depth. 2、tap water pipe from east to west along xidajie D600,4-6 meters depth.	Class IIclass II	1. Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. If the relocation method is used, it shall be kept away from the station foundation pit as possible. 2. Temporarily relocate main pipelines affecting the station, and monitor the stratum deformation at locations after relocation. Once exceeded alarm range, take measures such as grouting reinforcement.

11	Dongdajie station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a three-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 23 meters, and it is proposed to adopt continuous waterproof concrete walls for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1gas pipeline from west to east along dongdajie d250,about 2-3 meters depth,distance from the north side of the midline is about 12 meters.esat side of zijin mountain,from north to south ,2-5 meters depth.	Class IIclass II	1. Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. If the relocation method is used, it shall be kept away from the station foundation pit as possible. 2. Temporarily relocate main pipelines affecting the station, and monitor the stratum deformation at locations after relocation. Once exceeded alarm range, take measures such as grouting reinforcement.
12	Chengdong Road station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a three-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 22 meters, and it is proposed to adopt continuous waterproof concrete walls for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

					Distance between Number 96 building of dongguangdongli (4-7floors, brick-concrete structure)and the line is sbout 11meters	Class I	1. Strength the construction monitoring for foundation pit bracing structure and traffic dispersion road surface. Strictly control the ground settlement and horizontal displacement of bracing structures. 2. Monitor the deformation of buildings besides foundation pit, ground surface and retaining structure and reserve grouting holes at buildings near the foundation pit; conduct grouting reinforcement if excess deformation of foundation is detected.
				Passing under municipal pipeline	1gas pipeline from west to east along dongdajie d250,about 2-3 meters depth,distance from the north side of the midline is about 12 meters. from north to south along chengdong road ,2-3 meters depth.distance from east side of the middle line is about 13 meters,distance from west side is about 11.5 meters	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
13	Weilaidadao station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
					gas pipeline from east to west along the zhengbian road d250,2-3meters depth ,distance from south side of middle line is about 25meters,distance from the north side ofweilaidadao is21 meters ,south side about 24 meters.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
14	Fengtai South station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

				Passing under municipal pipeline	1、gas pipeline from north to south along the fengtai road,2-3meters depth ,distance from east side of middle line is about 15meters,located on the south side of zhengbian road,d250,from north to south ,2-3 meters depth,north side of the middleline.2、water pipe from west to east ,d600,about 6 meters depth	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
15	Zhongzhoudadao station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a three-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 23 meters, and it is proposed to adopt continuous waterproof concrete walls for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				neighboring existing structures and buildings	zhongzhou dadao viaduct	Class I-CLASS II	1.Generally optimal construction parameters may be adopted while strengthening the management of excavation parameters and status control, and carrying out simultaneous pressure grouting and necessary supplementary pressure grouting measure to guarantee its safety. In case of excessively large ground load, or close distance, compensatory filling may be adopted to duly reinforce the earth surrounding tunnel, or strengthen the pipe segment structure. 2.As for intrusion of bridge pile foundation into the tunnel structure, it is necessary to dismantle such pile foundations before arrival of the shield tunnel machine. It is possible to take pile foundation underpinning, or pile dismantlement for bridge reconstruction. 3. Grouting pipes shall be reserved in the tunnel to reinforce the surrounding soil. Meanwhile, high-pressure jet sprouting piles shall be established between the bridge pile foundation and the structure of the inter-zone tunnel for isolation.
				Passing under municipal pipeline	east side of zhongzhoudadao,d250,from north to south ,about 2-5 meters depth,distance from the north sideof the junction is about 30 meters	Class CLASS IICLASS II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.

16	Tongtai Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1、Gas pipeline located on the east side of tongtai road d250,from south to north ,2-3meters depth.the north side gas pipeline,west to east ,2-5 meters depth2、From west to east along shangdu road,D600,3meters depth,located on the south side of the middleline.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
17	Huanghe East Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1、Gas pipeline located on the east side of huanghe river road d250,from south to north , 3meters depth.the north side of shangdu roadd250,west to east ,2-5 meters depth 2、bothway tap water pipe from east to west along shangdu road D600,3 meters depth 3、The south side of the Power cable from west to east along shangdu road,2 meters depth	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.

18	Agriculture East Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1、Gas pipeline located on the east side of nongye road,from south to north ,2-3meters depth.distance from the east side of midline is 20.5 meters.the north side of shangdu road d250,west to east ,2-3 meters depth, 2、bothway tap water pipe from east to west along shangdu road D600,3 meters depth 3、The south side of the Power cable from west to east along shangdu road,2 meters depth	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
19	Zhongxing Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1、Natural gas pipeline is located on the north of shangdu road D250,from west to east ,2-5 meters depth.2、bothway tap water pipe from east to west along shangdu road D600,3 meters depth.3、south of power cable from east to west along shangdu road,2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
20	Boxue Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

				Passing under municipal pipeline	1、bothway tap water pipe from east to west along shangdu road D600,3 meters depth.2、south of power cable from east to west along haihang road D600,2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
21	Hanghai East Road station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	single tap water pipe from east to west along haihang road D600,3 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.

Table 8.1-4 Construction risks and measures of Interval

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution
1	xinliu road station –hanghai road station	shield method	geology risk	K0+000-K25+200	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	class IIclass II	Adjust the shield tunneling parameters according to dynamic monitoring data; carry out reinforcement of mixing pile and rotary churning pile at shield tunneling in and out section;
2	shanmen road station –xinglongpu road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K2+444～K2+495	Huiji District’s office building of Land and Resources,7floor,5meters from the linefloor distance from the line is	CLASS II	1. Adopt earth pressure balance shield and select optimal construction parameters to ensure stable cutting face; strength the synchronous grouting and necessary supplement measures to control the settlement of structures. 2. Adjust shield construction parameters at any time to minimize the over-excavation and under-excavation, eliminate the slump or squeezing of soils before the shield and reduce the lateral force applied on pile foundation from lateral deformation of foundation soil. 3. Adopt synchronous grouting, reduce the gap formed outside the tunnel after shield tail passed and reduce the horizontal displacement of soils around the tunnel and the resulted negative friction resistance. 4. Strengthen the monitoring and take related measures including monitoring of deformation and settlement of structures; the large deformation detected shall be timely feed back to design and construction unit so as to adjust the construction parameters or take necessary ground reinforcement measures. 5. During side channel construction: ① The design temperature and thickness of frozen soil curtain of side channel shall meet the requirement. ② Prepare preventive emergency plans such as freezing hole construction plan, freezing construction plan, excavation and pouring construction plan, frost heave and melting settlement prevention plan. 6. After shield passed, open the embedded grouting pipe in duct according to deformation of ground surface and building/structures, and timely carry out two-shot grouting reinforcement behind the wall for surrounding soils. 7. Control the uneven settlement difference of buildings of no more than ≤3‰
				K2+600～K2+619	Peaceful residential homes, Building 8,，17floor floor，distance from the line is 9meters 。Frame structure	class II	
				K2+623～K2+663	RCC family member courtyard (Gadameilin district),distance from the line is o meters 。17 floors，Frame structurefloor	class II	
				K2+800～K2+900	CR City Concert (Xinyu Garden) district ,1 #, 5 # Buildingsfloor distance from the line is ,9meters	class II	
				K2+800～K2+910	City bus company, family member courtyard，7floor floor，distance from the line is 15meters from the line	class II	
	xinglongpu road station –dongfeng road station			K3+280～K3+339	National Food Authority’s Zhengzhou Institute of Science，3~6floor floor，distance from the line is 15m from the line。	class class II	
				K3+410～K3+546	Tractor plant family member building，5floor floor， distance from the line is 12meters。	class II	
				K3+573～K3+600	Nanyang Road 137，6floor floor ， distance from the line is 15meters from the line	class II	
				K3+610～ K3+723	Tianxiu home district, 1 # ~ 4 # Building, distance from the line is 16meters from the line，7 floors，mixed structurefloor mixed structure	class II	
				K3+730～ K3+784	Zhengzhou Oriental Tumor Courtyard，5floor ，distance from the line is 15m，mixed structure 。	class II	
				K3+957～K3+990	ICBC family member building，5floor ，distance from the line is 11m，mixed structure	class II	
				K4+000～K4+213	张砦村，2~7floor ，distance from the line is 17m，mixed structure	class II	
				K4+291～K4+463	Fun district, 1 #, 2 #, 3 #, 4 #, 5 # Buildingfloor ，11meters from the line distance from the line is ，6--7 floors，mixed structuremixed structure	class II	
				K3+200～K3+328	Grain transport community, Building 9, Building 10，6floor floor， distance from the line is 11m from the line，mixed structuremixed structure	class II	
				K3+611～K3+621	Huiji District’s Board of Education family member building，7floor floor，mixed structuremixed structure ， distance from the line is 13meters from the line。	class II	
				K3+635～K3+773	Yuhua Wen Hui Garden District, Building 1 to 5，7floor floor，mixed structuremixed structure ， distance from the line is 16meters from the line。	class II	
				K3+917～K4+049	Yuhua Wen Qing Garden District Building 1 to 4，7floor ，mixed structure ，distance from the line is 13m。	class II	
				K4+129～K4+211	Yaxin good times area, 3 to 4 Building 7floor ，mixed structure ，distance from the line is 13m。	class II	
				K4+217～K4+277	Chuangye Homes，7floor ，mixed structure ，distance from the line is 9m。	class II	
				K4+286～K4+500	Sunshine Holiday district, 1 #, 2 # Building，7floor ，mixed structure ，distance from the line is 10m。	class II	
4	dongfeng road station-nonongye road station	shield method	Crossing Underneath Existing Buildings	K4+529～K4+558	Nanyang Road, No. 111 Courtyard，6floor ，distance from the line is 6m。	classII	
				K4+929～K5+010	China Railway Bridge Bureau family member courtyard 1 #，7floor ，distance from the line is 8m。	class II	

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution
				K5+116～K5+247	Zhengzhou Boiler Factory family member courtyard 1 #, 2 #，7floor ，distance from the line is 11m。	class II	
				K5+268～K5+318	Zhengrong Group Limited family member courtyard, 3 #, 6 # building，5floor ，distance from the line is 8m	class II	
				K5+328～K5+390	Vision Garden 2 #, 3 # Building，7floor ，distance from the line is 11m。	class II	
				K5+392～K5+456	Old meat processing factory family member courtyard, 1 #, 3 #, 5 # Building，6floor ，distance from the line is 12m。	class II	
				K5+480～K5+679	Nanyang Road 68 homes, 1 #, 2 #, 3 #, 10 #, 41 # Building，6floor ，distance from the line is 12m。	class II	
				K4+785～K4+833	Mold factory family member courtyard 1 # building，6floor ，distance from the line is 12m。	class class II	
				K4+845～K4+900	Kaiyuan district, 1 #, 2 # Building，6floor ，distance from the line is 14m。	class II	
				K4+937～K5+025	Nanyang Road, No. 239 Courtyard，6floor ，distance from the line is 14m。	class II	
				K5+390～K5+441	Ronghua community, 1 # Building，5floor ，distance from the line is 12m。	class II	
				K5+477～K5+520	Nanyang Road 253 (food company meat branch family member building) 1 #, 3 #，6floor ，distance from the line is 11m。	class II	
5	nongyeroad station –huanghe road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K5+790～K5+890	Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	class II	
				K5+900～K5+965	Provincial Prospecting machinery factory family member courtyard 1 #, 5 #, 6 # building，6floor ，distance from the line is 12m。	class II	
				K6+043～K6+082	Nanyang Road, No. 52 (Yuhua Wen Jinyuan), three buildings，7floor ，distance from the line is 13m。	class II	
				K6+205～K6+234	Sipo Road 9，8floor ，distance from the line is 12m。	class II	
				K6+429～K6+500	Nanyang Road, No. 46，17floor ，distance from the line is 11m。	class II	
				K6+517～K6+548	Nanyang Road, No. 41 courtyard, 5 # Building，6floor ，distance from the line is 9m。	class II	
				K6+613～K6+679	Huafu Institute of Dermatology，5~7floor ，distance from the line is 10m。	class II	
				K6+690～K6+762	City No. 71 high school，5floor ，distance from the line is 11m。	class II	
				K6+900～K7+073	Zhengzhou Textile staff apartments, 29 #, 30 # Building，4floor ，distance from the line is 14m。	class II	
				K7+100～K7+177	Nanyang Road, No.1 primary，3~6floor ，distance from the line is 9m。	class II	
				K5+843～K5+878	Transport company family member courtyard, (Nanyang Road No. 268 courtyard), 1 # Building，7floor ，distance from the line is 15m。	class II	
				K5+889～K6+021	Nanyang Road, No. 270 Courtyard, 2 #, 4 # Building，7floor ，distance from the line is 12m。	class II	
				K6+034～K6+085	Nanyang Road, No. 279 Courtyard, 1 #, 2 # Building，5~7floor ，distance from the line is 12m。	class II	
				K6+100～K6+180	Pearl Factory, family member courtyard, 1 #, 2 #, 3 # Building (Nanyang Road 275)，6floor ，distance from the line is 9m。	class II	
				K6+260～K6+305	Nanyang Road, No. 283 Courtyard，5floor ，distance from the line is 13m。	class II	
				K6+600～K6+975	Hengtian Heavy Industry Co., Ltd family area，3~6floor ，distance from the line is 14m。	class II	
				K7+032～K7+168	Nanyang Road, No. 296 Courtyard, 1 #, 2 #, 3 #，6~12floor ，distance from the line is 15m。	class II	
6	huanghe road station	shield method	Adjacent / Crossing	K7+214～K7+696	Zhengzhou Textile Machinery Co family member courtyard, 6 #, 5 #, 4 #, South 3 #,	class II	

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution
	–jinshuiroad station		Underneath Existing Buildings		2 # Building South，4floor ，distance from the line is 15m。		
				K7+900～K8+150	Nanyang Road No. 12 courtyard, 1 #, 2 # Building，3~6floor ，distance from the line is 10m。	class II	
				K7+970～K8+010	Jinshui District Police Fire Brigade，7floor ，distance from the line is 14m。	class II	
				K8+174～K8+190	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)，5floor ，crossing underneath number 7 building	CLASS II	
				K8+190～K8+220	Tingdao foreign language training，4floor ，crossing underneath。	CLASS II	
				K8+250～K8+300	Zhengzhou City Library，2~6floor ，distance from the line is 5m。	CLASS II	
				K7+220～K7+320	Garden community, (Nanyang Road 300) 5 # building，7floor ，distance from the line is 14m。	class II	
				K7+900～K8+020	Zhongheng Garden, 2nd Courtyard, 1 #, 2 #, 3 # Building，5~6floor ，distance from the line is 8m。	class II	
7	jinshui road station –taikang road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K8+485～K8+495	Jinshui Road, 11th courtyard, 1 # building，4floor ，distance from the line is 11m。	class II	
				K8+640～K8+690	Minggong Road No. 67 courtyard, (Jinfeng Golden Coast International), 1 # Building，7floor ，distance from the line is 6m。	CLASS II	
				K8+920～K9+017	Minggong Road, No. 156 Courtyard, 1 #, 2 # Building，6floor ，distance from the line is 6m。	CLASS II	
				K9+030～K9+100	Jin Ming Yuan South, Building # 1，7floor ，distance from the line is 4m。	CLASS II	
8	taikang road station –erqi suquare station	shield method	Adjacent / Crossing Underneath Existing Buildings	K9+700～K9+860	Huigang New Town 1 #, 2 #, 3 # Building，28floor ，distance from the line is 0m。	CLASS II	
				K10+000～K10+059	Small building mosques，4~6floor ，distance from the line is 6m。	CLASS II	
				K9+275～K9+315	West Cai district, (Ming Gong Road No. 240 Courtyard) 1 # ，4~7floor ，Crossing underneath	CLASS II	
				K9+325～K9+410	Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)，2~7floor ，distance from the line is 9m。	class II	
				K9+545～K9+608	Ming Gong Road No. 272, (Rural Credit Cooperative Union, family member building)，6floor ，crossing underneath。	CLASS II	
				K9+638～K9+674	Yalong district, 17 # Building，7floor ，正下穿。	CLASS II	
				K9+638～K9+674	Yalong districtl 16 # Building, 1 #, 2 # Building，7floor ，distance from the line is 16m。	class II	
				K9+687～K9+719	Catholic Church，2~5floor ，distance from the line is 2m。	CLASS II	
			Crossing Underneath bridge	K9+800～K10+000	Jiefang Road overpass Pile foundationCrossing underneath	CLASS II	
9	erqi suquare station –shuncheng street station	shield method	Adjacent / Crossing Underneath Existing Buildings	K10+510～K10+614	Shangfuxin Village House 1#，18floor ，distance from the line is 6m。	class II	
				K10+625～K10+779	Fuchun Apartment 1 # building，7floor ，distance from the line is 15m。	class II	
				K10+317～K10+348	Zhengzhou Feb 7 Strike Monument，14floor ，钢筋混凝土结构。distance from the line is 3m。	CLASS II	
				K10+528～K10+614	Huating Apartments, Dehua Street community 1 #, 2 # Building，16floor ，distance from the line is 15m。	class II	
				K10+630～K10+775	Jinding Huafu House, front 1 #，11floor ，distance from the line is 13m。	class II	
				K10+630～K10+775	Jinding Huafu House, rear，5~7floor ，distance from the line is 8m。	class II	
10	shuncheng street station –dongdajie street station	shield method	Adjacent / Crossing Underneath Existing Buildings	K10+915～K10+990	Hongxin Jia Yuan 1 # building，7floor ，distance from the line is 14m。	class II	
				K11+070～K11+151	Xidan apartments, two buildings，7floor ，distance from the line is 8m。	class II	
				K11+250～K11+286	West Street, No. 231，16floor ，distance from the line is 13m。	class II	
				K11+380～K11+446	Zhongkai City Lights Clove Court, 1 #, 2 # Building，12floor ，distance from the line is 12m。	class II	

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution
				K10+956～K11+025	Ginza International，7floor ，distance from the line is 15m。15floor ，distance from the line is 14m。	class II	
				K11+038～K11+100	233 West Main Street (the third secondary school, family member building)，18floor ，distance from the line is 11m。	class II	
				K11+230～K11+300	Sun Moon Star City, 1 # building，20floor ，distance from the line is 15m。	class II	
				K11+328～K11+566	Zhongkai City Lights Clove Court, 1 #, 2 # Building，7floor ，distance from the line is 14m。	class II	
				K11+580～K11+666	Yangtze River City in City，7floor ，distance from the line is 13m。	class II	
11	dongdajie road station-chengdong road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K11+978～K12+105	number 220 community in dongdajie，6floor ，distance from the line is 10m。	class II	
				K12+133～K12+366	Zhongkai City Lights Guangjingcui Court, 1 #, 2 # Building，7floor ，distance from the line is 8m。	class II	
12	chengdong road station-weilaidadao road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K12+716～K12+830	East Main Street, No. 1 Court, 1 # building，4~7floor ，distance from the line is 11m。	class II	
				K12+992～K13+072	Knitting mill family member courtyard, 1 # building，5floor ，distance from the line is 12m。	class II	
				K13+076～K13+226	Yutong Garden 1 # building ，6floor ，distance from the line is 12m。	class II	
				K13+230～K13+408	Municipal underwear factory family member courtyard, 1 #, 2 #, 3 # Building，5~6floor ，distance from the line is 14m。	class II	
				K12+820～K12+857	Zheng Bian Road, Building 23,，5floor ，distance from the line is 7m。	class II	
				K13+158～K13+225	Cargo Terminal No. 23 North Street Courtyard, 1 #, (Phoenix Road Community)，5floor ，distance from the line is 18m。	class II	
				K13+332～K13+390	Boai ENT Hospital of Zhengzhou，6floor ，distance from the line is 9m。	class II	
				K13+398～K13+430	Zheng Bian Road, No. 49, family member courtyard, 1 # Building，5floor ，distance from the line is 13m。	class II	
				K13+512～K13+650	Dongming Road 30 Courtyard, (electric power district), 1 #, 2 # Building，6floor ，distance from the line is 9m。	class II	
			Crossing Underneathwater and rivers	K12+900～K13+000	Crossing underneath xionger river	class II	
13	zhognzhoudadao road station-tongtai road station	shield method	Crossing Underneath bridge	K15+850～K15+950	crossing underneath zhongzhoudadao overpass	CLASS II	
14	tongtai road station –huanghedong road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K17+206～K17+266	guancheng chinese hospital，8 floor,,10meters from the line	class II	
			Crossing Underneathwater and rivers	K17+200～K17+400	Underneathqili river,，The bottom to the top of tunnel is 10m	CLASS II	
15	zhongxing road station –boxue road station	shield method	Crossing Underneath bridgeCrossing Underneath bridge	K20+800～K15+920	Crossing underneath the high-speed rail bridge pile foundation	CLASS II	
16	boxue road street station-hanghaidong road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K24+300～K24+8000	Dongyinggang cun,1-2floor,crossing undernath	CLASS II	
			Crossing Underneath railway	K23+250～K23+360	underneath longhai railway,，ground line	class II	

To conclude, due to rather complex underground conditions hard to be totally clarified in advance, there is indeed rather high safety risk during subway construction. However, such risk is not totally inevitable. Domestic subway engineering circles have obtained rick experience in this aspect, and there are many successful examples as well. For example, Huangzhuang transit station of No. 10 subway line and No. 4 subway line of Beijing is constructed by means of mine tunneling. Such station is of a large scale and complex structure with a large number of surrounding constructions and dense distribution of underground pipelines, which is rarely seen even in the world. However, the project was smoothly completed through strict risk technical management throughout construction, and no construction safety accident happened during construction.

8.1.5 EHS Analysis and Mitigation Measures during Construction Period

8.1.5.1 EHS Analysis and Mitigation Measures during Construction

Traffic accident has become of the reasonsfor the most injury and deaths to the public throughout the world. All the project staffs shall safeguard traffic safety when leaving for or from the worksite, and operating project equipment on free road or public road. The safety measures to prevent and control injury and deaths in traffic accident shall be intended to protect the project workers and road users, including the increase in traffic flow on the existing road, or major contents of the project in case of road transport. The following measures are requested to be taken:

(1) Reduce simultaneous use of road by the passengers and construction vehicles as much as possible;

(2) Cooperate with local community and authority to improve the road signs and increase visibility and increase the overall safety level of the roads,especially roads near school and other areas that involve children. Jointly carry out traffic education and safety education for passengers with local community(for example, publicity activity in school);

(3) Coordinate with personnel handling emergency to ensure suitable first aid in case of accident;

(4) Use materials purchased in local area if possible to shorten transport distance and reduce the possibility of traffic accident;

(5) Adopt safe traffic controlling measures, and warn the passengers and vehicles against dangerous conditions with road signs and signaler.

8.1.5.2 EHS Analysis and Mitigation Measure against Contagious Diseases during Construction Period

Contagious diseases have posed great threat to health of global public. Usually the health threat of large-scaled development project comes from poor sanitary conditions and living conditions, and infection due to sexual transmitted diseases and disease transmission medium. In view of lack of long-term effective measure therein, it is necessary to take various behavioral and environmental rectification measures to

prevent contagious diseases successfully.

It is requested to take the following intervention measured within the scope of the project:

(1) Carry out regular physical check for the workers;

(2) Prevent transmission of the worker's disease to local community by the following methods: carry out health education, for example information communication strategy, strengthen face-to-face consultancy work to solve systematic problems influencing personal behaviors; encourage individuals to take protective measures, and prevent transmission of diseases to others through use of condom.

(3) Train medical staffs to treat disease;

(4) Carry out immunity injection for the workers to improve health and prevent infection;

(5) Provide medical care service;

(6) Treat the patients in site medical organ or that of the local community to ensure easy access to medical treatment for the workers; keep the information on the workers in secrecy, and provide suitable nursing service(especially for mobile workers);

8.1.5.3 EHS Analysis and Mitigation Measures against Noise and Vibration during Construction Period

The project is a large-sized construction project, and opening digging of the underground station(including the entrance and exit of the station, and civil construction of air kiosk), part of the underground sections, civil construction of vehicle depot and parking lots, and ground lines and ground stations, and underground construction of shield machine etc. shall be carried out during construction period. The aforesaid construction will use a large number of mechanical equipment with high noise and vibration such as excavators, air compressors, pick and heavy transport truck etc.. A series of health impacts on the construction operators due to long-term exposure to the aforesaid equipment of high noise and vibration. Hearing will be seriously influenced after long-term working or living in environment with noise above 90dB, leading to diseases of neurological system such as neurasthenia with major symptoms such as headache and sleep disorder, changes in EEG(for example changes in rhythm, low wave radiation and decrease of indexes), and functional disorder of autonomic nerves etc: Mechanical vibration will cause various adverse influences on human body: pale fingers and barriers to blood circulation, numbness and hurt of hand and wrist, dizziness and nausea etc., for the amplitude and frequency of various parties in the human body vary from each other during vibration, which will lead to abnormal position of organs in human body, and physical discomfort and melancholy etc..

The following measures shall be taken to reduce influence on construction operators by equipment with high noise and vibration:

(1) Give priority to construction machinery with low noise and vibration during

selection of equipment, and regularly maintain and keep the construction machinery and equipment;

(2) The constructors operating equipment with high noise and vibration shall strictly carry out working-rest system to guarantee sufficient rest, and alternating shift and overtime work are forbidden except in special cases.

(3) Carry out regular physical check for the personnel operating equipment with high noise and vibration

8.1.5.4 Atmospheric EHS Analysis and Mitigation Measures during Construction Period

Dust will arise due to digging and drilling on the dry ground during construction of stations constructed with open digging. Moreover, the ground surface will be exposed and water will evaporate to form dry particles and loose ground surface after destruction of the original vegetation during construction. Thus dust will be raised in case of high wind or earth refilling. A part of the dust is floating in the air, and another part fly down ground or surface of buildings nearby with the wind. Dust pollution will cause great damage during construction. The dust floating in the air will be inhaled by the construction personnel, which will not only lead to various diseases of respiratory duct, but also spread various diseases due to the a large amount of pathogen carried by the dust, which will seriously influence the physical health of constructors.

The construction dust and decorative materials during subway tunnel construction, decoration and decoration of subway station contain volatile organic substances and gases such as formalin, benzene and dimethyl benzene etc.. Moreover, long-term exposure to such environment due to the long construction period of subway construction will cause serious influences on the health of the constructors, and tends to cause diseases of respiratory system etc..

During application of substation devices, it may involve the selection of insulator materials. A favorable insulator used at early stage contains PCB compound, which is a colorless or light yellow oily material difficult to dissolve in water and has many good chemical and physical characteristics such as high thermal stability, chemical stability, fat solubility, insulativity, viscosity and dielectric constant. However, it is soluble in fat and other organic compound with large hazard on human body. So the related materials containing PCB compound have been forbidden during installation of substation devices in domestic and it is normally replaced with corresponding rubbers so that it will not lead to pollution.

The following measures shall be taken during construction period against the health damage caused by air pollution to the constructors:

(1) Establish special personnel to take charge of cleaning on the site of ground construction; splash water and clean the site in time to reduce dust raised thereby. Duly sprinkle water during digging of dry earth surface to keep certain humidity of the operational surface.

(2) The workers shall wear masks during tunnel construction. The ventilation system in the tunnel shall be kept in normal working state to guarantee sufficient amount of

ventilation. Construction inside the tunnel shall be stopped in case the ventilation system is damaged.

(3) Environmental protection materials shall be used during decoration of the tunnel and subway station, and the content of formalin therein shall meet the requirements of relevant standards.

(4) The constructors shall wear corresponding gas masks and gloves during installation of the equipment of transformer substation to prevent physical damage due to poisonous substances in the equipment.

(5) In the process of construction, the personnel should wear work clothes, helmets, protective gloves, masks, goggles, etc., in order to avoid the damage caused by toxic substances in the equipment。

8.1.5.5 Spoil ground EHS analysis and mitigation measures

The waste residue produced during the construction process will be transported to Yaohu spoil ground and Jiaoqiao spoil ground. In the process of transportation of waste residue in, attention must be paid to the following:

(1) The waste residue should be cleaned up and transported away without delay, in order to ensure the construction site clean and tidy, so as to protect the body health of construction workers;

(2) In the process of construction, the workers shall wear work clothes, masks, helmets, etc.;

(3) Spray water on construction site on a regular basis for dedusting, and cover the bare soil;

(4) The satisfactory vehicle washing and cleaning facilities as well as full-time cleaners are available. Vehicles entering and leaving the site must be washed and cleaned by the facilities.

For the management of Yaohu spoil ground and Jiaoqiao spoil ground, the followings are required:

(1) Don't pile or discard the waste residue without order, but separate it in terms of its type and use;

(2) Set in the hazardous location signs or instructions such as security warnings to remind workers or other management personnel to pay attention to safety;

(3) For rainy days, stop the transportation of waste residue into the spoil ground, and at the same time, establish a temporary cover of waste residue and the temporary drainage facilities.

8.2 Risk Analysis and Mitigation Measures during Operational Period

8.2.1 Risk Analysis and Mitigation Measures during Operational Period

8.2.1.1 Analogical Accident Cases during Operational Period

(1) Cases on foreign subway accident

23 typical significant subway safety operational accidents at home and abroad in recent 30 years are summarized in Table 8.2-1. According to the analysis, at least 1201 deaths and 7952 injuries were caused in the 23 significant accidents, and the indirect losses caused thereby were immeasurable.

Table 8.2-1List of Significant International Subway Accident

Time	Site	Type and Cause of Accident	Loss
February 1975	London, England	Subway train bump onto the wall at the end of the tunnel	over 30 deaths
November 1986	London, England	Subway fire accident caused by electrical spark in the machinery room	32 deaths and over 150 injuries
March 1990	Philadelphia, America	Derailing of train	3 deaths, 162 injuries
August 1991	New York, America	Derailing of train and fire accident	at least 6 deaths, and over 100 injuries
March 1995	Tokyo, Japan	Artificial release of poisonous sarin gas	12 deaths, and 5500 injuries
July 1995	Paris, France	Bomb explosion	8 deaths, and 150 injuries
October 1995	Bak of Azerbaijan	Subway fire accident by mechanical trouble	558 deaths, and 269 injuries
May 1999	White Russia	Crowding due to excessive number of passengers	54 persons were stamped to death
June 1999	Saint Petersburg of Russia	Subway explosion	6 deaths
August 1999	Cologne, Germany	Subway train collision due to system trouble	67 injuries, including 7 serious injuries
March 2000	Tokyo, Japan	Derailing of subway train and collision with another train due to rail problem	5 deaths, and over 60 injuries
June 2000	New York, America	Derailing of train	89 injuries
August 2000	Paris, France	Derailing of train due to over speed	24 injuries
November 2000	Salzburg, Austria	Fire accident and collision with another train due to mechanical trouble	155 deaths, and 18 injuries
January 2003	London, England	Derailing due to mechanical trouble	32 injuries
February 2003	Daegu City, Korea	Arson	198 deaths, and 147 injuries

August 2003	London, England	Power failure in a large area	Nearly two thirds of the subway operation was suspended, and about 250000 persons were trapped in subway
February 2004	Moscow, Russia	Bomb explosion	At least 40 deaths and 100 injuries
January 2005	Bangkok, Thailand	Train collision due to artificial factors	212 injuries
July 2005	London, England	Successive explosion	52 deaths, and over 700 injuries
September 2005	Valencia, Spain	Collision of subway train	42 injuries, including 2 serious injuries
September 2005	Chicago, America	Derailing of lightweight railway train	1 deaths, and 83 injuries, including 17 serious injuries
July 2006	Valencia, Spain	Derailing and overturn of train due to overspeed	41 deaths, and 47 injuries

(1) Domestic Subway Accidents

Two subway trains collided on No. 10 subway line of Shanghai at 14:51 on 27th of 2011, which caused 271 injuries. Manual dispatching was adopted for subway tariff from Jiaotong University station to East Nanjing Road station on No. 10 subway line of Shanghai due to trouble in signal equipment at 14:10 that day. No. 5 subway train collided with the rear end of No. 16 subway train in the interval tunnel from Yuyuan to Laoximen at 14:51 due to sudden power failure of the equipment that day and suspension of operational signal. The operators of the No. 10 subway line adopted manual dispatching for traffic. However, failure to strictly abide by relevant management rules by the relevant personnel led to the accident.

Cause of accident: The company has many emergency plans. However, as the trains shall go through maintenance and repair at night, and it is hard to carry out exercise during the operational peak period during the day, exercise has not been properly and fully carried out. Moreover, emergency exercise against fire accident, terrorist attach, and passenger evacuation etc. is carried out once a month on average, while there are rather few exercises on operational dispatching. The trains depend more on automatic system after installation of automatic safety orientation system, and almost no exercise on manual dispatching has been carried out.

Preventive Measures against Accident during Operational Period

The subway trains operate in a single direction under the semi-sealed underground space, and there is poor ventilation in the tunnel. Thus passenger evacuation will be greatly restricted in case of accident. On the other hand, trains can carry a large number of passenger, and belong to a public place with a high concentration of personnel and a rapid public means of transport with a high mobility of personnel, thus it is impossible to carry out strict security check for the passengers like trains and plane. Therefore it is subject to terrorist attack such as arson, explosion or biochemical attack etc., and the project needs to refer to the accident emergency plan of the operating subways at home and abroad to formulate strict preventive measures.

Floodproofing measures for entrance during operation period: the subway station entrance shall be designed according to 100-year return period standard and be 15cm-45cm higher than the ground surface. In emergency, the station shall reserve 1m

high waterproof baffle plate to insert in case of emergency to avoid the flood generated from rainstorm entering the underground station.

(2) Formulate emergency plan and carry out mimic exercise

It is hard to totally eradicate accident and disaster, thus great attention shall be paid to formulation of emergency plan. “Prevention first” is the principle for safe and normal operation of subway. Preparedness ensures success, unpreparedness leads to failure. Different accident calls for different emergency disposal methods. The personal casualty and loss of property caused by accident and disaster cannot be minimized unless several emergency plans against emergency accidents are formulated in advance, and emergency handling capacities against emergency accident are strengthened. Rapid response and proper measures are key to disposal of emergent accidents and disasters. Emergency plan is a necessary supplement to daily safety management work, which include the major contents as follows: organization and formation of commanding system, and configuration of emergency equipment(mainly including alarming system, rescue equipment, firefighting facilities, and telecommunication equipment etc.), accident handling and restoration of normal operation. It is quite necessary to carry out mimic exercise on emergent handling of accident to prevent accident and guarantee safe subway operation in addition to strengthening ideological education on safety among employees, improve the awareness of group safety, perfecting various rules and regulations, and strictly implementing labor disciplines and operational disciplines, and establishing safety supervisory management organ. Strengthen awareness of safe production among all members and gradually improve the emergency capacities, capacity of concerted cooperation and comprehensive rescue capacity for accident of various specialties and types of work to serve the purpose of tampering employees. For example, Beijing subway has carried out mimic exercise named “prior emergency handling in case of train parked in the tunnel due to explosion” at Jianguomen station.

(3) Handling Countermeasure after Accident---Safe Evacuation of Passengers

According to the experience and lessons drawn from significant subway accidents throughout the world, failure to rapidly and safely evacuate passengers in time is an important reason for serious consequences. Thus rapid and timely safe passenger evacuation is an extremely important content in the whole subway safety system. A perfect safe passenger evacuation program shall be as much detailed and specific as possible. In case traffic cannot be restored within one to two hours, the subway company shall lose no time in contacting bus company and establish dedicated buses to different areas at each subway entrance to effectively evacuate passengers. The subway company shall undertake the responsibility of informing passengers after occurrence of accident instead of neglecting or even ignoring the right to know of the passengers under the excuse of “trouble”, which will cause horror and disorder among the passengers.

(4) Establish expert system for handling accident

Analysis and handling of subway accident is a complex technical work that involves much experience, and there are many reasons for subway accident. Rapid, effective and accurate identification of the reason for the trouble and taking effective measures to restore normal operation of the subway in time is work that is worthy of in-depth

research. Computer technology has been extensively integrated with engineering techniques such as safety management, safety assessment and risk analysis and prediction etc. in the field of safety science, and has promoted the development process of safety science. Safety analysis, accident diagnosis and safety decision making etc. can be carried out through accurate and rapid scientific calculation function of computer. At present, computer monitoring system is generally installed on subway. However, status monitoring function has not been fully performed, and a backstage trouble handling and analyzing system is needed to realize disposal of the monitoring signals, and fully realize intelligent monitoring of the system and improve the utilization rate of the whole monitoring system. There is a large amount of knowledge and experience at expert level in some field in the expert system, which can dispose of the problems in such field by utilizing the knowledge and means of solving problems of human expert. Disposal measures can be rapidly obtained through utilizing the expert's experience to assist managerial personnel in disposing of accident and improving the safe economic operational level of subway. The expert system for handling subway accident is established on such basis. Once accident and disaster happen, the trains running on the whole route cannot go on operating according to the original prescribed operational chart, and the central control room must make scientific and accurate adjustment of all the trains in time. The ineffective management of the central control room in the arson case of the subway in Daequ of Korea led to failure to stop another train from running into the station that had caught fire and increase in the number of casualties, while most of the dead persons were the passengers in the second train.

Automatic train control system shall include automatic train dispatching system in case of emergent accident and disaster. Such automatic dispatching system shall be a real-time expert system, and the automatic dispatching software shall be composed of fact base, rule base, reasoning machine and data blackboard etc.. The fact base is mainly for storing static facts related to reasoning; rule base is mainly for storing expertise of dispatching experts, for example, judging rules for trouble, and rules for adjusting operational chart etc.; The reasoning machine simulate the thinking modes of the dispatching experts, and utilize the rules in the rule base according to the facts in the fact base to carry out reasoning step by step. The intermediate structure of reasoning is temporarily stored on the data blackboard. Automatic dispatching system will formulate new train operational program in time to prevent aggravation of disaster.

(5) Safety Summary for Operational Period

As a large-capacity public means of transport, the safety of subway is directly related to the life safety of massive passengers. Safe operation is the primary objective and basic principle for subway transport. Transport safety of subway is a huge and complex systematic project, and the major factors influencing safe operation of subway are mainly people, vehicle, rail, power supply, signal and social disaster etc.. The subway operational management department shall do well in the following aspects:

Strengthen publicity and education for passengers and staffs;

②Equip advanced equipment and testing system;

③Establish monitoring and alarming system;

④Formulate emergency program;

⑤Carry out mimic exercise

⑥Pay attention to emergent evacuation of passengers after occurrence of accident

8.2.2 EHS and Mitigation Measures of Noise and Vibration during Operational Period

The equipment of high noise during operational period mainly comes from noise and vibration during repair at the subway depot; the noise and vibration produced by the operating trains.

The workers who are exposed to high-noise operation in the repair workshop of the depot for a long time shall wear ear plug etc.. The driver and crews of the subway train shall shorten their working time and receive regular physical check to guarantee physical and mental health.

8.2.3 EHS Analysis and Mitigation Measures for Air Environment during Operational Period

Due to relatively sealed underground space, limited air circulation, and lack of direct shining, subway system is subject to contagious diseases. The research literature publicized by WHO and America EPA shows that generally the interior air pollution level is 2 to 5 times that of external atmospheric environment, and 100 times in extreme cases. The seriousness of air pollution in underground subway station which is more sealed is self evident, which will cause hidden danger to the heath of the staffs working in the subway station for a long time.

Normal operation of the ventilation system shall be guaranteed and regular air quality test shall be carried out to lower air pollution in the underground space.

Non-poisonous pesticides and herbicide shall be used during greening of the subway depots, the parking lots and transformer substation during operational period.

8.2.4 EHS Analysis and Mitigation Measures for Electromagnetic Environment during Operational Period

As shown in analogical data, the maximum value of electromagnetic noise in the subway working zone is 61 dB(μV/m), which is equal to 1125μV/m; The possible maximum value of radio noise of the spark radiation formed through contact with the rail line is 108.5 dB(μV/m), which is equal to 0.25V/m. The aforesaid two values are smaller than the “output limit for public luminance” in “Protective Rules for

Electromagnetic Radiation". Thus it will not cause adverse influences on physical health of the staffs.

8.2.5 EHS Analysis and Mitigation Measures for Dangerous Solid Wastes during Operational Period

The dangerous solid wastes of the project are mainly the waste oil and dregs produced by oil-bearing waste water treatment system of the subway depots and the parking lots wiping tarpaulin of various processes, and waste transformer oil. The waste oil and dregs produced by the oil-bearing waste water treatment system, and wiping tarpaulin of various processes, and waste transformer oil belong to class HW08 in the "State List of Dangerous Wastes", and such dangerous wastes shall be entrusted to relevant qualified units for harmless disposal. The staffs shall wear protective gloves and masks when exposed to such pollutants.

8.3 Conclusion

(1) Risk during construction period mainly occurs during digging of base pit or interval tunnel. Improper selection of construction methods tends to cause uneven settlement, ground collapse or bulging; Accidents such as collapse, roof fall, sand gushing water gushing, and water transmission etc. tend to happened during construction due to influences by multiple factors such as geological and hydrological factors etc.; Improper selection of construction methods and retaining program will cause breakage of adjacent underground pipelines or cracking, leaning or even collapse of surrounding constructions. Major risk source during operational period: The major risks and accidents during operational period come from social hazards such as arson or terrorist attack etc., and the accidents due to improper operation by staff and mechanical failure etc.. The aforesaid accidents have not only caused huge economic losses and tend to cause personal casualty and significant social influences.

(2) The stratum are mainly earth with medium within the depth of 30m under the line(K0+0.000~K25+200) and underground stations(Xinliu Road Station, Shamen Road Station, Xinglongpu Road Station, Dongfeng Road Station, Nongye Road Station, Huanghe Road Station, Jinshui Road Station, Taikang Road Station, Er'qi Square Station, Shuncheng Street Station, Dongdajie Station, Chengdong Road Station, Future Avenue Station, South Fengtai Road Station, Zhongzhou Avenue Station, Tongtai Road Station, East Huanghe Road Station, East Nongye Road Station, Zhongxing Road Station, Boxue Road Station, East Hanghai Road Station), the characteristic are high compressibility, low strength and poor stability. The area belongs to area with medium risk level of geological disaster. The major categories of geological disaster are ground collapse, ground fissure, ground precipitation and uneven ground settlement. Meanwhile, the subway station is constructed by means of opening digging and cover digging, and extraction and drainage of a large quantity of underground water in base pit tends to cause sudden decrease in underground water level and drifting sand, regional ground settlement and collapse, and deformation and cracking etc. of surrounding buildings. As No.3 subway line runs across the bridge piles such as Beihuan and Nanyang Road approach bridge, Nanyang and Jinshui Road

approach bridge, Zhongzhou Road and Shangdu Road approach bridge, the elevated bridge of Longhai railway line and Shiwu highspeed railway line etc,, and tends to cause settlement and deformation of the aforesaid buildings or structures, and many overturn the structures and endanger safety in serious cases.

(3) Carry out pre-construction investigation and design of risk sources during construction period, and establish environmental safety classification system for construction period, adopt new construction techniques and technology, strengthen monitoring and measurement during construction, establish environmental safety technical management system for subway construction, and formulate emergency measures to lower risk.

As No.3 subway line runs across the bridge piles such as Beihuan and Nanyang Road approach bridge, Nanyang and Jinshui Road approach bridge, Zhongzhou Road and Shangdu Road approach bridge, the elevated bridge of Longhai railway line and Shiwu highspeed railway line etc, and various of municipal fundamental pipes,, it is necessary to carry out strict monitoring and monitoring measures against structural deformation of the tunnel, ground settlement, structure deformation and settlement etc.. Adopt earth pressure balance shield and select optimal construction parameters to ensure stable cutting face; strength the synchronous grouting and necessary supplement measures to control the settlement of structures, meanwhile it is necessary to take ground reinforcement measures.

Supporting and water-stopping measures such as diaphragm wall, drilling hole pile plus water seal curtain etc. have been adopted for subway stations constructed by means of open digging and semi-cover digging of the project to control drainage and extraction of underground water and prevent ground settlement. Meanwhile, observe settlement of the surrounding buildings of the base pit, and monitor the underground water level etc..

(4)Take risk management measures such as strengthening publicity and education for passengers and staffs; Equipping advanced equipment and testing system; Establishing monitoring and alarming system; Formulating emergency program; Carrying out mimic exercise; strengthening emergent evacuation of passengers after occurrence of accident to lower the possibility of risk and personal and property losses caused thereby;

9 Dismantlement and Immigration Relocation

9.1 Immigration Information:

The project will have social impacts related to the need for land acquisition and demolition of a number of structures like houses or enterprises. Based on the survey, about 767 people from 239 families will be affected by the acquisition of 55.3 ha of land, including 52.4 ha of collectively owned land; about 1,308 people from 449 families will be affected by the demolition of 35,347 m2 of private houses; and about 1,026 employees from 264 enterprises, institutes and small shops will be affected by the demolition of 66,313 m2 of structures.

9.2 Impact of the Project

The areas impacted by the phase 1 project of No. 3 Zhengzhou rail traffic line under World Bank load are totally concentrated within Zhengzhou city. As for the administrative division, the impacted areas of No. 3 line include 6 district units such as Huiji District, Jinshui District, Er'Qi District, Guangcheng District, Zhengdong New Zone and Zhengzhou Economic& Technological Development Zone. See Table 9.2-1 for the stations, parking lots and depots involved by each district:

Table 9.2-1 Distribution of Stations and Depots of Phase I Project of No. 3 Zhengzhou Rail Traffic Line

Series No.	Administrative District	Station
1	Huiji District	Xinliu Road Station, Shamen Road Station, Xinglongpu Station, Dongfeng Road Station, Depot
2	Jinshui District	Dongfeng Road Station, Nongye Road Station, Huanghe Road Station, Jinshui Road Station, Weilai Road Station, South Fengtai Road Station, Zhongzhou Avenue Station
3	Er'qi District	Taikang Road Station, Er'qi Square Station
4	Guancheng District	Shuncheng Street Station, Dongdajie Station, Chengdong Road Station
5	Zhengdong New Zone	Zhongzhou Avenue Station, Tongtai Road Station, East Huanghe Road Station, East Nongye Road Station, Zhongxing Road Station, Boxue Road Station
6	Zhengzhou	East Hanghai Road Station, Depot

According to the project characteristics, the major project influences include:

(1) Permanent land occupation: Various kinds of lands to be occupied permanently within the land area occupied by the project, including the collective land

requisitioned by depots and parking lots, and the urban state-owned construction land requisitioned for construction of subway entrance, exit and ventilation pavilion.

(2) Temporary land: Various kinds of lands temporarily occupied during construction period whose original functions may be resumed after construction;

(3) Dismantled Buildings: All the buildings within the land occupied by the project, mainly including framework structure, brick-concrete structure, brick-wood structure and simple structure etc.;

(4) Land attachment influenced: The land attachment within the land occupied by the project, mainly including enclosure walls, wells, fruit trees and elevation etc..

(5) Public facilities influenced: The public facilities and public service facilities within the influences of the project;

(6) Influenced households: The households with land, buildings or land attachment within the land occupied by the project, or direct influences;

(7) Influenced communities: The communities with land, buildings or land attachment within the land occupied by the project, or direct influences;

(8) Population influenced by project: The populations of the households, enterprises and institutions influenced by land requisition and relocation constitute the populations influenced by the project;

(9) Labor forces influenced: Labor force engaged in agricultural production on the land requisitioned;

(10) Disadvantaged groups: Disadvantaged groups refer to the social groups that are subject to damage, lack adaptability to social changes and are adversely positioned in society due to capacity of social participation, social security, disability and poverty etc.. The disadvantaged groups mainly include the following types: households that enjoy the minimum living security, single elderly, female single-parent families, orphans and the disabled etc..

(11) Tenants influenced: All the populations that rent or carry out business activities inside the buildings influenced by the project according to the agreement;

9.3 Project Land Requisition and Relocation

(1) Quantity of Land Requisitioned

The project requisitions 829.68 mu of land in total, including 786 mu of collective land, and 43.68 mu of state-owned land. The current situation of the collective land requisitioned is vegetable field, arable field, fruit farm and woodland. All the state-owned land requisitioned is totally state-owned construction land.

Moreover, the total temporarily occupied by the phase 1 project of No. 3 line is 500 mu in total, and all of the land is state-owned construction land. Enclosed construction

is mainly carried out for the part of the current traffic roads, and will be restored to original conditions after completion of the construction.

As for distribution, all of the collective land requisitioned by the project lies at parking lot and depots(786mu in total). See Table 9.3-1. The land occupied by other stations is state-owned construction land. See Table 9.3-2 for the area of the state-owned land occupied by each station.

Table 9.3-1 Collective Land Occupied by Phase 1 Project of No. 3 Line Unit: Mu

	Vegetable Field	Arable Land	Fruit Garden	Woodland	Other Land	Total	Number of Households Influenced	Number of People Influenced
I. Parking Lot	82	96	0	0	35	213	148	477
Laoyechen Village	34	96	0	0	23	153	108	345
Gucheng Village	48	0	0	0	12	60	40	132
II. Depot	0	115	112	287	59	573	91	290
Dawang Zhuang	0	44	44	110	22	220	35	118
Shanwang Village	0	36	36	90	18	180	29	91
	0	35	32	87	19	173	27	81
Total	82	211	112	287	94	786	239	767

Table 9.3-2 Areas of Permanently Occupied State-Owned Land at Each Station of Phase 1 Project of No. 3 Rail Traffic

Series No.	Station	Area of Land Requisitioned(Mu)
1	Xinglongpu Station	7.45
2	Dongfeng Road Station	3.43
3	Nongye Road Station	5.69
4	Huanghe Road Station	5.44
5	Jinshui Road Station	6.42
6	Taikang Road Station	2.25
7	Shuncheng Street Station	1.63
8	Dongdajie Station	0.30
9	Chengdong Road Station	2.73
10	Weilai Road Station	4.21
11	South Fengtai Road	0.00
12	Zhongzhou Avenue	4.12
Total		43.68

(2) Quantity of Relocation

Totally 101,660 square meters of various kinds of buildings are to be dismantled for phase 1 project of No. 3 Zhengzhou rail traffic line. Such buildings include 35,347 square meters of private residences, 66,313 square meters of various kinds of

buildings such as enterprises, institutions and shops, involving 449 households, 264 enterprises, shops and institutions and 1,026 employees influenced by relocation.

Table 9.3-3 Survey of Influences due to Relocation of Phase 1 Project of No. 3 Zhengzhou Rail Traffic Line

Series No.	Station	Number of Residents(Household)	Residential Area (Square Meter)	Enterprises and Shops	Employees	Business Area(Square Meter)
3	Xinglongpu Station	116	10056	18	119	5564
4	Dongfeng Road Station	111	7218	34	139	8471
5	Nongye Road Station	24	1250	18	114	6976
6	Huanghe Road Station	69	4175	61	128	11607
7	Jinshui Road Station	0	0	41	90	10375
8	Taikang Road Station	129	12648	30	39	528
10	Shuncheng Street Station	0	0	9	45	6730
11	Dongdajie Station	0	0	1	10	600
12	Chengdong Road Station	0	0	19	77	5277
13	Weilai Road Station	0	0	2	180	7224
15	Zhongzhou Avenue	0	0	31	85	2961
Total		449	35347	264	1026	66313

9.4 Influenced Objects:

(1) Populations Influenced by Land Requisition

239 households and 767 persons have been influenced by land requisition, including 148 households(477 persons) influenced by parking lots, 91 households(290 persons) influenced by depots.

(2) Populations Influenced by Relocation

Relocation project at each station of phase 1 of No. 3 line involves 22 enterprises and units, involving 449 private families, and influencing 1,308 persons. 264 enterprises, institutions and shops will be relocated, involving 1,026 employees.

As for relocation and land occupation caused by the project, Zhengzhou Municipal Rail Traffic Construction& Management Office has entrusted Wuhan University to make comprehensive RAP that meets the requirement of OP4.12 to fully restore the life of the immigrants and sufficiently compensate the losses, and maintain and even improve the living level. See RAP of the project for specific contents. The project will be supervised by internal and external monitoring agencies for implementation of

RAP.

9.5 Environmental Impact Analysis and Comments on Relocation

9.5.1 Rationality Analysis on Relocation

(1) No Economic Influences

Influenced relocated households, enterprise, and shop owners and employees can receive rational monetary compensation or relocation compensation in kind, and various land attachments influenced have been compensated according to replacement cost. No labor force influenced will lose job permanently due to influences on their units or land requisition.

(2) Public Facilities Improved

The public facilities of the community and the community environment etc. influenced by the project will be restored to level before relocation, and efforts will be made to improve them. The relocated areas are mainly located around each station, and the dismantled houses will be replaced by new urban infrastructure, and will be planned and constructed according to urban rail traffic as a whole. The traffic facilities and commercial supplementary facilities around each relocated station will be improved in essence, and the community environmental will be improved fundamentally after project completion.

9.5.2 Influences of Relocation on Employment and Economic Income

(1) Influences of Relocation on Employment

Mainly 264 shops will be influenced during relocation, involving 1,026 shop employees. The shops cannot operate during relocation, and employment of the aforesaid employees will be influenced. In addition to he relocation compensation for the aforesaid relocated shops, temporary relocation subsidy in the amount of 4% of the appraised price of the relocated buildings in the real estate market will be paid for the enterprises and shops that have suspended production or business due to relocation.

(2) Influences of Relocation on Economic Income

The means of compensation for relocation this time includes monetary compensation and compensation in kind to guarantee the economic income thereof will be increased instead of being lowered due to relocation.

Compensation for houses dismantled: The influenced populations can obtain suitable residences from the market on their own through monetary compensation, or resettlement houses will be arranged for house replacement for the relocated

households, thus the normal living conditions thereof will not be influenced due to project construction and relocation.

Compensation for land requisition and relocated enterprises: production resettlement and restoration is to restore the normal production and business activities of the influenced populations due to land requisition or relocation of the project, including compensation or replacement of the business venues of the enterprises and shops, compensation for relocation and transition, and losses due to suspension of production so that the influenced populations will obtain production and business conditions and income no lower than the original conditions. Meanwhile, proper arrangement will be made for the long-term living of the peasants depending on the requisitioned land to guarantee their living level will be improved instead of being lowered due to land requisition.

9.5.3 Environmental Impact Analysis in Relocation Zone

The major environmental impacts on the relocation zone during dismantlement and relocation are the environmental noise influences due to dismantlement of surrounding old houses, and the impacts due to construction dust and construction rubbish.

The major source of impacts of environmental noise is the noise caused due to operation of relocation construction machinery, with the maximum noise exceeding 100dB. In addition, the aforesaid houses involved in relocation lie in urban center with dense concentration of surrounding buildings and a high density of population. Therefore there is a large number of populations influenced by noise of relocation. However, due to short relocation cycle, it is necessary to do well in construction organization program, and select equipment with low noise if possible and avoid explosion operation while doing well in publicity for the surrounding residents and units. Generally, the noise caused by relocation is acceptable for the residents.

Dust pollution will be caused due to destruction of buildings during relocation, and the pollution index such as PM2.5 in the air will be greatly increased in case of great wind. Thus it is necessary to avoid great wind during relocation and do well in water sprinkling and dust reduction.

A lot of construction rubbish will be produced during relocation, and Zhengzhou municipal administrative department shall carry out coordination. The construction rubbish shall be disposed of in the construction rubbish site or landfill site of Zhengzhou city.

9.6 Environmental Protective Measures for Relocation

9.6.1 Planning and Design

The specific measures during project planning and design are as follows:

Carry out program optimization, comparison and selection, and give more

consideration to the influences of project construction on local social economy; Try to utilize the empty lands and greening land on both sides of the urban roads if possible to reduce occupation of the existing roads and urban built zones in case land occupation is unavoidable.

Carry out site survey repeatedly when relocation is unavoidable; Reduce amount of relocation and provide convenience for travelling by urban residents if possible according to the layout characteristics of surrounding traffic facilities and municipal facilities while meeting the basic travelling demands of the subway passengers.

Give sufficient consideration to the factor of land requisition and relocation, and reduce the amount thereof when comparing different design programs.

9.6.2 Project Implementation

The rail traffic group relocation office will take the following measures during construction of No. 3 rail traffic line to reduce inconvenience brought to influenced populations as much as possible.

(1) Rationally arrange construction plan and traffic organization design to lower the influences of subway construction on the surrounding environment and traffic order. Carry out scientific design and reduce enclosure area to the greatest extent during enclosed construction while giving sufficient consideration to various influencing factors and complete excavation and backfill within the shortest possible time; Construction shall avoid peak time on crossroads with busy traffic; It is strictly forbidden to carry out rude construction and destroy the original pipelines. In addition, necessary warning signs, lamps and guiding marks shall be established for convenience of passage by passengers and vehicles. The site shall be cleaned and traffic shall be opened in time after completion of construction.

(2) The deserted earth dug out during engineering construction shall be transported in time, and shall not exceed load limit during transport. Measures shall be taken to guarantee no littering of earth from the transport vehicle on the way. The earth on the wheels shall be washed clean before the vehicle runs out of the site to prevent littering of earth everywhere and influencing environmental tidiness. Meanwhile, cleaning system shall be carried out for the roads in front of the gate of the construction unit, and the deserted soil, if any, shall be cleaned in time.

(3) Project construction shall not be carried out between 10 pm to 8 am on the next day within 200 meters to the residential area. Meanwhile, the construction unit shall give priority to that during selection of construction equipment and methods, and shall adopt low-noise machinery. Noise elimination or control measures shall be taken for the construction machinery for the construction site that carries out construction at night and influences surrounding residents. Meanwhile, establish temporary sound screen etc. around the construction site, or in areas with concentrated residents to guarantee sonic environmental quality of the residential areas.

(4) The project construction unit shall contact the local environmental sanitary department, and clean the domestic wastes on the construction site in time to guarantee site tidiness of the construction area.

9.6.3 Requirements for Environmental impact assessment during Relocation

(1) Select low-noise equipment during dismantlement of buildings and avoid explosion operation if possible. It is forbidden to carry out relocation at night(22：00~6:00) .

(2) It is forbidden to carry out dismantlement and relocation in case of great wind. Do well in water sprinkling and dust reduction during relocation.

(3) The construction rubbish produced during relocation shall be disposed of in the construction rubbish site or landfill site。

10 Public Participation and Public Notification of Information

10.1 Purpose of Public Participation in Investigation

Public participation, as an important part of environmental impact assessment and an effective method to better the decision making process, will help develop practical alternatives and design plan as well as mitigating measures, win public support and understanding from the general public and mitigate project construction's impact on social, economic and environmental aspects. By public participation, the government, social groups and the general public along the route whose essential interest would be affected get informed of the project construction and the possible environmental impact, and give feedback and suggestions so as to make the design plan more appropriate and acceptable and minimize the project's impact.

10.2 Means and Process of Investigation

According to "Methods for Environmental Impact Assessment of the PRC" and "Probationary Methods for Public Participation in Environmental Impact Assessment" issued by State Ministry of Environmental Protection, and the requirements of business policies of the World Bank, we have carried out public participation activities by means of carrying out public notification of information, issuing public questionnaire, holding informal discussions, carrying out monographic cooperation and holding information release conference etc. during assessment.

At present, monographic cooperation, online public notification, the first run of questionnaire on public participation, public notification on network, public notification of texts, the second run of questionnaire on public participation, and the public notification of environmental impact assessment report will be carried out before assessment by the World Bank. See Table 10.2-1 for details:

Table 10.2-1 List of Public Participation in Investigation

Round	Duration	Means	Contents of Investigation	Result
1	May 2012	The first online public notification	Inform general engineering information, collect public opinions toward project	One person called to ask questions about stations along the line. No feedback on environmental protection received from the public
2	Dec. 2012	The first questionnaire	Status quo on environment, the attitude to subway construction	Support by 91.76% of the public
3	Nov. 2011	Monographic	Project design plan, station	Collection of comments

Round	Duration	Means	Contents of Investigation	Result
	~ Aug. 2012	cooperation	locations and optimal layout, consultation activities on emigration and resettlement such as impact of land requisition and demolishment, land compensation, the resettlement method and willingness	and suggestions
4	Jul. 19 2013	The first announcement on newspaper	Inform general engineering information, collect public opinions toward project	No feedback on environmental protection received from the public
5	2009-2013	Expert consultancy and lecture	For details, see 10.3.4	Guide the EIA institution to conduct EIA
6	2009-2013	coordination meeting between governments and associated departments	For details, see 10..3.5	Guide the EIA institution to conduct EIA
7	2009-2013	Expert evaluative meeting	For details, see 10..3.6	Analyze the project and give instructions
8	Aug. 2013	Public announcement	EIA on Project of Rail Transit #3, Zhengzhou	No feedback on environmental protection received from the public
9	Aug. 2013	The 2nd questionnaire	Collect comments of the public on the measures proposed	The public expect implementation of the project according to the determined measures; See feedback information form for specific information
10	Aug. 2013	The 2nd announcement on newspaper	Environmental impact measures, in brief edition Ask for comments and suggestions	No feedback on environmental protection received from the public
11	Aug. 2013	Public-involved symposium	For details, see 10.3.7	Analyze the project and give instructions
12	Aug. 2013	the 2nd online public announcement	Project environmental impact, key points in measures to be taken, conclusion. The brief edition of EIA	No feedback on environmental protection received from the public
13	Aug. 2013	Text public announcement	The brief edition of EIA for Phase-I f Rail Transit #3 Project, Zhengzhou, made public	No consultation on environmental protection received from the public
14	2013	The 2nd text public announcement	The brief edition of EIA for Phase-I f Rail Transit #3 Project, Zhengzhou, for the World Bank, made public	Before the WB assessment

10.3 Contents of Public Participation in Investigation

10.3.1 Monographic Cooperation

10.3.1.1 Major Consultative Activity

The Rail Transit Project Management Office (RTPMO) has organized designers, emigration resettlement consultancy bodies, the land requisition and demolishment offices at districts and the sub-district resettlement offices and the impacted population to publicly release information on important topics involved in resettlement planning and carry out consultation. See Table 10.3-1 for the consultative activities that have been done:

Table 10.3-1 Major Activities in Public Notification and Resettlement Information and Consultation

Series No.	Date	Contents of Public Notification and Consultation	Participant	Organizer
1	Nov. ~ Dec. 2011	Project design plan	The designer, RTPMO, the land requisition and demolishment offices at districts, the sub-district resettlement office, and resident representatives from the community in the locality of various stations along the routes	RTPMO, the land requisition and demolishment offices at districts
2	Mar ~ Apr. 2012	Station locations and layout optimization	Wuhan University, RTPMO, the land requisition and demolishment offices at districts, Sub-district resettlement offices	RTPMO
3	Mar. ~ Apr. 2012	Impact of land requisition and demolishment	Wuhan University, RTPMO, the land requisition and demolishment offices at districts, Sub-district resettlement offices	RTPMO
4	Apr. 2012	Compensation for land requisitioned	RTPMO, the land requisition and demolishment office of Huiji District	RTPMO
5	Mar. – Apr. 2012	House Compensation Standards	RTPMO, the land requisition and demolishment offices at districts, the sub-district resettlement office, and resident representatives from the community in the locality of various stations along the routes	RTPMO, the land requisition and demolishment offices at districts
6	Apr, 2012	Social Influences Of the Project	RTPMO, the land requisition and demolishment offices at districts, the sub-district resettlement offices, the impacted population and the impacted enterprises and public institutions	RTPMO, the land requisition and demolishment offices at

Series No.	Date	Contents of Public Notification and Consultation	Participant	Organizer
				districts
7	Apr. ~ May 2012	Means and intent of resettlement	Wuhan University, RTPMO, the land requisition and demolishment offices at districts, the sub-district resettlement offices, the impacted population and the impacted enterprises and public institutions	RTPMO, the land requisition and demolishment offices at districts
8	Jun. 2012	social security of the population whose land requisitioned	RTPMO, the land requisition and demolishment office of Huiji District, the sub-district resettlement offices	RTPMO, the land requisition and demolishment offices at districts
9	Jun. ~Jul 2012	Employment of population losing land	RTPMO, the land requisition and demolishment office of Huiji District, the sub-district resettlement offices	RTPMO, the land requisition and demolishment offices at districts
10	Jul. ~ Aug 2012	Resettlement and restoration of enterprises and shops	RTPMO, the land requisition and demolishment offices of various districts, representatives of the impacted enterprises and public institutions, and the stores	RTPMO, the land requisition and demolishment offices at districts

10.3.1.2. Opinions of Questionnaire on Monographic Cooperation

During the period from Apr. ~ Jul. 2012, the emigration resettlement consultancy team drew one influenced person at the age above 15 from each influenced family out of 108 influenced families for questionnaire on opinions and proposals related to public participation. See Table 10.3-2 for the summary results of survey:

Table 10.3-2 Summary Table for Public Opinions and Proposals

Contents of survey	Opinions or suggestions	Percentages %
I. Are you clear about construction of Rail Transit Line#3?(single-choice)	1) clear	72.22
	2) not quite clear	18.52
	3) not clear	9.26
II. Do you agree to construction of No.3 line? (single choice)	1) Agree	87.96
	2) Object	1.85
	3) Not mind	10.19
III. The benefits that may be brought about by project construction (Multiple choice)	1. Convenient traffic	87.96
	2. Improve urban image	72.22
	3. Improve urban construction environment	75.00
	4. Others	77.78
IV. Adverse consequences that may be caused by project? (Multiple choices)	1. Inconvenient traffic	72.22
	2. Environmental impact	59.26
	3. Loss of residence	30.56
	4. Loss of job	21.30
	5. Others	52.78
V. Do you know about land requisition or resettlement compensation policies of Zhengzhou City? (Single-choice)	1) clear	80.56
	2) not quite clear	12.04
	3) not clear	7.41
VI. Do you have any opinions and proposals toward land requisition and resettlement in the project?(multiple choice)	1. Reduce resettlement as much as possible	85.19
	2. Reduce land requisition as much as possible	50.00
	3. Connect public traffic if possible	107.41
	4. Give as much consideration to life and travelling safety of residents along the routes	90.74
	5. Take measures to reduce pressure on traffic due to construction	98.15
	6. Carry out phased construction, and shorten construction impact cycle if possible	91.67
VII. Intent for resettlement after dismantlement of house	1. Back to Previous residence	41.67
	2. Provide resettlement house	14.81
	3. Provide economically affordable house	16.67
	4. Give compensation in cash and purchase house on our own	22.22
	5. Others	4.63

10.3.1.3 Analysis of Survey Results of Monographic Questionnaire:

The following conclusions can be drawn through analysis of the survey statistical data in Table 10.3-2:

Firstly, it is found from the survey that the influenced population have known more about the Zhengzhou Rail Transit Project and the policies on demolishing compensation for more than 72% of citizens know clearly the Rail Transit Line (RTL)3# and over 87% support its construction. This is because Zhengzhou, in recent years, has conducted large-scaled urban construction, and the land requisition and

demolishing is quite normal to citizens there who also are aware of the relevant policies more or less. In the meanwhile, most citizens are expecting the subway construction and operation to alleviate the increasing urban traffic congestion and so they are more concerned with and sensitive to news about RTL #3.

Secondly, though with expectation and positive support to RTL#3, many citizens are also worried about some potentially negative impact from its construction, for example, land requisition and demolishment will lead some population to residential loss, relocation of enterprises and store may have influence on employment of citizens along the line, and construction at the down-town area may possibly compound traffic congestion causing more difficulties for people travel. For this reason, some citizens proposed some concerns in RTL#3 construction: first, open spaces at both sided of the current roads shall be made as full use of as possible in the construction of the subway inlets/outlets and the kiosks; second, the subway shall be built in an scientific order and shall not affect more on the surrounding environment and traffic. Also, some other citizens suggested building RTL#3 in phases to minimize the negative impact.

Thirdly, the intent of house resettlement: most citizens are willing to resettle in the way of property right transfer. More than 40% of them expect the most to resettle back to their current residence after the Subway stations are built for their current locations are advantageous in residence and environment. Some residents hope to resettle by giving economically affordable housing but are worried that the governments cannot publish such a preferential policy because average households are not qualified for this in normal conditions. About 22% of households are willing to receive money for compensation because from our survey they are known to own more than one houses and their residence will not be affected by construction of RTL#3.

10.3.1.4 Monographic Cooperation---Public Participation in Feedback of Opinions

During the period Apr. ~ May 2012, RTPMO and the Project-related Emigrant Center of Wuhan University, had summarized and generalized suggestions and opinions given by the impacted population during the social/economical investigation on the influenced population and the public participation, and considered or introduced these in their development of the emigrant resettlement action plan. Table 10.3-3 shows feedback toward public participation and consultation opinions to date.

Table 10.3-3 Public Participation, Major Consultation Opinions and Solution Program for Zhengzhou RTL## Project Funded by the World Bank

Issue	Reason and Consequences of Issues	Solution
Influences by land requisition	Villagers of Laoyancheng and Guchengcun, already with insufficient land, will be hard to get employed once their land lost.	1） During the Village-in-City rebuilding, the two villages will be given 10% of total requisitioned land for independent development and operation to compensate for the financial loss to the impacted population. 2） After stations, parking lots and vehicle depots are built for RTL#3, employment opportunities for some auxiliary posts such as securities, cleaners, ticket clerks will be given to competent members of household with land loss in priority.
Influences of resettlement	Construction of entrance and exit and air kiosk will cause resettlement of a certain number of buildings	1） Carry out site survey during project design for many times and try to avoid or reduce passage through concentrated areas of resident's houses, and arrange the exit, entrance and air kiosk on both sides of the current roads; Select the program with the most economic number and structure of constructions when resettlement is inevitable. 2） After the subway inlets/outlets and the kiosks are built and when Zhengzhou RTPMO is building residential buildings over the demolished sites, the original residents shall have the priority right to select and own housing by property right transfer based on previous house's building area.
Influences on enterprises and shops	Firstly, part of the enterprises and shops are to be resettled. Secondly, normal operation of some enterprises and shops are influenced during project construction.	1） Optimize the direction of the routes and establishment of stations, reduce unnecessary land requisition and resettlement, and minimize the number of the enterprises and shops to be resettled. 2） Rationally arrange construction cycle, and control construction cycle as much as possible. 3） Carry out scientific and rational construction organization, and provide convenience to normal operation of the enterprise and shops along the routes. 4） Do not retain the site under the premise safety is guaranteed, and dismantle retaining structure upon completion of construction. 5） Reserve suitable space at the passages of goods of the enterprise to provide convenience to vehicle traffic. 6） Allow enterprises to indicate the operational information of the enterprises and shops along the subway line on the retaining wall.
Destruction of traffic facilities	Subway construction may destruct the current traffic facilities along the line, and leave hidden dangers of safety, which will influence the living and travelling safety of the residents	1) The construction fence walls shall be solid and reliable, and shall be repairs in case of damage. 2) In case construction poses danger to the vehicle lanes or pedestrian lane outside the enclosure, special personnel shall be arranged to carry out site commanding and management; 3) Establish alarming signs on broken road surface or other places with hidden danger;

Issue	Reason and Consequences of Issues	Solution
Environmental and Noise Pollution	Subway construction may cause certain influenes on surrounding environment, and mechanical construction will cause noise pollution.	1) Enclose the construction section if possible, and repair the enclosure wall in case it is damaged. 2) Strengthen site construction management, place the construction materials in order, and clean rubbish in time 3) Cover or clear the exposed dust in time 4) Adopt technology and techniques that control noise of high dB during construction if possible; 5) Construction and operation with high noise is forbidden before 8 am and after 10 pm; 6) Build temporary sound isolation walls etc. to reduce influences on the surrounding residents; 7) Grant suitable compensation for the residents that have received serious noise interference; 8) Monitor the harmful gases during construction and operation, and strictly use eco-friendly construction materials and construction technology
Damage on surrounding houses	Damage to construction outside the line may be caused due to construction and digging of shield tunnel by some residents during construction	1) Inform each owner of the buildings that the project will run across or influence before construction; 2) Carry out comprehensive site survey of the buildings that may be influenced, and put forth disposal plan; 3) Establish liaison mechanism between the construction team and community residents, and carry out dynamic monitoring of the influences on the constructions; 4) Compile popular and comprehensible publicity materials on the possible influences of construction and operation and distribute to community residents. 5) Learn about the regional conditions the line passes by in advance, and make out prevention plan against the possible accident;
Influences on Traffic	Enclosed subway construction has posed greater pressure on the traffic that has long been overburdened.	1) Carry out phased construction instead of comprehensive construction on the whole line to prevent massive blocking; 2) Reserve opening at certain distance during fenced construction, especially the opening shall be larger on roads with larger traffic flow; 3) The enclosure of the construction team shall occupy as little area as possible, and reserve certain traffic space; 4) Immediately clear the site and dismantle the enclosure to restore traffic once construction of some section is completed. 5) Open the micro circulatory traffic network of the surrounding communities in advance; 6) Strengthen information release, and issue traffic guide
Compensation for operational losses	The wage and profit lose of operators cannot be compensated;	Publicize resettlement information earlier to grant operators sufficient time to cope with the influences caused by resettlement; compensate for suspension of production and business according to the certain proportion of appraised price of the building resettled.

Issue	Reason and Consequences of Issues	Solution
Disposal of relation between owners and tenants	All the compensation funds have been granted to the owners, and the interest of the tenants cannot be guaranteed.	The compensation funds are distributed to different people according to ownership relations. The house compensation is paid to the owner, and the compensation for decoration, losses of wage and profit is paid to the tenant.
Enable the populations influenced by the project to fully participate in various project links	Enable the influenced groups to share the project interest, and strengthen the initiative of local government at various levels and masses	Establish complaint and feedback channels for opinions, for example, establish complaint telephone, and suggestion box etc.; establish consultative system; hold informal discussion attended by RTPMO, district requisition compensation office, neighborhood resettlement office, community representatives and influenced populations to jointly negotiate countermeasures to solve the problems.

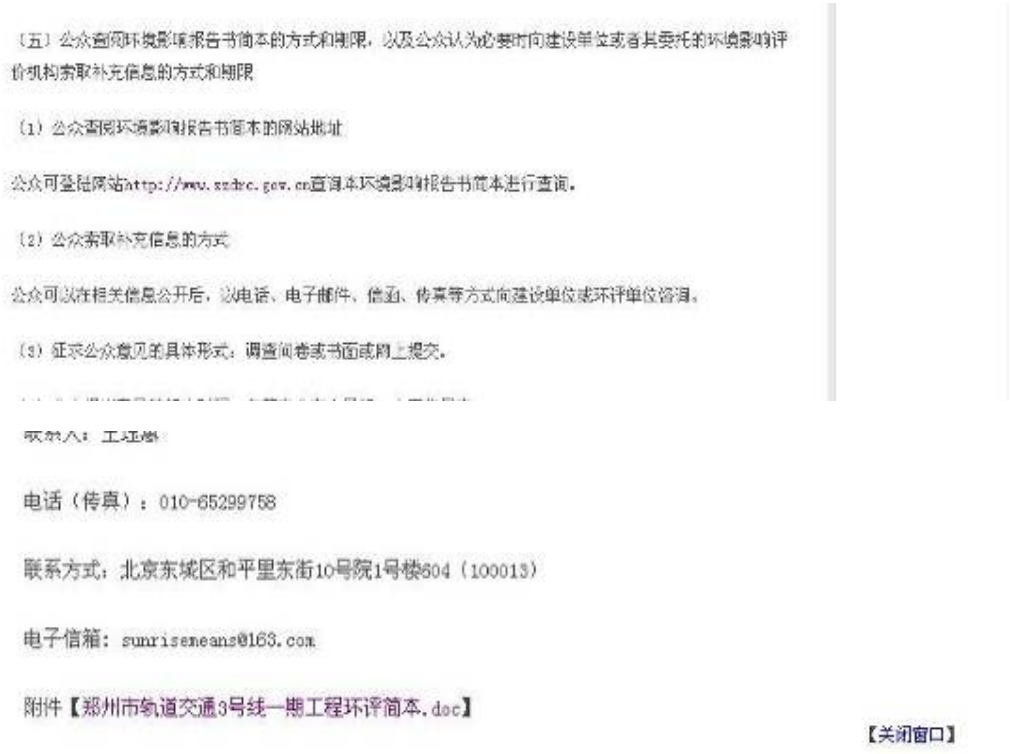
10.3.2 Online Public Notification

As required by "Probationary Method for Public Participation in Environmental Impact Assessment"(H.F[2006] No. 28 document of the State Environmental Protection Administration), the first public notification of information on EIA of Phase-I project of RTL#3 of Zhengzhou City is carried out on the website (http://www.zzdrc.gov.cn) of Zhengzhou Rail Transit Construction Management Office (ZRTCMO) on May 17, 2012.

On 19 Aug. 2013, the 2nd public announcement on EIA of Phase-I project of RTL#3 of Zhengzhou City as well as the brief edition of EIA were posted on the website of Zhengzhou Rail Transit Construction Management Office (http://www.zzdrc.gov.cn) as seen in Figs. 10.3.3 and 10.3.4.

Fig. 10.3.2 The 1st online public notification

Fig. 10.3-3 The 2nd online public notification



（五）公众查阅环境影响报告书简本的方式和期限，以及公众认为必要时向建设单位或者其委托的环境影响评价机构索取补充信息的方式和期限

（1）公众查阅环境影响报告书简本的网站地址

公众可登陆网站http://www.sxdrc.gov.cn查询本环境影响报告书简本进行查询。

（2）公众索取补充信息的方式

公众可以在相关信息公开后，以电话、电子邮件、信函、传真等方式向建设单位或环评单位咨询。

（3）征求公众意见的具体形式：调查问卷或书面或网上提交。

联系人：王经理

电话（传真）：010-65299758

联系方式：北京东城区和平里东街10号院1号楼804（100013）

电子信箱：sunriseneans@163.com

附件【郑州市轨道交通3号线一期工程环评简本.doc】

【关闭窗口】

Fig. 10.3-3 The published brief edition of EIA

In these public notification, the nature of Phase-I project of Zhengzhou RTL#3, the working procedures and contents of EIA, the main instructions on the public comments, how the public is involved, and the expiry date of public participation were described. During the notification period of Aug. 2012 ~ Sep. 2013, altogether one call for a citizen was received to ask questions about station locations on RTL#3, no objection received, nor any feedback stating any substantial negative environmental impact.

10.3.3 Public Announcement on Newspaper

Fig. 10.3-4 Public Announcement on Newspaper

The 1st and the 2nd public announcements on EIA of Phase-I project of RTL#3 of Zhengzhou City were published on Orient Today, an influential local paper in Zhengzhou, for a period of ten working days respectively, in July and August, 2013. During the periods, no citizen called to consult the environmental concerns.

10.3.4 Information Discussion with Experts

During the meeting with experts, the panel discussed issues such as topographic mapping and building safety. For details, see Table 10.3.4

Table 10.3.4 Summary of Expert Comments in the meeting with experts

No.	Date	Location	Means	Contents	Participants	Result
1	Mar. 2013	Henan Engineering Institute of Survey and Mapping	Meeting	Inspection and acceptance of Topographic Survey and Mapping for RTL#3	Henan Engineering Institute of Survey and Mapping, ZRTCMO, and related expert panel	Topographic Survey and Mapping for RTL#3 passed acceptance inspection by Henan Quality Supervision Center for Survey and Mapping
2	Apr. 2009	ZRTCMO	Meeting	Prediction of RTL#3 passenger flow	ZRTCMO, Communication College of Southeast University, China railway Siyuan Survey& Design Group Co., Ltd., China Railway Eryuan Engineering CO., Ltd., Beijing Urban Engineering Design &Research Institute Co., Ltd China Railway Wuyuan Survey &design Group Co., Ltd	To give directions on the RTL#3 Passenger flow prediction report
3	Jul. 2009	ZRTCMO	Meeting	Pre-feasibility of RTL#3	The Planning Bureau, Environmental Protection Bureau, Bureau of Cultural Relics, Water Resources Bureau, of Zhengzhou City, ZRTCMO, the designer	Give directions on development of RTL#3 pre-feasibility report
4	Nov. 2011	ZRTCMO	Meeting	EIA on Zhengzhou Rail Transit Development	ZRTCMO, the designer, The institution for planning EIA	To give directions on preparation of the planning

No.	Date	Location	Means	Contents	Participants	Result
				Planning	preparation, district governments, Environmental Protection Bureau, Municipal Land Bureau, The Planning Bureau, Bureau of Cultural Relics	EIA
5	Dec. 2011	Zhengzhou Infrastructure Survey Institute	Meeting	Assessment of geologic disaster hazards	Experts of the seismic engineering center, Zhengzhou Infrastructure Survey Institute, Geophysical Research Center of State Seismological Bureau	Discuss the concept and the plan to prepare the report on assessing geological disaster hazards in RTL#3 project
6	Dec. 2011	Zhengzhou Infrastructure Survey Institute	Meeting	Assessment of seismic safety	Experts of the seismic engineering center, Zhengzhou Infrastructure Survey Institute, Geophysical Research Center of State Seismological Bureau	Discuss the concept and the plan to prepare the report on assessing geological safety in RTL#3 project

10.3.5 Coordination Conference held by Government and Relevant Departments

In the coordination Conference held by Government and Relevant Departments, such issues as construction safety in railway transit projects, pipeline networks along the line were discussed. For details, see Table 10.3-5.

Table 10.3-5 Summary from coordination Conference held by Government and Relevant Departments

No.	Date	Location	Means	Contents	Participants	**Result**
1	May 2009	ZRTCMO	Meeting	Safety management measures of ZRTCMO	ZRTCMO, Branch of Construction Company, the Surveyor, the designer, the Municipal Construction Commission, The Public Security Bureau, the Civil Defense Office	The safety management measures on Zhengzhou Railway Transit Project Construction were prepared to strengthen safety production and construction management for best code of practice and to ensure safety and health of employees of all involved entities.
2	Nov. 2011	ZRTCMO	Meeting	Investigation of buildings and pipeline network along the line	ZRTCMO, Branch of Construction Company, the Surveyor, the Municipal Construction Commission, Municipal Planning Bureau, Water Resources Bureau, Bureau of Cultural Relics	Give technical support and directions
3	Nov. 2012	Songyang hotel	Meeting	Zhengzhou Urban Railway Transit Construction Planning	ZRTCMO, Municipal party committee, The People's Government of Zhengzhou, DRC, Municipal Construction Commission, Communication Commission, Finance Bureau, The Homeland Resource Bureau, the environmental-protection bureau, Municipal Planning Bureau, Water Resources Bureau, Bureau of Cultural Relics	Zhengzhou Subway Network Planning Proposal discussed

10.3.6 Expert Review Meeting

For this project, the relevant topics and review meetings that have been completed are summarized in the table 10.3-6.

Table 10.3-6 Summary of Expert Review Meetings

No.	Date	Location	Means	Contents	Participants	Result
1	2009.4.29~4.30	Songyang hotel	Meeting	Zhengzhou RTL#4,5,6 passenger flow prediction in prefeasibility	Railway Transit Co., Ltd, Communication College of Southeast University, China railway Siyuan Survey& Design Group Co., Ltd., China Railway Eryuan Engineering CO., Ltd., Beijing Urban Engineering Design &Research Institute Co., Ltd China Railway Wuyuan Survey &design Group Co., Ltd and invited expert panel	The experts reviewed the result documents, and gave comments to further modify and improve the passenger flow prediction reports. For details, see the attachment.
2	2009.7.30~7.31	Songyang hotel	Meeting	Prefeasibility report on Zhengzhou RTL #3	Zhengzhou Municipal Government, Municipal DRC, Finance Bureau, The Homeland Resource Bureau, the environmental-protection bureau, Municipal Planning Bureau, Water Resources Bureau, Bureau of Cultural Relics, the civil defense office, China railway Siyuan Survey& Design Group Co., Ltd., the designer and the invited expert panel	The prefeasibility report considered complete, with basic acceptable technical standards applied. Multiple plans were compared for the main project and the system plan and the technical proposal were feasible. For details see the attachment.
3	2013.1.14～1.16	Zhongzhou Crown Holiday Inn	Meeting	Expert Review meeting on Zhengzhou Railway Transit Construction Planning (2013 ~	NDRC, China International Engineering Consulting Corporation, Henan DRC, Henan Homeland Resource Department, Henan Housing Construction Dept., Henan Environmental Protection Department, Henan Department of	The line network plan is basically in line with Zhengzhou space structure, layout of land use and main traffic corridors and

No.	Date	Location	Means	Contents	Participants	Result
				2019)	Communication, Henan Bureau of Cultural Relics, Henan Civil Defense, Zhengzhou Municipal Government, Municipal DRC, Finance Bureau, The Homeland Resource Bureau, the environmental-protection bureau, Municipal Planning Bureau, Water Resources Bureau, Bureau of Cultural Relics, the civil defense office, ZRTCMO, Fire-brigade, Erqi District, Zhongyuan District, Jinshui District, Guancheng District, Huiji District, Gaoxin District, Zhengdongxin District, Economy Development District, Railway Transit Company, and the invited expert panel	it is necessary to speed up railway transit development at the central urban areas in Zhengzhou. For details, see the attachment.
4	2013.7.1	Beijing	Meeting	EIA meeting on Zhengzhou Railway Transit Construction Planning (2013 ~ 2019)	Railway Transit Company, The EIA preparation institution, Ministry of Environmental Protection, Henan Environmental Protection Department, Zhengzhou DRC, Zhengzhou Environmental Protection Bureau, Zhengzhou Urban and Country Planning Bureau, The Homeland Resource Bureau, Bureau of Cultural Relics, and the expert panel	The Planning is basically in line with Zhengzhou urban planning, environmental protection. Comments were made on further optimization/adjustment and the implementing process. For details, see the attachment.

10.3.7 Meetings for Public Participation

To gain the general public's support, ZRTCMO organized meetings with the district governments (administration committees), the sub-district offices and representatives of the general public along the line to discuss the project. For details, see table 10.3-7.

Table 10.3-7 Summary of Opinions and Suggestions from the Public Participation Meetings on EIA

No.	Date	Location	Means	Contents	Participants	Result
1	2013.8.23 23 Aug. 2013	Songshan hotel	Meeting	Consult the public along the line of Phase-I project of RTL#3 on the routing, the station plan, the construction plan, the environmental protection measure to be taken	The Contactor, the designer, the EIA institution, the Environmental protection bureau of Huiji District, Changxing Sub-district and Liuzhai Sub-district of Huiji District	It is hoped for the project to emphasize noise protection and traffic safety and maintain a free traffic during the construction; flying dust and other environmental pollution must be prevented in strict accordance with the environmental protection measures.
2	2013.8.23 23 Aug. 2013	Songshan hotel	Meeting	Consult the public along the line of Phase-I project of RTL#3 on the routing, the station plan, the construction plan, the environmental protection measure to be taken	The Contactor, the designer, the EIA institution, Jinshui Bureau of Environmental Protection, Nanyanglu and Nanyangxincun Sub-districts and resident representatives of Jinshui District	It is expected to pay attention to the noise and vibration control, and minimize impact on schools and hospitals.
3	2013.8.23 23 Aug. 2013	Songshan hotel	Meeting	Consult the public along the line of Phase-I project of RTL#3 on the routing, the station plan, the construction plan, the environmental protection measure to be taken	The Contactor, the designer, the EIA institution, Erqi Bureau of Environmental Protection, Erqi District, Bureau of Cultural relics, Minggonglujie Sub-district and resident representatives of Jinshui District	Hoping to provide protection to the Erqi Memorial Tower, pay attention to the traffic jam and congestion during construction, to minimize their impact of pedestrian. The Project Owner shall undertake to prepare reasonable measures to make traffic free.
4	2013.8.23	Songshan hotel	Meeting	Consult the public along	The Contactor, the designer,	Strengthen

No.	Date	Location	Means	Contents	Participants	Result
	23 Aug. 2013			the line of Phase-I project of RTL#3 on the routing, the station plan, the construction plan, the environmental protection measure to be taken	the EIA institution, guancheng Hui Ethnic Bureau of Environmental Protection, Xidajie, Dongdajie, Beixiajie, Chengdongjie, erligang and Hanghaidonglu Sub-districts and resident representatives of Jinshui District	management during construction, night work is forbidden. Maintain the traffic free during construction.

Fig. 10.3-5 Pictures taken during meetings with experts, held by governments for coordination, and for public participation

10.3.8 The First Questionnaire

10.3.8.1 Scope and Object of Investigation

Opinion questionnaire on public participation is issued to the residents in adjacent areas along the project for assessment. The objects of survey are the individual public that may be directly influenced by the pollution source of the project.

10.3.8.2 Analysis of Number of Samples in Survey

Totally 300 opinion forms have been issued in the questionnaire, and are mainly distributed to the public of different ages, sexes, educational levels and occupations along the line. 267 forms have been recovered, with the recovery rate being 89%. The opinions therein can stand for various opinions of the social classes. See Table 10.3-8 for the statistical data on the objects of survey:

Table 10.3-8 Statistical Table for Objects of Survey

Category of Project	Mix of Personnel	Number of People	Percentage(%)
Occupation	Institution	24	8.99%
	Enterprise	106	39.70%
	teachers	36	13.48%
	student	24	8.99%
	Retired (Jobless)	40	14.98%
	Others	37	13.86%
Educational level	Middle school and below	117	43.82%
	College and above	116	43.45%
	Blank	34	12.73%
Age Group	<30	34	12.73%
	30-40	87	32.58%
	40-50	92	34.46%
	>50	54	20.22%

10.3.8.3 Contents of Survey Form

The contents of opinion form are as follows:

Public Opinion From for Phase I Project of RTL#3 of Zhengzhou City

name			gender			age		ethnic	
career	Public servant	clerk	teacher	Retired worker	Student	Other	Education level	Middle school and below	College and above
Address								Phone:	

Project Profile: RTL#3 is a backbone line in the central urban areas running all underground from the northwest to southeast, starting at Xinliulu Station close to the Henan Sports Center in the north and ending at Hanghaidonglu Station of No.17 Str. of Economic Development District, through Changxin Road, Nanyang Road, Minggong Road, JIefang Road, West Street, East Street, Zhengbian Road, Shangdu Road and No.17 Street, about 25.2km in total length. It is planned to have 21 stations at the average interval of 1.29 km , a vehicle depot and a parking lot. The project, with total investment of RMB 18.20853 billion, is planned to start building in 2016 and to put into operation at the end of 2020. **Main environmental impacts:** impact arising from land space to be occupied, construction and demolishment, impacts of noise, vibraiton, waste water and solid waste on environment during construction; during the operational period, the main impacts are vibration and kiosk noise, smelling gases, noise of the cooling column, station/plant product, sewage. Now we are conducting the initial work of the project and requesting your comments of the public along the loine on environmental protections during the project implementation. Please fill the following form with your opinions and sugestions.
1. Do you think implementation of the project is beneficial to traffic conditions of Zhengzhou? □Yes □No □I don't know If No, please justify:
2. Are you satisfied with the current road traffic conditions in Zhengzhou? □ Yes □ Just so so □No
3. Are you willing to select subway for travel after completion of the project?□ Yes □ Depends on the price □ Depends on the distance to the stations
4. What are the current major environmental impacts in the local region? □ Noise □ Vibration □ Flying dust □ Others
5、From which aspects do you think your living standard will be impacted during construction? □ Noise □ Flying dust □ Waste water □ Damaged landscaping □ Vibration □ Traffic jam
6、What are the major environmental impacts during the operational period of the project in your opinion? □ Noise □ Vibration □ Water pollution □ Smelling kiosk □ electromagnetic interference □ Damaged cultural relics
7、What do think of the land requisition and demolishment? □ Positively agree □ Agree □ Depend on compensation □ disagree
8、What are your attitudes to impacts possibly during construction of the project? □ acceptable □ Basically acceptable, but mitigations must be taken □ Unacceptable In case of Unacceptable, please justify:
9、For this project, to which do you pay the most attention? □ impact during construction □ impacts during operation □ both □ neither
10、Do you think the social and economic development will benefit from this project? □ Yes □ No □ I don't know In case of No, please justify:
11、What are your attitudes toward project construction? □ Support □ Object □ Don't mind In the case of Object, please justify:
Your additional requirements and suggestions on this project (pages attached)

Respondent: Date:

10.3.8.4 Statistical Data on Results of Questionnaire

See Table 10.3-9 for the statistical data on the results of questionnaire on public participation.

Table 10.3-9 Statistical Table on Results of Questionnaire on Public Participation

Series No.	Item	Contents	Number of Persons(Person)	Percentage(%)	Remarks
1	Do you think implementation of the project is beneficial to traffic conditions of Zhengzhou?	Yes	253	94.76%	
		No	2	0.75%	
		I don't know	12	4.49%	
2	Are you satisfied with the current road traffic conditions in Zhengzhou?	Yes	69	25.84%	
		Just so so	42	15.73%	
		No	156	58.43%	
3	Are you willing to select subway for travel after completion of the project?	Yes	35	13.11%	
		Depends on the price	164	61.42%	
		Depends on the distance to the stations	68	25.47%	
4	What are the current major environmental impacts in the local region?	Noise	75	28.09%	Multiple choices
		Vibration	42	15.73%	
		Flying dust	110	41.20%	
		others	54	20.22%	
5	From which aspects do you think your living standard will be impacted during construction?	Noise	110	41.20%	Multiple choices
		flying dust	88	32.96%	
		waste water	54	20.22%	
		Damaged landscaping	69	25.84%	
		vibration	65	24.34%	
		Traffic jam	172	64.42%	
6	What are the major environmental impacts during the operational period of the project in your opinion?	Noise	89	33.33%	Multiple choices
		Vibration	76	28.46%	
		Water pollution	41	15.36%	
		Smelling kiosk	95	35.58%	
		electromagnetic interference	65	24.34%	
		Damaged cultural relics	18	6.74%	

Series No.	Item	Contents	Number of Persons(Person)	Percentage(%)	Remarks
7	What do think of the land requisition and demolishment?	Positively agree	104	38.95%	Multiple choices
		Agree	86	32.21%	
		Depend on compensation	123	46.07%	
		Disagree	0	0.00%	
8	What are your attitudes to impacts possibly during construction of the project?	Acceptable	55	20.60%	
		asically acceptable, but mitigations must be taken	209	78.28%	
		Unacceptable	3	1.12%	
9	For this project, to which do you pay the most attention?	impact during construction	178	66.67%	
		impacts during operation	37	13.86%	
		both	39	14.61%	
		neither	13	4.87%	
10	What are your attitudes toward project construction?	support	245	91.76%	
		object	0	0.00%	
		I don’t mind	22	8.24%	

10.3.8.5 Analysis of Questionnaire Results

(1) The recovery rate of the inquiry form for public opinion on the environmental impact assessment is 89%, which shows strong awareness of participation in urban construction, and great care about the project construction among Zhengzhou citizens.

(2) Of the Zhengzhou citizens, 58.43% are not satisfied with the current traffic conditions and 94.76% believe that this project will improve it.

(3) Once the project is built, 13.11% of citizens are willing to take subway, 61.42% expressed that whether to take subway depended on the ticket price and 25.47% said it would be dependent on the distance from the stations.

(4) The citizens believes that the current traffic conditions and main impact on Zhengzhou are attributed to flying dust (41.2%), noise, (28.09%), vibration (15.73%) and traffic jam (20.22%) caused by urban construction activities.

(5) The public considers the main environmental impact during construction is the traffic jam and noise. Of the environmental impacts arising from construction, the public are the most concerned with traffic jam (64.42%) and noise (41.20%), followed by flying dust (32.96%), vibration (24.34%), waste water (20.22%) and damaged landscaping (25.84%) in turn.

(6) Of the environmental impacts during operation, the public are the most concerned

with noise (33.33%) and vibration (28.46%), followed by smelling kiosks (35.58%), electromagnetic interference (24.34), water pollution (15.36%), and damaged cultural relics (6.74%) in turn.

(7) For the public's attitude to land requisition and demolishment: 38.95% expressed positively support, 46.07% would subject to the compensation, 32.21% basically agreed and no citizen showed objection.

(8) 91.76% of the general public agreed to construct the project, 8.24% did not mind and no one expressed objection.

10.3.8.6 Treatment on feedbacks from public participation

The main comments from public participation and the treatments are summarized in the table below.

Table 10.3-10 Summary of main comments from public participation and the treatments

No	Main comments	Public citizens	Solutions
1	Routing selected as far from the residential areas as possible to minimize noise and electromagnetic interference	Residents along the line	The subway stations is selected to give full consideration to the current residential areas covering the surrounding areas and facilitating people's going out.
2	Stations to be selected in such a reasonable way that interference with citizens is minimized.	Residents along the line	The subway route is selected under the roads avoiding crossing directly under the residential areas and reducing impact on residents of subway operation. Construction machineries and tools will be arranged reasonably and the work hours will be under strict control to impact of lower noise from construction on ambiences. When construction is performed at some sensitive areas, noise barrier will be used.
3	Measures to be taken to mitigate the impact of land requisition and demolishment (including housing and the stores)	Citizens and stores that will be directly influenced by the project	compensation will be given for land requisition and demolishment (including the housing and the stores) as per relevant policies in Zhengzhou. For detailed measures, see the special report on the emigrant resettlement.
4	Maintain a free traffic to minimize traffic congestion.	Residents along the line	The Project Owner will occupy the current traffic trunk lines as less as possible to minimize impact of construction, full discussion with the traffic administration authorities will be made before any construction begins at a specific location. At the intersections, the pavement nearby will be used to divert traffic flow, and additionally, the vehicle flow will also be diverted. The construction machineries and tools will be required to drive over designated route to reduce the traffic flow on the road under construction and prevent traffic jam.

10.3.8.7 Inquiry of Group Opinions

(I) Scope and Object for Soliciting Group Opinions

The scope of opinion inquiry is the scope of engineering assessment, and the major objects of survey are the village committees, communities, scientific research and educational units and social groups etc. that may be greatly and directly influenced by the pollution caused by the project.

(II) Contents of Table of Opinion Inquiry

[Inquiry Table for Public Opinion on Phase I Project of RT L#3 of Zhengzhou City]

[project profile][environmental impact][environmental protection measures] same as that for individuals.

Entity name	(stamped)		Address:		
Completed by		Date		contact	

1 Your attitude toward project construction: □ Support □ Conditional support □ objection □ Don't mind

2 The main impacts of influence of the project construction on you are

□ Environmental influences(noise, vibration, electromagnetic influence and sewage etc.) □ interference with traffic □ land requisition and demolishment

□ others Please in detail:

3 when you are impacted by the noise from excavation, you hope

□ heighten the fence □ give compensation □ others please in detail:

4 For the temporary impact from construction, you □ may understand □ may understand but mitigation measures are required to take, □ may complain

5. Your attitude toward the environmental protection measures to be adopted in the project and the requirements are:

□ Agree to and satisfied □ to be improved and strengthened(specific opinion:) □ No opinion

6. the measures you hope to take to mitigate noise during operation are

□ Installation of ventilated sound-proof windows □ building of acoustic barrier □ relocation or functional exchange, □ adjusting the route far away from the residential area □ financial compensation □ other please in detail

7the measures you hope to take to mitigate vibration during operation are

□ making it deeper underground □ relocation or functional exchange □ taking vibration isolation measures □ financial compensation □ other

8 for the smelling kiosks, you hope

□ The Project Owner eliminates the smells □ making them far away from the residential area □ relocation

8 If your land is to be requisitioned or you are required to relocate, what is your opinions and requirements

□ Support the project and give positive coordination □ get compensated reasonably as per the national laws and regulations, will not delay the project, □ Others Please in detail

9 Your attitude and requirement on the environmental protection measure to be taken during operation are : □ Agree to and satisfied □ to be improved and strengthened(specific opinion:) □ No opinion

10 The extent of influence of the project construction on you (1) Greatly (2) heavy influence, but can be overcome (3) No influence

11 What are your suggestions and opinions on the environmental impact and the mitigation measures for this project? (pages may be attached to)

Prepared by: Environmental Protection Center of Department of Communication and Transportation

Respondent: **Date:**

(III) Major Results of Inquiry about Opinion

See Table 10.3-11 for the major results of inquiry about group opinions.

Table 10.3-11 Table of Major Results of Inquiry about Group Opinions

Series No.	Entity Name	Contact	Tel.	Address	Major Opinion
1	West Street Sub-district Office	WU Nali	13949031802	No.4 Weixing Str.	Support
2	Nnayang Road Sub-district Office	Yuan DOngmei	13503867122	No. 16 East third Str.	Support
3	Minggong Road Sub-district Office	-	66223152	Intersection of Minggong Road and Erdao Str.	Support
4	Erlingang Sub-district Office	Li Xiaogang	13837191397	No. 38 Huozhan Str.	Support
5	Nanyangxincun Sub-district Office	Ma Lifen	63677263	No.2 Yuejin Road	Support
6	HCnagxing road Sub-district Office	-	63984101	No. 21 Changxing Road	Support
7	Beixia Street Sub-district Office	Deng Yan	66210169	No. 16 Beixia Str.	Support
8	Chengdong road Sub-district Office	Wang Yalin	13598002627	No. 126 Chemgdong Road	Support
9	East Street Sub-district Office	Li Yuchao	15003711631	No.1 Shuyuan Str..	Support
10	Nangyang Road Fire-brigade	Cai Shipei	18203600998	No. 10 Dashiqiao	Conditional support, hoping to maintain a free traffic and free fire-fighting access
11	Huiji District Land Resource Bureau	Guan Jielang	65326360	No. 169 Nanyang Road	Support
12	Zhengzhou Geologic Engineering Institute	Liu Jiangcheng	86680058	No. 56 Nanyang Road	Support
13	Zhengzhou Academy of Grain Science	Li Baojiang	13703951080	No. 153 Nanyang Road	Support
14	North Community of the 2nd Hospital of Zhengzhou University	-	63585996	No. 32 Nanyang Road	Conditional support, requiring reduction of night noise, in interfering with patient rest
15	Huafu Skin Hospityal	Wang Junrun	13526454955	No. 37 Nanyang Road	Support
16	Orient Tumor Hospital, Zhengzhou	Zheng yao	63625298	No. 1353 Nanyang Road	Conditional support, the construction noise interfering patient rest. Reduce the noise during construction and maintain a free access to the hospital
17	Zhengzhou Library	Song Dongdong	63827602	No. 5 Nanyang Road	Support
18	Zhengzhou Art Creation Institute	Shen Sheng	63817615	No. 6 Nanyang Road	Support
19	Tingdao Foreign Language School	Zhang Songqiao	63841890	Dashiqiao road	Support

(IV) Implementation of Group Opinions

See Table 10.3-12 for information on inquiry and implementation of group opinions.

Table 10.3-12 Information Table on Inquiry and Implementation of Group Opinions

Name of Unit	Major Opinion	Implementation
West Street Sub-district Office	None	\
Nnayang Road Sub-district Office	None	\
Minggong Road Sub-district Office	None	\
Erlingang Sub-district Office	None	\
Nanyangxincun Sub-district Office	None	\
HCnagxing road Sub-district Office	None	\
Beixia Street Sub-district Office	None	\
Chengdong road Sub-district Office	None	\
East Street Sub-district Office	None	\
Nangyang Road Fire-brigade	Conditional support, hoping to maintain a free traffic and free fire-fighting access	The Project Owner promises to implement every and each environmental protection measures stated in EIA report.
Huiji District Land Resource Bureau	None	\
Zhengzhou Geologic Engineering Institute	None	\
Zhengzhou Academy of Grain Science	None	\
North Community of the 2nd Hospital of Zhengzhou University	Conditional support, requiring reduction of night noise, in interfering with patient rest	The Project Owner promises to implement every and each environmental protection measures stated in EIA report.
Huafu Skin Hospityal	None	
Orient Tumor Hospital, Zhengzhou	Conditional support, the construction noise interfering patient rest. Reduce the noise during construction and maintain a free access to the hospital	The Project Owner promises to implement every and each environmental protection measures stated in EIA report.
Zhengzhou Library	None	\
Zhengzhou Art Creation Institute	None	\
Tingdao Foreign Language School	None	\

10.3.9 The Second Questionnaire

10.3.9.1 Scope and Object of Survey

The 2nd questionnaire involved 221 areas sensitive to noise and vibration including entities, schools, communities and Catholic churches near or over the 21 stations, 1 vehicle depot and 1 parking lot along the line.

10.3.9.2 Analysis of the Number of Samples in Survey

Totally 900 inquiry forms for opinions have been issued in the survey by questionnaire, which have been mainly issued to the public of different ages, sexes, educational levels and occupations along the project. The interviewees may be mainly those directly influenced by the project construction, and the opinion forms are densely distributed along the routes and around underground stations. 714 forms have been recovered, with the recovery rate being 79.3%. The opinions therein can stand for various opinions of the social classes. See Table 10.3-13 for the statistical data on the objects of survey.

Table 10.3-13 Statistical Table for Objects of Survey

Category of Project	Mix of Personnel	Number of People	Percentage(%)
Occupation	Institution	104	14.57%
	Enterprise	174	24.37%
	Individual Businessmen	198	27.73%
	Student	46	6.44%
	Peasant	32	4.48%
	Retiree (Jobless)	143	20.03%
	Others	17	2.38%
Educational level	Primary School	78	10.92%
	Junior Middle School	87	12.18%
	High School(Secondary Specialized School)	164	22.97%
	Junior College	197	27.59%
	University and Above	155	21.71%
	Blank	33	4.62%
Age group	<30	187	26.19%
	30-40	246	34.45%
	40-50	159	22.27%
	>50	122	17.09%

10.3.9.3Contents of Questionnaire

Project Profile	Phase-I project of RTL#3 starts at Xinliulu Station close to the Henan Sports Center in the north and ending at Hanghaidonglu Station of No.17 Str. of Economic Development District in the south, through Changxin Road, Nanyang Road, Minggong Road, Jiefang Road, West Street, East Street, Zhengbian Road, Shangdu Road and No.17 Street, about 25.2km in total length, connecting urban functional centers such as Erqi Plaza Business Center and the center of Economic Development District. It is planned to have 21 stations at the average interval of 1.29 km , a vehicle depot and a parking lot. The routing is shown in the figure below. 

Main Environmental impacts	The negative impact of the project includes: the project will have some effect on sound/vibration/water/ecologic environment and atmosphere (e.g. vegetation damage, waste water , noise and flying dust from construction) which can be mitigated by the project owner by measures such as reducing noise level, suppressing dust and waste water treatment, within the short period of construction. Through the traffic dispersion, waste water treatment, noise reduction and water spray measures, their environmental impact will be minimized during construction. During operation, the noise and vibration of the fans and cooling column will have adverse effect on residents. By reasonable design and selection of fans and cooling columns, installation of sound-proof hood on the cooling column, use of longer mufflers for the air kiosks, setting and installation of railway shock absorbers and use of elastic supporting blocks to support the one-piece track bed, and use of steel-spring floating-slab track bed and so forth, the impact of vibration on environment will be controlled within the level set out in the national standards. The economical, environmental protection and technically feasible principles are considered in selection of the route. During the design, construction and operation, effective protection measures will be taken for the social/ecologic/sound/vibration/electromagnetic/water environment, the atmosphere and the soild waste to control effectively the adverse effect and to contribute regional economic development and a stable society along the route. The project is considered freasible from the point of environmental protection view.

Name		Sex		Age		Nationality		Educational Level	
Occupation		Working Unit or Residence				Contact			

1. what do you think of the current condition where the project is to be located?□ Very good □ Good □ average □ poor

Please tick the environmental issue you are the most unsatisfied with

□ Noise □ Vibration □ Flying dust□ Waste water □ Traffic jam □ Other Please in detail

2. What impact do you think the project will have on the environmental issue you are the most unsatisfied with? □加重 Worsening □ Mitigation □ No effect

3. which one will have larger impact on you during construction? (multiple choices allowed)

□ noise □ vibration□ electromagnetic interference □ flying dust □ waste water □ inconvenient traffic □ land requisition and demolishment

□ Other (Please in detail)

4. when you are impacted by the noise from excavation, you hope

□ heighten the fence □ give compensation □ others please in detail:

5. For the temporary impact from construction, you

□ may understand □ may understand but mitigation measures are required to take, □ may complain

6. which impact do you think is the main impact during operation?

□ noise □ vibration □ Smelling kiosk □ electromagnetic interference □ wastewater □ other (Please in detail)

7. the measures you hope to take to mitigate noise during operation are

□ Installation of ventilated sound-proof windows □ building of acoustic barrier □ relocation or functional exchange, □ adjusting the route far away from the residential area □ financial compensation □ other please in detail

8. the measures you hope to take to mitigate vibration during operation are

□ making it deeper underground □ relocation or functional exchange □ taking vibration isolation measures □ financial compensation □ other

9. for the smelling kiosks, you hope

□ The Project Owner eliminates the smells □ making them far away from the residential area □ relocation

10. If your land is to be requisitioned or you are required to relocate, what is your opinions and requirements

□ Support the project and give positive coordination □ get compensated reasonably as per the national laws and regulations, will not delay the project, □ Others Please in detail

11. Your attitude and requirement on the environmental protection measure to be taken during construction are: □ Agree to and satisfied □ to be improved and strengthened(specific opinion:) □ No opinion

12. Your attitude and requirement on the environmental protection measure to be taken during operation are ： □ Agree to and satisfied □ to be improved and strengthened(specific opinion:) □ No opinion

13. what do you think of the project overall?

□ Support □ Don't mind □ Objection Please justify

14. What are your suggestions and opinions on the environmental protection measures for this project?

Respondent: Date:

10.3.9.4 Analysis on and suggestions from questionnaire

Table 10.3-14 Statistical Table on Results of Questionnaire with Public Participation

Series No.	Item	Content	Number of People(Persons)	Percentage(%)
1	What do you think of the current condition where the project is to be located?	very good	36	5.04%
		good	78	10.92%
		average	333	46.64%
		poor	267	37.39%
	the environmental issue you are the most unsatisfied with (multiple choices allowed)	noise	223	31.23%
		vibration	88	12.32%
		flying dust	267	37.39%
		waste water	76	10.64%
		traffic jam	154	21.57%
		other	32	4.48%
2	What impact do you think the project will have on the environmental issue you are the most unsatisfied with? (146 not answered, because of unclearness)	worsening	230	32.21%
		mitigation	254	35.57%
		No effect	84	11.76%
3	which one will have larger impact on you during construction? (multiple choices allowed)	noise	325	45.52%
		vibration	219	30.67%
		electromagnetic interference	65	9.10%
		waste water	83	11.62%
		flying dust	432	60.50%
		inconvenient traffic	548	76.75%
		land requisition and demolishment	87	12.18%
		others	35	4.90%
4	when you are impacted by the noise from excavation, you hope (multiple choices)	heighten the fence	363	50.84%
		give compensation	351	49.16%
		others	0	0.00%
5	For the temporary impact from construction, you	may understand	76	10.64%
		may understand but mitigation measures are required to take	612	85.71%
		may complain	21	2.94%
6	which impact do you think is the main impact during operation? (multiple choices)	noise	288	40.34%
		vibration	256	35.85%
		Smelling kiosk	273	38.24%
		electromagnetic interference	143	20.03%
		wastewater	43	6.02%
		other	21	2.94%
7	the measures you hope to	Installation of ventilated	78	10.92%

	take to mitigate noise during operation are	sound-proof windows		
		building of acoustic barrier	298	41.74%
		relocation or functional exchange	84	11.76%
		adjusting the route far away from the residential area	87	12.18%
		financial compensation	213	29.83%
8	the measures you hope to take to mitigate vibration during operation are	making it deeper underground	361	50.56%
		relocation or functional exchange	65	9.10%
		taking vibration isolation measures	389	54.48%
		financial compensation	276	38.66%
		others	7	0.98%
9	for the smelling kiosks, you hope	The Project Owner eliminates the smells	355	49.72%
		making them far away from the residential area	310	43.42%
		relocation	49	6.86%
10	If your land is to be requisitioned or you are required to relocate, what is your opinions and requirements	Support the project and give positive coordination	336	47.06%
		get compensated reasonably as per the national laws and regulations, will not delay the project,	378	52.94%
11	Your attitude and requirement on the environmental protection measure to be taken during construction are	Agree to and satisfied	427	59.80%
		to be improved and strengthened	133	18.63%
		No opinion	154	21.57%
12	Your attitude and requirement on the environmental protection measure to be taken during operation are	Agree to and satisfied	465	65.13%
		to be improved and strengthened	90	12.61%
		no opinion	159	22.27%
13	what do you think of the project overall?	Support	636	89.08%
		Don’t mind	78	10.92%
		objection	0	0.00%

(I) Analysis of the result from the questionnaire

(1) Totally 900 inquiry forms for opinions have been issued in the survey by questionnaire, which have been mainly issued to the public of different ages, sexes, educational levels and occupations along the project. The interviewees may be mainly those directly influenced by the project construction, and the opinion forms are densely distributed along the routes and around underground stations. 714 forms have been recovered, with the recovery rate being 79.3%. Of the citizens living along the route, 89.08% supports the project and 10.92% don’t mind.

(2) In the first questionnaire, most of citizens along the route are not satisfied with the current local conditions. In this one on investigation of the unsatisfied environmental condition, most highlight the traffic jam (21.57%), followed by flying dust (37.39%) and noise (31.23%) during construction. 32.21% believe this project will aggravate the current environment while 35.57% think the environmental impact from the project is temporary and will be alleviated after the project is over and the urban traffic congestion will be relieved substantially after it is built. In addition, 11.76% believe the project will have no effect on the current environment.

(3) For the environmental impacts during construction: the public are the most worried about flying dust (60.5%) and noise (45.52%), followed by vibration 30.67% etc. In this questionnaire highlighting the environmental measures taken during construction and operation, for the question about the noise interference arising from excavation of the stations, 50.84% believes the need to make the fence for construction higher while 49.16% prefer to financial compensation. For the short-time impact during construction, 85.71% can basically withstand but require taking mitigating measures and 10.64% are acceptable.

(4) For the environmental impacts during operation: the public are the most worried about noise (40.34%) and smelling kiosks (38.24%), followed by vibration (35.85%), electromagnetic interference (20.03%) and water pollution (6.02%), damaged cultural relics (2.94%). For measures on noise, kiosks and vibration during operation, the public requiring building of acoustic barrier and claiming financial compensation for the noise account for 41.74% and 29.83%, respectively, while some citizens select to install ventilation sound-proof windows and relocate. For the measures to be taken during operation, more than half of respondents agree to take better isolation vibration measures and make it deeper underground, and claim financial compensation. For protective measures from kiosk smelling, most of the respondents agree to locate kiosks far away from the residential area (43.42%) and take measures to eliminate the smell (49.72%).

(5) For the attitude toward and requirement on the environmental protection measure to be taken during construction: 59.8% of respondents agree and are satisfied, 21.75% are satisfied with measures with no comments. 18.63% require more measures.

(6) For the attitude toward and requirement on the environmental protection measure to be taken during operation: 65.13% of respondents agree and are satisfied, 22.27% are satisfied with measures with no comments. 7.9% require more measures.

From the 2nd questionnaire, it is known that the public along the RTLK#3 know more about the routing and the stations as well as the environmental impacts to be brought by the project during the construction and the operation, and are basically satisfied with the measures proposed after being informed of the measures on noise, vibration, air, ecology and water during construction and operation and hope these measures will be implement practically during the project implementation.

10.3.9.5 Treatment on feedbacks from public participation

The result from the 2nd questionnaire indicates a vast majority of respondents are positive in RTL#3 and hope the project is implemented as soon as possible. They are satisfied with the treatment on previous feedbacks. They are informed of many

policies involved in the project, get familiar with the environmental protection measures proposed for this project and hope these measures are strictly complied.

Table 10.3-15 Summary of main comments from public participation and the treatments

No	Main comments	Public citizens	Solutions
1	Measures to mitigate the blocked traffic	Citizens within the project area	The public are informed of the traffic dispersion plan which is more detailed, and the related entities shall base on the place to strengthen traffic management, arrange construction, occupy less road and quicken the progress during construction so as to ensure a free people and vehicle flow. For the details, see the traffic dispersion plan list 5.10-7for each station in the environmental protection measures
2	Measures to mitigate such pollution as noise during construction	Citizens within the project area	Noise impact during construction: use low-noise machineries as possible, machineries failing to meet the national standard are not permitted to work, frequent maintenance and service will be made to the machineries during construction; loud-noise machineries (loaders and vibrators) are not allowed to work at night (22:00 ~ 6:00). For working in the day time, impact on schools shall be reduced as possible by avoiding construction activities during the class hours. After operation, the environmental protection measures will be taken at any places along the line where the sound level is beyond the standard to ensure all places along the line sensitive to sound meet the standard. For details, see the summary list of environmental protection measures 11.6-1.11.6-2
3	Measures to mitigate noise during operation	Citizens within the project area	The underground sections will be mainly impacted by the environmental control devices at stations. The mufflers will be extended to at least 3 m long at 13 kiosks with investment about RMB 1,950,000, the super-low-noise cooling column will be used at 9 stations with investment of RMB 2,700,000 while the environmental control devices will be invested with RMB 4,650,000 in total. For the heavily-impacted noise-sensitive places, the acoustic-proof building may be used to protect the sound-receiving locations, for instance, use of ventilation soundproof windows may reduce indoor noise by 20 dB. The soundproof ventilation window which is not expensive is used as an auxiliary measure because of affecting vision and ventilation thus resident’s daily life.

10.3.10 Public Notification on Site

 Hanghaidong road Sub-district Office	Erligang Sub-district Office
 Jiefang Road Sub-district Office	 Minggong road Sub-district Office
 Liuzhai Sub-district Office	 West Str. Sub-district Office
 Chengdong road Sub-district Office	 Changxing road Sub-district Office

Nanyang Road Sub-district Office

Beixia Str. Sub-district Office

Fig. 10.3-5 Pictures of Public Notification at different Sub-district Offices

10.3.11Public Notification on "Environmental impact assessment Report on RTL#3 of Zhengzhou Funded by Loan of World Bank"

"Environmental impact assessment Report on Phase I Project of RTL#3 of Zhengzhou Funded with the Loan of World Bank" is publically notified on the official website of the World Bank (http://www.worldbank.org.cn/), and the information on the contact person, telephone and contact address etc. are left on the website to ensure timely and effective collection of public opinions during period of public notification. The deadline for receiving the opinion lasts till publication of the environmental impact report.

10.3.12 Feedback Mechanism for Public Opinions

Phase I project of Zhengzhou RTL#3 involves numerous residential areas, enterprises and public institutions and so will be built for a longer period during which part of residential areas, schools, hospitals and stores will be impacted by noise and vibrations arising from the project and also the traffic, income and living of residents will be affected. Moreover, some residents have been involved in impacts caused by resettlement. Thus the influenced public will have some opinions toward the environmental impacts that involve their immediate interest of their own during the construction period and operational period, and will have somewhat dissatisfaction and complaints. The construction unit shall establish a set of transparent and simple procedures to collect and dispose of the public opinions to guarantee the complaints of the influenced populations will be satisfactorily solved, and dispose of the dissatisfactions of the masses in an objective, fair and efficient way and guarantee smooth implementation of the project.

The feedback mechanism mainly include determining means of collecting dissatisfaction and complaints; formulating complaint procedures; determining the contents and means of replying to complaints; recording, tracing and feeding back complaints.

10.3.13 Public Participation Mechanism during Implementation Period of the Project

10.3.13.1 Subjects for investigation

ZRTCMO, Zhengzhou Railway Transit Company and the contractors shall make public information about construction activities and consult the citizens living within the heavily-impacted sensitive areas, and enterprises that will be affected due key crossing works and the competent authorities in time, provide a participation platform for the public to be informed of and follow up environmental protection issues they are concerned with and so as to supervise the implementation of these measures during construction, establish associated complaint mechanism to collect opinions and suggestions in order to lay a foundation to improve and remedy the existed environmental protection works and environmental management.

10.3.13.2 The method and requirements on investigation

The method to investigate the implementation includes: publicity, special review meetings, posting notices, safety warning and road indications etc.

Media publicization: use the network, TV channels, newspaper, broadcasting to announce construction activities and collect opinions during construction.

Hotline: open a telephone hotline to receive and handle environmental-protection related complaints during construction process.

Special review meeting: hold special review meeting to discuss construction plans, for instance, key works such as crossing under important pipelines and bridges, and removal and rebuilding of public facilities.

Posting notice: post notices about construction activities at the areas directly affected by the project

The safety warning and road indication: warning signs shall be erected at the construction sites to remind the public of personal safety and the road signs shall be installed for convenience of the public.

Table 10.3-16 Method for, Requirements on and Main Content in the Public Participation

Subject	Means	Content	requirements
the affected population, institutions /enterprises/entities Along the line (schools etc.)	Publicization Posting notices	① Construction activities, construction lines and progress announced ② the environmental impact from the	Use TV channels, Micro blog and so on to establish a public participation platform. Establish publicity board at affected residential areas and affected areas of any

		construction and taken environmental protection measures and their implementation ③ The road dispersion and diversion plan during construction ④ indicate the range of public opinions and means ⑤ contact person and means for the project owner and the contractors on how to handle public opinions. ⑥ The contactor shall set safety warning signs meeting national standards at important or dangerous locations at the construction sites.	organizations, within the construction site, posting notices.
	hotlines	Collect public dissatisfaction due to the construction	Record any call in written, report to the railway transit group, answer questions and visit by call
Associated government departments	Special review meetings	Discuss plans for key works, pipelines and bridges etc.	Key works shall be implemented as per the studied and reviewed plans.

10.3.13.3 Public Participation Mechanism during Implementation Period of the Project

I. Means of Collecting Dissatisfaction and Complaints

(1) Collect the environmental problems produced during construction period and operational period lodged by the mass through ZRTCMO, the environmental protection bureaus of various district along the project line;

(2) Collect problems in environmental protection through ZRTCMO, community neighborhood committee, village committee or township, street, and offices.

(3) The influenced populations may reflect the problems in environmental protection they are concerned about by means of mail, visit and telephone etc.

II. Compliant Procedures

ZRTCMO will publicize the procedures to dispose of dissatisfaction and complaints to the social public through various channels before project construction is started:

Phase I

The dissatisfied influenced objects may put forth oral or written satisfaction to the

staffs of municipal environmental protection bureaus, community or neighborhood committee. In case of oral dissatisfaction, the staffs shall properly keep the written records, and the Rail Transit Co., Ltd. shall give a definite reply within a week.

Phase II

In case the complainer are still not satisfied with the reply and opinions in phase I, it may appeal to the environmental protection bureaus of Zhengzhou or various districts and counties within one month upon receipt of the decision in phase I, and the aforesaid environmental protection bureau shall made the decision on disposal of the complaint within 3 weeks.

Phase III

In case the influenced object is still dissatisfied toward the reply and opinions in Phase III, it may appeal to the civil court within 15 days after receipt of the reply.

III. Principles for Handling Complaints

ZRTCMO shall carry out site investigation on the problems complained about by the masses, and fully solicit opinions of the mass, and consult with them repeatedly and patiently. In addition, it shall put forth disposal opinions according to various principles and standards set out in the state laws and resettlement action plans in an objective and fair way. And it shall reflect the complaints beyond its capacity to the environmental protection bureau of Zhengzhou or various district and county in time and assist them in investigation.

In case the decision-making organ in the preceding phase fails to give a reply to the appeal within the prescribed time limit, the complainer shall have the right to appeal to higher authority.

IV. Contents and Means of Replying to Complaints

(1) Contents of Reply

Brief account of dissatisfaction of complainer

Results of investigation on facts

The relevant state environmental protection principles and standards

Opinions for handling and specific basis

(2) Means of replying to complaints

Directly serve the written reply to the complainer for the complaints on some individual problems;

Inform the community through holding resident meeting or issue of documents for the problems frequently complained about;

The reply materials shall be sent to Rail Transit Co., Ltd. no matter whatever means of

reply is adopted.

V. Record, Tracing and Feedback of Complaints and Appeal

ZRTCMO shall do well in registration and management of the complaints and disposal results during project construction and operational period, and shall report to the environmental protection bureau of Zhengzhou and districts in written form once a month. The environmental protection bureau will carry out regular inspection of the registration of complaints and disposal.

The emigration office of Zhengzhou Rail Transit Co., Ltd. has formulated the registration form for disposal of complaints and appeals of the influenced population to completely record disposal of complaints and relevant issues on the influenced populations. See Table 10.3-17 for the sample form:

Table 10.3-17 Registration Form for Complaints and Appeals on Environmental Protection

Receiving Unit		Time:		Site:	
Name of Complainer	Contents of Complaint		Claims	Proposed Solution	Actual Disposal
Complainer (Signature)				Recorded by (Signature)	
Note: 1. The recorder shall faithfully record the contents of complaints and requirements of the complainer. 2. The course of complaining shall not be interfered or hindered in any way. 3. The proposed solution program shall be replied to the complainer within the prescribed time limit.					

VI. Means of Contact to Express Complaint and Appeal

ZRTCMO will arrange dedicated environmental protection personnel to specially take charge of collecting and receiving dissatisfaction and complaints of the influenced populations. See Table 10.3-18 for the name of the person in charge, office address and telephone number.

Table 10.3-18 Information on Organ and Personnel Receiving Complaints and Appeals of the Influenced Populations

complaining and appeal organization	Contact	Address	Phone
ZRTCMO	Yuan Xiaoshuai	Xintai Builging, at Intersection between South Zijinshan road and Jicheng Str. Guangchen Hui Ethinic District, Zhengzhou	0371-67170061

10.4 Summary

(1) Most of the public along the project line support construction of phase I project of RTL#3, Zhengzhou, and hold that the project construction will promote traffic and economy of Zhengzhou, and expect earlier completion of the project.

(2) Through the public participation investigation, the citizens along the line have known about the project profile, the routing and the station locations proposed, the environmental problems that will arise from the project and the proposed mitigation

measures to these.

(3) The public along the line understand and accept the environmental measures to deal with the impact basically, and expect to strengthen construction management and strictly implement the proposed environmental protection measures during the construction period in the report to avoid interference with the people due to traffic jam, sewage, slurry, construction dust and noise.

(4) The public hope the relevant parties to improve the transparency of the resettlement policies, strictly act on laws and rules, and inform the households to be resettled as early as possible to enable them to make sufficient preparation.

(5) Strictly take measures, and prevent ground settlement; strengthen monitoring on ground settlement during construction; formulate emergency plan with a certain aim.

(6) The opinions obtained through public survey are beneficial for the relevant construction, design, building, operation and management units and departments to pay more attention to the adverse influences the project may cause, and take comprehensive measures and win the understanding and support by the public along the project line so as to embody the social, economic and environmental benefits brought about by the project.

11 Environmental and Social Management Plan

11.1 Purpose of Environmental and Social Management Plan

Environmental management is part of engineering management, and an important link for effective implementation of engineering environmental protection. Environment management for phase I project of Rail Transit Line 3 of Zhengzhou City is intended to guarantee smooth implementation of various environmental protection measures of the project, and reduce the adverse influences caused by project construction on environment, guarantee smooth implementation of environmental protection in the project zone and resettlement zone so as to coordinate project construction, environmental protection and economic development.

11.2 Contents of Environmental and Social Management Plan

The Environmental and Social Management Plan of Rail Transit Line 3 of Zhengzhou City is compiled based on environmental impact assessment, and the major contents include environmental management system and responsibility, environmental management training, and environmental protection measures for the adverse influences during environmental impact assessment, and estimation of investment on environmental protection.

11.3 Environmental Management System

Environmental management for phase I project of Rail Transit Line 3 of Zhengzhou includes external management and internal management. The management period is divided into three phases of first phase of construction, construction period and operation period.

(1) External management: Various environmental management administrative departments and World Bank will carry out external management, and will determine the corresponding standards and requirements environmental protection of the construction project shall reach based on the relevant World Bank and state laws and rules, take charge of irregular supervision, inspection of work in various phases, and completion acceptance etc. of the environmental protection project.

(2) Internal management: The owner shall take charge of organizing implementation of internal management, and optimize, organize and implement environmental protection measures of the project, and guarantee the requirements of environmental protection for World Bank and state construction project, and local environmental protection department are reached. The internal environmental management system of the project is managed by the owner, supervisory unit (project supervisory unit) and

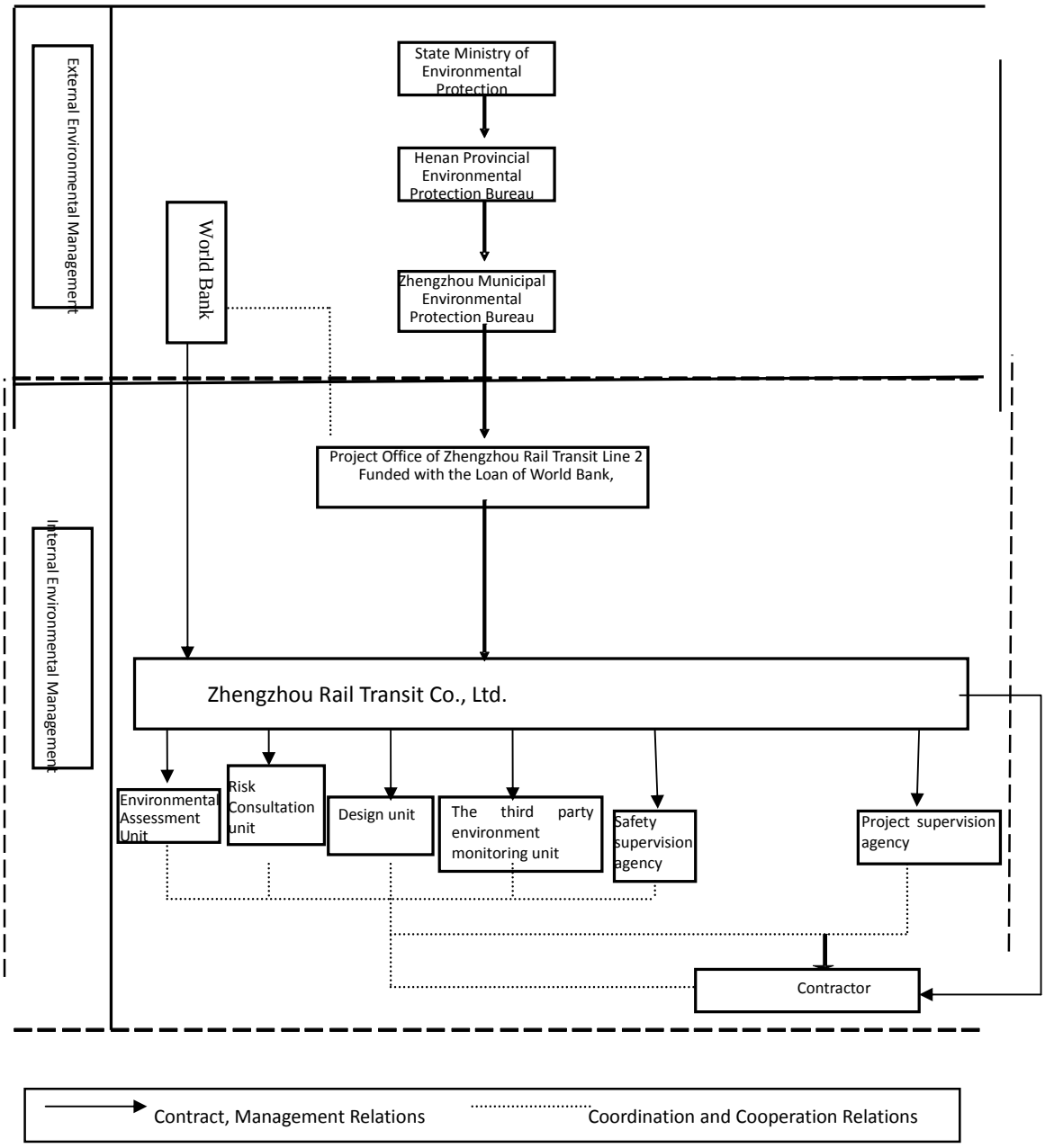
contractor respectively. Meanwhile, the design unit, environment assessment unit, risk consultation unit, safety monitoring and environment monitoring unit shall actively cooperate in the work, and subject to the supervision of World Bank.

11.3.1 Environment management system in first phase of construction of project

The environment management in first phase of project construction is mainly implemented by Zhengzhou Rail Transit Group Co., Ltd. and coordinated by environment assessment unit and design unit and also supervised by Ministry of Environment Protection, Provincial Environment Protection Bureau, Zhengzhou Municipal Environment Protection Bureau and World Bank.

11.3.2 Environment management systems in construction period and operation period

The details of management systems in construction period and operation period see figures 11.3.1-a and 11.3.1-b. The responsibilities of all organs of management system refer to tables 11.3.1-a and 11.3.2-b.



Risk consultation unit The third party environment monitoring unit Safety supervision agency Engineering management agency Safety supervision agency

Figure 11.3-1a Environmental Protection Management System of Phase I Project of Rail Transit Line 3 of Zhengzhou in Construction Period

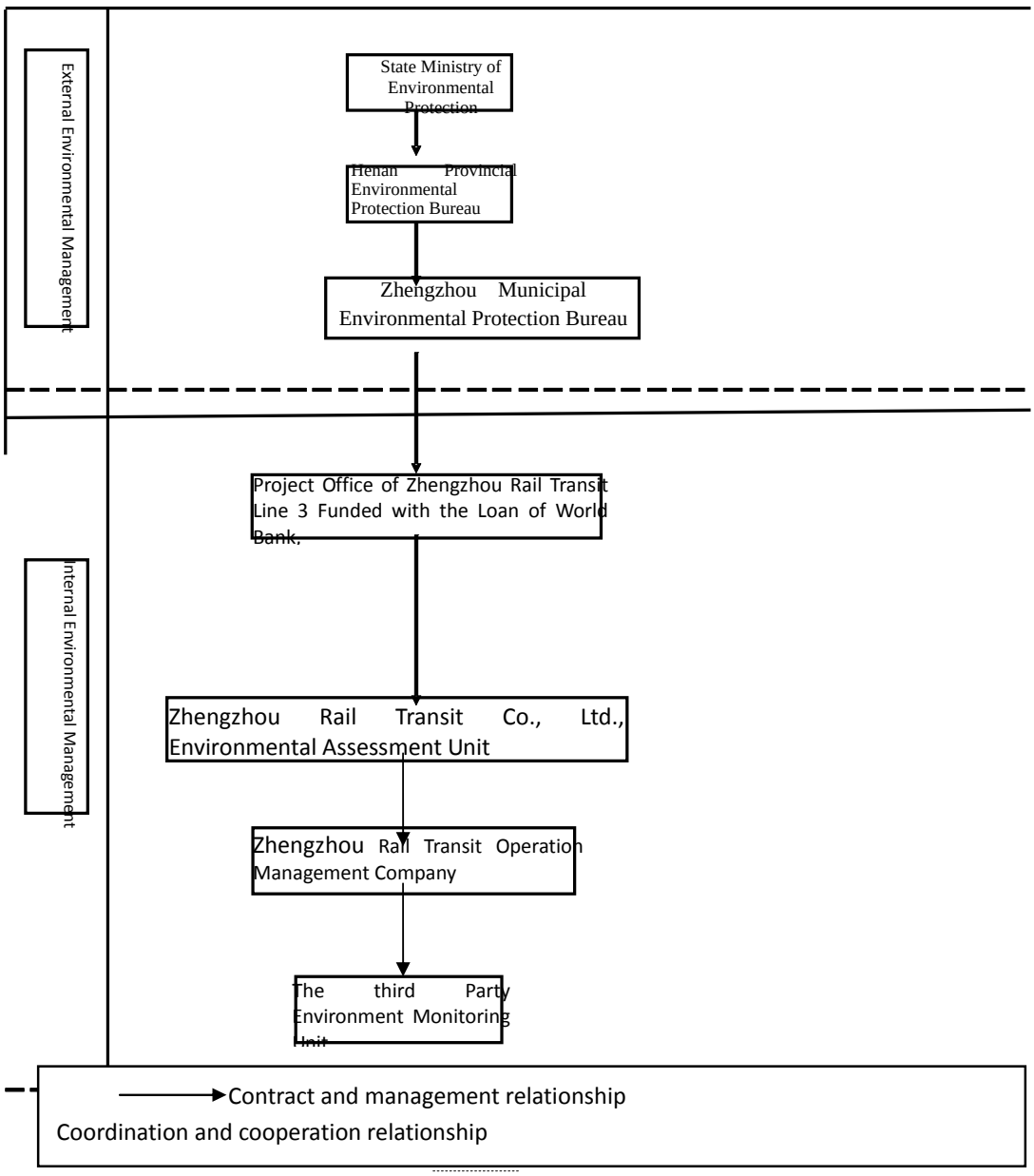


Figure 11.3-1b Environment protection system of phase I project of No.3 rail of Zhengzhou in operation period

11.4 Environmental Management Organ, capability and Duties

11.4.1 Environmental Management Organ, Capability and Duties in First Phase of Project Construction

Organ and personnel: in first phase of construction, the owner unit is the main body of environment management. In first phase of construction, the owner unit assigns a full-time or part-time environment protection management staff to take charge of coordinating environmental protection in the first phase of project construction.

Capacity requirements: the environment management staff shall graduate from major related to civil engineering and have received environment management training, have environment management qualification and participate in No.1 line project environment management, and have related experiences of subway project environment management.

Duties: ① Protect the benefits of the units subject to land requisition and resettlement and the residents during land requisition and relocation. The owner unit shall strictly comply with state and Zhengzhou city resettlement regulations and determine reasonable compensation and setting modes for the units and residents subject to the relocation.

② Entrust the environment assessment unit to prepare the environment assessment report to conduct environment impact prediction and evaluation in project construction period and operation period and put forward various environment assessment measures; the preparation of report shall meet the requirements of World Bank, state and local environment protection laws and regulations and related technical policies. Through the implementation of measures in report in the design documents by the design unit and including the environment protection project investment into the project estimate (budget), it can realize the requirements for “simultaneous design” in “three simultaneously” in environmental protection project.

③ The construction unit shall attach equal attention to environmental protection project and the major project during project contracting, and make it definite in the tender of the engineering construction. In addition, it shall put forth requirement for environmental protection to the construction organizational program of the construction unit, and give priority to the construction unit and team with strong sense of environmental protection, better achievements in environmental protection and stronger capacity to lay foundation for civilized construction, and “simultaneous construction” with high quality in environment protection.

11.4.2 Environmental Management Organ, capability and Duties in construction period

The environment management in construction period consists of three parts of owner

unit environment management, project supervision unit and contractor environment management, and is also supervised and inspected by World Bank, Ministry of Environment Protection, Principal Environment Protection Bureau and Zhengzhou Municipal Environment Protection Bureau, in which the contractor is the implementation unit of various environment protection measures in this phase, and the design unit, environment assessment unit, risk consultation unit, safety monitoring and environment monitoring unit shall actively cooperate in the work and provide the services.

11.4.2.1 Environment management of owner unit

Organ staff: In project construction period, the owner unit shall assign 2 full-time environmental protection managerial persons to take charge of environmental management and environmental supervision in construction period, and also of disposing complaints toward environmental problems.

Capacity requirements: the environment management staff shall graduate from major related to civil engineering and have received environment management training, have environment management qualification and participate in No.1 line project environment management, and have related experiences of subway project environment management.

Duties: urge the contractor to establish and improve the construction management institutions and system, encourage the contractor to fulfill the construction environment management according to ISO14001 environment management system (EMS) and safety and health management according to 18000 occupational safety and health management system; from global view, timely master the construction environment protection tendencies of entire line; regularly check and summarize the implementation conditions of environment protection measures and fund utilization conditions; actively organize and solve in case of major environment protection issue or dispute and assist the contractors to deal with the relationships with the environment protection department, the public and the interested parties.

11.4.2.2 Environment management of project supervision unit

The project supervision unit mainly takes charge of project supervision works and the supervision and implementation of project risk prevention measures in construction period. The supervision unit shall consider various environment protection works and measures specified in EIA, ESMP, environment protection works design documents and construction contract as the main contents of supervision works, strictly control the environment protection works quality and supervise the implementation of various environment protection measures by the contractor. The project supervision agency of this project designates a full-time environment supervision engineer which is directly led by general supervision engineer.

(1) Purpose of Environmental Supervision

Carry out environmental supervision during construction period according to requirements for design of environmental protection during project construction, and comprehensively supervise and inspect implementation and effect of the environmental protection measures by the contractors, dispose of and solve

environmental pollution accidents in time; Meanwhile, the supervisory achievements during the construction will be taken as the basis of acceptance inspection for development project, and the necessary special report in the acceptance inspection report.

(2) Duties

Environmental supervision is an important part of project supervision during project construction, and the main duties are as follows: carry out environmental supervision over implementation of the environmental protection measures during the project construction period and operational period, and supervise, inspect and manage the environmental protection by the project contractor and professional parts of the environmental protection project; supervise, review and assess the implementation of various environment protection measures by the contractor according to the contract provisions and national laws, regulations and policies of environment protection as well as the environment monitoring data and inspection results; timely find out and correct the construction actions against the environment protection provisions in the contract and national environment protection requirements.

In this project, the main contents of supervision works are as follows: carry out supervision and inspection of environmental protection of all contractors on the construction site and residential camps, for example the implementation of noise reduction measures on construction site, handling measures of construction spoil and construction wastes, treatment measures for production wastewater, sprinkling and dedusting measures, waterproof and water stop measures for construction in station and section, environment control device noise reduction measures, underground section vibration reduction measures, ground traffic dispersion measures, land requisition and relocation measures, compensation measures, construction risk and geologic risk preventive measures in construction period, EHS protection measures in construction period and material culture resource protection measures in construction period; The main duties should include supervision of geologic risks in construction period and risks due to construction accident, and the management and implementation of risk prevention when passing through major municipal works. at same time, the effectiveness of measures can be the ground to bring forward correction requirements to the contractor under the coordination of the third party environment monitoring agency and safety monitoring agency and in reference to the monitoring data provided by them (such as construction period noise, raise dust, vibration, production sewage drainage, underground water level and ground settlement) (see table 11.6-1 – 11.6.3 for details).

The working methods are as follows:

① Dispatch supervisors to carry out site inspection and monitoring of the construction area and residential area of the contractors, and comprehensively supervise and inspect implementation of environmental protection measures, and put forth rectification requirements within a prescribed time limit to the unqualified items below the standard, and compile environmental supervision diary for project construction.

② Assist environment management organs and relevant departments in disposing of

environmental pollution and environmental disputes caused by the project according to the environmental protection laws, rules, engineering design documents and project contracts.

③ Compile weekly, monthly and annual report on environmental supervision, and put forth significant environmental problems and proposals on solution to the problems. Delivery the environment supervision report after construction completed.

④ Participate in acceptance inspection during project construction and completion acceptance;

(3) Management Organ and Working Methods

Environmental supervision is an important part of environmental management, and is relatively independent. Thus independent environmental supervisory organ shall be established. Such function shall be undertaken by unit with supervisory qualification, which will supervise, examine and assess implementation of various environmental protection measures of construction unit according to the contract provisions, the requirements of state environmental protection laws, rules and policies, and the environmental monitoring data and results of circuit inspection. Discover and rectify construction in violation of environmental protection provisions under the contract, and the requirements of state environmental protection provisions.

1 full-time/part-time environmental protection supervisor under the leading of general supervision engineer will be assigned for each bid section according to the particularity and complexity of special environment supervision of this project and the specialty requirements. The environment supervisor shall have received environment protection training, have participated in No.2 environment management training and have the capacity of environment management.

Establish level I linear supervisory organizational organ according to the characteristics of the project: See Figure 11.4-1 for the supervisory organizational organ:

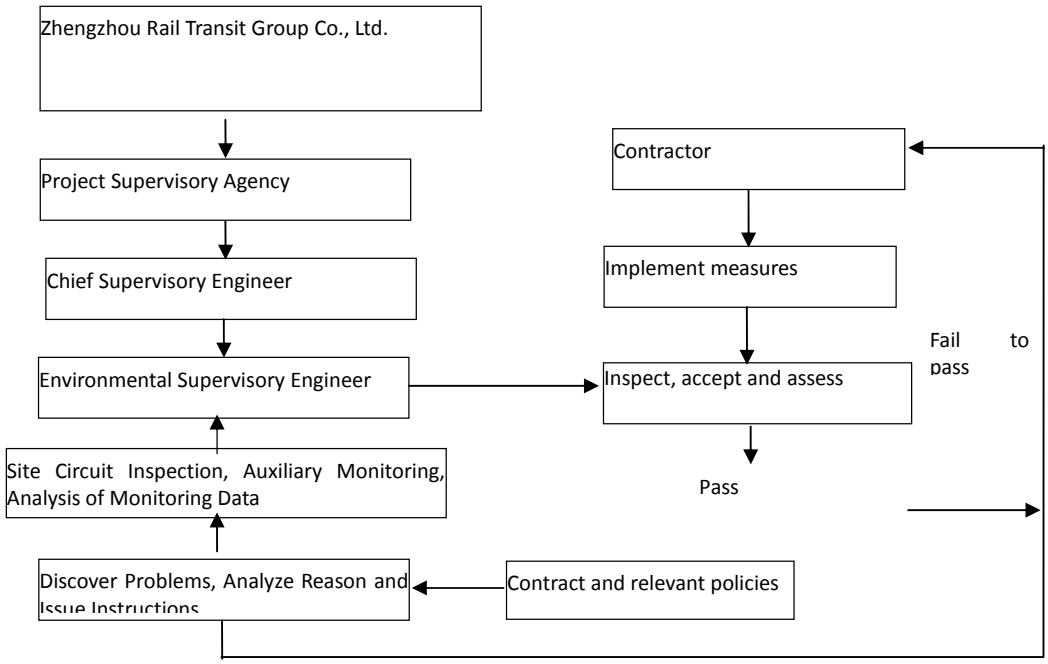


Figure 11.4-1 Environmental Supervisory Organ and Working Process in Construction Period

11.4.2.3 Contractor environment management in construction period

Staff: The contractor shall assign 2 full-time/part-time personnel for each bid section to take charge of the environment protection works in construction period.

Capability requirements: engineering technical personnel received environment protection training and that with training plan and having certain capability and qualification.

Duties: assume related duties and rights and make full use of frontline environment protection supervision duties; implement environment management responsibility system and environment protection assessment system; ensure the construction progress with the environment protection measures taken according to related state environment protection laws, EIA and ESMP; strictly comply with the environment protection contents specified in contract provisions and bid/bidding documents; implement the environment protection tasks assumed by the contractor.

Detailed working tasks: for example the implementation of noise reduction measures on construction site, handling measures of construction spoil and construction wastes, treatment measures for production wastewater, sprinkling and dedusting measures, waterproof and water stop measures for construction in station and section, environment control device noise reduction measures, underground section vibration reduction measures, ground traffic dispersion measures, land requisition and relocation measures, compensation measures, construction risk and geologic risk preventive measures in construction period, EHS protection measures in construction period and material culture resource protection measures in construction period;

The working methods are as follows:

A. Formulate annual work plan on environmental protection

B. Inspect construction progress, quality, operation and testing of environmental protection facilities and dispose of problems during implementation:

C. The contractor shall communicate and consult with the masses in the project area, and establish bulletin in each construction unit to inform the public of the specific construction activities and construction time during construction; Meanwhile, the contractor shall provide information on the contact person and telephone number so that the public may complain or put forth proposal for the construction activities.

D. Account use of annual environmental protection expenses

E. Report information on implementation of environmental protection provisions under the contract; require the contractor to monitor its environmental activities, and provide 1 record report on environmental achievements every day or every week; The project office and construction supervision team will supervise and examine such records.

11.4.2.4 Environment management of environment consultation agencies in construction period

The environment consultation agencies in construction period include design unit, environment assessment unit, risk evaluation and consultation unit, environment monitoring unit and safety monitoring unit; their mainly duties are as follows: assigned by the owner, provide related consultation services and conduct site monitoring; provide data support and technical support for environment management of construction unit and supervision unit. The detailed working contents refer to table 11.3.1-a.

11.4.3 Environment management agencies, capabilities and duties in operation period

The environment management in operation period is responsible by Zhengzhou Rail Operation Management Company which is the subordinate unit of Zhengzhou Rail Transit Company. At same time, Zhengzhou Rail Operation Management Company entrusts environment monitoring unit to conduct long term monitoring for noise, vibration and waster water generated from No.3 line operation.

Staff and capability requirements: in project operation period, Zhengzhou Rail Operation Management Company shall assign a full-time environment protection management staff to take charge of environment protection works during project operation period of line 3, of which the works are directed and supervised by Ministry of Environment Protection, Henan Provincial and Zhengzhou Municipal Bureau of Environment Protection. The full-time environment management staff shall have received environment management training with related environment management qualification, and have been engaged in line 1 project environment management and

have related experiences in subway project environment management.

Duties: take charge of environmental management of the whole company and external environmental management; do well in education and publicity to improve the awareness of environmental protection and technical levels of managerial personnel and staffs at various levels; formulate environmental management methods and operational regulations for pollution prevention and control facilities during operational period of the rail transit, regularly maintain, inspect and repair sewage treatment equipment, and noise control measures for air kiosks etc. to guarantee normal operation thereof. Cooperate with the environmental protection authority in environmental management, supervision and inspection; cooperate with the environmental protection authority in disposal of various environmental pollution accidents etc.

According to the characteristics of environmental impacts of the project and the assessment results of the report, the key points in environmental management during operational period of the project are as follows: noise monitoring and management for the environmental control equipment of the underground stations and noise in other sections; monitoring and management of the impacts on the environmental quality by the vibration of the train in underground sections along the project line; management of the depots and comprehensive drainage facilities on the base, and monitoring of the disposal effect.

11.4.4 Environment supervision and management of World Bank and environment protection government agencies

The World Bank, Ministry of Environment Protection, Provincial Environment Protection Bureau, Zhengzhou municipal environmental protection bureau and the environmental protection bureaus in various districts shall carry out external management, regular and irregular inspection of implementation of environmental protection facilities of Rail Transit Line 3 to guarantee implementation of various environmental protection measures of Rail Transit Line 3; Meanwhile, pay attention to the environmental protection problems reflected by the public toward Rail Transit Line 3, and mainly supervise and inspect such problems reflected by the public.

The project environment management systems and duties in construction period and operation period refer to table 11.3-1-a and table 11.3.1-b.

Table 11.3.1-a Agencies and duties of environment management system in construction period

Agency nature		Agency name	Agency duties
External environment management	Supervision agency	State Environmental Protection Administration, Provincial and municipal environment protection bureau	Governmental administrative supervision and management agency; take charge of the environment protection works at each phase of entire project
Internal	Management	World Bank Load	Take charge of the environment protection

environment management	agency	Project office for Zhengzhou Rail Transit No.3 line phase 1 project	works at each phase of entire project
		Zhengzhou Rail Transit Group Co., Ltd.	Owner unit, take charge of the environment protection works of each phase, including the environment protection management works from start of construction to completion acceptance; take charge of the environment protection management responsibilities of entire project area
	Supervision agency	World Bank	Supervise and check the implementation of environment management plan
	Implementation agency	Contractor	Implementation agency; implement various environment protection measures in EIA and ESMP. Include: implementation of noise reduction measures, vibration reduction measures, water pollution prevention measures, atmosphere pollution prevention measures, traffic dispersion measures, construction soil and construction waste disposal, construction staff health and safety protection measures.
	Consultation service agency	Supervision agency	Entrusted by the owner unit, take charge of supervision and management of contract environment protection measures, including implementation of noise reduction measures, vibration reduction measures, water pollution prevention measures, atmosphere pollution prevention measures, traffic dispersion measures, construction soil and construction waste disposal, construction staff health and safety protection measures; at same time supervise the implementation of environment monitoring such as underground water level, waste water quality, construction noise, vibration, raise dust and ground settlement, and prepare environment monitoring report;take charge of supervision and management of geologic risk and safety management, construction accident risk and safety management and environment risk of contractor in construction period, and prepare the safety supervision report.
		Design unit	Through design in construction phase, implement various environment protection measures in EIA and EMSP into the design documents, and instruct the construction activity of contractor.
		Environment assessment unit	Entrusted by the owner unit, provide explanation and related technical support for various environment protection measures put forward in EIA and ESMP.
		Environment monitoring unit	Entrusted by the owner unit, complete various environment monitoring such as

			noise, vibration, production waste water and raise dust brought forward in construction period, and prepare the safety monitoring report.
		Safety monitoring unit	Entrusted by the owner unit, complete the monitoring including underground water level, ground settlement and building settlement provided in EIA and ESMP in construction period, and prepare the safety monitoring report
		Risk evaluation and consultation unit	Entrusted by the owner unit, prepare project risk evaluation report; provide technical support for various risk management measures mentioned in project risk evaluation report, EIA and ESMP.

Table 11.3-1-b Composition agency of environment management systems in operation period

Agency nature		Agency name	Agency duties
External environment management	Supervision agency	State Environmental Protection Administration, Provincial and municipal environment protection bureau	Governmental administrative supervision and management agency; take charge of the environment protection works in project operation period
Internal environment management	Management agency	World Bank Loan Project office for Zhengzhou Rail Transit No.3 line phase 1 project	Take charge of the environment protection works in project operation period
		Zhengzhou Rail Transit Group Co., Ltd.	Owner unit, take charge of the environment protection works in project operation period; take charge of the environment protection management responsibilities of entire project area
	Supervision agency	World Bank	Supervise and check the implementation of environment management plan
	Implementation agency	Zhengzhou Rail Operation Management Company	A subordinate unit of Zhengzhou Rail Transit Group Co., Ltd.; noise monitoring and management for the environmental control equipment of the underground stations and noise in other sections; monitoring and management of the impacts on the environmental quality by the vibration of the train in underground sections along the project line; management of the depots and comprehensive drainage facilities on the base, and monitoring of the disposal effect
	Consultation service agency	Environment monitoring unit	Entrusted by the owner unit, complete the environment monitoring such as noise and vibration put forward in EIA and ESMP in construction period; prepare environment monitoring report.

11.5 Environmental Management Training

11.5.1 Purpose of Training

It is necessary to carry out training on environmental protection and skills and training of environment management measures in EIA and ESMP for the employees engaged in environment management and supervision of owner unit, supervision unit and contractor for smooth and effective implementation of the project so as to enable them fully understand and learn the environment protection of project, and cultivate the capability for environment management and supervision of line 3 and provide personnel and technical guarantee for the implementation of various environment protection measures in EIA and ESMP.

11.5.2 Objects of Training

Personnel engaged in line 3 environment management and supervision of owner unit, supervision unit and contractor.

11.5.3 Contents of Training

The major contents of training involve environmental protection laws, environment protection technologies, EIA and ESMP environment management measures, environment monitoring technologies and etc.

11.5.4 Training Plan

In first phase of construction, the owner unit shall organize the environment awareness training for all staff of related departments; in construction period, organize the employees on important posts including construction site management staff in owner unit, engineering supervision unit, contractor project manager and site environment protection responsible personnel to participate in environment management knowledge training; organize related personnel of rail company and contractor directly participating in management to attend the environment management skill training; in operation period, organize rail company environment protection management personnel for special training on environment management in operation period.

See Table 11.5-1 for the specific training plan.

Table 11.5-1 Training Plan

Project phase and training organization agency	Training organization agency	Training teacher		Contents of Training	Training objective	Training Time	Training Expenses
Construction period	Zhengzhou Rail Transit Group Co., Ltd.	Famous experts engaged in environment protection specialty for long time, and familiar with World Bank environment protection policy, especially for subway construction technology	3 persons of owner unit, 5 persons of project supervision unit per bid section; 5-10 persons of contractors per bid section	Related environmental protection laws in construction period; related construction spoil, noise, vibration, underground water, construction waster water, raise dust pollution control measures, impact on traffic, resident livings, resident income and vulnerable groups in construction period and relief measures, construction risk management measures in construction period, project geologic risk control measures in construction period, EHS, public participation, noise in construction period, construction waste water, vibration, TSP, underground water and ground settlement and other environment monitoring technical contents.	Fully understand the environment protection of subway project in construction period; learn the capability for environment management and supervision for line 3, and provide personnel and technical guarantee for implementation of various environment protection measures of EIA and EMSP.	2~3 Day	150,000 yuan
Operation period	Zhengzhou Rail Transit Group Co., Ltd.	Famous experts engaged in environment protection specialty for long time, and familiar with World Bank environment protection policy, especially for subway operation period environment impact features.	2 persons for Zhengzhou Rail Transit Group Co., Ltd., 3 persons for Zhengzhou Rail Operation Co., Ltd.	Related environment protection laws, standards and technical systems such as wastewater drainage, operation noise and vibration in operation period; odor and waste water monitoring and control technology in operation period, noise, vibration and electromagnetic monitoring and control technology.	Full understand the environment impact after subway operation and the adopted environment protection measures; get familiar with related environment monitoring technology and ensure normal operation of various environment protection facilities.	3～4 Day	50,000 yuan

11.6 Abstract of Environmental Protection Measures

See Table 11.6-1 and Table 11.6-2 for summary of the environmental protection measures:

Table 11.6-1 List of Common Mitigation Measures for Environmental Impacts by Phase I Project of Rail Transit Line 3 of Zhengzhou Funded with the Loan of the World Bank

Phase	Environmental Factors		Measures	Implementation Organ	Supervisory Organ	Monitoring Organ	Monitoring Items	Expenses(10,000 Yuan)
Feasibility Study and Design	Natural Environment	Ecological Environment	(1) Comprehensively consider the means of paving of the line, and the principle of occupying less arable fields and green land during selection of the route to reduce impact on urban ecological environment; (2) Carry out landscape design for the air kiosks, entrance and exit to make it compatible with the style of the surrounding buildings; (3) For the landscape design around car depot & integrated base and main substation, the greening shall give priority to local native plants and also the fruit trees, but favorable for evergreen and flower species, and dynamically combine the arbors, shrub, flowers and grassland with proper colors and pattern combination so as to form a beautiful seasonal landscape.	Design Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee
		Environmental Vibration	(1) In case the underground routes must run through the ground buildings and residential areas, the depth thereof shall be duly increased if conditions permitting to reduce vibration and nose, and interference with the ground buildings;	Design Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee
		Sound Environment	(1) Carry out noise control from the sonic source, and select low-noise equipment and structural type (2) Rationally plan the functional division of the land along the project line according to urban upgrading and planning, optimize layout of buildings, and avoid new environmental problems (3) Scientifically plan the layout of the buildings, and the first row of the buildings near the noise source shall be planned to be non-noise sensitive buildings such as commercial venues and offices etc.; (4) Dismantle residential houses near the sonic source first according to upgrading of the old urban areas; reserve noise prevention distance for the newly-developed houses or make use of the shielding and sound-isolation function of the non-sensitive buildings according to greening design and relocation of the buildings to put the impact on the sensitive buildings within the permitted scope under the standard;	Design Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee
		Electromagnetic Environment	(1) It is requested to carry out rational layout of the major transformer substation, and rational planning of the surrounding land of the major transformer substation to keep the enclosure walls thereof far away from the residential area(at least 15 meters to the residential area)	Design Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee
		Solid waste	(1) Explicitly prohibits the procurement of equipment containing polychlorinated biphenyls material in transformers and other equipment in the design and tender documents.	Design Unit	Project Owner Local Environmental Protection Bureau			
	Social Environment	Resident’s Life	(1) The principle of route selection is to reduce resettlement and impact on residents’ life as much as possible; (2) Do well in various preparatory work before construction, and carry out detailed survey of the roads, various underground pipelines such as power supply, telecommunication, water supply and drainage pipelines etc. along the subway line; Determine the resettlement and relocation program with relevant departments in advance; Do well in various emergency preparatory work to reduce impacts on residents’ life.	Design Unit	Project Owner			calculated into design fee
		Traffic	(1) The routes plane shall be constructed along the urban arteries and deployed within the planned red lines of the roads. The station routes shall be parallel to the planned red lines. Reduce interference with ground traffic in addition to considering the station positions and construction methods.	Design Unit	Project Owner			calculated into design fee

Phase	Environmental Factors		Measures	Implementation Organ	Supervisory Organ	Monitoring Organ	Monitoring Items	Expenses(10,000 Yuan)
			(2) Distribution of stations is determined after considering the major concentration points of passenger flow, and coordination with the urban comprehensive planned traffic network to attract passenger flow as much as possible, provide convenience for travel by passengers and really embody the principle of human paramount.					
		Protection of Disadvantaged Group	(1) Non-barrier passage for the disabled shall be established at various stations; (2) The toilet cesspit for females shall be increased according to due proportion at various stations.	Design Unit	Project Owner			calculated into design fee
		Human Health	(1) It shall be definitely prohibited that the relevant materials such that contains Polychlorinated Biphenyls during purchase of the equipment of transformer substation; (2) Non-poisonous pesticide and herbicide with low residue shall be used during greening of the depots and transformer substation.					
	Material Cultural Resources	Cultural Relics	(1) As for landscape design for the sections adjacent to historical and cultural areas and protected cultural relics, the dimension, height and color design shall be compatible with the surrounding environment, especially the features and customs of the scenic area. (2) Entrust qualified unit to carry out detailed prospecting of cultural relics along the rail transit line before project construction, and avoid and protect the ancient ruins and underground buried substances discovered during prospecting and unlisted in the list of protected cultural relics at present; (3)Do well in protection of protected cultural relics and underground burial site of cultural relics before project construction, formulate specific protection program, and report to local cultural relics authority and planning department for approval.	Design Unit	Project Owner Local Environmental Protection Bureau Cultural Relics Bureau			calculated into design fee
Construction Period	Natural Environment	Sound Environment	(1) It is forbidden to carry out construction operation that produces environmental noise pollution at night in the concentrated area of buildings sensitive to noise in the urban areas; In case continuous operation is to be carried out due to special needs, “Nighttime Construction License” shall be handled for nighttime construction, and the approved nighttime operation shall be publically notified to the adjacent residents. (2) It is forbidden to drive pile at night. In case it is really necessary to do so, it shall be reported to Zhengzhou Municipal Environmental Protection Bureau for approval, and restrict operational time within the scope of 7:00-12:00 and 14:00-22:00. (3) The machinery with high noise such as power generator and air compressor etc. in the secluded place or inside the tunnel if possible, and keep them far away from sensitive points in sound environment such as residential area, school and hospital etc.. (4) The transport vehicles shall be enter into and get out of the construction site on the side far away from the residential area (5) Use commodity concrete, and no concrete mixer shall be placed on the construction site; (6) Incorporate measures to reduce environmental noise pollution as the contents of construction organization and design during tender invitation for the construction project, and make definite in the contract signed. (7) In addition to strict control of various sources of environment noises according to the relevant state environmental noise standards during the college entrance examination and half a month before the college entrance examination, it is forbidden to carry out construction operation that produce noise beyond standards and	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee

Phase	Environmental Factors		Measures	Implementation Organ	Supervisory Organ	Monitoring Organ	Monitoring Items	Expenses(10,000 Yuan)
			interfere with people's life.					
		Environmental Vibration	(1)The operational rotues of the construction vehicles, especially heavey transport vehicles shall avoid areas sensitive to vibration if possible. (2)High vibration operations will be carried out in periods with a high environmental vibration background value(7:00～12:00，14:00～22:00), and construction operations with strong vibration and serious pollution will be restricted during night.(3)As for sections where shield tunneling construction is adopted, detailed survey shall be carried out toward the sensitive points near the tunnel, and keep records well and take preventive measures such as consolidation toward influences such as cracking of houses and ground settlement etc..(4) During construction period, prepare complete monitoring program for culture relics and ancient architectures affected, focus on the monitoring of their settlement, tilting and crack development, define the pre-alarm value, alarm value and control value and prepare the construction emergency plan;(5) Renovate the key buildings in advance; conduct the retaining protection for the building with poor stability;(6) Except reasonable adjustment of parameters such as soil chamber pressure, jack pushing force and grouting pressure during shield propelling, reduction of disturbance for surrounding soil mass as possible and control of surrounding stratum deformation, conduct grouting reinforcement for stratum around the ancient building foundation if necessary so as to enhance the bearing capacity and further control the ancient building deformation.	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee
		Atmospheric Environment	(1)Hard enclosure shall be established on the construction site, and the major roads shall be hardened and kept clean. (2)Special personnel shall be established for the environmental protection on the construction site. Corresponding sprinkling equipment shall be equipped to sprinkle water in time and reduce dust pollution. (3)Duly spray water when dismantling and digging dry earth ground to keep certain humidity of the operational surface. (4)The rubbish and residual earth produced during house dismantlement shall be cleaned away and transported within 3 days after dismantlement of the house, and the residual earth piles and exposed ground left over for over 2 days shall be covered with dust-proof cloth or solidified to prevent dust. (5)The vehicles transporting rubbish, residual earth and sands shall obtain "permit for transport vehicles of residual earth and sands". The transport trucks shall be well sealed withtout leakage, and shall not be excessively full during loading to guarantee no littering during transport. In case of littering during transport, cleaning shall be carried out in time to reduce pollution. (6)Explosion, dismantlement, earth and stone operation and manual dry sweeping shall be not carried out in case of dry weather with air pollution index above 100, or strong wind above level 4. In case of air pollution index between 80-100, cleaning shall be carried out every 4 hours with alternative of sprinkling and cleaning. And denser cleaning shall be carried out in case the air pollution index is larger than 100. (7)Establish washing platform inside the gate of the construction site. The washing operational ground and the roads connecting the entrance and exit must be hardened. Frequently wash the earth on the transport vehicles and chassis. The operational vehicles shall clean the earth on the wheels	Construction Unit	Project Owner Local Environmental Protection Bureau	The owner entrusts qualified organ to undertake the work by means of contract.	TSP	monitoring expenses(200,000 yuan); The other expenses are calculated into engineering fee

Phase	Environmental Factors			Measures	Implementation Organ	Supervisory Organ	Monitoring Organ	Monitoring Items	Expenses(10,000 Yuan)
				when running out of the boundary to reduce earth carried by the wheels.					
		Water Environment	Ground Water	(1) Do well in design of drainage system on the construction site during the construction period. The excretion sewage of the construction personnel shall be collected and disposed of by the environmental health personnel regularly. (2) Establish sediment tank at the drainage outlet on the construction site, and the construction sewage shall be recycled for washing or greening the site through sediment disposal. The construction slurry in shield tunneling shall be totally recycled through disposal by the mud-water separation system.	Construction Unit	Project Owner Local Environmental Protection Bureau	The owner entrusts qualified organ to undertake by means of contract	pH, SS, Oil, , COD	monitoring expenses(150,000 yuan); The other expenses are calculated into engineering fee
			Underground Water	(1)Establish septic tank in the construction camp, and equip with anti-leakage measures to prevent pollutionon the underground water; (2)The domestic rubbish produced during construction period shall be collectively managed, and handed over to the municipal environmental health department for collective disposal to prevent pollution on the underground water source. (3)The digging construction scale of the base pit of underground station is large, and the adverse factors that influence the stability of base pit shall be comprehensively considered, and suitable protective measures shall be adopted to ensure the safety of the base pit construction, surrounding road, underground pipelines and buildings. (4) Strengthen construction monitoring, and carry out close monitoring over the enclosure structure of the base pit, horizontal and vertical movement of the sourrounding buildings, the changes of stress on the enclosure structure and underground water level, and earth pressure；	Construction Unit	Project Owner Local Environmental Protection Bureau	The owner entrusts qualified organ to undertake by means of contract	Underground water level, ground settlement extent, water quality	monitoring expenses(600,000 yuan); The other expenses are calculated into engineering fee
	Ecological environment	Vegetation greening		(1) Carry out necessary restoration and compensation for the green land occupied, and restore its ecological functions as soon as possible. (2) Protect the vegetation in the land requisitioned and areas along the line during project construction, and reduce damage to the woods, grass land and bushes in the land temporaily used, and around the operational zone.	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
		Water and soil erosion		(1)The construction unit shall formulate construction organizational plan for the earth and stone project according to the climatic features and characteristics of rainfall in the area. The construction unit will avoid the rainy season to carry out large-scaled earth and stone project; And it will make out water and soil conservation measures during construction of earth and soil project; (2) The construction deserted dregs will be cleaned and transported in time, and the road base surface built will be stamped solid; Properly carry out protective measures;	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
		Solid wastes		(1)The construction unit will sign construction rubbish transport contract with the company engaged in transport of construction rubbish, and apply for approval certification for disposal of construction rubbish.(2)The construction unit shall be equipped with managerial personnel to carry out site management of the disposal of	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee

Phase	Environmental Factors		Measures	Implementation Organ	Supervisory Organ	Monitoring Organ	Monitoring Items	Expenses(10,000 Yuan)
			dregs and rubbish. The vehicles transporting dregs shall be equipped with sealed cover, and shall run according to the prescribed time, site and routes.(3)The residual earth site shall be leveled in time, and be equipped with drainage pitches etc. to prevent water and soil erosion.					
	Social environment	Traffic evacuation	(1)Strengthen tariffic management during construction period and rationally arrange construction program to carry out construction with less road occupied and speed up construction progress through making out detailed traffic evacuation program during open digging of stations that influences traiffc.	Project owner	Project Owner Municipal Government			calculated into engineering fee
		Resident income	(1)Compensation and reward measures will be taken for the impacts on resident income due to occupation of agricultural fields, and income of the businesses and relevant employees respectively.	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
		Resident Living	(1) Carry out survey of the roads, various underground pipelines along the subway line; Determine the resettlement and relocation program with relevant departments in advance; (2) Establish enclosure on the construction site to lower impacts on residents' life due to construction noise; sprinkle water to reduce dust on the construction site, and the odd construction materials shall be covered to reduce impacts due to dust.	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
		traffic accessibility	Each station are set straight ladder, provide convenient for people with more bags	Design Unit	Project Owner			calculated into design fee
		Human Health	(1)Carry out immunity injection for the construction personnel to improve health and prevent infection; carry out regular physical check for the construction personnel. (2)Strictly carry out working and rest system for the construction personnel operating equipment with high noise and vibration, guarantee sufficient rest, and shall not alternate shifts and work overtime except on special occasions. (3)The workers shall wear masks during tunnel construction. The ventilation system in the tunnel shall be kept in normal working state to guarantee sufficient amount of ventilation. Construction inside the tunnel shall be stopped in case the ventilation system is damaged. (4)Environmental protection materials shall be used during decoration of the tunnel and subway station, and the content of formalin therein shall meet the requirements of relevant standards. (5)The constructors shall wear corresponding gas masks and gloves during installation of the equipment of transformer substation to prevent physical damage due to poisonous substances in the equipment.					
		Resettlement	(1) Make out compensation and reward program for the personal households with resettled houses and requisitioned land, and the enterprises, units and shops influenced by resettlement, and the employees of the shops influenced during resettlement. (2)Make out feedback mechanism for public opinion to collect the opinions of the public influenced.	Project owner	Municipal Government			Calculated into resettlement expenses
	Materials Cultural Resources	rotection of Cultural Relics	(1)In case of discovering cultural relics and ruins during construction, construction shall be stopped at onec,e and protective measures such as blockading the site, reporting to cultural relics management department of Zhengzhou City, which will organize rational measures to dig the cultural relics and ruins. Construction shall be proceed until such work is completed. (2)Formulate perfect monitoring program for the influenced cultural relics and ancient buildings; mainly monitor	Construction Unit	Project Owner Local Environmental Protection Bureau Cultural Relics Bureau			calculated into engineering fee

Phase	Environmental Factors		Measures	Implementation Organ	Supervisory Organ	Monitoring Organ	Monitoring Items	Expenses(10,000 Yuan)
			settlement, leaning and development of cracks etc. thereof, and set early warning value, alarming value and control value; make out emergency construction plan;					
Operational Period	Natural Environment	Sound Envrionment	(1) Regularly rectify the wheel tread;(2)Regularly grind the steel rail to keep smooth surface;(3)Strengthen operational management of the comprehensive base, and improve the awareness of environmental protection of the driver and passengers; control horning; It is forbidden to carry out commissioning and workshop production with high noise. (4)It is requested to give priority to the low and medium-rise buildings within 15 meters to the air kiosks and cooling tower when considering resettlement measures. (5)Adjust the location of the air kiosks and cooling tower to keep the distance between them and the sensitive points larger than 15 meters. (6)Install silencer on the wind pipes and ventilators for the ventilation and air kiosks to reduce impacts due to noise by the ari kiosks.	Project owner	Project Owner Local Environmental Protection Bureau			/
		Environmental Vibration	(1) Give priority to vehicles with low noise and vibration value, and excellent structure during choice of vehicles; (2)Strengthen maintenance of the wheel rails, and regularly rotate wheels and grind steel rails; apply oil to the curves with small radius to guarantee desirable operational conditions thereof and reduce additional vibration.	Project Owner	Project Owner Local Environmental Protection Bureau			/
		Atmospheric Environment	(1)The underground stations shall adopt decoration materials that comply with state environmental standard, which is good for protecting human health, and reducing the impacts on the surrounding environment due to the strange smell from the exhaust of the air kiosk during the preliminary operational period.(2) Buildings with a high concentration of populations such as schools, hospitals and concentrated residential areas etc. shall not be built within 15 meters to the air kiosks.	Project owner and government planning department	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
		Water Envrionment	Strengthen monitoring of the dometic sewage and production sewage during operational period of the stations and depots along the project line to discharge such sewage after reaching the standard.	Project owner entrusts qualified unit	Project Owner Local Environmental Protection Bureau	The owner entrusts qualified organ to undertake by means of contract	pH, SS, , COD	15
	Ecological Environment	Vegetation Greening	/	Project Owner	Local Environmental Protection Bureau			calculated into engineering fee
		Solid Wastes	(1)Estalbish dustbin for the domestic rubbish at the stations along the line, and arrange managerial staffs to clean the ground and wagon in time, and classify the rubbish and collectively transport to environmental health department for collective disposal.	Project Owner	Local Environmental Protection Bureau			calculated into engineering fee
	Social Environment	Protection of Disadvantagted Populations	(1)Establish non-barrier passage for the disabled at stations; (2)The toilet cesspit for females shall be increased according to due proportion at various stations.(3)Formulate ratinal ticket price mechanism for the low-income populations;	Construction Unit	Project Owner			calculated into engineering fee
		complaint channels	In every station location visible complaints and other complaints	Project Owner	Local Environmental Protection Bureau			Calculated into daily operational expenses
		Human Health	(1)The staffs exposed to high-noise operation in the depot repair workshops shall wear ear plug etc.. (2)The driver and passengers of the subway train shall shorten the working time as much as possible, and regularly receive physical check to guarantee physical and mental health. (3) Guarantee normal operation of the ventilation system and	Project Owner	Local Environmental Protection Bureau			Calculated into daily operational expenses

Phase	Environmental Factors		Measures	Implementation Organ	Supervisory Organ	Monitoring Organ	Monitoring Items	Expenses(10,000 Yuan)
			carry out regular air quality test to lower air pollution in the underground sections. (4)The staffs exposed to dangerous wastes such as waste oil and dregs produced by the treatment system of oil-bearing waste water, the oily cleaning cloth of various processes, waste transformer and waste storage battery etc. shall wear protective gloves and masks.					
	Material cultural ruins	Cultural relics	Strengthen own protective measures of the cultural relics and ancient buildings, properly take engineering measures, establish vibration monitoring mechanism, strengthen long-term tracing and monitoring to guarantee no adverse impact will be caused on the protected cultural relics due to operation of the train.	The project owner entrusts qualified unit	Project Owner Local Environmental Protection Bureau Cultural relics bureau			90

Table 11.6-2 List of General Characteristic Mitigation Measures of the Environmental Impacts by Zhengzhou Rail Transit Line 3 Funded with the Loan of World Bank

Phase	Environmental Elements		Measures	Implementation Organ	Supervisory Organ	Monitoring Organ	Monitoring Items	Expenses(100,000 Yuan)
Feasibility Study and Design Stage	Natural Environment	Environmental Vibration	(1) Adopt 60kg/m seamless routes adopted in engineering design will positively prevent vibration pollution. (2) The the protective distance for buildings on both sides of the underground routes in areas such as “mixed district, CBD”, “industrial concentrated district”, and “both sides on the traffic artery” shall be 25 meters. The protective distance for	Design unit	Project Owner Local Environmental Protection Bureau			/
		Sound Environment	(1) It is requested that buildings sensitive to noise such as residential area, school and hospital not be built within the noise prevention distance, for example 15 metter to the air kiosk and cooling tower(category 4 area), 26 meters(category 2 area) and 50 meters(category 1 area).	Design unit	Project Owner Local Environmental Protection Bureau			Calculated into design fee
		surface water	(1) Construction site and waste residue site are not set in the scope of 200m from both sides of river channels of Jialu River, Jinshui River, Xiong’er River, Qili River and Chaohe River.	Design unit	Project Owner Local Environmental Protection Bureau			Calculated into design fee
		groundwater	(1) Xinliu Road Station, Shamen Road Station, Xinglongpu Road Station, Dongfeng Road Station, Nongye Road Station, Huanghe Road Station, Jinshui Road Station, Taikang Road Station, Shuncheng Street Station, Weilai Avenue Station, South Fengtai Road Station, Tongtai Road Station, East Huanghe Road Station, East Nongye Road Station, Zhongxing Road Station, Boxue Road Station and East Hanghai Road Station adopt cast-in-situ bored pile & waterproof curtain for enclosure. (2) Erqi Square Station, Dongdajie Street Station, Chengdong Road Station and Zhongzhou Avenue Station adopt underground diaphragm wall.(2) All intervals adopt shield method for construction	Design Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee
		ecological environment	(1)For the design of entrances and ventilation pavilion of 10 stations including Weilai Avenue Station, Fengtainan Road Station, Zhongzhou Avenue Station, Tongtai Road Station, Huanghedong Road Station, Nongyedong Road Station, Zhongxing Road Station, Boxue Road Station, Hanghai East Road Station, it shall consider in principle their location of new district and economic development zone, which is an integrated modern new downtown and CBD of commercial, office, information and business functions, so their structures and appearances shall be uniform as possible; adopt blending landscape design handling principle to uniformly plan and construct with surrounding buildings and construct the ventilation pavilion station, pavilion and other ground buildings together to meet the design requirements of local urban regions.(2)For 5 stations in Zhengzhou old town area including Xinglongpu Road Station, Dongfeng Road Station, Nongye Road Station, Huanghe Road Station and Jinshui Road Station, there are dense buildings around the stations and the ground buildings appears crowded. The rail transit construction shall be considered together with Zhengzhou old town reconstruction planning and Nanyang Road expansion project; The along-line regions integrates the functions of resident, commercial, traffic connection, special mending and lacing, so the design of the stations and ventilation pavilions in this section shall be arranged in combination with surrounding buildings as possible, and it can consider the joint construction with existing ground buildings if conditions allow so as to					

			ensure the coordination of station buildings with surrounding urban building landscape, reduce the impact of newly built facilities on ground landscape visual effect and make them open space presenting the urban style.(3)For Erqi Square Station and Chengdong Road Station, since they are near national and provincial historic sites to be protected such as Memorial Tower for February 7th Strike, Zhengzhou Confucius Temple and Zhengzhou Shang Dynasty Relics and there are many modern buildings such as Hualian Shopping Center, Wanda Plaza and Zhengzhou Department Store, and also near 3 historic and cultural blocks of Shuyuan Street, Confucius Temple- Chenghuang Temple, Dehua Street-Datong Road, the design of entrance/exit and ventilation pavilion of these stations shall fully consider the actual conditions and adopt the combination design concept of blending method and hidden method to both reduce the impact of station entrance/exit and ventilation pavilion on ground landscape visual effect, and not lose the eye-catching state of station building so that it can maintain the open landscape space of Zhengzhou city and surrounding grandeur feeling, but also blend into the modern atmosphere.					
	Social Environment	Resident's life	(1)Comparison of recommended scheme and alternative scheme is made for routes of lines including section at north of North Ring Road and section between Jinshui Road Station and Erqi Square Station, and select the scheme with the least amount of demolition so as to reduce its influence on residents.	Design Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee
		Traffic	(1) Dashiqiao area has large traffic volume and severe congestion, so Jinshui Road Station selects cover-excavation method for construction to reduce its influence on ground traffic. (2) Nanyang Road is relatively narrow but with large traffic volume, for Dongfeng Road Station, Huanghe Road Station and Nongye Road Station which are located along the Line and adopt open-cut method for construction, since they have large traffic volume now, rationally arrange construction site, do not occupy road or occupy road as least as possible, and shorten construction time to the greatest extent; (3)For Taikang Road Station, Shuncheng Street Station, Dongdajie Station and Chengdong Road Station in prosperous area , since they have large ground traffic volume and occupy large areas of roads, main measures are to formulate traffic dispersion scheme, and vehicles can pass round in advance; elaborately arrange construction site and occupy roads as least as possible; set accommodation lane at both sides of construction site to the greatest extent to relieve traffic obstruction; accelerate construction progress, reduce time of road occupying; take priority in guaranteeing unobstructed bus route etc.	Design Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee
		The traffic channel	（1） The section of Nanyang road : Cover construction at sections crossing the intersection and fully fencing open-cut construction for stations at both sides, necessary demolition at the same time, traffic limitation, keep one driveway and one non-motor vehicle lane at either direction, and regional traffic organization.. （2） The section of Minggong road : fully fencing open-cut construction for stations at both sides, necessary demolition at the same time, traffic limitation, keep one driveway and one non-motor vehicle	Design Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee

			lane at either direction, and regional traffic organization.. （3） The section pf Jiefang road : During the peak period, regional organization will be used to ease the traffic on the premise of station traffic organization in Er qi square stadion. （4） The section of east street and west street : During the peak period, regional organization will be used to ease the traffic on the premise of station traffic organization in Shunche jie sdation and in dodajie sation.					
		Planning	Main opinions in Construction Planning and Planning Environmental Impact Assessment are implemented: (1) The line starts from Xinliu Road Station, passes Nanyang Road→Minggong Road→Jiefang Road→Xidajie Street→Dongdajie Street→Zhengbian Road→Shangdu Road→Crossing Lianyungang-Lanzhou Railway→Jingkai 17th Avenue. Length and direction of the line is in basic consistency with those of the planned line.(2)The whole route is totally underground line. (3)Totally 21 stations are established, which are all underground stations, including Xiuliu road station、Shamen road station、Xinglongpu road station、Dongfeng road sttion、Agricultural road station、Huanghe road station、Jinshui road station、Taikang road station、Erqi square station、Shunchenjie station、Dongdajie station、Chengdong road station、Weilaidadao station、Fengtai south station、Zhongzhoudadao station、Tongtai road station、Huanghe east station、Agricultural east station、Zhongxing road station、Boxue road station、Hanghai east station。Station setting is in conformity with the original planning.(4)Parking lot is set at southern bank of Jialu River, and car depot is set at east of East Hanghai Road Station, which are in conformity with the original planning	Design Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee
	Material Cultural Resources	Cultural relics	（1）Rail Transit Line 3 passes round the axis of the Memorial Tower and passes the outside of tower footing, and the depth of the line shall meet the requirement of 15m made by cultural relics protection department(2) When designing Erqi Square Station, Chengdong Road Station and Taikang Road Station near historical and cultural sites under government protection, the design of its entrance & exit, ventilation kiosk and cooling tower shall be coordinated with Shang Dynasty Culture Display Area in People’s Park and landscape belt of park at riverside of Jinshui River, Erqi Memorial Tower in honor of the Great Strike and Dehua Street Commercial Center as well as Shang Dynasty Site respectively(3) Depth of underground city wall of Shang Dynasty Site in Zhengzhou is about 8-13m, so buried depth of the metro is suggested to be 15-20m.(4)Design of rail near Erqi Memorial Tower in honor of the Great Strike, Shang Dynasty Site in Zhengzhou and Zhengzhou Confucious’ Temple adopts steel spring floating slabs to reduce the influence of metro vibration on historical and cultural sites under government protection.	Design Unit	Project Owner Local Environmental Protection Bureau			calculated into design fee

Construction Period	Natural Environment	Atmospheric Environm		(1)Construction site shall set hard enclosures with height of not less than 2.5m, and main roads must be hardened and keep cleaning; construction site shall appoint specially-assigned personnel to be in charge of cleaning-keeping work, and conduct sprinkling and cleaning in time to reduce dust（2）Regularly monitor sensitive points near each station construction	Construction Unit	Project Owner Local Environmental Protection Bureau		Tsp	Monitoring expenses: 600,000 yuan; Expenses for temporary sediment tank: 500,000 yuan
		Sound Environment		(1)Set temporary sound insulation enclosing wall or absorbent lined barrier with height of 3-4m at sensitive points which are greatly affected by construction noise of stations. See the following table for the specific measures: see table 11.6-2a	Construction Unit	Project Owner Local Environmental Protection Bureau	The owner entrusts qualified organ to undertake by means of contract	Equivalent sound level A	Monitoring expenses: 600,000 yuan; Other expenses: 2.25 Million yuan
		Environmental Vibration		During construction period, strengthen vibration monitoring and settlement observation for station construction site and surrounding sensitive points as well as underneath and adjacent vibration sensitive points, and reinforcement measures shall be taken if necessary.。See the following table for the specific measures: see table 11.6-2b	Construction Unit	Project Owner Local Environmental Protection Bureau	The owner entrusts qualified organ to undertake by means of contract	Vibration level Z	Monitoring expenses is 200,000 yuan; The other expenses is calculated into engineering fee
		Water Environmen	surfacewater	(1) Construction site and waste residue site shall not be set in the scope of 200m from surface water body. Construction waste residue and dried sludge after treatment by shield mud and water separation system shall be stacked in the designated place, and enclosure measures must be taken, and they shall be sent to local residue management department for treatment.(2) Excavation and earth filling are strictly prohibited on rainstorm days. Temporary spoil and windrow must be covered with tarpaulin or other coverings on rainy days to prevent spoil from flowing into and polluting surface water body due to scour of rainstorm.(3) Waste water produced in car depot shall be treated in adjustment oil removal sedimentation basin, and waste water produced at 21 stations along the Line shall be treated in septic tanks.	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
			groundwater	(1) Daily pumping drainage of groundwater amount is large during foundation pit dewatering process, to protect groundwater quality, it is suggested that dewatering and drainage shall be discharged into urban rainwater system after removing SS in temporary sedimentation basin. (2) It is suggested to strengthen monitoring and supervision over water level, flow direction and flow rate of groundwater along the Line (especially section of Zhongxing Road-East Hanghai Road).	Construction Unit	Project Owner Local Environmental Protection Bureau			Monitoring expenses: 100,000 yuan; Expenses for temporary sediment tank: 500,000 yuan
	Environment	Vegetation Greening		(1) Protect vegetation within land acquisition and along the Line to the greatest extent during project construction, and minimize deterioration of vegetation such as forest, grass and bushwood around temporary ground and operating zone.	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
		Solid Wastes		(1) Spoil will be transported to southwestern hilly area for ravine filling, there are four construction waste disposal sites determined at present which are located in Houzhai Village, Honghuasi Village, Xiaoliu Village and Shawoli Village.	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
	Materials	Cultural Relics		(1) It shall be reinforced before construction of Erqi Memorial Tower in	Construction Unit	Project Owner	The owner	Vibration speed	Monitoring

	Cultural Resources		honor of the Great Strike, and isolation pile measure shall be taken for shield construction of Line 3. (2) (2) Strengthen vibration monitoring and settlement observation for cultural relics involved along the Line during construction period. (3) Within 50 meters from Erqi Tower, the shield tunneling, especially the operation, will be under strict control to ensure equipment in good condition. The earth-pressing balance mode will be applied, the shield tunneling excavation position, earth cut from each cycle and the volume of synchronous grouting shall be under control, and secondary grouting will done to achieve tunneling in balance. The tunneling parameters of the shield tunneling machine will be studied in detail and parameters such as grouting ratio, pressure, thrust force and speed of the machine will be optimized based on specific geologies in Zhengzhou to ensure the shield tunneling machine passes below Erqi Tower in continuous and steady way in order to achieve minimal ground settlement and meet the requirement on protection of historical relics.		Local Environmental Protection Bureau Cultural Relics Bureau	entrusts qualified organ to undertake by means of contract		expenses is 200,000 yuan; The other expenses is calculated into engineering fee
		Ancient and renowned trees	(1) There is no old and famous tree along the Line.	Project Owner	Municipal Government			Calculated into resettlement expenses
	Social environment	Traffic evacuation	(1) For construction of Jinshui Road Station and Taikang Road Station which most severely affect traffic during construction period, it is suggested to adopt cover-excavation method for construction. (2) Detailed construction organization and traffic dispersion scheme is required to be formulated for other stations adopting open-cut method for construction to minimize its influence on traffic, pedestrians, motor vehicles and traveling of disadvantaged groups such as the disabled.	Project Owner	Municipal Government			Calculated into resettlement expenses
		Resident income	(1) Conduct two placement means including monetary indemnity and property right in exchange for material object for demolition of private reidence;(2) For land acquisition, it shall be compensated as the maximum uniform annual output value of local district with 28.6 times of compensation, and young crops shall be compensated as well, the above compensation fees shall be directly sent to each family. (3) Shops shall be compensated as the market price when demolished, decoration fees shall be given, and six-month business suspension compensation fees shall also be given, and the minimum salary compensation of six months at one time will be given to employees in shops.	Project Owner	Government			Calculated into immigrant relocation costs
	Construction risk	Construction risk of the station	See the following table for the specific measures: see table 11.6-2c	Construction Unit	Project owner and local environmental protection bureau			Calculated into engineering supervision expenses
		Risk of interval construtions	See the following table for the specific measures: see table 11.6-2d					

	Environmental Supevision during Construction Period		(1)Carry out monitoring and supervision over the environmental problems caused by construction	Construction Unit	Project owner and local environmental protection bureau			Calculated into engineering supervision expenses
	Environmental Protection Organ and Personnel Training	Environmental Protection Organ and Training	(1) Training on establishment of environmental protection organs of the construction unit and building unit, environmental protection laws, construction planning, and environmental monitoring guidelines and regulations etc..	Construction Unit	Project owner and local environmental protection bureau			20
Operational Period	Natural Environment	Sound Environment	(1) Jialu River Parking Lot is surrounded by green belt with width of 10m and enclosing walls all around, western enclosing wall is increased to 3.5m in height, which requires investment increment of 609,000 yuan; one testing line of car depot on East Hanghai Road is set with acoustic barrier with height of 2m, which requires investment increment of 1.35 million yuan.(2) Ventilation kiosk silencers at 17 ventilation kiosk areas are extended from 2m to 3m or 4m in length. Three cooling towers adopt ultra-low noise cross-flow type, and one of them is surrounded by acoustic enclosure; 7 ventilation kiosk areas and 5 cooling towers which are near to sensitive points change site selection and become over 15m from the points,Details are as follows:Table 11.6-2e	Construction Unit	Project Owner Local Environmental Protection Bureau		Equivalent sound level A	Monitoring expenses: 200,000 yuan; Other expenses: 62.59Million yuan
		Environmental Vibration	(1)For three cultural relics protection units of Shanhaimomuduha Tomb ,Zhengzhou Memorial Tower for February 7th Strike, Zhengzhou Confucius Temple and Zhengzhou Shang Dynasty Relics 4 along both sides of the line in this project, set the steel spring floating slab ballast beds or equivalent moderate shock-absorbing measures., totaling 780m at both sides and requiring 1.95million yuan investment. (2)For 38 over-limit sensitive spots where the line passes just through (in 5m range from the outer rail center line just above track) such as school, hospital and residence areas, including RCC family member courtyard (Gadameilin district) so on, arrange the steel spring floating slab integral ballast beds, totaling 7052m at both sides and requiring investment of 105.78 million yuan. (3)For 45 over-limit sensitive spots within 10--15m range mainly including City bus company, family member courtyard, and Tianxiu courtyard so on, use the flexible support block type integral ballast bed or equivalent moderate shock-absorbing measures, totaling 8753m for double line and the investment of 87.53 million yuan. (4)For the environment sensitive spot with over-limit environment vibration VLz10, or VLz10 is qualified, but VLzmax exceeds the standard environment requirements, including 28 locations of Peaceful residential homes, Building 8 and so on,, use type III vibration reduction fasteners or equivalent moderate shock-absorbing measures, totaling for 5239mm and investment of 17.45 million	Construction Unit	Project owner and local environmental protection bureau	The project owner entrusts qualified organ by contract	Vibration Level	Monitoring expenses: 200,000 yuan; Other expenses: 229.3 Million yuan

			yuan. See the following table for the specific measures: see table 11.6-2f					
		Atmospheric Environm	(1) the distance from ventilation pavilions at Shuncheng Street Station and Taikang Road Station to the sensitive spot is less than 15m, and the odors emitted from ventilation pavilion will impact the resident livings to some extent; in combination with the control measures listed in noise topic, the environment assessment suggests to adjust the locations of 8 ventilation pavilions with the distance of less than 15m from sensitive spots. (2)To effectively relieve the odor impact, it is necessary to plant arbors around ventilation pavilion and make the outlet opposite to the sensitive spots such as residential building.	Constructin unit	Project Owner, Local Environmental Protection Bureau			Calculated into expenses for noise measures
		Water Environment	(1) The design adopts adjustment, oil separation and settlement tank to treat the inspection & repair oily sewage.(2)In the design, the domestic sewage is discharged after treatment with septic tank. the sewage of each station during project construction period is able to be included in existing or planned municipal sewage pipeline network and then into related urban sewage treatment plant for centralized treatment	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
		Electromagnetic Environment	(1)there are no environmental sensitive points around the depots and parking lots, thus no measures need be taken on such influence in the project。 (2)keep the fencing wall of main substation away from residential area as possible, and the least distance from residential area shall be more than 50m.	Project Owner	Project Owner, Local Environmental Protection Bureau	The project owner entrusts qualified organ to undertake the work by contract	Power frequency electromagnetic field, strong radio interference field	/
		Solid Wastes	(1)The rubbish at various stations will be collected by the environmental health staffs, and collectively handed over to the urban rubbish site for disposal. (2)The dangerous substances such as waste oil and dregs, oily cleaning cloth of various processes, and waste transformer oil in the depots and comprehensive base shall be entrusted to the relevant qualified unit for harmless disposal. (3) The storage cells regularly replaced shall be recycled by the factory regularly, and anti-penetration treatment shall be carried out for the storage room of the storage cells to prevent leakage of the infiltration fluid.	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
	Environment	Vegetation Greening	1) Comprehensive greening shall be carried out for the depots, comprehensive base and transformer station etc. during operational period, and the species of the trees shall be mainly local plants.	Construction Unit	Project Owner Local Environmental Protection Bureau			calculated into engineering fee
	Material cultural resources	Cultural relics	（1）For three cultural relics protection units of Shanhaimomuduha Tomb ,Zhengzhou Memorial Tower for February 7th Strike, Zhengzhou Confucius Temple and Zhengzhou Shang Dynasty Relics 4 along both sides of the line in this project, set the steel spring floating slab ballast beds or equivalent moderate shock-absorbing measures., totaling 780m at both sides and requiring 1.95million yuan investment. See the following table for the specific measures: see table 11.6-2g	Construction Unit	Project Owner, Local Environmental Protection Bureau	The project owner entrusts qualified organ to undertake the work by contract	Vibration speed	Calculated into Vibration costs

	Environmental protection organ and personnel training	Environmental Protection Organ and Training during operational period	Establish environmental protection organ of the operational unit, and training on environmental noise, vibration, air, and waste water monitoring and control techniques for relevant environmental protection managerial personnel	Project Owner	Project Owner, Local Environmental Protection Bureau			5
Total Environmental Protection Investment			Total investment: 238309000yuan(excluding investment for monitoring during operational period)					

Table 11.6-2a Summary sheet of main sensitive spots affected by construction noise

No.	Station	Sensitive point	Position relative to stations	Size	Closest distance from the constructional boundary (m)	Predicted noise before measures (dB(A))	Measures to reduce noise	Investment (RMB ¥:×10^4)	Predicted noise after measures (dB(A))
1	Shamen Road Station	Chengshi Bei'an Community 1# building	North end west side	5 units - 2 households, 6 floors, 1 building, about 60 households	18	54.4	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the west side.	25	47.4
2		Changxing Building	South end west side	5 units, 12 households each unit, about 60 households	13	57.3			50.3
3		Huiji District Changxing Road Subdistrict Office	North end east side	Subdistrict Office	9	60.5			53.5
4		Changxing Road 2# Yard 13#, 10# building	North end east side	5 units, 2 households, 7 floor, 2 buildings, about 140 households	24	51.9			44.9
5		Baiwen Garden 1#, 2#, 6#, 7# building	South end east side	3 units, 2 households for each stairs, 1 building; 4 units, 2 households for each stairs, 2 buildings; 8 nits, 2 households for each stair, 1 building, 6 floors (in which the first floor is for store); total about 190 households	Immediately Close to	70.0			63.0
6	Xinglongpu Road Station	Zhengzhou Public Transportation Company Family Area	North end west side	3 units, 2 households for each stair, 7 floors, 3 buildings; 1 units, 4 households for each stair, 7 floors, 1 building; total about 154 households	Immediately Close to	70.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the east side.	25	63.0
7		Huarun Chengshi Zhiyin (Xinyu Yayuan) Community 1#, 5# building	North end east side	2 units, 2 households, 5 floors, total about 40 households	15	56.0			49.0
8		Changjian Yufeng (in construction)	South end west side	8 households per floor, 17 floors, total about 136 households	22	52.7			45.7
9	Dongfeng Road Station	Sunshine Holiday Community 3# Building Sunshine Holiday Community 2# Building	North end west side	3 units, 2 households for each stair, 7 floors, 4 buildings, total about 84 households	6	64.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles;	25	57.0
10		Tongle Community 46# Building Tongle Community 61# Building Food Machinery Plant Family Area 2# Building	South end east side	4 units, 2 households for each stair, 6 floors, 1 building; 1 units, 3 households for each stair, 4 floors, 1 building; 1 units, 3 households for each stair, 7 floors, 1 building; total about 81 households	Immediately Close to	70.0			63.0
11		Tongle Community North Area 1#, 2#, 3#, 4#, 5# building	North end east side	1 unit, 2 households for each stair, 7 floors, 2 buildings; 1 unit, 2 households for each stair, 5 floor, 1 building; 5 units, 2 households for each stair, 6 floors, 1 building; 3 units, 2 households for each stair, 7 floors, 1 building; total about 140 households	3	70.0			63.0
12		Futian Lijing Garden Community 39#, 40# building	South end west side	7 floors, 2buildings, about 40 households each floor; total about 560 households	Immediately Close to	70.0			63.0
13	Nongye Road Station	Ronghua Family Area 3#, 4#	North end west side	3 units, 2 households, 5 floors, 1 building; 7 floors, 1 building; total about 72 households	12	58.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the north side.	25	51.0
14		Zhengzhou Ceramics Factory Family Area 1#, 3# building, Nanyang Road No. 62	South end east side	3 units, 2 households for each stair, 5 floors, 2 buildings, total about 60 households	6	64.0			57.0

15		Nanyang Road 68# Yard Zhengtie Nanyang New Town Community 1#, 2#, 3#, 10#, 41# building	North end east side	4 units, 2 households, 7 floors, 1 building; 1 unit, 4 households, 7 floors, 3 building; 5 units, 2 households, 7 floors, 1 building; total about 210 households.	11	58.7			51.7
16		Xiaoyuzhai (Nanyang Road 266# Yard) 3#, 5# building	South end west side	5 units, 3 households, 6 floors, 1 building; 2 units, 3 households; 6 floors, 1 building; total about 114 households	6	64.0			57.0
17	Huanghe Road Station	Zhengzhou Textile Machinery Staff Apartment 18# - 20# building	North end east side	3 units, 2 households, 7 floors, 3 buildings; total about 126 households	7	62.6	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the east side.	25	55.6
18		Nanyang Road 296# Yard (Nanyang Renjia) 1#, 2#, 3#	North end west side	2 units, 3 households, 12 floors, 1 building; 3 units, 2 households, 6 floors, 1 building; 1 unit, 2 households, 6 floors, 12 households; 9 units, 2 households, 6 floors, 1 building; total about 312 households	Immediately Close to	70.0			63.0
19		Zhengzhou Textile Machinery Co., Ltd. Family Area 6#, 5#, 4#, south 3#, south 2# building	South end east side	10 households per floor, 4 floors, 5 buildings, total about 150 households	Immediately Close to	70.0			63.0
20		Huayuan Community (Nanyang Road No.300) 5# building	South end west side	3 units, 2 households, 7 floors, 1 building, total about 42 households	Immediately Close to	70.0			63.0
21	Jinshui Road Station	Film Bureau Family Area 6#, 7# building (Nanyang Road No. 7)	North end east side	3 units, 2 households, 5 floors, 1 building; 1 unit, 2 households, 5 floors, 1 building; total about 32 households	Immediately Close to	70.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the south side.	25	63.0
22		Zhengzhou City Library	North end east side	In library	Immediately Close to	70.0			63.0
23		Zhengzhou National Oil Reserve Base Family Area 1# building	South end west side	5 units, 2 households, 7 floors, 1 building, total about 70 households	24	51.9			44.9
24		Downtown Community Phase II 1# building	South end east side	3 units, 2 households, 18 floors, 1 building, total about 108 households	31	49.7			42.7
25	Taikang Road Station Jinshui Road Station	Xicai Community (Minggong Road 240# Yard)2#, 3# building	South end west side	7 floors, 10 households 2 buildings; total about 140 households	Immediately Close to	70.0			63.0
26		Minggong Road N0.245 (Xiqian Street 85# Yard 1#, 2# building)	South end west side	about 20 households for low rise; 3 units, 3 households, 7 floors, 1 building, about 63 households; total about 83 households	Immediately Close to	70.0			63.0
27		Huarun Yuefu (in construction)	South end east side	10 households per floor, 58 floors, 1 building; about 580 households	20	53.5			46.5
28	Erqi Square Station	Huigang New Town 1#, 2#, 3# building	Northwest end west side	15 households per floor, 1 building; 10 households per floor, 1 building; 20 households per floor, 1 building; total about 1260 households	10	59.5	/		59.5
29		Xiaolou Mosque, Female Mosque	West end north side	Religion	12	58.0			51.0
30	Shuncheng Street Station	Hongxin Garden 1# building	East end north side	3 units, 4 households, 7 floors, 1 building; about 约 84 households	6	64.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed	25	57.0
31		Xidan Apartment 2# Building	East end north side	7 households per floor, 7 floors, 1 building; 4 units, 4 households; 7 floors,	26	51.2			44.2

				1 building; about 138 households			piles instead of drilled and grouted piles; locate the vehicle access at the west side.		
32		Xiandai Xingyuan 1#	West end south side	About 120 households	9	60.5			53.5
33		Yinzuo International	East end south side	15 floors, 5 units, 2 households per stair; about 150 households	Immediately Close to	70.0			63.0
34	East Street Station	Changjiang Chengzhongcheng	West end south side	4 units, 2 households, 7 floors, 1 building, about 42 households	Immediately Close to	70.0	Erect a 3m-high fence; build simple acoustic-proof shelters to house air compressors and generators; Use static-pressed piles instead of drilled and grouted piles; locate the vehicle access at the east side.	25	63.0
35		Hongyu Garden 1#, 2#, 3# building	West end south side	About 500 households	20	53.5			46.5
36		East Street 220# Yard	East end south side	6 units, 2 households 6 floors, 1 building; about 72 households	7	62.6			55.6
37		Ziyan Huating 1#, 2# building	West end north side	6 households per floor, 24 floors, 2 buildings, about 288 households	14	56.6			49.6
38		Zhengzhou Guancheng District State Administration of Taxation Office Service Hall (to be relocated)	West end north side	Government office, 8 floors	Immediately Close to	70.0			63.0
39		The First People's Hospital of Zhengzhou	East end north side	1200 beds	19	54.0			47.0
40	Chengdong Road Station	Dongguandongli 96# Yard 1# building	East end north side	3 units, 2 households, 5 floors, 1 building, about 30 households	16	55.5	/	/	55.5
41		Shangcheng Garden 1# building	West end north side	2 units, 3 households, 7 floors, about 42 households	43	46.9			39.9
42	Fengtainan Road Station	Zhengzhou Huimin Middle School	West end north side	About 72 classrooms, 2900 teachers and students	25	51.6	/	/	51.6
43		Zhengzhou City Public Security Bureau SWAT Detachment	East end north side	Government office, 8 floors	27	50.9			43.9
	TOTAL							225	

Table 11.6-2b Summary list of main sensitive spots of station contruction vibration impact

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
1	Xinliu road station	Yuhua ninth city, Building 1 #~ 3 #	K0+100～ K0+280	Xinliu Road-Shamen Road Station Section	46	14.5	House	25 floors，Frame structure	I	about 1475 househlds	2010	Open cut methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
2	Shamen road station	Huiji District, Changxing Road, Street office	K1+454～K1+537	Xinliu Road-Shamen Road Station Section	30	14.3	institution	4~5 floors，mixed structure	II	Street agency	In the 1990 s	Open cut methed
3		Changxing Road, No. 2 Courtyard	K1+476～K1+539	Xinliu Road-Shamen Road Station Section	38	14.3	House	7 floors，mixed structure	Ⅱ	about 140 househlds	2000	Open cut methed
4		Cityorth Shore District, 1 # building	K1+450～K1+540	Xinliu Road-Shamen Road Station Section	18	14.5	House	6 floors，mixed structure	Ⅱ	about 60 househlds	2000	Open cut methed
5		Baiwen Garden, Buildings 1 #, 2 #, 6 #, 7 #	K1+587～K1+700	Shamen Road-Xinglongpu Road Station Section	17	14.7	House	6 floors，mixed structure	Ⅱ	about 190 househlds	2010	Open cut methed
6	Xinglongpu road station	CR City Concert (Xinyu Garden) district ,1 #, 5 # Buildings	K2+800～K2+900	Shamen Road-Xinglongpu Road Station Section	9	16.0	House	6 floors，mixed structure	Ⅱ	about 40 househlds	In the 1980 s	Open cut methed
7		City bus company, family member courtyard	K2+800～K2+910	Shamen Road-Xinglongpu Road Station Section	15	14.5	House	7 floors，mixed structure	Ⅱ	about 154 househlds	In the 1990 s	Open cut methed
8		Projects under construction (Chang Jian.Yufeng)	K2+940～K3+170	Xinglongpu Road-Dongfeng Road Station Section	50	14.0	House	17 floors，Frame structure	Ⅰ	about 136 househlds	Under contruction	Open cut methed
9	Dongfeng road station	Fun district, Northern District, fun district building 1#、2#、3#、4#、5#	K4+291～K4+463	Xinglongpu Road-Dongfeng Road Station Section	11	14.9	House	6～7 floors，mixed structure	Ⅱ	about 140 househlds	In the 1990 s	Open cut methed
10		Sunshine Holiday district, 1 #, 2 # Building	K4+286～K4+500	Xinglongpu Road-Dongfeng Road Station Section	10	14.9	House	7 floors，mixed structure	Ⅱ	About 80 househlds	In the 1980 s	Open cut methed
11		Fun district, Southern District, fun district building 46, 61	K4+560～K4+600	Dongfeng Road-Agricultural Road Station Section	36	14.5	House	6 floors，mixed structure	Ⅱ	about 81 househlds	In the 1980 s	Open cut methed
12		Fu Tian Lijing Garden District, 39 #, 40 # Building	K4+585～K4+774	Dongfeng Road-Agricultural Road Station Section	17	15.0	House	7 floors，mixed structure	Ⅱ	about 560 househlds	2000	Open cut methed
13	Agricultural road station	Nanyang Road 68 homes, 1 #, 2 #, 3 #, 10 #, 41 # Building	K5+480～K5+679	Dongfeng Road-Agricultural Road Station Section	12	14.5	House	7 floors，mixed structure	Ⅱ	about 210 househlds	In the 1980 s	Open cut methed
14		Residential Community of Meat Product Branch of Food Company	K5+570～K5+700	Dongfeng Road-Agricultural Road Station Section	40	14.1	House	5～7 floors，mixed structure	Ⅱ	about 72 househlds	In the 1980 s	Open cut methed
15		Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	K5+790～K5+890	Agricultural Road-Huanghe Road Station Section	10	14.6	House	5 floors，mixed structure	Ⅱ	about 60 househlds	In the 1980 s	Open cut methed
16		Small Yuzhai (Nanyang Road	K5+753～K5+832	Agricultural Road-Huanghe Road Station Section	20	14.4	House	6 floors，mixed structure	Ⅱ	about 114 househlds	In the 1980 s	Open cut methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
		courtyard 266--275) Building										
17	Huanghe road station	Zhengzhou Textile staff apartments, 18 # to 20 # buildings	K7+000～K7+100	Agricultural Road-Huanghe Road Station Section	37	14.5	House	7 floors，mixed structure	Ⅱ	about 126 househlds	2000	Open cut methed
18		Nanyang Road, No. 296 Courtyard, 1 #, 2 #, 3 #	K7+032～K7+168	Agricultural Road-Huanghe Road Station Section	15	13.9	House	6～12 floors，mixed structure	Ⅱ	about 312 househlds	In the 1990 s	Open cut methed
19		Buildings 6#, 5#, 4#, and Buildings 3# and 2# in the south of Community of Zhengzhou Textile Machinery Co., Ltd.	K7+214～K7+696	Huanghe Road-Jinshui Road Station Section	15	13.9	House	4（floors，mixed structure	Ⅱ	about 150 househlds	In the 1970 s	Open cut methed
20		Garden community, (Nanyang Road 300) 5 # building	K7+220～K7+320	Huanghe Road-Jinshui Road Station Section	14	13.3	House	7 floors，mixed structure	Ⅱ	about 42 househlds	In the 1980 s	Open cut methed
21		Zhengzhou Jianguo Medicine Institute	K07+280～K07+400	Huanghe Road-Jinshui Road Station Section	15	13.9	Hospital	4 floors，mixed structure	Ⅱ		In the 1980 s	Open cut methed
22	Jinshui road station	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)	K8+174～K8+190	Huanghe Road-Jinshui Road Station Section	6#(12m)，7#(0m)	14.8	House	5 floors，mixed structure	Ⅱ	about 32 househlds	In the 1980 s	covered excavation methed
23		Zhengzhou City Library	K8+250～K8+300	Huanghe Road-Jinshui Road Station Section	5	14.4	Library	2～6 floors，mixed structure	Ⅱ	—	In the 1980 s	covered excavation methed
24		Jinfeng jinan	K09+158～K09+183	Jinshui Road-Taikang Road Station Section	33	14.6	House	28 floors Frame	Ⅰ	about 324 househlds	Nearly 10 years	Open cut methed
25		Zhengzhou National Oil Reserve Depot, family member courtyard 1 # building	K8+290～K8+360	Huanghe Road-Jinshui Road Station Section	20	14.4	House	7 floors，mixed structure	Ⅱ	about 70 househlds	In the 1980 s	covered excavation methed
26	Taikang road station	Huarun Yue House (under construction)	K9+245～K9+610	Taikang Road-Erqi square Station Section	45	19	House	58 floors	Ⅰ	about 580 househlds	Under contruction	Open cut methed
27		West Cai district, (Ming Gong Road No. 240 Courtyard) 1 #	K9+275～K9+315	Taikang Road-Erqi square Station Section	0	14.2	House	4～7 floors，mixed structure	Ⅱ	about 82 househlds	In the 1980 s	Open cut methed
28		West Cai district, (Ming Gong Road, No. 240 Courtyard), 2 #, 3 # Building	K9+275～K9+315	Taikang Road-Erqi square Station Section	16	14.2	House	7 floors，mixed structure	Ⅱ	about 84 househlds	In the 1980 s	Open cut methed
29		Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)	K9+325～K9+410	Taikang Road-Erqi square Station Section	9	14.2	House	2、3，7 floors，mixed structure	Ⅱ	About 83househlds	In the 1980 s	Open cut methed
30	Erqi square	Huigang New Town	K9+700～	Taikang Road-Erqi square	0	19.9	House	28 floors，	Ⅰ	about 1260	Under	Open cut methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
	station	1 #, 2 #, 3 # Building	K9+860	Station Section				Frame structure		househlds	contruction	
31		Small building mosques	K10+000～K10+059	Taikang Road-Erqi square Station Section	6	23.5	Religion	4～6 floors，mixed structure	Ⅱ	—	In the 1960 s	Open cut methed
32	Shunchengjie station	Modern XingYuan 1 #	K10+800～K10+873	Erqi square-Shunchengjie Station Section	23	14.4	House	14～17 floors，Frame structure	Ⅰ	about 120 househlds	2000	Open cut methed
33		Hongxin Jia Yuan 1 # building	K10+915～K10+990	Shunchengjie-Dongdajie Station Section	14	14.4	居住	7 floors，mixed structure	Ⅱ	about 84 househlds	2000	Open cut methed
34		Xidan apartments, two buildings	K11+070～K11+151	Shunchengjie-Dongdajie Station Section	8	14.9	House	7 floors，mixed structure	Ⅱ	about 138 househlds	2000	Open cut methed
35		Ginza International	K10+956～K11+025	Shunchengjie-Dongdajie Station Section	14	14.2	House	15 floors，Frame structure	Ⅰ	about 150 househlds	2010	Open cut methed
36	Dongdajie station	Zi Yan Huating 1 #, 2 # Building	K11+821～K11+917	Shunchengjie-Dongdajie Station Section	23	14.4	House	24 floors，Frame structure	Ⅰ	about 288 househlds	2010	Open cut methed
37		Yangtze River City in City	K11+580～K11+666	Shunchengjie-Dongdajie Station Section	13	16.0	House	7 floors，mixed structure	Ⅱ	about 42 househlds	In the 1990 s	Open cut methed
38		Yuhong Garden, 1 #, 2 #, 3 # Buildings	K11+675～K11+800	Shunchengjie-Dongdajie Station Section	25	14.8	House、Office	26 floors，Frame structure	Ⅰ	about 500 househlds	2010	Open cut methed
39		Municipal Guancheng State Taxation office services hall	K11+929～K11+978	Dongdajie-Chengdong Road Station Section	33	14.3	institution	8 floors，mixed structure	Ⅱ	—	In the 1990 s	Open cut methed
40		First People's Courtyard of Zhengzhou	K11+990～K12+055	Dongdajie-Chengdong Road Station Section	22	14.3	Hospital	5 floors，mixed structure	Ⅱ	--	In the 1990 s	Open cut methed
41		220 East Main Street	K11+978～K12+105	Dongdajie-Chengdong Road Station Section	10	14.3	House	6 floors，mixed structure	Ⅱ	about 72 househlds	In the 1990 s	Open cut methed
42	Chengdong road station	East Main Street, No. 1 Court, Building 1	K12+716～K12+830	Chengdong Road-Weilaidadao Station Section	11	20.5	House	4～7 floors，mixed structure	Ⅱ	about 30 househlds	In the 1980 s	Open cut methed
43		East Main Street, No. 1 Court, Building 2	K12+716～K12+830	Chengdong Road-Weilaidadao Station Section	32	20.5	House	4～7 floors，mixed structure	Ⅱ	about 66 househlds	In the 1980 s	Open cut methed
44		East Main Street, No. 1 Court,	K12+550～K12+600	Dong dajie station- Chengdong Road Station Section	38	21.2	House	7 floors，mixed structure	Ⅱ	about 42househlds	In the 1980 s	Open cut methed
45		Zhengbian road 23	K12+820～K12+857	Chengdong Road-Weilaidadao Station Section	7	20.5	House	5 floors，mixed structure	Ⅱ	about 72 househlds	In the 1980 s	Open cut methed
46	Fengtai south road station	Zhengzhou Huimin High School	K14+686～K14+769	Weilaidadao –Fengtai south Road Station Section	47	14.3	School	5 floors，mixed structure	II	about2900 peple	In the 1990 s	Open cut methed
47		Zhengzhou City Public Security Bureau Police	K14+793～K14+942	Fengtai south Road ~ Zhongzhoudadao Station Section	27	14.3	institution	7～8floors，Frame structure	I	-	2010	Open cut methed

SN	station	Target Name	Mileage	section	The recent distance（m）	Buried depth（m）	Using function	Scale	Buildings Category	Sensitive point overview	Contruction year	construction way
		Detachment										
48	traction line	Dongyinggang Village	K24+300～K24+800	Boxue Road - Hanghai east Road Station Section	0	13.0	House	Below the second floor are peasant houses	Ⅲ	about 70 househlds	In the 1990 s	Open cut methed

Table 11.6-2c Construction risks and measures of stations

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution

1	Xinliu Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	There are a DN219 gas pipe along Xinliu road with underground 2 meters depth.	Class II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
2	Shamen Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	There are a DN219 gas pipe along Changxin road with underground 3 meters depth.	Class class II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.

3	Xinlongpu Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	There are a DN250 gas pipe along Nanyang road with underground 2 -4 meters depth. a DN400 drinkable water pipe along Xinglongpu road with underground 2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
4	Dongfeng Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

				neighboring existing structures and buildings	No. 111 in Nanyang Road (TongLe Xiao Qu Nan Qu),The distance from the line is 6m.	Class IIclass II	The impact on foundation pit and the protection of surrounding buildings shall be specially considered. The design adopts drilling piles to prevent the water infiltration from surrounding soiles into the foundation pit and reinforce concrete support to reduce foundation pit deformation and prevent underwater level decrease outside of foundation pit so as to reduce the settlement of surrounding buildings and pipelines; it shall be closely monitored during construction and the grouting shall be done if necessary. Strictly control the ground settlement and horizontal displacement of bracing structures.
				Passing under municipal pipeline	There are a DN250 gas pipe along Nanyang road with underground 2-4 meters depth. a DN600 concrete drinkable water pipe along Nanyang road with underground 2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
5	Agriculture Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	There are a DN250 gas pipe along Nanyang road and a gas pipe at Agriculture Road station with underground 2-4 meters depth, a DN600 concrete drinkable water pipe along Nanyang road with underground 2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
6	Huanghe Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

				Passing under municipal pipeline	There are a electric cable at Agriculture Road station with a depth of 2 metres, a DN250 gas pipe along Nanyang road with underground 2-4 meters depth, a DN600 concrete drinkable water pipe along Nanyang road with underground 2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
7	Jinshui Road station	underground 2-floor separating island station	Cover cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of cover digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	underneath the jinshui river and jinshui overpass	Class CLASS IICLASS II	1.Generally optimal construction parameters may be adopted while strengthening the management of excavation parameters and status control, and carrying out simultaneous pressure grouting and necessary supplementary pressure grouting measure to guarantee its safety. In case of excessively large ground load, or close distance, compensatory filling may be adopted to duly reinforce the earth surrounding tunnel, or strengthen the pipe segment structure. 2.As for intrusion of bridge pile foundation into the tunnel structure, it is necessary to dismantle such pile foundations before arrival of the shield tunnel machine. It is possible to take pile foundation underpinning, or pile dismantlement for bridge reconstruction. 3. Grouting pipes shall be reserved in the tunnel to reinforce the surrounding soil. Meanwhile, high-pressure jet sprouting piles shall be established between the bridge pile foundation and the structure of the inter-zone tunnel for isolation.
8	Taikang Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

				Passing under municipal pipeline	double gas pipeline in the north side of taikang road d250, Distance from The north side of the midline is 10、12.5，Distance from The East side of the midline is 8.5 m.From west to east along taikang road D600, 8 meters depth.Minggong road ,D600,from south to north,about 4 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for handling of existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors.
9	Erqi Square station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a three-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 23 meters, and it is proposed to adopt continuous waterproof concrete walls for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				neighboring existing structures and buildings	distance from xiaolou qingzhen temple and qingzhen woman temple is about 6 meters.	Class IIclass II	1. Strength the construction monitoring for foundation pit bracing structure and traffic dispersion road surface. Strictly control the ground settlement and horizontal displacement of bracing structures. 2. Monitor the deformation of buildings besides foundation pit, ground surface and retaining structure and reserve grouting holes at buildings near the foundation pit; conduct grouting reinforcement if excess deformation of foundation is detected.

10	Shunchengjie station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				neighboring existing structures and buildings	distance from honhxinjiayuan number 1 building （7 floor，brick-concrete structure）	Class I	1. Strength the construction monitoring for foundation pit bracing structure and traffic dispersion road surface. Strictly control the ground settlement and horizontal displacement of bracing structures. 2. Monitor the deformation of buildings besides foundation pit, ground surface and retaining structure and reserve grouting holes at buildings near the foundation pit; conduct grouting reinforcement if excess deformation of foundation is detected.
				Passing under municipal pipeline	1、Gas pipeline from west to east along xiadajie D250,about 2-3 meters depth.from north to south along shuncheng street,about 2-3 meters depth. 2、tap water pipe from east to west along xidajie D600,4-6 meters depth.	Class IIclass II	1. Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. If the relocation method is used, it shall be kept away from the station foundation pit as possible. 2. Temporarily relocate main pipelines affecting the station, and monitor the stratum deformation at locations after relocation. Once exceeded alarm range, take measures such as grouting reinforcement.

11	Dongdajie station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a three-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 23 meters, and it is proposed to adopt continuous waterproof concrete walls for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1gas pipeline from west to east along dongdajie d250,about 2-3 meters depth,distance from the north side of the midline is about 12 meters.esat side of zijin mountain,from north to south ,2-5 meters depth.	Class IIclass II	1. Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. If the relocation method is used, it shall be kept away from the station foundation pit as possible. 2. Temporarily relocate main pipelines affecting the station, and monitor the stratum deformation at locations after relocation. Once exceeded alarm range, take measures such as grouting reinforcement.
12	Chengdong Road station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a three-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 22 meters, and it is proposed to adopt continuous waterproof concrete walls for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

					Distance between Number 96 building of dongguangdongli (4-7floors, brick-concrete structure)and the line is sbout 11meters	Class I	1. Strength the construction monitoring for foundation pit bracing structure and traffic dispersion road surface. Strictly control the ground settlement and horizontal displacement of bracing structures. 2. Monitor the deformation of buildings besides foundation pit, ground surface and retaining structure and reserve grouting holes at buildings near the foundation pit; conduct grouting reinforcement if excess deformation of foundation is detected.
				Passing under municipal pipeline	1gas pipeline from west to east along dongdajie d250,about 2-3 meters depth,distance from the north side of the midline is about 12 meters. from north to south along chengdong road ,2-3 meters depth.distance from east side of the middle line is about 13 meters,distance from west side is about 11.5 meters	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
13	Weilaidadao station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
					gas pipeline from east to west along the zhengbian road d250,2-3meters depth ,distance from south side of middle line is about 25meters,distance from the north side ofweilaidadao is21 meters ,south side about 24 meters.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
14	Fengtai South station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.

				Passing under municipal pipeline	1、gas pipeline from north to south along the fengtai road,2-3meters depth ,distance from east side of middle line is about 15meters,located on the south side of zhengbian road,d250,from north to south ,2-3 meters depth,north side of the middleline.2、water pipe from west to east ,d600,about 6 meters depth	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
15	Zhongzhoudadao station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a three-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 23 meters, and it is proposed to adopt continuous waterproof concrete walls for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				neighboring existing structures and buildings	zhongzhou dadao viaduct	Class I-CLASS II	1.Generally optimal construction parameters may be adopted while strengthening the management of excavation parameters and status control, and carrying out simultaneous pressure grouting and necessary supplementary pressure grouting measure to guarantee its safety. In case of excessively large ground load, or close distance, compensatory filling may be adopted to duly reinforce the earth surrounding tunnel, or strengthen the pipe segment structure. 2.As for intrusion of bridge pile foundation into the tunnel structure, it is necessary to dismantle such pile foundations before arrival of the shield tunnel machine. It is possible to take pile foundation underpinning, or pile dismantlement for bridge reconstruction. 3. Grouting pipes shall be reserved in the tunnel to reinforce the surrounding soil. Meanwhile, high-pressure jet sprouting piles shall be established between the bridge pile foundation and the structure of the inter-zone tunnel for isolation.
				Passing under municipal pipeline	east side of zhongzhoudadao,d250,from north to south ,about 2-5 meters depth,distance from the north sideof the junction is about 30 meters	Class CLASS IICLASS II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.

16	Tongtai Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1、Gas pipeline located on the east side of tongtai road d250,from south to north ,2-3meters depth.the north side gas pipeline,west to east ,2-5 meters depth2、From west to east along shangdu road,D600,3meters depth,located on the south side of the middleline.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
17	Huanghe East Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1、Gas pipeline located on the east side of huanghe river road d250,from south to north , 3meters depth.the north side of shangdu roadd250,west to east ,2-5 meters depth 2、bothway tap water pipe from east to west along shangdu road D600,3 meters depth 3、The south side of the Power cable from west to east along shangdu road,2 meters depth	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.

18	Agriculture East Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1、Gas pipeline located on the east side of nongye road,from south to north ,2-3meters depth.distance from the east side of midline is 20.5 meters.the north side of shangdu road d250,west to east ,2-3 meters depth, 2、bothway tap water pipe from east to west along shangdu road D600,3 meters depth 3、The south side of the Power cable from west to east along shangdu road,2 meters depth	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
19	Zhongxing Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1、Natural gas pipeline is located on the north of shangdu road D250,from west to east ,2-5 meters depth.2、 bothway tap water pipe from east to west along shangdu road D600,3 meters depth.3、south of power cable from east to west along shangdu road,2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.

20	Boxue Road station	underground 2-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	1、bothway tap water pipe from east to west along shangdu road D600,3 meters depth.2、south of power cable from east to west along haihang road D600,2 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.
21	Hanghai East Road station	underground 3-floor island station	open cut normal method	Construction method risk and Geologic risk	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	Class IIclass II	1. The main body of the station is constructed by means of open digging method with a bi-level three-span steel reinforcement rod and concrete rectangular framework structure. The depth of the base pit of the station is about 17 meters, and it is proposed to adopt drilling filling pile plus waterproof curtain for the bracing structure. 2. Stratified excavation, timely supporting and prohibition from over-excavation; the steel support shall have anti-releasing measures. 3. Properly carry out anti-seepage for station buildings to avoid the rise of underground water level and pollution of station interior; conduct foundation pit monitoring and phreatic water level observation and treatment; reinforce the waterproof design and treatment at bottom of foundation pit.
				Passing under municipal pipeline	single tap water pipe from east to west along haihang road D600,3 meters depth.	Class IIclass II	Adopt measures such as permanent relocation, temporary relocation and temporary hanging for existing pipelines; the specific method shall be determined according to pipeline features, station construction method, station buried depth and other factors. The valves of water supply pipe and gas pipe newly set outside two ends of station shall be properly protected.

Table 11.6-2d Construction risks and measures of Interval

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution
1	xinliu road station –hanghai road station	shield method	geology risk	K0+000-K25+200	The aforesaid stratums belong to category I wall rock with uneven distribution of rock properties and ordinary engineering geological conditions. The stratums are composed of powdery earth, powdery clay, powdery sand and fine sand. The rock and soil layers are mainly earth with medium and high compressibility, low strength and poor stability.	class IIclass II	Adjust the shield tunneling parameters according to dynamic monitoring data; carry out reinforcement of mixing pile and rotary churning pile at shield tunneling in and out section;
2	shanmen road station –xinglongpu road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K2+444～K2+495	Huiji District’s office building of Land and Resources,7floor,5meters from the linefloor distance from the line is	CLASS II	1. Adopt earth pressure balance shield and select optimal construction parameters to ensure stable cutting face; strength the synchronous grouting and necessary supplement measures to control the settlement of structures. 2. Adjust shield construction parameters at any time to minimize the over-excavation and under-excavation, eliminate the slump or squeezing of soils before the shield and reduce the lateral force applied on pile foundation from lateral deformation of foundation soil. 3. Adopt synchronous grouting, reduce the gap formed outside the tunnel after shield tail passed and reduce the horizontal displacement of soils around the tunnel and the resulted negative friction resistance. 4. Strengthen the monitoring and take related measures including monitoring of deformation and settlement of structures; the large deformation detected shall be timely feed back to design and construction unit so as to adjust the construction parameters or take necessary ground reinforcement measures. 5. During side channel construction: ① The design temperature and thickness of frozen soil curtain of side channel shall meet the requirement. ② Prepare preventive emergency plans such as freezing hole construction plan, freezing construction plan, excavation and pouring construction plan, frost heave and melting settlement prevention plan. 6. After shield passed, open the embedded grouting pipe in duct according to deformation of ground surface and building/structures, and timely carry out two-shot grouting reinforcement behind the wall for surrounding soils. 7. Control the uneven settlement difference of buildings of no more than ≤3‰
				K2+600～K2+619	Peaceful residential homes, Building 8,，17floor floor，distance from the line is 9meters 。Frame structure	class II	
				K2+623～K2+663	RCC family member courtyard (Gadameilin district),distance from the line is o meters 。17 floors，Frame structurefloor	class II	
				K2+800～K2+900	CR City Concert (Xinyu Garden) district ,1 #, 5 # Buildingsfloor distance from the line is ,9meters	class II	
				K2+800～K2+910	City bus company, family member courtyard，7floor floor，distance from the line is 15meters from the line	class II	
	xinglongpu road station –dongfeng road station			K3+280～K3+339	National Food Authority’s Zhengzhou Institute of Science，3~6floor floor，distance from the line is 15m from the line。	class class II	
				K3+410～K3+546	Tractor plant family member building，5floor floor，distance from the line is 12meters。	class II	
				K3+573～K3+600	Nanyang Road 137，6floor floor ，distance from the line is 15meters from the line	class II	
				K3+610～ K3+723	Tianxiu home district, 1 # ~ 4 # Building, distance from the line is 16meters from the line，7 floors，mixed structurefloor mixed structure	class II	
				K3+730～ K3+784	Zhengzhou Oriental Tumor Courtyard，5floor ，distance from the line is 15m，mixed structure 。	class II	
				K3+957～K3+990	ICBC family member building，5floor ，distance from the line is 11m，mixed structure	class II	
				K4+000～K4+213	张砦村，2~7floor ，distance from the line is 17m，mixed structure	class II	
				K4+291～K4+463	Fun district, 1 #, 2 #, 3 #, 4 #, 5 # Buildingfloor ，11meters from the line distance from the line is ，6--7 floors，mixed structuremixed structure	class II	
				K3+200～K3+328	Grain transport community, Building 9, Building 10，6floor floor，distance from the line is 11m from the line，mixed structuremixed structure	class II	
				K3+611～K3+621	Huiji District’s Board of Education family member building，7floor floor，mixed structuremixed structure ， distance from the line is 13meters from the line。	class II	
				K3+635～K3+773	Yuhua Wen Hui Garden District, Building 1 to 5，7floor floor，mixed structuremixed structure ， distance from the line is 16meters from the line。	class II	
				K3+917～K4+049	Yuhua Wen Qing Garden District Building 1 to 4，7floor ，mixed structure ，distance from the line is 13m。	class II	
				K4+129～K4+211	Yaxin good times area, 3 to 4 Building 7floor ，mixed structure ，distance from the line is 13m。	class II	
				K4+217～K4+277	Chuangye Homes，7floor ，mixed structure ，distance from the line is 9m。	class II	
				K4+286～K4+500	Sunshine Holiday district, 1 #, 2 # Building，7floor ，mixed structure ，distance from the line is 10m。	class II	
4	dongfeng road	shield	Crossing	K4+529～K4+558	Nanyang Road, No. 111 Courtyard，6floor ，distance from the line is 6m。	classII	

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution
	station-nonongye road station	method	Underneath Existing Buildings	K4+929～K5+010	China Railway Bridge Bureau family member courtyard 1 #，7floor ， distance from the line is 8m。	class II	
				K5+116～K5+247	Zhengzhou Boiler Factory family member courtyard 1 #, 2 #，7floor ， distance from the line is 11m。	class II	
				K5+268～K5+318	Zhengrong Group Limited family member courtyard, 3 #, 6 # building，5floor ， distance from the line is 8m	class II	
				K5+328～K5+390	Vision Garden 2 #, 3 # Building，7floor ， distance from the line is 11m。	class II	
				K5+392～K5+456	Old meat processing factory family member courtyard, 1 #, 3 #, 5 # Building，6floor ， distance from the line is 12m。	class II	
				K5+480～K5+679	Nanyang Road 68 homes, 1 #, 2 #, 3 #, 10 #, 41 # Building，6floor ， distance from the line is 12m。	class II	
				K4+785～K4+833	Mold factory family member courtyard 1 # building，6floor ，distance from the line is 12m。	class class II	
				K4+845～K4+900	Kaiyuan district, 1 #, 2 # Building，6floor ，distance from the line is 14m。	class II	
				K4+937～K5+025	Nanyang Road, No. 239 Courtyard，6floor ，distance from the line is 14m。	class II	
				K5+390～K5+441	Ronghua community, 1 # Building，5floor ，distance from the line is 12m。	class II	
				K5+477～K5+520	Nanyang Road 253 (food company meat branch family member building) 1 #, 3 #，6floor ， distance from the line is 11m。	class II	
5	nongyeroad station –huanghe road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K5+790～K5+890	Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	class II	
				K5+900～K5+965	Provincial Prospecting machinery factory family member courtyard 1 #, 5 #, 6 # building，6floor ， distance from the line is 12m。	class II	
				K6+043～K6+082	Nanyang Road, No. 52 (Yuhua Wen Jinyuan), three buildings，7floor ， distance from the line is 13m。	class II	
				K6+205～K6+234	Sipo Road 9，8floor ， distance from the line is 12m。	class II	
				K6+429～K6+500	Nanyang Road, No. 46，17floor ， distance from the line is 11m。	class II	
				K6+517～K6+548	Nanyang Road, No. 41 courtyard, 5 # Building，6floor ，distance from the line is 9m。	class II	
				K6+613～K6+679	Huafu Institute of Dermatology，5~7floor ，distance from the line is 10m。	class II	
				K6+690～K6+762	City No. 71 high school，5floor ， distance from the line is 11m。	class II	
				K6+900～K7+073	Zhengzhou Textile staff apartments, 29 #, 30 # Building，4floor ，distance from the line is 14m。	class II	
				K7+100～K7+177	Nanyang Road, No.1 primary，3~6floor ， distance from the line is 9m。	class II	
				K5+843～K5+878	Transport company family member courtyard, (Nanyang Road No. 268 courtyard), 1 # Building，7floor ， distance from the line is 15m。	class II	
				K5+889～K6+021	Nanyang Road, No. 270 Courtyard, 2 #, 4 # Building，7floor ， distance from the line is 12m。	class II	
				K6+034～K6+085	Nanyang Road, No. 279 Courtyard, 1 #, 2 # Building，5~7floor ， distance from the line is 12m。	class II	
				K6+100～K6+180	Pearl Factory, family member courtyard, 1 #, 2 #, 3 # Building (Nanyang Road 275)，6floor ， distance from the line is 9m。	class II	
				K6+260～K6+305	Nanyang Road, No. 283 Courtyard，5floor ，distance from the line is 13m。	class II	
				K6+600～K6+975	Hengtian Heavy Industry Co., Ltd family area，3~6floor ， distance from the line is 14m。	class II	
				K7+032～K7+168	Nanyang Road, No. 296 Courtyard, 1 #, 2 #, 3 #，6~12floor ，distance from	class II	

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution
					the line is 15m。		
6	huanghe road station –jinshuiroad station	shield method	Adjacent / Crossing Underneath Existing Buildings	K7+214～K7+696	Zhengzhou Textile Machinery Co family member courtyard, 6 #, 5 #, 4 #, South 3 #, 2 # Building South，4floor ，distance from the line is 15m。	class II	
				K7+900～K8+150	Nanyang Road No. 12 courtyard, 1 #, 2 # Building，3~6floor ，distance from the line is 10m。	class II	
				K7+970～K8+010	Jinshui District Police Fire Brigade，7floor ，distance from the line is 14m。	class II	
				K8+174～K8+190	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)，5floor ，crossing underneath number 7 building	CLASS II	
				K8+190～K8+220	Tingdao foreign language training，4floor ，crossing underneath。	CLASS II	
				K8+250～K8+300	Zhengzhou City Library，2~6floor ，distance from the line is 5m。	CLASS II	
				K7+220～K7+320	Garden community, (Nanyang Road 300) 5 # building，7floor ，distance from the line is 14m。	class II	
				K7+900～K8+020	Zhongheng Garden, 2nd Courtyard, 1 #, 2 #, 3 # Building，5~6floor ，distance from the line is 8m。	class II	
7	jinshui road station –taikang road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K8+485～K8+495	Jinshui Road, 11th courtyard, 1 # building，4floor ，distance from the line is 11m。	class II	
				K8+640～K8+690	Minggong Road No. 67 courtyard, (Jinfeng Golden Coast International), 1 # Building，7floor ，distance from the line is 6m。	CLASS II	
				K8+920～K9+017	Minggong Road, No. 156 Courtyard, 1 #, 2 # Building，6floor ，distance from the line is 6m。	CLASS II	
				K9+030～K9+100	Jin Ming Yuan South, Building # 1，7floor ，distance from the line is 4m。	CLASS II	
8	taikang road station –erqi suquare station	shield method	Adjacent / Crossing Underneath Existing Buildings	K9+700～K9+860	Huigang New Town 1 #, 2 #, 3 # Building，28floor ，distance from the line is 0m。	CLASS II	
				K10+000～K10+059	Small building mosques，4~6floor ，distance from the line is 6m。	CLASS II	
				K9+275～K9+315	West Cai district, (Ming Gong Road No. 240 Courtyard) 1 # ，4~7floor ，Crossing underneath	CLASS II	
				K9+325～K9+410	Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)，2~7floor ，distance from the line is 9m。	class II	
				K9+545～K9+608	Ming Gong Road No. 272, (Rural Credit Cooperative Union, family member building)，6floor ，crossing underneath。	CLASS II	
				K9+638～K9+674	Yalong district, 17 # Building，7floor ，正下穿。	CLASS II	
				K9+638～K9+674	Yalong districtl 16 # Building, 1 #, 2 # Building，7floor ，distance from the line is 16m。	class II	
				K9+687～K9+719	Catholic Church，2~5floor ，distance from the line is 2m。	CLASS II	
			Crossing Underneath bridge	K9+800～K10+000	Jiefang Road overpass Pile foundationCrossing underneath	CLASS II	
9	erqi suquare station –shuncheng street station	shield method	Adjacent / Crossing Underneath Existing Buildings	K10+510～K10+614	Shangfuxin Village House 1#，18floor ，distance from the line is 6m。	class II	
				K10+625～K10+779	Fuchun Apartment 1 # building，7floor ，distance from the line is 15m。	class II	
				K10+317～K10+348	Zhengzhou Feb 7 Strike Monument，14floor ，钢筋混凝土结构。distance from the line is 3m。	CLASS II	
				K10+528～K10+614	Huating Apartments, Dehua Street community 1 #, 2 # Building，16floor ，distance from the line is 15m。	class II	
				K10+630～K10+775	Jinding Huafu House, front 1 #，11floor ，distance from the line is 13m。	class II	
				K10+630～K10+775	Jinding Huafu House, rear，5~7floor ，distance from the line is 8m。	class II	

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution
10	shuncheng street station –dongdajie street station	shield method	Adjacent / Crossing Underneath Existing Buildings	K10+915～K10+990	Hongxin Jia Yuan 1 # building，7floor ，distance from the line is 14m。	class II	
				K11+070～K11+151	Xidan apartments, two buildings，7floor ，distance from the line is 8m。	class II	
				K11+250～K11+286	West Street, No. 231，16floor ，distance from the line is 13m。	class II	
				K11+380～K11+446	Zhongkai City Lights Clove Court, 1 #, 2 # Building，12floor ，distance from the line is 12m。	class II	
				K10+956～K11+025	Ginza International，7floor ，distance from the line is 15m。15floor ，distance from the line is 14m。	class II	
				K11+038～K11+100	233 West Main Street (the third secondary school, family member building)，18floor ，distance from the line is 11m。	class II	
				K11+230～K11+300	Sun Moon Star City, 1 # building，20floor ，distance from the line is 15m。	class II	
				K11+328～K11+566	Zhongkai City Lights Clove Court, 1 #, 2 # Building，7floor ，distance from the line is 14m。	class II	
				K11+580～K11+666	Yangtze River City in City，7floor ，distance from the line is 13m。	class II	
11	dongdajie road station-chengdong road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K11+978～K12+105	number 220 community in dongdajie，6floor ，distance from the line is 10m。	class II	
				K12+133～K12+366	Zhongkai City Lights Guangjingcui Court, 1 #, 2 # Building，7floor ，distance from the line is 8m。	class II	
12	chengdong road station-weilaidadao road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K12+716～K12+830	East Main Street, No. 1 Court, 1 # building，4~7floor ，distance from the line is 11m。	class II	
				K12+992～K13+072	Knitting mill family member courtyard, 1 # building，5floor ，distance from the line is 12m。	class II	
				K13+076～K13+226	Yutong Garden 1 # building ，6floor ，distance from the line is 12m。	class II	
				K13+230～K13+408	Municipal underwear factory family member courtyard, 1 #, 2 #, 3 # Building，5~6floor ，distance from the line is 14m。	class II	
				K12+820～K12+857	Zheng Bian Road, Building 23,，5floor ，distance from the line is 7m。	class II	
				K13+158～K13+225	Cargo Terminal No. 23 North Street Courtyard, 1 #, (Phoenix Road Community)，5floor ，distance from the line is 18m。	class II	
				K13+332～K13+390	Boai ENT Hospital of Zhengzhou，6floor ，distance from the line is 9m。	class II	
				K13+398～K13+430	Zheng Bian Road, No. 49, family member courtyard, 1 # Building，5floor ，distance from the line is 13m。	class II	
				K13+512～K13+650	Dongming Road 30 Courtyard, (electric power district), 1 #, 2 # Building，6floor ，distance from the line is 9m。	class II	
			Crossing Underneathwater and rivers	K12+900～K13+000	Crossing underneath xionger river	class II	
13	zhognzhoudadao road station-tongtai road station	shield method	Crossing Underneath bridge	K15+850～K15+950	crossing underneath zhongzhoudadao overpass	CLASS II	
14	tongtai road station –huanghedong road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K17+206～K17+266	guancheng chinese hospital，8 floor,,10meters from the line	class II	
			Crossing Underneathwater and rivers	K17+200～K17+400	Underneathqili river,，The bottom to the top of tunnel is 10m	CLASS II	

No.	Station	Engineering proposal	Construction method	Risk engineering category	Description of basic risk conditions	Risk classifications	Solution
15	zhongxing road station –boxue road station	shield method	Crossing Underneath bridgeCrossing Underneath bridge	K20+800～K15+920	Crossing underneath the high-speed rail bridge pile foundation	CLASS II	
16	boxue road street station-hanghaidong road station	shield method	Adjacent / Crossing Underneath Existing Buildings	K24+300～K24+8000	Dongyinggang cun,1-2floor,crossing undernath	CLASS II	
			Crossing Underneath railway	K23+250～K23+360	underneath longhai railway,，ground line	class II	

Table 11.6-2e Noise control measures for ventilation pavilion and cooling tower

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
1	Yuhua 9th City 1# building	Layer 1	K0+090 ～ K0+100	30	30	30	/	6.72	11.28	0.02	0.08	（1）Main exhaust port backing to the sensitive spot.（2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	28.13	29.12	0.00	0.01
1	Yuhua 9th City 1# building	Layer 2	K0+090 ～ K0+100	30	30	30	/	7.12	11.77	0.02	0.07			28.07	29.07	0.00	0.01
1	Yuhua 9th City 1# building	Layer 5	K0+090 ～ K0+100	30	30	30	/	7.61	10.19	0.01	0.09			27.36	28.35	0.00	0.01
1	Yuhua 9th City 1# building	Layer 8	K0+090 ～ K0+100	30	30	30	/	6.31	10.17	0.01	0.07			26.13	27.12	0.00	0.01
2	Hualian Family Area 3# Building	Layer 1	K1+436 ～ K1+460	26	26	26	30	4.78	10.79	0.18	0.49	（1）Main exhaust port backing to the sensitive spot.（2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;（3）Use Ultra-low noise cooling tower（4）The cooling tower is provided with noise hood at the outside	45	32.51	33.01	0.01	0.03
2	Hualian Family Area 3# Building	Layer 3	K1+436 ～ K1+460	26	26	26	30	5.64	11.22	0.14	0.42			35.60	35.84	0.01	0.04
3	Hualian Family Area 4# building	Layer 1	K1+436 ～ K1+460	23	25	20	26	/	0.41	0.13	0.71			36.89	37.19	0.01	0.08
3	Hualian Family Area 4# building	Layer 3	K1+436 ～ K1+460	23	25	20	26	/	1.06	0.11	0.56			33.21	33.82	0.01	0.03
4	Hualian Family Area5# building	Layer 1	K1+436 ～ K1+460	20	19	23	16	/	0.02	0.29	1.82			40.26	40.37	0.03	0.22
4	Hualian Family Area5# building	Layer 3	K1+436 ～ K1+460	20	19	23	16	/	/	0.45	1.84			39.60	39.72	0.05	0.22
5	Chengshi Bei'an Residence Community 1# building	Layer 1	K1+615 ～ K1+650	33	33	33	/	/	/	0.03	0.15	（1）Main exhaust port backing to the sensitive spot.（2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;（3）The wind pavilion is moved 10m to the north	15	27.38	28.38	0.00	0.02
5	Chengshi Bei'an Residence Community 1# building	Layer 2	K1+615 ～ K1+650	33	33	33	/	/	/	0.03	0.18			27.34	28.33	0.00	0.02
5	Chengshi Bei'an Residence Community 1# building	Layer 5	K1+615 ～ K1+650	33	33	33	/	/	/	0.02	0.16			26.74	27.73	0.00	0.02
6	Chengshi Bei'an Residence Community 4# building	Layer 1	K1+615 ～ K1+650	16	19	13	/	7.55	8.55	0.05	0.55			30.75	32.48	0.00	0.04
6	Chengshi Bei'an Residence Community 4# building	Layer 2	K1+615 ～ K1+650	16	19	13	/	6.26	9.06	0.06	0.46			30.65	32.34	0.00	0.03
6	Chengshi Bei'an Residence Community 4# building	Layer 5	K1+615 ～ K1+650	16	19	13	/	6.44	8.60	0.04	0.30			29.35	30.76	0.00	0.02

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
7	Zhengzhou Public Transportation Company Family Area 2# building	Layer 1	K2+787 ～ K2+803	26	23	31	/	/	/	0.01	0.25	（1）Main exhaust port backing to the sensitive spot.		29.39	30.12	0.00	0.03
7	Zhengzhou Public Transportation Company Family Area 2# building	Layer 2	K2+787 ～ K2+803	26	23	31	/	/	/	0.01	0.23			29.32	30.05	0.00	0.02
7	Zhengzhou Public Transportation Company Family Area 2# building	Layer 5	K2+787 ～ K2+803	26	23	31	/	/	/	0.01	0.17			28.36	29.13	0.00	0.02
8	Changjian Yufeng (in construction)	Layer 1	K3+070 ～ K3+090	48	48	48	40	12.52	15.19	0.02	0.09	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use low noise cooling tower	35	33.13	33.28	0.00	0.01
9	Nanyang Road No.219 Yard 6# building	Layer2	K4+405 ～ K4+425	14	18	1	/	/	2.44	0.03	0.84	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）The location of wind pavilion is adjusted, and moved 6m to the center of the road	15	33.63	39.89	0.00	0.09
9	Nanyang Road No.219 Yard 6# building	Layer 4	K4+405 ～ K4+425	14	18	1	/	/	1.38	0.03	0.28			32.17	34.39	0.00	0.03
10	Nanyang Road No.219 Yard 4# building	Layer 1	K4+405 ～ K4+425	26	30	15	/	4.54	10.57	0.04	0.17			29.11	31.45	0.00	0.02
10	Nanyang Road No.219 Yard 4# building	Layer 3	K4+405 ～ K4+425	26	30	15	/	3.74	9.02	0.04	0.22			28.84	30.98	0.00	0.02
11	Sunshine Holiday Community 3# Building	Layer 1	K4+405 ～ K4+425	6	6	6	/	7.87	12.67	0.27	1.27			35.29	36.28	0.01	0.04
11	Sunshine Holiday Community 3# Building	Layer 3	K4+405 ～ K4+425	6	6	6	/	7.44	12.38	0.14	0.58			34.15	35.14	0.01	0.03
12	Sunshine Holiday Community 2# Building	Layer 1	K4+405 ～ K4+425	17	14	21	/	/	1.81	0.07	0.21			31.42	32.14	0.01	0.02
12	Sunshine Holiday Community 2# Building	Layer 3	K4+405 ～ K4+425	17	14	21	/	/	1.11	0.08	0.21			30.95	31.70	0.01	0.02
13	Tongle Community 46th building	Layer 1	K4+600 ～ K4+637	30	25	39	16	4.07	8.66	0.57	2.46	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to	45	34.36	34.50	0.02	0.09
13	Tongle Community 46th building	Layer 3	K4+600 ～	30	25	39	16	4.62	7.65	0.42	2.75			33.93	34.08	0.01	0.11

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
			K4+637									more than 3m to reduce the noise of ventilation pavilion for 10dB;; （3）Use Ultra-low noise cooling tower （4）The location of wind pavilion is adjusted, and moved 3m to the center of the road					
14	Tongle Community 61th building	Layer 1	K4+600 ～ K4+637	28	23	31	23	5.43	7.84	0.23	1.54			32.73	33.02	0.01	0.06
14	Tongle Community 61th building	Layer 3	K4+600 ～ K4+637	28	23	31	23	5.98	7.12	0.18	1.72			32.47	32.78	0.01	0.07
15	Food Machinery Plant Family Area 2# Building	Layer 1	K4+600 ～ K4+637	28	28	28	35	8.46	8.56	0.06	0.66			34.76	35.03	0.01	0.07
15	Food Machinery Plant Family Area 2# Building	Layer 3	K4+600 ～ K4+637	28	28	28	35	8.16	8.45	0.06	0.65			34.59	34.85	0.01	0.07
16	Xincun Community 3# Building	Layer 1	K5+640 ～ K5+660	31	35	20	/	9.11	8.78	0.01	0.18	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	27.75	29.74	0.00	0.02
16	Xincun Community 3# Building	Layer 3	K5+640 ～ K5+660	31	35	20	/	8.41	8.09	0.01	0.19			27.56	29.46	0.00	0.02
17	Ronghua Community 2#	Layer 1	K5+640 ～ K5+660	12	12	12	/	3.89	6.90	0.19	1.40			33.55	34.54	0.01	0.11
17	Ronghua Community 2#	Layer 3	K5+640 ～ K5+660	12	12	12	/	4.72	6.77	0.12	1.07			32.78	33.77	0.01	0.09
18	Ronghua Community 3#	Layer 1	K5+640 ～ K5+660	25	21	29	/	6.53	7.86	0.03	0.26			29.77	30.52	0.00	0.03
18	Ronghua Community 3#	Layer 3	K5+640 ～ K5+660	25	21	29	/	5.24	8.03	0.04	0.23			29.45	30.21	0.00	0.02
19	Xiaoyuzhai (Nanyang Road 266# Yard) 3# building	Layer 2	K5+816 ～ K5+836	21	15	26	16	/	/	0.74	3.20	（1）Main exhaust port backing to the sensitive spot. （2）moved 10m to the center of the road （3）Use Ultra-low noise cooling tower	30	34.66	34.90	0.02	0.14
19	Xiaoyuzhai (Nanyang Road 266# Yard) 3# building	Layer 5	K5+816 ～ K5+836	21	15	26	16	/	/	0.63	2.26			33.29	33.56	0.02	0.10
20	Transport Company Family Area (Nanyang Road No. 268) 1# building	Layer 1	K5+843 ～ K5+878	21	26	10	19	/	/	0.46	2.69			35.22	36.56	0.02	0.18
20	Transport Company Family Area (Nanyang Road No. 268) 1# building	Layer 3	K5+843 ～ K5+878	21	26	10	19	/	/	0.34	2.68			34.76	35.84	0.01	0.17
21	Zhengzhou Textile Machinery Apartment 29#	Layer 1	K7+000 ～ K7+030	4	1	9	1	2.09	16.59	9.19	18.79	（1）Main exhaust port backing to the sensitive spot.	45	61.53	61.53	2.38	9.28

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
21	Zhengzhou Textile Machinery Apartment 29#	Layer 3	K7+000 ～ K7+030	4	1	9	1	/	3.43	0.91	5.13	（2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use Ultra-low noise cooling tower （4）moved 8m to the center of the road		46.76	46.84	0.10	0.89
22	Zhengzhou Textile Machinery Apartment 30#	Layer 1	K7+000 ～ K7+030	12	16	4	25	/	0.38	0.15	2.18			38.65	41.34	0.02	0.27
22	Zhengzhou Textile Machinery Apartment 30#	Layer 3	K7+000 ～ K7+030	12	16	4	25	/	/	0.13	1.29			38.02	39.10	0.01	0.15
23	Zhengzhou Textile Machinery Apartment 18#	Layer 1	K7+000 ～ K7+030	16	16	16	11	7.34	10.34	0.54	4.04			34.94	35.25	0.01	0.11
23	Zhengzhou Textile Machinery Apartment 18#	Layer 2	K7+000 ～ K7+030	16	16	16	11	8.11	10.25	0.41	3.65			34.82	35.14	0.01	0.10
23	Zhengzhou Textile Machinery Apartment 18#	Layer 5	K7+000 ～ K7+030	16	16	16	11	7.33	8.49	0.23	2.29			33.42	33.77	0.01	0.08
24	Zhengzhou Textile Machinery Apartment 19#	Layer 1	K7+000 ～ K7+030	38	34	42	19	5.96	9.07	0.26	1.47			34.12	34.27	0.01	0.06
24	Zhengzhou Textile Machinery Apartment 19#	Layer 2	K7+000 ～ K7+030	38	34	42	19	5.01	8.89	0.31	1.49			34.01	34.16	0.01	0.06
24	Zhengzhou Textile Machinery Apartment 19#	Layer 5	K7+000 ～ K7+030	38	34	42	19	4.36	8.05	0.26	1.25			32.65	32.84	0.01	0.05
25	Huayuan Community 5#	Layer 1	K7+240 ～ K7+320	13	11	18	/	2.45	7.22	0.25	1.02	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	34.87	35.43	0.03	0.11
25	Huayuan Community 5#	Layer 3	K7+240 ～ K7+320	13	11	18	/	3.84	8.30	0.14	0.60			33.82	34.44	0.01	0.06
26	Huayuan Community6#	Layer 1	K7+240 ～ K7+320	37	32	42	/	3.23	7.34	0.03	0.14			26.67	27.44	0.00	0.01
26	Huayuan Community6#	Layer 3	K7+240 ～ K7+320	37	32	42	/	4.32	5.51	0.02	0.21			26.52	27.31	0.00	0.02
27	Film Bureau Family Area 6# building	Layer 1	K8+200 ～ K8+330	22	25	10	15	/	0.02	0.25	2.22	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use low noise cooling	35	40.60	41.04	0.03	0.28
27	Film Bureau Family Area 6# building	Layer 2	K8+200 ～ K8+330	22	25	10	15	/	0.50	0.33	1.80			40.41	40.82	0.03	0.22
27	Film Bureau Family Area 6# building	Layer 5	K8+200 ～ K8+330	22	25	10	15	/	/	0.16	1.14			38.28	38.56	0.02	0.13
28	Film Bureau Family Area 5#	Layer 1	K8+200 ～	45	45	45	35	7.17	10.07	0.07	0.37			34.10	34.24	0.01	0.04

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
	building		K8+330									tower					
28	Film Bureau Family Area 5# building	Layer 2	K8+200 ～ K8+330	45	45	45	35	7.66	9.71	0.06	0.41			34.07	34.20	0.01	0.04
28	Film Bureau Family Area 5# building	Layer 5	K8+200 ～ K8+330	45	45	45	35	6.77	9.20	0.07	0.40			33.55	33.69	0.01	0.04
29	Zhengzhou City Library	Layer 1	K8+200 ～ K8+330	32	29	41	31	9.85	/	0.05	/			35.32	35.44	0.00	#VALUE!
30	Downtown Community Phase II 1# building	Layer 1	K8+400 ～ K8+420	31	31	31	/	2.65	6.73	0.05	0.23	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	27.87	28.86	0.00	0.02
30	Downtown Community Phase II 1# building	Layer 2	K8+400 ～ K8+420	31	31	31	/	3.64	6.07	0.04	0.27			27.82	28.82	0.00	0.03
30	Downtown Community Phase II 1# building	Layer 5	K8+400 ～ K8+420	31	31	31	/	3.73	5.65	0.03	0.25			27.15	28.14	0.00	0.03
30	Downtown Community Phase II 1# building	Layer 8	K8+400 ～ K8+420	31	31	31	/	3.42	6.07	0.02	0.17			25.97	26.97	0.00	0.02
31	Nanyang Road No. 326 (Zhengzhou National Oil Reserve Base Family Area) 1#	Layer 1	K8+400 ～ K8+420	39	37	45	/	2.73	8.01	0.03	0.11	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;	15	26.14	26.91	0.00	0.01
31	Nanyang Road No. 326 (Zhengzhou National Oil Reserve Base Family Area) 1#	Layer 3	K8+400 ～ K8+420	39	37	45	/	4.42	8.20	0.02	0.10			26.01	26.79	0.00	0.01
32	Xicai Community (Minggong Road 240# Yard) 2#, 3# building	Layer 1	K9+275 ～ K9+315	44	40	48	27	/	/	0.19	1.15	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use Ultra-low noise cooling tower （4）moved 8m to the center of the road	45	35.95	36.03	0.02	0.13
32	Xicai Community (Minggong Road 240# Yard) 2#, 3# building	Layer 3	K9+275 ～ K9+315	44	40	48	27	/	/	0.20	1.22			35.71	35.79	0.02	0.14
33	Minggong Road No.245 (Xiqian Street 85# Yard 1#, 2# building)	Layer 1	K9+340 ～ K9+375	20	17	24	4	/	6.76	1.53	6.16			39.09	39.21	0.01	0.10
33	Minggong Road No.245 (Xiqian Street 85# Yard 1#, 2# building)	Layer 3	K9+340 ～ K9+375	20	17	24	4	/	3.02	0.48	3.22			37.73	37.88	0.01	0.09
34	Huigang New Town 3# building	Layer 1	K9+890 ～ K9+980	21	25	10	/	12.51	10.41	0.01	0.31	（1）Main exhaust port backing to the sensitive spot.	15	30.75	33.79	0.00	0.03

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
35	Female Mosque	Layer 2	K10+010 ～ K10+020	41	41	41	/	/	/	0.01	/	（2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;		25.66	26.65	0.00	#VALUE!
35	Female Mosque	Layer 5	K10+010 ～ K10+020	41	41	41	/	/	/	0.01	/			25.25	26.25	0.00	#VALUE!
36	Hongxin Garden 1# building	Layer 2	K10+915 ～ K10+990	35	32	39	32	/	/	0.04	0.59	（1）Main exhaust port backing to the sensitive spot.		34.95	35.09	0.00	0.06
36	Hongxin Garden 1# building	Layer 5	K10+915 ～ K10+990	35	32	39	32	/	/	0.03	0.45			34.33	34.47	0.00	0.05
37	Xidan Apartment 3#	Layer 1	K11+070 ～ K11+151	36	36	36	26	/	/	0.07	0.84			36.36	36.48	0.01	0.09
37	Xidan Apartment 3#	Layer 3	K11+070 ～ K11+151	36	36	36	26	/	/	0.08	0.73			36.10	36.22	0.01	0.08
38	Xidan Apartment 1#	Layer 1	K11+070 ～ K11+151	41	46	30	39	/	/	0.05	0.44			33.46	33.78	0.00	0.05
38	Xidan Apartment 1#	Layer 3	K11+070 ～ K11+151	41	46	30	39	/	/	0.04	0.49			33.34	33.65	0.00	0.05
39	East Street 220# Yard	Layer 1	K11+978 ～ K12+105	/	/	/	5	/	4.52	2.70	7.92	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use low noise cooling tower	35	48.75	48.75	0.36	1.82
39	East Street 220# Yard	Layer 3	K11+978 ～ K12+105	/	/	/	5	/	1.05	1.35	5.25			44.51	44.51	0.16	0.92
40	Shangcheng Licun (East Street 248# Yard)	Layer 1	K12+110 ～ K12+200	/	/	/	5	/	4.96	0.80	6.16			48.75	48.75	0.09	1.18
41	Shangcheng Garden 1# building	Layer 1	K12+600 ～ K12+650	60	56	53	43	7.74	9.68	0.04	0.28	（1）Main exhaust port backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB; （3）Use low noise cooling tower	35	32.43	32.58	0.00	0.03
41	Shangcheng Garden 1# building	Layer 3	K12+600 ～ K12+650	60	56	53	43	7.54	10.71	0.04	0.21			32.33	32.48	0.00	0.02
42		Layer 1	K12+716 ～	29	32	16	/	/	/	0.03	0.50	（1）Main exhaust port	15	28.29	30.77	0.00	0.05

SN	Name of sensitive spot	The measuring points	Mileage	Distence(m)				Superscalar of predicated value during the air conditioning period		Increment of predicated value from the current value		Measures	Investment (10,000 yuan)	Contribution value in the air conditioning period after taking measures		Increment of predicated value after taking measures	
				Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Exhaust wind pavilion	Day	Night	Day	Night			Day	Night	Day	Night
	Dongguandongli 96# Yard 1# building		K12+830									backing to the sensitive spot. （2）Extend the silencer to more than 3m to reduce the noise of ventilation pavilion for 10dB;					
42	Dongguandongli 96# Yard 1# building	Layer 3	K12+716 ～ K12+830	29	32	16	/	/	/	0.04	0.20			28.08	30.35	0.00	0.02
43	Dongguandongli 96# Yard 2# building	Layer 1	K12+716 ～ K12+830	28	32	16	/	4.14	8.64	0.04	0.24			28.54	30.90	0.00	0.02
43	Dongguandongli 96# Yard 2# building	Layer 3	K12+716 ～ K12+830	28	32	16	/	5.72	8.71	0.02	0.21			28.30	30.49	0.00	0.02
44	Dongguandongli 96# Yard 6# building	Layer 1	K12+716 ～ K12+830	37	39	28	/	7.51	7.94	0.01	0.14			26.43	27.99	0.00	0.01
44	Dongguandongli 96# Yard 6# building	Layer 3	K12+716 ～ K12+830	37	39	28	/	5.32	4.23	0.02	0.33			26.30	27.82	0.00	0.03

Table 11.6-2f .Table Of Sensitive Point Vibration Control Measures

SN	Target Name	Mileage	Relationship with the line position（m）	Location	Using function	Prediction point Location	VLZmax(dB)	VLZ10（dB)	Structural noise prediction	Superscalar of VLZmax		Superscalar of Structural noise prediction		Sensitive Point Vibration Control Measures	Mileage of Sensitive Point Vibration Control Measures	Length (m)	Total investment(Ten thousand yuan)
										Day	Night	Day	Night				
1	New Hope Ao Garden, 17 #, 3 #	K00-195～K00-472	47	Right	House	Outdoor 0.5m	59.0	54.6	/	/	/	/	/				
2	Fuwa beauty area, Building 3, Building 1,	K00+843～K00+921	18	Left	House	Outdoor 0.5m	69.5	55.2	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K0+793 ～ K1+150	357	178.5
3	Taili community, Building 1,	K00+940～K00+968	16	Left	House	Outdoor 0.5m	68.1	56.0	/	/	/	/	/				
4	Hongda district, 11 #, 10 #, 9 #, 5 # Buildinsg	K00+986～K01+100	18	Left	House	Outdoor 0.5m	69.7	56.4	/	/	/	/	/				
5	Huiji District, Changxing Road, Street office	K01+454～K01+537	15	Left	institution	Outdoor 0.5m	69.6	56.9	/	/	/	/	/				
6	Changxing Road, No. 2 Courtyard	K01+476～K01+539	38	Left	House	Outdoor 0.5m	61.7	57.1	/	/	/	/	/				
7	Yuhua ninth city, Building 1 #~ 3 #	K00+100～K00+280	46	Right	House	Outdoor 0.5m	58.2	57.6	/	/	/	/	/				
8	Angel Kindergarten	K00+310～K00+320	18	Right	House	Outdoor 0.5m	68.6	57.6	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K0+260 ～ K0+370	110	55
9	Sanquan Food Co., Ltd., staff quarters	K00+644～K00+670	20	Right	House	Outdoor 0.5m	71.6	57.7	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K0+594 ～ K0+720	126	126
10	ChengHuang 5-rings Mansion	K01+010～K01+030	25	Right	institutio	Outdoor	66.0	57.7	/	/	/	/	/				

					n	0.5m										
11	Hualian family member courtyard, Buildings 2, 4, 5,	K01+362～K01+450	23	Right	House	Outdoor 0.5m	66.8	57.8	/	/	/	/	/			
12	Cityorth Shore District, 1 # building	K01+450～K01+540	18	Right	House	Outdoor 0.5m	66.6	57.8	/	/	/	/	/			
13	Baiwen courtyard, 1 #, 2 #,6#,7# Buildings	K01+587～K01+700	17	Left	House	Outdoor 0.5m	66.9	57.8	/	/	/	/	/			
14	Phosphate fertilizer factory family member courtyard, 1 #, 2 # Buildings	K02+411～K02+440	17	Left	House	Outdoor 0.5m	69.6	58.1	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K2+361 ～ K2+573	212	106
15	Huiji District's office building of Land and Resources	K02+444～K02+495	5	Left	institution	Outdoor 0.5m	73.8	58.2	47.3	/	1.8	2.3	5.3				
15	Huiji District's office building of Land and Resources	K02+444～K02+495	5	Left	institution	Indoor	73.8	58.3	47.3	/	1.8	2.3	5.3				
16	Peaceful residential homes, Building 8,	K02+500～K02+619	9	Left	House	Outdoor 0.5m	68.2	58.5	38.7	/	/	/	/				
16	Peaceful residential homes, Building 8,	K02+500～K02+619	9	Left	House	Indoor	68.2	58.7	38.7	/	/	/	/				
17	RCC family member courtyard (Gadameilin district)	K02+623～K02+663	0	Left	House	Outdoor 0.5m	72.3	59.2	42.8	/	0.3	/	0.8	Steel springs, floating slab,or The same level of vibration reduction measures	K2+573 ～ K2+950	377	565.5
17	RCC family member courtyard (Gadameilin district)	K02+623～K02+663	0	Left	House	Indoor	72.3	59.6	42.8	/	0.3	/	0.8				
18	CR City Concert (Xinyu Garden) district ,1 #, 5 # Buildings	K02+800～K02+900	9	Left	House	Outdoor 0.5m	70.6	59.7	44.2	/	/	/	2.2				
18	CR City Concert (Xinyu Garden) district ,1 #, 5 # Buildings	K02+800～K02+900	9	Left	House	Indoor	70.6	59.8	44.2	0.6	3.6	/	2.2				
19	Changxing Building	K01+650～K01+790	32	Right	House	Outdoor 0.5m	62.8	59.8	/	/	/	/	/				
20	Huiji District, Tumor Courtyard of Traditional Chinese Medicine	K01+801～K01+871	29	Right	Hospital	Outdoor 0.5m	65.8	60.0	/	/	/	/	/		//		
21	City bus company, family member courtyard	K02+800～K02+910	15	Right	House	Outdoor 0.5m	69.5	60.2	/	/	2.5	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K2+750 ～ K2+960	210	105
22	Zhongji urban spring	K03+080～K03+140	33	Left	House	Outdoor 0.5m	60.8	60.2	/	/	/	/	/				

23	Jianye Yihao Chengbang District, 1 #, 7 #, 8 # Building	K03+144～K03+266	33	Left	House	Outdoor 0.5m	60.8	60.4	/	/	/	/	/				
24	National Food Authority's Zhengzhou Institute of Science and family Courtyard	K03+280～K03+550	15	Left	institution	Outdoor 0.5m	73.1	60.7	/	/	1.1	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K3+230 ～ K3+378	148	148
24	National Food Authority's Zhengzhou Institute of Science and family Courtyard	K03+280～K03+550	44	Left	House	Outdoor 0.5m	66.5	60.9	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K3+378 ～ K3+560	182	91
25	Tianxiu home district, 1 # ~ 4 # Building	K03+610～K03+723	16	Left	House	Outdoor 0.5m	72.0	61.1	/	/	0.0	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K3+560 ～ K4+479	919	919
26	Zhengzhou Oriental Tumor Courtyard	K03+730～K03+784	15	Left	Hospital	Outdoor 0.5m	72.1	61.3	/	2.1	5.1	/	/				
27	ICBC family member building	K03+957～K03+990	11	Left	House	Outdoor 0.5m	72.7	61.5	/	2.7	5.7	/	/				
28	Zhang Zhaicun	K04+000～K04+213	17	Left	House	Outdoor 0.5m	71.9	62.1	/	/	/	/	/				
29	Fun district, 1 #, 2 #, 3 #, 4 #, 5 # Building	K04+291～K04+463	11	Left	House	Outdoor 0.5m	70.5	62.2	/	/	/	/	/				
29	Fun district, 6 # - 11 # building	K04+291～K04+463	28	Left	House	Outdoor 0.5m	65.9	62.4	/	/	/	/	/				
30	Projects under construction (Chang Jian.Yufeng)	K02+940～K03+170	50	Right	House	Outdoor 0.5m	57.6	62.5	/	/	/	/	/				
31	Grain transport community, Building 9, Building 10	K03+200～K03+328	11	Right	House	Outdoor 0.5m	74.7	62.6	/	/	2.7	/	/	Steel springs, floating slab,or The same level of vibration reduction measures	K3+150 ～ K3+378	228	342
31	Grain transport community, 3 #~ 8 # Building	K03+200～K03+328	23	Right	House	Outdoor 0.5m	71.2	62.6	/	/	/	/	/				
32	Huiji District's Board of	K03+611～K03+621	13	Right	House	Outdoor	72.7	62.7	/	/	0.7	/	/	Flexible short	K3+561 ～	606	606

	Education family member building					0.5m								sleeper and monolithic track bedb,or The same level of vibration reduction measures	K4+167		
33	Yuhua Wen Hui Garden District, Building 1 to 5	K03+635～K03+773	16	Right	House	Outdoor 0.5m	69.9	62.8	/	/	/	/	/				
34	Yuhua Wen Qing Garden District Building 1 to 4	K03+917～K04+049	13	Right	House	Outdoor 0.5m	70.4	62.8	/	/	/	/	/				
35	City Brewery, family member courtyard north courtyard Building 25,	K04+056～K04+120	18	Right	House	Outdoor 0.5m	71.4	62.8	/	/	/	/	/				
36	Yaxin good times area, 3 to 4 Building	K04+129～K04+211	13	Right	House	Outdoor 0.5m	72.8	62.9	/	/	0.8	/	/				
37	Chuangye Homes	K04+217～K04+277	9	Right	House	Outdoor 0.5m	74.4	62.9	47.9	4.4	7.4	2.9	5.9	Steel springs, floating slab,or The same level of vibration reduction measures	K4+167 ～ K4+550	383	574.5
37	Chuangye Homes	K04+217～K04+277	9	Right	House	Indoor	74.4	62.9	47.9	4.4	7.4	2.9	5.9				
38	Sunshine Holiday district, 1 #, 2 # Building	K04+286～K04+500	10	Right	House	Outdoor 0.5m	70.8	63.0	44.4	/	/	/	2.4				
38	Sunshine Holiday district, 1 #, 2 # Building	K04+286～K04+500	10	Right	House	Indoor	70.8	63.0	44.4	0.8	3.8	/	2.4				
38	Sunshine Holiday district Building 3# ~ 9 #	K04+286～K04+500	30	Right	House	Outdoor 0.5m	65.4	63.2	/	/	/	/	/				
39	Nanyang Road, No. 111 Courtyard	K04+529～K04+558	6	Left	House	Outdoor 0.5m	72.0	63.2	45.5	2.0	5.0	0.5	3.5	Steel springs, floating slab,or The same level of vibration reduction measures	K4+479 ～ K4+608	129	193.5
39	Nanyang Road, No. 111 Courtyard	K04+529～K04+558	6	Left	House	Indoor	72.0	63.3	45.5	/	/	0.5	3.5				
39	Fun district, Southern District, fun district building 46, 61	K04+560～K04+600	36	Left	House	Outdoor 0.5m	64.1	63.5	/	/	/	/	/				
40	Xinyuan Garden 3 #, 4 #	K04+620～K04+700	52	Left	House	Outdoor 0.5m	61.2	63.6	/	/	/	/	/				
41	Nanyang Road, No. 97 Courtyard (Henan Engineering College family member courtyard), 1 #, 4 #, 5 # Building	K04+720～K04+900	16	Left	House	Outdoor 0.5m	72.3	63.6	/	/	0.3	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K4+670 ～ K4+879	209	209
42	Henan Engineering college family member courtyard’s five buildings	K04+720～K04+900	34	Left	House	Outdoor 0.5m	68.2	63.7	/	/	1.2	/	/				
43	China Railway Bridge Bureau	K04+929～K05+010	8	Left	House	Outdoor	73.4	63.8	46.9	/	1.4	1.9	4.9	Steel springs,	K4+879 ～	181	271.5

	family member courtyard 1 #					0.5m								floating slab,or The same level of vibration reduction measures	K5+060		
43	China Railway Bridge Bureau family member courtyard 1 #	K04+929～K05+010	8	Left	House	Indoor	73.4	63.8	46.9	/	1.4	1.9	4.9				
44	Home world community 1 #, 2 # Building	K05+024～K05+105	27	Left	House	Outdoor 0.5m	66.3	63.8	/	/	/	/	/				
45	Zhengzhou Boiler Factory family member courtyard 1 #, 2 #	K05+116～K05+247	11	Left	House	Outdoor 0.5m	72.7	63.8	/	/	0.7	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K5+066 ～ K5+218	152	152
45	Zhengzhou Boiler Factory, family member courtyard 3 # - 8 #	K05+116～K05+247	27	Left	House	Outdoor 0.5m	69.4	63.9	/	/	/	/	/				
46	Zhengrong Group Limited family member courtyard, 3 #, 6 # building	K05+268～K05+318	8	Left	House	Outdoor 0.5m	73.2	63.9	46.8	/	1.2	1.8	4.8	Steel springs, floating slab,or The same level of vibration reduction measures	K5+218 ～ K5+368	150	225
46	Zhengrong Group Limited family member courtyard, 3 #, 6 # building	K05+268～K05+318	8	Left	House	Indoor	73.2	64.2	46.8	3.2	6.2	1.8	4.8				
47	Home world community 1 # Building	K05+328～K05+390	13	Left	House	Outdoor 0.5m	72.4	64.2	/	/	0.4	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K5+368 ～ K5+740	372	372
47	Home world community 3 #, 2 # Building	K05+328～K05+390	33	Left	House	Outdoor 0.5m	68.3	64.3	/	/	/	/	/				
48	Old meat processing factory family member courtyard, 1 #, 3 #, 5 # Building	K05+392～K05+456	12	Left	House	Outdoor 0.5m	73.4	64.5	/	/	1.4	/	/				
49	Nanyang Road 68 homes, 1 #, 2 #, 3 #, 10 #, 41 # Building	K05+480～K05+679	12	Left	House	Outdoor 0.5m	70.4	64.6	/	0.4	3.4	/	/				
50	Fu Tian Lijing Garden District, 39 #, 40 # Building	K04+585～K04+774	17	Right	House	Outdoor 0.5m	66.8	64.6	/	/	/	/	/				
51	Mold factory family member courtyard 1 # building	K04+785～K04+833	12	Right	House	Outdoor 0.5m	73.4	64.7	/	3.4	6.4	/	/	Flexible short sleeper and monolithic track bedb,or The same level of	K4+735 ～ K5+075	340	340
52	Vision garden, 1 # building	K04+845～K04+900	14	Right	House	Outdoor 0.5m	72.5	64.8	/	/	0.5	/	/				
53	Nanyang Road, No. 239 Courtyard	K04+937～K05+025	14	Right	House	Outdoor 0.5m	72.1	64.8	/	/	0.1	/	/				

53	Mineral Homeworld 2 # ~ 5 #	K04+937～K05+025	37	Right	House	Outdoor 0.5m	67.5	65.0	/	/	/	/	/	vibration reduction measures			
54	Nanyang Road, No. 244 Courtyard # 1 (aquaculture company family member courtyard)	K05+325～K05+349	16	Right	House	Outdoor 0.5m	71.8	65.0	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K5+275 ～ K5+427	152	152
55	Ronghua community, 1 # Building	K05+390～K05+441	12	Right	House	Outdoor 0.5m	73.3	65.1	/	3.3	6.3	/	/				
56	Nanyang Road 253 (food company meat branch family member building) 1 #, 3 #	K05+477～K05+520	11	Right	House	Outdoor 0.5m	74.2	65.1	/	4.2	7.2	/	/	Steel springs, floating slab,or The same level of vibration reduction measures	K5+427 ～ K5+570	143	214.5
56	Residential Community of Meat Product Branch of Food Company	K05+570～K05+700	40	Right	House	Outdoor 0.5m	63.4	65.2	/	/	/	/	/				
57	Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	K05+790～K05+890	10	Left	House	Outdoor 0.5m	70.9	65.2	44.5	/	/	/	2.5	Steel springs, floating slab,or The same level of vibration reduction measures	K5+740 ～ K6+132	392	588
57	Zhengzhou ceramics factory family member courtyard, 1 #, 3 # Building, Nanyang Road 62	K05+790～K05+890	10	Left	House	Indoor	70.9	65.2	44.5	/	/	/	2.5				
57	Zhengzhou ceramics factory family member courtyard, 2 #, 4 #, 5 #, 6 #	K05+790～K05+890	25	Left	House	Outdoor 0.5m	66.7	65.2	/	/	/	/	/				
58	Provincial Prospecting machinery factory family member courtyard 1 #, 5 #, 6 # building	K05+900～K05+965	12	Left	House	Outdoor 0.5m	74.6	65.2	/	/	2.6	/	/				
59	Henan Geology and Mineral Resources Building	K05+986～K06+032	22	Left	institution	Outdoor 0.5m	67.6	65.3	/	/	/	/	/				
60	Nanyang Road, No. 52 (Yuhua Wen Jinyuan), three buildings	K06+043～K06+082	13	Left	House	Outdoor 0.5m	74.4	65.4	/	/	2.4	/	/				
61	Sipo Road 9	K06+205～K06+234	12	Left	House	Outdoor 0.5m	70.6	65.5	/	0.6	3.6	/	/	Flexible short sleeper and monolithic track bedb,or	K6+132 ～ K6+467	335	335
62	Nantong district, (Sipo Road 7th courtyard) 1 #	K06+250～K06+350	34	Left	House	Outdoor 0.5m	68.7	65.5	/	/	/	/	/				

63	College family member courtyard 1 # 3 #	K06+364～K06+406	28	Left	House	Outdoor 0.5m	70.1	65.6	/	/	/	/	/	The same level of vibration reduction measures			
64	Nanyang Road, No. 46）	K06+429～K06+500	11	Left	House	Outdoor 0.5m	69.3	65.6	/	/	/	/	/				
65	Nanyang Road, No. 41 courtyard, 5 # Building	K06+517～K06+548	9	Left	House	Outdoor 0.5m	74.0	65.6	47.6	4.0	7.0	2.6	5.6	Steel springs, floating slab,or The same level of vibration reduction measures	K6+467 ～ K6+598	131	196.5
65	Nanyang Road, No. 41 courtyard, 5 # Building	K06+517～K06+548	9	Left	House	Indoor	74.0	65.6	47.6	/	2.0	2.6	5.6				
66	Taiji Kindergarten, Beijia Education	K06+550～K06+590	6	Left	School	Outdoor 0.5m	70.8	65.6	41.3	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K6+598 ～ K7+123	525	262.5
66	Taiji Kindergarten, Beijia Education	K06+550～K06+590	6	Left	School	Indoor	70.8	65.6	41.3	/	/	/	/				
67	Huafu Institute of Dermatology,	K06+613～K06+679	10	Left	institution	Outdoor 0.5m	73.8	65.6	47.3	/	1.8	2.3	5.3				
67	Huafu Institute of Dermatology,	K06+613～K06+679	10	Left	institution	Indoor	73.8	65.7	47.3	/	1.8	2.3	5.3				
68	City No. 71 high school	K06+690～K06+762	11	Left	School	Outdoor 0.5m	71.4	66.1	/	/	/	/	/				
69	The 2nd Hospital, Zhengzhou University	K06+825～K06+878	23	Left	Hospital	Outdoor 0.5m	69.8	66.1	/	/	/	/	/				
70	Zhengzhou Textile staff apartments, 29 #, 30 # Building	K06+900～K07+073	14	Left	House	Outdoor 0.5m	69.8	66.2	/	/	/	/	/				
71	Zhengzhou Textile staff apartments, 18 # to 20 # buildings	K07+000～K07+100	37	Left	House	Outdoor 0.5m	63.9	66.3	/	/	/	/	/				
72	Small Yuzhai (Nanyang Road courtyard 266--279)	K05+753～K06+085	15	Right	House	Outdoor 0.5m	69.5	66.3	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K5+703 ～ K6+050	347	173.5
73	Pearl Factory, family member courtyard, 1 #, 2 #, 3 # Building (Nanyang Road 275)	K06+100～K06+180	9	Right	House	Outdoor 0.5m	75.6	66.3	49.1	0.6	3.6	4.1	7.1	Steel springs, floating slab,or The same level of	K6+050 ～ K6+355	305	457.5
73	Pearl Factory, family member	K06+100～K06+180	9	Right	House	Indoor	75.6	66.4	49.1	0.6	3.6	4.1	7.1				

	courtyard, 1 #, 2 #, 3 # Building (Nanyang Road 275)													vibration reduction measures			
74	Nanyang Road, No. 283 Courtyard	K06+260～K06+305	13	Right	House	Outdoor 0.5m	74.4	66.4	/	4.4	7.4	/	/				
75	Municipal Corporation family member courtyard (Nanyang Road No. 289 courtyard), 1 #, 2 #, 3 #, 4 # Building	K06+455～K06+511	36	Right	House	Outdoor 0.5m	66.6	66.5	/	/	/	/	/				
76	Hengtian Heavy Industry Co., Ltd family area	K06+600～K06+975	14	Right	House	Outdoor 0.5m	72.4	66.5	/	/	0.4	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K6+598 ～ K7+170	572	286
77	Nanyang Road, No. 296 Courtyard, 1 #, 2 #, 3 #	K07+032～K07+168	15	Right	House	Outdoor 0.5m	67.7	66.5	/	/	0.7	/	/				
78	Zhengzhou Jianguo Medicine Institute	K07+280～K07+400	15	Left	Hospital	Outdoor 0.5m	69.7	66.5	/	/	/	/	/				
79	Nanyang Road branch of Shiyan Kindergarten, Zhengzhou	K07+280～K07+400	54	Left	School	室外 0.6m	61.5	66.6	/	/	/	/	/				
80	Buildings 6#, 5#, 4#, and Buildings 3# and 2# in the south of Community of Zhengzhou Textile Machinery Co., Ltd.	K07+214～K07+696	15	Left	House	Outdoor 0.5m	72.2	66.6	/	/	0.2	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K7+164 ～ K7+780	616	616
81	Hongyihua Hong Kong City	K07+770～K07+900	20	Left	House	Outdoor 0.5m	65.6	66.7	/	/	/	/	/				
82	Nanyang Road No. 12 courtyard, 1 #, 2 # Building	K07+900～K08+150	10	Left	House	Outdoor 0.5m	71.9	66.7	45.4	1.9	4.9	0.4	3.4	Steel springs, floating slab,or The same level of vibration reduction measures	K7+850 ～ K8+350	500	750
82	Nanyang Road No. 12 courtyard, 1 #, 2 # Building	K07+900～K08+150	10	Left	House	Indoor	69.4	66.8	42.9	/	/	/	0.9				
83	Jinshui District Police Fire Brigade	K07+970～K08+010	14	Left	institution	Outdoor 0.5m	68.6	66.8	/	/	/	/	/				
84	Nanyang Road No. 8courtyard,	K08+110～K08+180	14	Left	House	Outdoor 0.5m	68.6	66.9	/	/	/	/	/				
85	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang	K08+190～K08+220	0	Left	House	Outdoor 0.5m	74.5	67.0	48.0	4.5	7.5	3.0	6.0				

	Road 7)）																
85	Film Bureau, family member courtyard, 6 #, 7 # F (Nanyang Road 7)）	K08+190～K08+220	0	Left	House	Indoor	74.5	67.0	48.0	/	2.5	3.0	6.0				
86	Zhengzhou City Library	K08+250～K08+300	5	Left	Library	Outdoor 0.5m	74.7	67.0	48.3	/	2.7	3.3	6.3				
86	Zhengzhou City Library	K08+250～K08+300	5	Left	Library	Indoor	74.7	67.1	48.3	/	2.7	3.3	6.3				
87	Garden community, (Nanyang Road 300) 5 # building	K07+220～K07+320	14	Right	House	Outdoor 0.5m	70.2	67.2	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K7+170 ～ K7+370	200	200
88	Zhongheng Garden	K07+420～K07+580	40	Right	House	Outdoor 0.5m	65.8	67.4	/	/	/	/	/				
89	Zhongheng	K07+710～K07+825	32	Right	House	Outdoor 0.5m	63.0	67.4	/	/	/	/	/				
90	Nanyang Road No. 309--314 courtyard,	K07+900～K08+020	8	Right	House	Outdoor 0.5m	72.0	67.4	45.5	/	/	0.5	3.5	Steel springs, floating slab,or The same level of vibration reduction measures	K7+780 ～ K8+070	290	435
90	Nanyang Road No. 309--314 courtyard,	K07+900～K08+020	8	Right	House	Indoor	72.0	67.4	45.5	/	/	0.5	3.5				
91	Zhongheng garden, 4 # to 10 #	K07+830～K07+950	27	Right	House	Outdoor 0.5m	68.0	67.5	/	/	/	/	/				
92	Qinghua Garden A, B, D, E Block	K08+136～K08+280	25	Right	House	Outdoor 0.5m	62.7	67.6	/	/	/	/	/				
93	Zhengzhou National Oil Reserve Depot, family member courtyard 1 # building	K08+290～K08+360	20	Right	House	Outdoor 0.5m	68.1	67.6	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K8+350 ～ K8+410	60	30
94	Jinshui Road, 11th courtyard, 1 # building	K08+485～K08+495	11	Left	House	Outdoor 0.5m	70.8	67.6	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or	K8+435 ～ K8+545	110	110

														The same level of vibration reduction measures			
95	Municipal Supply and Marketing Trading Corporation, family member courtyard, 1 #, 10 #, 11 # building	K08+985～K09+058	20	Left	House	Outdoor 0.5m	69.2	67.7	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K8+935 ～ K9+108	173	86.5
96	Minggong Road No. 67 courtyard, (Jinfeng Golden Coast International), 1 # Building	K09+158～K09+183	33	Left	House	Outdoor 0.5m	60.8	67.8	/	/	/	/	/				
97	Minggong Road, No. 139 Courtyard(Grain Bureau family member building)	K08+640～K08+690	6	Right	House	Outdoor 0.5m	72.6	67.8	46.1	/	0.6	1.1	4.1	Steel springs, floating slab,or The same level of vibration reduction measures	K8+590 ～ K9+150	560	840
97	Minggong Road, No. 139 Courtyard(Grain Bureau family member building)	K08+640～K08+690	6	Right	House	Indoor	72.6	67.8	46.1	/	0.6	1.1	4.1				
98	Minggong Road, No. 156 Courtyard, 1 #, 2 # Building	K08+920～K09+017	6	Right	House	Outdoor 0.5m	71.8	67.8	45.4	/	/	0.4	3.4				
98	Minggong Road, No. 156 Courtyard, 1 #, 2 # Building	K08+920～K09+017	6	Right	House	Indoor	71.8	67.8	45.4	/	/	0.4	3.4				
99	Jin Ming Yuan building and the building of South	K09+030～K09+100	4	Right	House	Outdoor 0.5m	72.0	67.9	44.6	/	0.0	/	2.6				
99	Jin Ming Yuan building and the building of South	K09+030～K09+100	4	Right	House	Indoor	72.0	67.9	44.6	/	0.0	/	2.6				
100	Huarun Yue House (under construction)	K09+245～K09+610	45	Left	House	Outdoor 0.5m	60.6	68.0	/	/	/	/	/				
101	Huigang New Town 1 #, 2 #, 3 # Building	K09+700～K09+860	0	Left	House	Outdoor 0.5m	70.4	68.0	40.9	/	/	/	/	Steel springs, floating slab,or The same level of vibration reduction measures	K9+650 ～ K10+109	459	688.5
101	Huigang New Town 1 #, 2 #, 3 # Building	K09+700～K09+860	0	Left	House	Indoor	70.4	68.2	40.9	/	/	/	/				
102	Small building mosques	K10+000～K10+059	6	Left	Religion	Outdoor 0.5m	68.2	68.2	41.7	/	/	/	/				
102	Small building mosques	K10+000～K10+059	6	Left	Religion	Indoor	68.2	68.4	41.7	/	/	/	/				
103	West Cai district, (Ming Gong	K09+275～K09+315	0	Right	House	Outdoor	74.8	68.4	48.4	/	2.8	3.4	6.4	Steel springs,	K9+225 ～	544	816

	Road No. 240 Courtyard) 1 #					0.5m											
103	West Cai district, (Ming Gong Road No. 240 Courtyard) 1 #	K09+275～K09+315	0	Right	House	Indoor	74.8	68.4	48.4	/	2.8	3.4	6.4	floating slab,or The same level of vibration reduction measures	K9+769		
103	West Cai district, (Ming Gong Road, No. 240 Courtyard), 2 #, 3 # Building	K09+275～K09+315	16	Right	House	Outdoor 0.5m	69.3	68.4	/	/	/	/	/				
104	Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)	K09+325～K09+410	9	Right	House	Outdoor 0.5m	71.4	68.4	44.9	/	/	/	2.9				
104	Courtyard No. 85 West Front Street, 1 # Building (Ming Gong Road, No. 245 Courtyard)	K09+325～K09+410	9	Right	House	Indoor	71.4	68.4	44.9	/	/	/	2.9				
106	Ming Gong Road No. 272, (Rural Credit Cooperative Union, family member building)	K09+545～K09+608	0	Right	House	Outdoor 0.5m	75.6	68.6	49.2	0.6	3.6	4.2	7.2				
106	Ming Gong Road No. 272, (Rural Credit Cooperative Union, family member building)	K09+545～K09+608	0	Right	House	Indoor	75.6	68.7	49.2	0.6	3.6	4.2	7.2				
107	Yalong district, 17 # Building	K09+638～K09+674	0	Right	House	Outdoor 0.5m	75.1	68.8	48.7	0.1	3.1	3.7	6.7				
107	Yalong district, 17 # Building	K09+638～K09+674	0	Right	House	Indoor	75.1	68.8	48.7	0.1	3.1	3.7	6.7				
108	Yalong districtl 16 # Building, 1 #, 2 # Building	K09+638～K09+674	16	Right	House	Outdoor 0.5m	70.7	68.8	/	/	/	/	/				
109	Catholic Church	K09+687～K09+719	2	Right	Religion	Outdoor 0.5m	74.6	68.9	48.1	/	2.6	3.1	6.1				
109	Catholic Church	K09+687～K09+719	2	Right	Religion	Indoor	74.6	68.9	48.1	/	2.6	3.1	6.1				
110	Jiefang Road Elementary School	K09+719～K09+750	42	Right	School	Outdoor 0.5m	65.1	69.0	/	/	/	/	/				
111	Shangfuxin Village House 1#	K10+510～K10+614	6	Left	House	Outdoor 0.5m	68.6	69.0	39.1	/	/	/	/	Steel springs, floating slab,or The same level of vibration reduction measures	K10+460 ～ K10+664	204	306
111	Shangfuxin Village House 1#	K10+510～K10+614	6	Left	House	Indoor	68.6	69.0	39.1	/	/	/	/				
111	Shangfuxin Village 2 #, 3#	K10+510～K10+614	41	Left	House	Outdoor 0.5m	61.3	69.0	/	/	/	/	/				
112	Fuchun Apartment 1 # building	K10+625～K10+779	15	Left	House	Outdoor 0.5m	70.0	69.0	/	/	/	/	/	Flexible short sleeper and monolithic track bedb,or	K10+664 ～ K10+829	165	82.5

														The same level of vibration reduction measures			
113	Huating Apartments, Dehua Street community 1 #, 2 # Building	K10+528～K10+614	15	Right	House	Outdoor 0.5m	66.8	69.0	/	/	/	/	/				
114	Jinding Huafu House, front 1 #	K10+630～K10+775	13	Right	House	Outdoor 0.5m	66.0	69.0	/	/	/	/	/				
114	Jinding Huafu House, rear	K10+630～K10+775	8	Right	House	Outdoor 0.5m	71.4	69.1	45.0	/	/	/	3.0	Steel springs, floating slab,or The same level of vibration reduction measures	K10+580 ～ K10+825	245	367.5
114	Jinding Huafu House, rear	K10+630～K10+775	8	Right	House	Indoor	71.4	69.1	45.0	/	/	/	3.0				
115	Modern XingYuan 1 #	K10+800～K10+873	23	Right	House	Outdoor 0.5m	63.2	69.2	/	/	/	/	/				
116	Hongxin Jia Yuan 1 # building	K10+915～K10+990	14	Left	House	Outdoor 0.5m	67.8	69.2	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K10+865 ～ K11+020	155	77.5
117	Xidan apartments, two buildings	K11+070～K11+151	8	Left	House	Outdoor 0.5m	69.3	69.3	41.9	/	/	/	/	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K11+020 ～ K11+201	181	181
117	Xidan apartments, two buildings	K11+070～K11+151	8	Left	House	Indoor	73.4	69.3	46.0	/	1.4	1.0	4.0				
118	West Street, No. 231	K11+250～K11+286	13	Left	House	Outdoor 0.5m	69.5	69.3	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate	K11+201 ～ K11+400	199	99.5
119	Zhongkai City Lights Clove Court, 1 #, Building	K11+380～K11+446	12	Left	House	Outdoor 0.5m	70.0	69.3	/	/	/	/	/				

														shock-absorbing measures.			
120	Fuhua Building	K11+450～K11+550	8	Left	House	Outdoor 0.5m	71.7	69.3	42.1	/	/	/	0.1	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K11+400 ～ K11+600	200	200
120	Fuhua Building	K11+450～K11+550	8	Left	House	Indoor	72.2	69.4	42.5	/	0.2	/	0.5				
121	Zi Yan Huating 1 #, 2 # Building	K11+821～K11+917	23	Left	House	Outdoor 0.5m	63.2	69.4	/	/	/	/	/				
122	Ginza International	K10+956～K11+025	14	Right	House	Outdoor 0.5m	65.9	69.5	/	/	/	/	/				
123	233 West Main Street (the third secondary school, family member building)	K11+038～K11+100	11	Right	House	Outdoor 0.5m	66.8	69.5	/	/	/	/	/				
124	218 West Main Street	K11+168～K11+221	20	Right	House	Outdoor 0.5m	65.7	69.6	/	/	/	/	/				
125	Sun Moon Star City, 1 # building	K11+230～K11+300	14	Right	House	Outdoor 0.5m	65.2	69.6	/	/	/	/	/				
126	Zhongkai City Lights Clove Court, 1 #, 2 # Building	K11+328～K11+450	15	Right	House	Outdoor 0.5m	67.3	69.6	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K11+278 ～ K11+716	438	219
127	Tangzi Lane (Bo'ai Street Community)	K11+328～K11+666	38	Right	House	Outdoor 0.5m	63.7	69.6	/	/	/	/	/				
128	Changcheng City in City	K11+460～K11+666	13	Right	House	Outdoor 0.5m	67.6	69.7	/	/	/	/	/				
129	Yuhong Garden, 1 #, 2 #, 3 # Buildings	K11+675～K11+800	25	Right	House	Outdoor 0.5m	62.6	69.7	/	/	/	/	/				
130	Municipal Guancheng State Taxation office services hall	K11+929～K11+978	33	Left	institution	Outdoor 0.5m	62.8	69.7	/	/	/	/	/				
131	First People's Courtyard of Zhengzhou	K11+990～K12+055	22	Left	Hospital	Outdoor 0.5m	65.5	69.8	/	/	/	/	/		/ /		
132	Guancheng District Education Center	K12+133～K12+211	21	Left	institution	Outdoor 0.5m	65.9	70.1	/	/	/	/	/				
133	Zhigong Road, Building 1	K12+230～K12+335	18	Left	House	Outdoor 0.5m	71.2	70.1	/	/	/	/	/	Steel springs, floating slab,or The	K12+180 ～ K12+450	270	405

														same level of vibration reduction measures			
134	Residential community of Zhengzhou Electric Power College	K12+400～K12+500	43	Left	House	Outdoor 0.5m	65.6	70.2	/	/	/	/	/				
135	220 East Main Street	K11+978～K12+105	10	Right	House	Outdoor 0.5m	69.1	70.2	42.6	/	/	/	0.6	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K11+928 ～ K12+083	155	77.5
135	220 East Main Street	K11+978～K12+105	10	Right	House	Indoor	69.1	70.2	42.6	/	/	/	0.6				
136	Mall Village, (248 East Main Street courtyard)	K12+000～K12+500	28	Right	House	Outdoor 0.5m	68.5	70.2	/	/	/	/	/				
137	Zhongkai City Lights Guangjingcui Court, 1 #, 2 # Building	K12+133～K12+366	8	Right	House	Outdoor 0.5m	72.3	70.3	44.8	/	0.3	/	2.8	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K12+083 ～ K12+450	367	367
137	Zhongkai City Lights Guangjingcui Court, 1 #, 2 # Building	K12+133～K12+366	8	Right	House	Indoor	72.3	70.4	44.8	/	0.3	/	2.8				
138	East Main Street, No. 1 Court, Building 2	K12+550～K12+600	38	Right	House	Outdoor 0.5m	61.1	70.4	/	/	/	/	/				
139	Dolidongguan96,1#	K12+716～K12+830	11	Left	House	Outdoor 0.5m	68.6	70.4	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K12+666 ～ K12+880	214	107
139	Dolidongguan96,2#	K12+716～K12+830	32	Left	House	Outdoor 0.5m	64.3	70.4	/	/	/	/	/				
140	Knitting mill family member courtyard, 1 # building	K12+992～K13+072	12	Left	House	Outdoor 0.5m	72.5	70.4	/	/	0.5	/	/	Flexible short sleeper and monolithic track bedb,or The same	K12+942 ～ K13+458	516	516
140	Knitting mill family member courtyard, 2 # Building	K12+992～K13+072	32	Left	House	Outdoor 0.5m	68.4	70.4	/	/	/	/	/				
141	Yutong Garden Building 1#	K13+076～K13+226	12	Left	House	Outdoor	73.1	70.7	/	/	1.1	/	/				

						0.5m							level of vibration reduction measures			
141	Yutong Garden Building 2#	K13+076～K13+226	36	Left	House	Outdoor 0.5m	67.8	70.8	/	/	/	/	/			
142	Municipal underwear factory family member courtyard, 1 #, 2 #, 3 # Building	K13+230～K13+408	14	Left	House	Outdoor 0.5m	73.4	70.8	/	/	1.4	/	/			
142	Municipal underwear factory, family member courtyard, 5 #, 4 # Building	K13+230～K13+408	34	Left	House	Outdoor 0.5m	68.5	70.8	/	/	/	/	/			
143	Zheng Bian Road, Building 60,	K13+414～K13+473	28	Left	House	Outdoor 0.5m	65.8	70.8	/	/	/	/	/			
144	Zheng Bian Road, Building 23,	K12+820～K12+857	7	Right	House	Outdoor 0.5m	67.2	71.0	39.7	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K12+770 ～ K12+907	137	68.5
144	Zheng Bian Road, Building 23,	K12+820～K12+857	7	Right	House	Indoor	67.2	71.0	39.7	/	/	/	/				
145	Great Wall Cambridge Garden	K13+038～K13+091	21	Right	House	Outdoor 0.5m	66.9	71.2	/	/	/	/	/				
146	Cargo Terminal No. 23 North Street Courtyard, 1 #, (Phoenix Road Community)	K13+158～K13+180	18	Right	House	Outdoor 0.5m	70.0	71.4	/	/	/	/	/	adopt GJ-III vibration reduction fasteners or equivalent moderate shock-absorbing measures.	K13+108 ～ K13+282	174	87
146	Cargo Terminal No. 23 North Street Courtyard, 3 #, (Phoenix Road Community)	K13+180～K13+225	18	Right	House	Outdoor 0.5m	68.0	71.4	/	/	/	/	/				
147	Langui district 1 # Building	K13+230～K13+325	16	Right	House	Outdoor 0.5m	68.6	71.4	/	/	/	/	/				
148	Boai ENT Hospital of Zhengzhou	K13+332～K13+390	9	Right	Hospital	Outdoor 0.5m	72.6	71.4	45.2	/	0.6	0.2	3.2	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K13+282 ～ K13+700	418	418
148	Boai ENT Hospital of Zhengzhou	K13+332～K13+390	9	Right	Hospital	Indoor	72.6	71.5	45.2	/	0.6	0.2	3.2				
149	Zheng Bian Road, No. 49, family member courtyard, 1 # Building	K13+398～K13+430	13	Right	House	Outdoor 0.5m	73.7	71.5	/	/	1.7	/	/				
150	Dongming Road 30 Courtyard, (electric power district), 1 #, 2 # Building	K13+512～K13+650	9	Right	House	Outdoor 0.5m	73.2	71.6	45.7	/	1.2	0.7	3.7				
150	Dongming Road 30 courtyard (electric power district), 3 #, 4 # Building	K13+512～K13+650	9	Right	House	Indoor	73.2	71.6	45.7	/	1.2	0.7	3.7				
150	Zhengzhou Huimin High School	K13+512～K13+650	45	Right	House	Outdoor	64.5	71.6	/	/	/	/	/				

						0.5m											
151	Zhengzhou City Public Security Bureau Police Detachment	K14+686～K14+769	47	Left	School	Outdoor 0.5m	60.1	71.7	/	/	/	/	/				
152	Henan Provincial People's Procuratorate	K14+793～K14+942	27	Left	institution	Outdoor 0.5m	62.2	71.7	/	/	/	/	/				
153	Dongming Road 30 Courtyard, (electric power district), 1 #, 2 # Building	K14+942～K15+052	26	Left	institution	Outdoor 0.5m	66.2	71.7	/	/	/	/	/				
154	Yingxie Garden 1 #, 2 # Building	K15+194～K15+485	55	Left	House	Outdoor 0.5m	60.6	71.8	/	/	/	/	/				
155	District under construction 1 #, 2 # Building	K16+878～K17+052	54	Left	House	Outdoor 0.5m	59.4	71.8	/	/	/	/	/				
156	Henan Zhongdu Dermatology Hospital	K17+147～K17+199	24	Left	Hospital	Outdoor 0.5m	66.2	72.1	/	/	/	/	/				
157	Guancheng Traditional Chinese Medicine Hospital	K17+206～K17+266	10	Left	Hospital	Outdoor 0.5m	71.0	72.1	43.6	/	/	/	1.6	Flexible short sleeper and monolithic track bedb,or The same level of vibration reduction measures	K17+156 ～ K17+316	160	160
157	Guancheng Traditional Chinese Medicine Hospital	K17+206～K17+266	10	Left	Hospital	Indoor	71.0	72.6	43.6	/	/	/	1.6				
158	Caixin Triana district, 1 #, 2 #, 3 #, 4 # Building	K17+390～K17+766	51	Right	House	Outdoor 0.5m	59.9	72.6	/	/	/	/	/				
159	Zhengshang Eastern Harbour, 1 #, 2 # Building	K19+152～K19+300	56	Left	House	Outdoor 0.5m	60.7	72.6	/	/	/	/	/				
160	Sinosun New World	K20+320～K20+680	60	Left	House	室外 0.6m	60.7	72.6	/	/	/	/	/				
161	Dongyinggang Village	K24+300～K24+800	0	Left and Right	House	Outdoor 0.5m	80.7	77.7	56.2	5.7	8.7	11.2	14.2	Steel springs, floating slab,or The same level of vibration reduction measures	K24+250 ～ K24+850	1200	1800
161	Dongyinggang Village	K24+300～K24+800	0	Left and Right	House	Indoor	80.7	77.7	56.2	5.7	8.7	11.2	14.2				

Table 11.6-2g List for vibration control measures for cultural relics sensitive spots

No.	Target to be protected	Mileage	District where it is located	Position relative to the line	Line type	Current value of vibration speed (mm/s)	Predicted value of vibration speed (mm/s)	Exceedance	Measures	Extend 50 from both ends		Length (m)	Investment (×10^4RMB)
										Start	end		
1	Shanhaimomuduha Tomb	K09+900～K09+930	Jinshui District	Left	Underground	0.08	2.019858	1.57	Steel springs, floating slab,or The same level of vibration reduction measures	9850	9980	130	195
2	2/7 Strike Monument	K10+317～K10+348	Erqi district	Right	Underground	0.09	1.333207	1.18		10267	10398	131	196.5
3	Zhengzhou Confucius Temple	K12+340～K12+400	Guancheng Hui-ethnic district	Left	Underground	0.08	1.226718	0.96		12290	12450	160	240
4	Shang-dynasty relic, Zhegnzhou	K12+500～K12+580	Ditto	Both left and right	Underground	0.08	/	0.00		12450	12630	180	270

11.7 Environmental Monitoring

11.7.1 Purpose of Monitoring

Environmental monitoring under the project mainly include monitoring of impacts on environment (water, air, noise, vibration environment, electromagnetic) along the line during construction period and operational period, and is intended to take all the necessary measures to learn about the scope and extent and period of impacts caused by various engineering behaviors during the project construction period and operational period on the objects under environmental protection so as to take corresponding mitigation measures on the engineering behaviors that cause environmental impacts, and verify the preventional and control effect of the environmental protection measures taken thereby and control the environmental impacts due to project construction within the permitted scope to the greatest extent.

11.7.2 Monitoring Plan

According to the engineering characteristics of various projects, phased environmental monitoring plans will be formulated for the construction period and operational period. See Table 11.7.1

Table 11.7-1 List of the Environmental Protection Monitoring Plan for Phase I Project of the Zhengzhou Rail Transit Line3 Funded with the World Bank Loan

Stage	Monitoring Objects	Monitoring Sites	Monitoring Items	Frequency	Total Expense (RMB10,000)	Monitoring Organ	Responsible Organization	Supervisory Organ	Executive Standards and Norms
Construction Period	Ambient air	Building 1 of Yuhua ninth city,Huiji District Changxing Road Subdistrict Office, Changxing Road 2# Yard 13#, 10# buildin, Baiwen Garden 1#, 2#, 6#, 7# building, Chengshi Bei'an Community 1# building, Huarun Chengshi Zhiyin (Xinyu Yayuan) Community 1#, 5# building, City bus company, family member courtyard, Projects under construction (Chang Jian.Yufeng), Fun district, Northern District, fun district building 1#、2#、3#、4#、5#, Zhengzhou Huimin High School and Dongyinggang Village so on.	TSP	Carry out monitoring once every quarter during the peak the construction period, and 3 continuous days each time. Monitor daily average value every day according to the specific requirements of "Quality Standards for Ambient Air" (GB3095-1996)	60	The project owner entrusts qualified organ to undertake the work by contract	Project Owner	Municipal and district environmental protection bureau	"Comprehensive Emission Standards for Atmospheric Pollutants" GB16297-1996
	Noise	Station construction site and surrounding senstivie points ,and same as above(Ambient air)	Equivalent A sound level	Monitor once every month during the construction period, and 1 day each time; The daily monitoring periods are 8：00~10：00, 14：00~16：00, 20：00~22：00	65	The project owner entrusts qualified organ to undertake the work by contract	Project Owner	Municipal and district environmental protection bureau	"Limit for Noise on Architectural Construction Site" GB12523-90
	Vibration	Dept construction site and surrounding sensitive points and sensitive points the project line runs under(represented by Fuwa beauty area, Building 3, Building 1, Film Bureau Family Area 2# building, Tingdao Foreign Language training, Minggong Road 240# Yard)2#, 3# building, Minggong Road N0.245 (Xiqian Street 85# Yard 1#, 2# building), Guancheng Traditional Chinese Medicine Hospital and Dongyinggang Village so on.	Vibration level	Monitor once every monthduring the construction period, and 1 day each time; The daily monitoring periods are 8：00~10：00, 14：00~16：00, 20：00~22：00	20	The project owner entrusts qualified organ to undertake the work by contract	Project Owner	Municipal and district environmental protection bureau	"Measurement Methods for Urban Environmental Vibration"(GB10071-88)
		Memorial Tower for February 7th Strike, Zhengzhou Confucius Temple，Zhengzhou Shang Dynasty Ruins	Vibration speed	Carry out continuous monitoring in case of shield tunneling, and 1 monitor every day;	20	The project owner entrusts qualified organ to undertake the work by contract	Project Owner	Municipal and district environmental protection bureau	"Technical Regulations for Prevention against Industrial Vibration for Ancient Buildings"(GB/T50452-2008)
	Surface Water	Discharge outlets of treatment facilities for vehicle cleaning water and slurry sewage	pH, SS, Oil, COD	Carry 1 monitor each month before 6 month, monitored once per quarter after then; 1 day each time	10	The project owner entrusts qualified organ to undertake the work by contract	Project Owner	Municipal and district environmental protection bureau	"Comprehensive Discharge Standards for Sewage"(GB8978-1996)
	Underground Water	Surrounding buildings of the base pit at the station, sensitive points the project runs under	Ground settlement	Rainfall period during construction, 1 time every day	60	Professional testing organ	Project Owner	Municipal and district environmental	/

Stage	Monitoring Objects		Monitoring Sites	Monitoring Items	Frequency	Total Expense (RMB10,000)	Monitoring Organ	Responsible Organization	Supervisory Organ	Executive Standards and Norms
			Station and sections constructed with open digging	Underground water level	Rainfall period during construction, 1 time every day				protection bureau	/
			Station and sections constructed with open digging	Water quality	Rainfall period during construction, 1 time every day					“Quality Standard for Underground Water” Class III
Operational Period	Water Environment	Sewage at Depots	Discharge outlet of sewage treatment plant at depots	pH, SS, oil, COD	2 time in the first year, 1 day per time; irregular monitoring thereafter;	20	The project owner entrusts qualified organ to undertake the work by contract	Project Owner	Municipal and district environmental protection bureau	“Comprehensive Sewage Discharge Standards” (GB8978-1996)
	Noise		Sensitive points around depots construction site, air kiosk of the stations and cooling tower（Building 1 of Yuhua ninth city，Hualian family member courtyard’s, Buildings 4，Cityorth Shore District, 1 # ,4#building，City bus company, family member courtyard 2#，Projects under construction (Chang Jian.Yufeng)，and Nanyang Road, No. 219 Courtyard4#,6# Sunshine Holiday district, 3 #, 2 # Building so on	Equivalent sound level A	2 time in the first year,; to be carried out in 2 periods(daytimne and night); 1 day per time	20	The project owner entrusts qualified organ to undertake the work by contract	Project Owner	Municipal and district environmental protection bureau	“Quality Standards for Sound Environment” GB3096-2008 and “Discharge Standard for Environmental Noise in Factory Area of Industrial Enterprise” GB12348-2008
	Vibration		New Hope Ao Garden, 17 #, 3 #，Fuwa beauty area, Building 3, Building 1，Taili community, Building 1, Hongda district, 11 #, 10 #, 9 #, 5 # Buildinsg，Huiji District, Changxing Road, Street office，Changxing Road, No. 2 Courtyard and Dongyinggang Village so on.	Vibration level	2 time in the first year,; to be carried out in 2 periods(daytimne and night); 1 day per time	20	The project owner entrusts qualified organ to undertake the work by contract	Project Owner	Municipal and district environmental protection bureau	“Measurement Methods for Urban Environmental Vibration”(GB10071-88)
			Memorial Tower for February 7th Strike, Zhengzhou Confucius Temple，Zhengzhou Shang Dynasty Ruins	Vibration speed	1 time in the 3 year period during the operational period; to be carried out in 2 periods(daytimne and night); 1 day per time	20	The project owner entrusts qualified organ to undertake the work by contract	Project Owner	Municipal and district environmental protection bureau	“Technical Regulations on Prevention of Industrial Vibration for Ancient Buildings”(GB/T50452-2008)
	Electromagnetic Radiation		The main substation field	Power frequenxcy electromagnetic field, strong radio interference field	1 time in the first 3 years, 1 hour per time	5				

11.8 Estimation of Environmental Protection Expenses and Analysis of Econoic Profit and Losses

11.8.1 Estimation of Environmental Protection Expesnes

The total environmental protection investement listed for rail transit line 3 of Zhengzhou City is 225419000 yuan. See Table 11.8-1 for summary table of project environmental protection measures and investment:

Table 11.8-1 Summary Table for Estimated Envrionmental Protection Investment

environmental elements	content of measures	investment estimation (10,000 yuan)
Noise	Ventilation kiosk silencers at 16 ventilation kiosk areas are extended from 2m to 3m or 4m in length.	240
	3 cooling towers adopt ultra-low noise cross-flow type.	90
	3 cooling towers adopt low noise cross-flow type.	100
	Jialu River Parking Lot is surrounded by enclosing walls (high enclosing wall at west) and green belt with width of 10m.	60.9
	The car depot on East Hanghai Road is set with acoustic barrier with height of 2m.	135
	Temporary sound insulation measures during construction period.	225
	Subtotal	850.9
Vibration	For three cultural relics protection units of Shanhaimomuduha Tomb ,Zhengzhou Memorial Tower for February 7th Strike, Zhengzhou Confucius Temple and Zhengzhou Shang Dynasty Relics 4 along both sides of the line in this project, set the steel spring floating slab ballast beds or equivalent moderate shock-absorbing measures., totaling 780m at both sides and requiring 1.95million yuan investment.	195
	For 38 over-limit sensitive spots where the line passes just through (in 5m range from the outer rail center line just above track) such as school, hospital and residence areas, including RCC family member courtyard (Gadameilin district) so on, arrange the steel spring floating slab integral ballast beds, totaling 7052m at both sides and requiring investment of 105.78 million yuan..	10578
	For 45 over-limit sensitive spots within 10--15m range mainly including City bus company, family member courtyard, and Tianxiu courtyard so on, use the flexible support block type integral ballast bed or equivalent moderate shock-absorbing measures, totaling 8753m for double line and the investment of 87.53 million yuan..	8753

environmental elements	content of measures	investment estimation (10,000 yuan)
	For the environment sensitive spot with over-limit environment vibration VLz10, or VLz10 is qualified, but VLzmax exceeds the standard environment requirements, including 28 locations of Peaceful residential homes, Building 8 and so on,, use type III vibration reduction fasteners or equivalent moderate shock-absorbing measures, totaling for 5239mm and investment of 17.45 million yuan..	1745
	Subtotal	21271
Water environment	Charges for sewage treatment during construction period	50
Electromagnetic environment	It is suggested to rationally arrange land for main transformer station and rationally plan surrounding land of the main transformer station to make enclosing walls of main transformer station at least 15m from residential areas.	/
Environmental monitoring fees during construction period	Monitoring for noise, vibration, water, air, groundwater level and sedimentation etc.	275
Environmental monitoring fees during operational period	Monitoring for noise, vibration, water and electromagnetism etc.	90 (each year)
Total investment (excluding investment for monitoring during operational period)		22541.9

11.8.2 Analysis of Economic Gains and Lossed due to Environmental Impacts

Analysis of economic gains and losses due to environmental impacts is mainly intended to measure the environmental protection effect that can be achieved through the environmental protection investment to be input for the construction project, and make general economic assessment of environmental impacts through comprehensive calculation of economic losses caused by factors of environmental impacts, benefits of environmental protection measures and engineering environmental benefits. Thus in addition to calculating investment and expenses for controlling pollution, the possible environmental and economic effects shall be accounted during analysis of economic gains and losses due to environmental impact.

Means of Assessment and Analysis

The economic gains and losses due to environmental impacts of the project are comprehensively assessed by means of static analysis method, and conclusion is drawn from environmental and economic perspectives.

(1)Net Benefits of Evironmental Protection Investment

Calculation of net benefits of environmental protection investment is intended to

assess the dominant environmental impacts of the project(beneficial or adverse impacts). The calculation formula is as follows:

$B_{总}=(B_{措}-K)+B_{工}–L_{前}$:

As shown in the formula：$B_{总}$: Net benefits of environmental protection investment;

$B_{措}$: Environmental economic benefits produced by environmental protection investment;

K : Environmental protection investment and expenses;

$B_{工}$: Environmenal and economic benefits due to environmental impacts of the project;

$L_{前}$: Environmental and economic lossed in case of no environmental protection funds

(2)Investment Efficiency Ratio in Environmental Protection

The benefits and expenses ratio of investment on environmental protection must be calculated to assess the rationality of investment on environmental protection, and feasibility of environmental protection. The calculation formula is as follows:

$E_{总}=(B_{措}+B_{工}–L_{前})/K$

In case $E_{总}\geq1$, it shows that the environmental economic benefits of the project are larger than the environmental protection expenses, and the project is accpetab le. In case $E_{总}<1$, it shows the environmental protection expenses of the project is larger than the benefits obtained, and the project shall be given up. The larger $E_{总}$ is, the better effect of environmental protection investment will be.

(1) Ratio between Environmental Protection Investment and Capital Construction Investment

Comparison of the index with that of similar domestic projects can confirm the rationality of the project.

11.8.2.2 Analysis of Economic Gains an Losses due to Environmental Impacts

The economic gains and losses due to environmental impacts of the project are comprehensively assessed by means of static analysis method, and conclusion is drawn from environmental and economic perspectives.

(I) Major Factors Influencing Environment

The major factors influencing environment entered into analysis of economic gains and losses due to environmental impacts are noise, ecological landscape and water pollution etc. according to characteristics of the project and specific local environmental conditions:

(II) Environmental economic losses produced before input of environmental

protection funds $L_{前}$

(1) Environmental economic losses caused by noise: $L_{前声}$

According to the characteristics of the project, the populations around the air kiosk, cooling tower and depots as well as the ground lines of entrance/exit depot will be influenced by noise to various extents. Thus the project mainly assesses the environmental economic losses caused to surrounding populations due to subway noise. The report has selected the assessment coefficiency for environmental and economic lossed caused by noise of rail transit in Germany to passengers adopted by Planco in 1992 in a similar case, i.e. RMB 1.2 yuan per 100 persons km.

Suppose the average running speed of the train is 35km per hour(daily operational hour: 18 hours). As rail transit is a rapid means of transport, if the short interval between the trains is omitted, the trains running on the route can be seen as continuous, and the social populations around the noise source will receive constant impacts by the noise. And such people are influenced by the noise as if they travel by subway at 35km per hour for 18 years. It is estimated 10101 persons will be influenced by the noise of the project, and $L_{前声}$ is 27.87 million yuan per year.

(2) Environmental economic losses($L_{前水}$) caused by water pollution:

If the sewage discharged by the project is directly discharged without being disposed, the receiving water body will be polluted, and environmental economic losses will be caused due to deterioration of water quality. Such environmental economic losses is approximately replaced by the sewage discharge expenses payable for discharge of sewage of the same water quality and quantity. According to the current charging standards and provisions of relevant department, in case the sewage produced by the project is directly discharged without being disposed, the construction unit will pay 310,000 yuan per year as the sewage discharge expenses. Thus $L_{前水}$ is 310,000 yuan per year.

(3)Total environmental and economic losses($L_{前}$) caused before input of environmental protection funds:

Environmental and economic losses caused before input of environmental protection funds: $L_{前} = L_{前声} + L_{前水}$=28.18 Million yuan per year

(III) Investment on Environmental Protection K

The investment on environmental protection of the project is 225419000 yuan, which will be amortized over 4.25 years. Thus K is 53039764 yuan.

(IV)Environmental economic benefits($B_{措}$) caused by investment on environmental protection:

(1)Environmental economic benefits($B_{措声}$) caused due to decrease in the number of people influenced by noise after noise control

According to the prediction results for impacts on sound environment, the noise level

at the sensitive points along the project line is basically maintained at the level before project construction after noise and pollution prevention and control measures are taken, that is the project construction will not increase the noise level of various sensitive points. $B_{措声}$ is 27.87 million yuan per year.

(1) Environmental economic benefits($B_{措水}$) caused by control of water pollution:

According to relevant provisions, the sewage of the project will be discharged after reaching standard through treatment. The sewage discharge fee in the amount of 50,000 yuan per year shall be paid after sewage treatment through calculation, and 310,000 yuan per year shall be paid before sewage treatment. Thus the environmental economic benefits produced through treatment of water pollution($B_{措水}$) is 260,000 yuan per year.

(1) Total environmental economic losses produced by investment on environmental protection($B_{措}$):

$B_{措} = B_{措声} + B_{措房} + B_{措水}$ =28.13 Million yuan per year

(V) Environmental economic benefits caused by engineering environmental impacts($B_{工}$):

The extent of environmental pollution will be different in case road traffic instead of rail transit is adopted to meet the ever increasing demands for traffic by economic and social development along the route of the project in Zhengzhou City.

(1)Comparison of Environmental Economic Losses due to Noise Pollution:

To compare the environmental economic losses casued by noise due to two means of transport, the function of road traffic shall be the same as that of the means of transport of the project, and the travelling speed per hour is 35km per hour, with the daily operational period being 18 hours and the same quantity of passengers. Moreover, as road traffic is totally on the ground, the number of people influenced by noise on the two sides of the traffil route will be larger than that of subway, and is estimated to be 104,000. The populations along the road are influenced by noise as if they travel by road at the speed of 35km per hour for 18 hours.

According to relevant data of Germany, the estimation coefficient for environmental economic losses caused by road traffic noise on the passengers is RMB 1.7 yuan per 100 persons km.

The environmental economic losses caused by road traffic noise($L_{路声}$) is 406.55 million yuan per year through calculation.

The environmental economic benefits($B_{工声}$) caused by noise pollution in the two ways is $B_{工声} = L_{路声} - L_{后声}$=406.55 Million yuan per year.

(2)Comparison of Environmental Economic Losses due to Atmospheric Pollution:

As rail transit utilizes power as energy, it produces less atmospheric pollution, thus the environmental economic losses caused by its atmospheric pollution is approximately 0.

According to the conclusion of atmospheric environmental impact assessment, the emission of automobile exhaust will be reduced due to project construction. The environmental economic losses due to road atmospheric pollution is estimated according to the environmental economic losses caused by the road traffic exhaust on passengers in Germany, that is RMB 0.2 yuan per 100 persons km. $B_{工气}$=47.83 Million yuan per Year.

(3)Total environmental economic benefits($B_{工}$) due to engineering environmental impacts:

$B_{工}= B_{工声} + B_{工气}$ =454.38 Million yuan Per Year

(VI) Analysis of Economic Gains and Losses due to Environmental Impacts:

(1) In case $B_{总}$ is larger than 0, it shows the environmental impacts of the project are mainly beneficial.

Net benefits from envrionemental protection investment $B_{总}=(B_{措}-K)+B_{工}-L_{前}$ =397,610,000 yuan per year.

(2) Environmental protection investment efficiency $E_{总}=(B_{措}+B_{工}-L_{前})/K$=8.01

$E_{总}$>1, which shows that the environmental economic benefits of the project is larger than the environmental protection expenses, and the environmental protection investment effect is good.

(3)Environmental protection investment/capital construction investment ratio:

The environmental protection investment of the project is 225419000 yuan, and the estimated total investment of the project is 197699790000 yuan, thus the environmental protection investment/capital construction investment is 1.14%, which is similar to that of the environmental protection investment of similar domestic project. Thus the environmental protection investment is rational.

11.8.3 Conclusion:

The completion and operation of the project will positively promote social economy and urban environment in areas along the routes of the project. The environmental economic losses caused by project construction will be controlled within a small scope after several environmental protection measures are taken. Project construction will produce significant social benefits and environmental benefits, which complies with the principle of simultaneous growth of economic benefits, social benefits and environmental benefits.

11.9 Environmental Reporting System

The construction unit, environmental supervisory unit and environmental monitoring unit shall report progress of environmental protection project regularly, existing problems and effect of environmental protection measures etc. during project implementation, and the owner shall report the major problems to local environmental protection bureau regularly.

12 Conclusions and suggestions

12.1 Environmental status assessment

12.1.1 Acoustic environment

There are 44 environmental protection objectives in the assessment scope, including 42 centralized residential buildings, one library and one religious venue. 44 ones among these sensitive points are affected by noise of ventilation system, and there is any sensitive spot in car depot and parking lot.

Among these sensitive points, 20 ones execute Category 4a Standard, 24 ones execute Category 1 Standard.

12.1.2 Vibration environment

There are 161 environmental protection objectives in the assessment scope, including 3 schools, 8 hospitals, 4 cultural relics sites under protection and 2 religious venues.

environmental vibration VLz10 value of sensitive points along the line is 50.1～68.5dB in the day and 47.3～64.5dB dB at night, meeting corresponding standard limit value requirements of GB10070-88 Standard of Vibration in Urban Area Environment.

12.1.3 Water environment

(I) Surface water

The line underneath passes through Jinshui River, Xiong'er River, Qili River and Chaohe River in the form of tunnel (shield construction), and parking lot is located at southern bank of Jialu River. In 2012, surface water quality of Yellow River basin under administration of Zhengzhou City was good and in conformity with Level III standard. Surface water of Huaihe River basin under municipal administration was seriously polluted, of which Jialu River was seriously polluted, Shuangji River was moderately polluted, and Yinghe River was mildly polluted; one of 12 monitoring sections conformed to Level II standard, one conformed to Level III standard, two conformed to Level IV standard, and other eight ones were poor Level V, accounting for 8.3%, 8.3%, 16.7% and 66.7% respectively; main pollutants affecting river water quality were ammonia nitrogen, chemical oxygen demand and permanganate index.

Main environmental protection objectives: Jinshui River, Xiong'er River, Qili River, Chaohe River and Jialu River.

(II) Ground water

Ground water type of areas along the line mainly includes perched water, Quaternary system's pore water among loose rock and fissure water of bedrock. According to the investigation, areas along the line take tap water as water source, In 2012, water quality by comprehensive evaluation for underground water environmental quality in Zhengzhou city area was good (Level I), water quality basically remained stable, and 7 points all reached underground water Level III standard.

12.1.4 Ecological environment

This project is located at Zhengzhou urban area, the areas passed by this project take human activities as the core, there are row upon row of office buildings, stores, residential buildings and Party and government organizations, which is artificial ecosystem based on urban structure; areas around Jialu river parking lot, Boxue road Station and Hanghai east Station are mainly farmland and wasteland, and ecosystem type is farmland ecosystem, areas around car depot are mainly forestland, and ecosystem type is forestland ecosystem.

There is no nature reserve, scenic spot or forest park in the assessment scope, and there are few farmlands only near car depot,and there are few forestland near parking lot.

12.1.5 Electromagnetic environment

Cable television receiving systems are basically installed in households along the line, and networking rate of cable television can reach 90%. Only few rural residents still adopt open-type television receiving mode due to economic reason,there are any sensitive spot around Boxue road Main Transformer Station.

Current electromagnetic environment around requested main transformer station meets standard requirements.

12.1.6 Ambient air

Ambient air quality of Zhengzhou city area in 2012 reached Level III standard; ambient air quality of four county-level cities and one county including Xinmi City, Xinzheng City, Xingyang City, Dengfeng City and Zhongmu County reached Level II standard, and that of Shangjie District reached Level III standard. Primary pollutants of urban ambient air are inhalable particle except sulfur dioxide in Xingyang City and Shangjie District.

Days of good ambient air quality in Zhengzhou city area in 2012 were 319 with rate of reaching the standard being 87.2%, days of good ambient air quality in four county-level cities, one county and one district under municipal administration were 312-345 with rate of reaching the standard being above 85%. Ambient air in Zhengzhou city area remained basically unchanged than 2011 in terms of pollution level. There was no acid rain.

12.1.7 Social environment

At the end of 2011, built-up area of Zhengzhou city proper was 354.7km2, total population of Zhengzhou was 8,857,000, The urban center is highly populated, which brings tremendous pressure to the city center's traffic. And there are defects in the existing road traffic system, reflecting the contradiction between traffic supply and demand more prominently, thus traffic paralysis caused by congestion in the core city zone may occur at any time. It's predicted that the annual passenger traffic volume of public transport in 2015 will increase to 1.6 billion person-times from the number of 0.65 billion in 2007, with an average annual growth rate of 10.5%, and the number will reach up to 2.13 billion person-times in recent years (in 2020).

Preservation buildings of cultural relics along the line include: separately of Memorial Tower for February 7th Strike, Zhengzhou Shang Dynasty Relics, Zhengzhou Confucius Temple. in which the distance of line to Memorial Tower for February 7th Strike body is only 3m,and in which the distance of line to Zhengzhou Shang Dynasty Relics is only 6m.

12.2 Environment impact assessment and measures of environment protection

12.2.1 Sound environment

(I) Construction period

The report indicates: in earthwork construction phase, the construction noises at locations 60m from construction boundary at day time and 350m at nigh time can meet the standard requirements; in foundation construction phase, the construction noises at locations 60m from construction boundary at day time can meet the standard requirements and the pile driving works must not be done at night time; in structure construction phase, the construction noises at locations 150m from construction boundary at day time and 350m at nigh time can meet the standard requirements. The construction sites are normally near the sensitive spots of ambient environment and the noise in construction site is hard to meet the requirements in GB12523-90 Noise Limits for Construction Site.

Environment measures provided in the report: properly arrange the construction sites; the construction machines with large noise shall be kept away from the side of residential area, school and hospital; reasonably arrange the construction operation time and the high noise works shall be arranged at day time as possible. If the process requires continuous operation or in case of special requirements, it shall be applied to local environment protection administrative department; During college entrance examination and half an month before the period, prohibit any building construction works which may lead to noise over-limit and resident disturbance besides strict control for various environment noise sources according to related national environment noise standards; set temporary 3-4m high sound barrier for 24 sensitive

spots construction boundary with severe noise impact by station and open-cut section construction.

(II) Operation period

In the Non-air conditioning period , The sensitive spots of 44 locations in underground station assessment range along the line are only affected by subway environment control device noise (no superposed background); the equivalent continuous A sound levels in day time and night time actual operation periods are separately of 32.7～57.9dB（A）、33.9～58.9dB（A）.

In the air conditioning period, The sensitive spots are only affected by subway environment control device noise (no superposed background); the equivalent continuous A sound levels in day time and night time actual operation periods are separately of 35.3～71.5dB（A）和 36.2～71.5dBA..

For 7 ventilation pavilions and 5 cooling towers including Shamen Road Station south cooling tower and ventilation pavilion, Dongfeng Road Station north ventilation pavilion and cooling tower, Dongfeng Road Station south ventilation pavilion and cooling tower,Nongye Road Station southwest ventilation pavilion and cooling tower, Huanghe Road Station north ventilation pavilion and cooling tower,Taikang road station southwest ventilation pavilion and cooling tower,,Jinshui Road Station northeast ventilation pavilion and cooling tower, Erqi Square Station northwest ventilation pavilion, East Street Station southeast cooling tower, which do not comply with the environment protection control distance requirements in Code for Metro Design, their locations shall be adjusted to control the distance more than 15m far away.

For 17 ventilation pavilions including Xinliu Road Station west side ventilation pavilion, Shamen Road Station north ventilation pavilion, Xinglongpu Road Station south ventilation pavilion, Dongfeng Road Station north ventilation pavilion, Dongfeng Road Station south ventilation pavilion, Nongye Road Station northwest ventilation pavilion, Nongye Road Station southwest ventilation pavilion, Huanghe Road Station north ventilation pavilion, Huanghe Road Station southwest ventilation pavilion, Jinshui Road Station northeast ventilation pavilion, Jinshui Road Station southeast ventilation pavilion, Jinshui Road Station southwest ventilation pavilion, Taikang Road Station south ventilation pavilion, Erqi Square Station northwest ventilation pavilion, Shuncheng Street Station northeast ventilation pavilion, Chengdong Road Station northwest ventilation pavilion, recommend taking the noise reduction measures with silencing treatment and make the exhaust port of ventilation pavilion back to the sensitive buildings.

Recommend using the ultralow noise cross flow type cooling tower at three locations including Shamen Road Station north side, Dongfeng Road Station south side, Nongye Road Station southwest side, Huanghe Road Station north side and Taikang Road Station south side, and the low noise cooling tower at 4 locations including Xinglongpu Road Station south side, Jinshui Road Station east side, Dongdajie Station southeast side and Chengdong Road Station northeast side.

The total environment protection investment required for noise control of underground station environment control devices is 4.85 million yuan (excluding

removal expense and modification and design cost), in which includes the newly added 1.5 million yuan for ultralow noise cross flow cooling tower, new added 0.8 million yuan for low noise cooling tower and 2.55 million yuan for addition of silencer in ventilation pavilions.

12.2.2 Vibration environment

(I) Construction period

The report analyzes that the vibrations during construction period mainly come from the vibration generated from construction machinery and the environment sensitive spots near the stations and part of open cut sections will be affected.

Measures provided in the report: reasonably lay out the construction sites and limit the construction works with heavy vibration pollution at night time; the traveling paths of construction vehicles shall avoid the vibration sensitive areas as possible; for construction around the old houses with poor building structures and foundations, intensify the vibration monitoring during construction period and take reinforcement measures for possible impacts such as house cracking and ground settlement.

(II) Operation period

After project is put into operation, the vibration value VLz10 of 161 environment sensitive spots along the line is 54.6~77.7dB at daytime with 0~ 25.4 dB increment than that at present, and 0.3~26.9 dB increment at nighttime. The environment vibration of 6 sensitive spots exceeds the standard requirements, in which there are 1 sensitive spots with the vibration level exceeding the standard value at daytime with the over-limit amount of0～2.7dB, 6 sensitive spots with then noise level exceeding the standard value at nighttime with the over-limit amount of 0.1～5.7dB; and the over-limit rate is up to3.7％.

The maximum speed response values of 3 cultural relics along the line including Zhengzhou Memorial Tower for February 7th Strike , Zhengzhou Confucius Temple and Shanhaimomuduha Tomb exceed the standard requirement, with the over-limit amounts separately of 1.18mm/s、0.96mm/s and1.57mm/s.

The indoor secondary structure noises in 38 sensitive buildings within 10m range from right above of project underground section to outer rail centerline are in the range of 38.7~56.2dB. In reference to standard reference limit of “42dB(A)”, there are total 32sensitive spots affected by secondary structure noise due to subway vibration with the over-limit amount of 0.1~14.2dB

The indoor secondary structure noises in 38 sensitive buildings within 10m range from right above of project underground section to outer rail centerline are in the range of 38.7~56.2dB dB dB. In reference to standard reference limit of “42dB(A)”, there are total 32sensitive spots affected by secondary structure noise due to subway vibration with the over-limit amount of 0.5~14.2dB.

For reasonable planning of land use along the line, predict the vibration pollution

during operation period of rail transit; suggest as follows: ① According to the regulations in Subway Design Specification (GB50157-2003) and vibration protection distance of this report, the protection distance of buildings at both sides of underground line in areas of “mixing area, CBD”, “industrial concentration area” and “both sides of traffic arterial road” specified in GB10070-88 Standard of Vibration in Urban Area Environment is 25m; the protection distance of buildings at both sides of underground line in “residential and culture education area” area is 38m. ② Scientifically plan the layout of buildings to arrange the first row buildings near the vibration sources as vibration non-sensitive building such as commercial and office building. ③ In combination with the modification of old town, firstly demolish the residential houses near the vibration source, and, in combination with the greening design and re-arrangement of buildings, reserve the vibration prevention distance for newly developed buildings so as to ensure the impact on sensitive buildings within allowable range of standard.

12.2.3 Water environment

(I) Surface water

The domestic sewage, muddy water and other production wastewater generated from construction stations, car depot and other sites are reused or drained into urban pipeline network after treatment of sedimentation tank, and will not affect the surface water and underground water environment.

The domestic sewage, muddy water and other production wastewater generated from construction stations, car depot and other sites are reused or drained into urban pipeline network after treatment of sedimentation tank, and will not affect the surface water and underground water environment.

(II) Ground water

The report indicates: since the groundwater depth of project along-line and nearby areas is normally deep and the bottom groundwater depths of along-line stations of this project are larger than the buried depth of groundwater level in this region, the dewatering works shall be done for open-cut or cover-cut construction methods. In addition, seven sections including Xinliu Road Station end siding area, Xinlongpu Station end siding area, Huanghe Road Station end siding area, Taikang Station end siding area, East Street Station end siding area, Tongtai Road Station end siding area and Zhongxing Road Station end siding area adopt open-cut construction method, which requires dewatering during tunnel construction; the other underground sections adopt shield construction method without need of dewatering.

The report predicts that, under the conditions of water proof measures, the possible ground settlements mainly concentrate in 10-20m range around the station foundation pit and the settlement amount around the station is normally no more than 30mm.

The report indicates that the underground water types of regions along the line of project are mainly of perched ground water, quaternary loose rock type hole water and bedrock crevice water, in which the quaternary loose rock type hole water is the

priority. The underground water is mainly supplied from surface waters (including Jinshui River, Xionger River, Chaohe River) with less impact from artificial exploitation. In normal water season and low water season, the underground water feeds surface water and the underwater drains to the surface water; while in flood season, the surface water level rises and the surface water feeds the underground water. The impact of this project construction on underground water feeding is very small.

The measures provide in the report are as follows: Construct the concrete diaphragm wall before the construction of underground station and section to block off the underground water and use as the retaining structure. Then based on the proper anti-seepage works, lay out the blank tubing under the channel at both sides of tunnel to collect the residual water to the ground surface; set up the sedimentation basin on the ground; the water is discharged to municipal sewage pipe network and then sewage treatment plant after sedimentation in the basin.

12.2.4 Ecological environmen

(1) The project does not involve any ecological sensitive area such as natural reserves, scenic spot and basic farmland conservation area.

(2) After construction and operation of this project, it will enhance the connectivity of all function block landscapes along the line, keep the smooth input/out operation between the function blocks, ensure the high efficiency operation of city, enhance the stability of urban landscape ecological system and ensure the healthy development of city.

(3) According to the landscape aesthetics analysis and analog survey analysis, if fully considered the unique historic city property of Zhengzhou city and land use pattern and adopted the design with blending method and hidden method, it can keep the coordination of ground buildings such as station entrance/exit and ventilation pavilions with ambient environment.

(4) The construction of rail transit has remarkable advantages in saving of land resource and energy, and in favor for integration and modification of Zhengzhou land resources, relief of regional land utilization pressure and improvement of land utilization efficiency.

12.2.5 Electromagnetic environmen

The report indicates: The ground line train traveling may impose certain impact on the TV user with antenna to receive signal, but most of the channels can be normally displayed. Since the cable TV connection rates at sensitive spots of this project are high,and there are any sensitive spot around Boxue road main substations,so there has no impact. By analogy monitoring, after construction and put into service of Boxue Road main substation and Erqi Square switching station, the generated power frequency electric field and magnetic field comply with the limits of power frequency electric field of 4kV/m and power frequency magnetic field of 0.1mT recommended in HJ453-2008 Technical Guidelines for Environment Impact - Urban Rail Transit.

It recommends properly laying out the main substations and reasonably planning the lands around the main substations so as to make the fence of substations away from the residential area as possible. The least distance from the residential area shall be more than 15m.

12.2.6 Ambient air

The air pollutant emission during construction period mainly comes from the raise dust generated by construction excavation, material placing, earthwork transport and construction materials such as yellow sand and cement,and yellow sand and cement is the main factor. In addition,the exhaust pollutants emission is low with minor air environment impact.

The exhaust gas during construction period mainly includes the tail gas emitted by construction machines and flying dust generated during construction field operation and transportation, in which the flying dust is the main influential factor for atmospheric pollution during construction period. There is very few tail gas emitted by the machinery during construction period with little impact on the environment. The flying dust during construction period will impose certain impacts on the residents around the construction sites and transportation roads. The flying dust amount is closely related to the construction mode, natural conditions of construction site and construction management. Since the construction sections in this project are short and the excavated earth volume during construction period are small, it can relieve the adverse impact on atmospheric environment by the construction by strengthening the management during construction period and taking effective dust suppressing measures.

According to the prediction: during initial period of operation, the odors emitted by the pavilions will be serious due to the mildews in underground dark and humid environment and also the impact of decoration materials; and there is evident odor within 15m range.

The measures provide in the report are as follows: in this design program, 8 sensitive spots at Dongfeng Road Station, Nongye Road Station, Huanghe Road Station and Shuncheng Street Station conflict with the land use of ventilation pavilion or the distance is less than 10m, and they are planned to be demolished; in addition, the distance from ventilation pavilions at Shuncheng Street Station and Taikang Road Station to the sensitive spot is less than 15m, and the odors emitted from ventilation pavilion will impact the resident livings to some extent; in combination with the control measures listed in noise topic, the environment assessment suggests to adjust the locations of 8 ventilation pavilions with the distance of less than 15m from sensitive spots. To effectively relieve the odor impact, it is necessary to plant arbors around ventilation pavilion and make the outlet opposite to the sensitive spots such as residential building.

12.2.7 Solid wastes

The report indicates the solid wastes of this project during construction period are mainly of engineering spoils, construction wastes and domestic wastes of construction

personnel. Failing to timely clear and handle will impose adverse impacts on the environment within construction range. The total amount of solid wastes of the project after operation is about 860 - 1370t/a. The production wastes mainly include the metal filings, waste scraps and waste batteries from car overhaul and wastewater treatment in car depot and comprehensive base, and the sludge and waste oil mud from sewage treatment plant.

The main measures provided in the report include: All spoils are transported to the spoil grounds specified by urban management department for landfill treatment. The construction unit shall assign managerial personnel to carry out site management of the disposal of spoils and rubbish. The vehicles transporting spoils shall be equipped with sealed cover, and shall run according to the prescribed time, site and routes. The engineering spoils and building wastes shall be handed over to Zhengzhou Municipal Urban Management Bureau Solid Waste Division for uniform and proper disposal.

Reasonably arrange the rubbish bin and collect the domestic wastes in the stations and carriages; transport the domestic wastes collected along the subway line and car depots to the environmental sanitation department for uniform disposal; the production solid wastes such as metal chips and waste scraps shall be recycled; the waste batteries shall be properly kept according to hazard waster regulations and transported by the manufacturer back to the plant for disposal; the sludge and domestic wastes from sewage treatment plant shall be transported together to the municipal solid waste landfill for disposal.

12.2.8 Social environment

(I) Impact assessment of the project on social environment

Whether in construction period or operation period, this project will affect the livings of Zhengzhou citizens in different degrees and from various aspects. The positive effects lie in that the project construction will provide Zhengzhou people a more rapid, convenient and environment protection public transit facility and Zhengzhou rail transit line 3 during operation period will become a more convenient, safe, comfortable and economic communication mean for the residents along the line; at same time, the project construction works and enclosure will inevitably bring forward adverse impact on the people along the line; however the adverse impact is controllable and temporary as long as implemented related relief measures in the report.

The positive effects also include followings: the barrier free access benefits the traveling of disables; the increase of female toilet proportion enhances the female social position and living convenience; the reasonable ticket fare is in favor of the low-incoming group and equivalent to increase of economic income; the rail transit line 3 improves the urban traffic after operation and brings forward favorable impact on land utilization change an therefore promote the implementation of development construction and planning of city.

The adverse impacts are mainly in construction period and include followings: the station enclosure impacts the local urban traffic; station construction enclosure imposes temporary impact on incoming of surrounding merchants; the construction

enclosure leads to inconvenient livings of nearby residents and increases their traveling time; noise and vibration disturbance due to construction machinery operation, construction raise dust, sewage, muddy water, deposition and transport of construction garbage and construction materials will affect the living quality of residents; the ground settlement and vibration affect the ground building stability during construction period.

12.2.8.1 Improvement measures for negative effects

The specific protection measures for impact on urban traffic environment impact by the project are as follows: the traffic dispersion program for 3# line complies with the principle of “Compensate a road for each road Occupation”. During construction of stations in Huiji District including Xinliu Road Station, Shamen Road Station and Xinglongpu Road Station, since the vehicle flow and passenger flow is small and the road is wide, the construction enclosure duration in traffic dispersion measures are short and the construction can be completed in short term. So its traffic impact is not much in long term. For Dongfeng Road Station, Nongye Road Station and Huanghe Road Station of Nanyang Road and Taikang Road Station of Minggong Road, the vehicle and passenger flows are dense and the roads are crowed. To avoid large impact of traffic by enclosure during construction period, the construction enclosure range in traffic dispersion measures are small and the enclosure duration is long. It is preferable to use cover-excavation construction method for Taikang Road.

For the impact on urban traffic by construction of Zhengzhou Rail Transit Line 3, except preparation of reasonable traffic dispersion program, it shall set up real time notice to provide the enclosure information to the residents and it shall inform the residents in advance if any necessary bypassing.

For 201 merchants to be demolished along the line, compensate according to market price and provide 6 months close-down compensation reward. For 858 store employees, offer one-off 6 months minimum wage compensation for actual employees registered in business license.

For the construction of stations in old district with dense residents, enterprises and public service unit, it shall reduce the construction noise and vibration impact by setting up construction enclosure, properly arranging the machinery in construction site, prohibiting pile driving operation at night time, and relieve the impact of raise dust by sprinkling and dedusting in construction site and covering the construction materials.

12.2.8.2 Improvement measures for positive effects

(1) Design of station wheelchair access

To ensure safe, convenient and rapid utilization of the traffic facilities by the people with various demands such as blind people, disabilities, office staff and the people with many luggage, Zhengzhou rail transit 3 line stations design the wheelchair access according to Code of Accessibility Design, such as sidewalk for the blind, accessible elevator and staircase, which can separately meet the requirements for the disables and the blind to ride the rail transit. The staircase provides a good luggage transport access for the people carrying many luggages. The design principle is to ensure

minimize transfer line and save the traveling time of office staff.

(2) Consideration of proportion of men and women toilet positions

According to related social survey and social feedback reports, due to different physiological characteristics of male and female, the time consumption in toilet for male and female has remarkable difference. According to the statistics, the average time consumption in toilet of male is only 1/5 of that of the female. Based on above reasons, improvement of toilet position design in 3 line stations to increase the toilet position numbers of the male and the female with the female toilet position increment larger than that for the male can reduce or avoid the lining-up for toilet of the female (the female toilet position increase will considerably shorten the lining-up time of the female) so that it can not only facilitate the female, but also enhance the satisfaction of the male waiting for the female.

(3) Reasonable consideration of low-incoming group during determination of ticket fare

In entire social group in Zhengzhou city, the low-incoming group is a special group accounting for a large portion. The definition of ticket fare for Zhengzhou rail transit 3 line shall consider the traffic of low-incoming group in Zhengzhou city. It shall prepare reasonable ticket fare satisfying most of people for different hierarchies and different incoming levels of low-incoming groups, and positively affect the society.

12.2.9Material and culture resources

There are four physical cultural heritages identified in this project, separately of Memorial Tower for February 7th Strike, Zhengzhou Shang Dynasty Relics, Zhengzhou Confucius Temple and Penggong Temple, in which the distance of line to Memorial Tower for February 7th Strike body is only 3m; there is no ground buildings such as entrance, ventilation pavilion or cooling tower in protection range in protection range and there is an entrance in construction control zone; the line passes through underground of Shang Dynasty Ruins and there is no ground building in its protection range and construction control range; the line passes through underground the construction control range of Zhengzhou Confucius Temple without any ground building; the Penggong Temple is located at west gate of People’s Park and the line passes through underground with far distance.

The protection measures provide in the assessment are as follows: carry out pre-reinforcement before construction at Memorial Tower for February 7th Strike; adopt shelter pile measures during 3# line shield construction and mount steel spring floating slabs in 50m range at both sides of protection range, and intensify the settlement monitoring during construction period; during design of stations near the cultural relics including Erqi Square Station, Chengdong Road Station and Taikang Road Station, the design of entrances, ventilation pavilions and cooling towers shall be kept uniform separately with People’s Park Shang Dynasty Cultural Display Area and Jinshui River Waterfront Park landscape, Memorial Tower for February 7th Strike and Dehua Commercial Center and Shang Dynasty ruins landscape.

Since Zhengzhou is one of national famous historical and cultural cities and listed in

eight ancient capital cities, the general style design for stations and ventilation pavilion of rapid rail transit of complete city shall have the visual image of city culture and coordinate with the heavy culture connotation of Zhengzhou.

12.3 Evaluation conclusion of cumulative impact

The main cumulative impacts of 3# line during construction period mainly include: ① Shield construction soil from sectional construction of 2# line and construction spoils of complete 3# and 5# lines;② Impacts from concurrent construction of 3# and 5# lines on the surrounding areas of station such as traffic congestion, increased flying dust and traveling inconvenience; ③ Cumulative impact on own settlement of tower foundation due to the construction near February 7th Memorial Tower.

The main cumulative impacts of 3# line during construction period mainly include: the same sensitive spot is subject to the impact of subway pavilion at both sides; the same sensitive spot is subject to the impact of vibrations from 2 subway lines nearby; interaction between urban bus rapid transit and rail transit after operation.

Intensify of management methods during construction period, improve the selection of spoil ground and various environment protection measures during operation and decommission period, reasonably select the construction sites and arrange the construction time. Carry out the construction works around Erqi Tower according to approved Protection Program for Zhengzhou Rail Transit Project Passing through side of February 7th Memorial Tower, and intensify the monitoring measures during construction period; as a result, it can relieve the adverse impact on environment for concurrent construction of major projects.

The cumulative noise impact during construction period can be relieved by reasonably adjusting the positions of pavilions and cooling towers, selecting low noise equipment and lengthen the silencer; the cumulative noise impact during operation period can be relieved by the vibration reduction measures such as adoption of steel spring floating slab. By in-depth design of BRT route, station position selection and departure intervals, it can make use of the advantages of both urban rapid transit and rail transit to set up 3D rapid public transit system.

12.4 Conclusion of analyses to alternative scheme

This report highlights the comparison and selection of alternative scheme in line trend, station location as well as the comparison and selection of alternative scheme in underground interval and underground station construction scheme.

(1) In the comparison and selection process, comprehensive comparison of line operation condition, construction hardness, civil work investment, passenger flow attraction and environmental impact have been taken into account. For the comparison selection of the line trend at the north of the North Ring, both schemes will down-traversing the existing road and have no conflict with the planning. But due to the influence of the Beijing-Guangzhou Railway at the west, the recommended scheme can attract more passengers. Furthermore, the plot at the northeast of Nanyang

Interchange is under reconstruction, which can reserve spaces for Line No.3. From the long-term planning point of view, the recommended scheme will go further north, down-traversing Lianyungang--Khorgos Expressway and Jialu River. Stations will be built in the planned Binhe Road intersection, Kaiyuan Road intersection and Dahe Road intersection. The Kaiyuan Road Station is a transfer station with subway Line No.2, so the transfer conditions are good. From the social impact point of view, the recommended scheme is relatively better. From the environmental impact point of view, the recommended scheme will not down-traversing existing housing estate, so the impact of vibration on residents is small. From the finance point of view, the recommended scheme is better due to the reducing of construction difficulty. To sum up, this report argues that the recommended scheme is relatively better.

For the comparison selection of line scheme from Jinshui Road Station to Seven Feb. Square Station, while the positions of Jinshui Road Station and Seven Feb. Square Station are fixed at both ends of this line, the scheme along Minggong Road is the straighter and the demolition amount is small. However this scheme is restricted by the Huigangxincheng under construction and the Memory Tower for “Feb. 7th”. Vibration and secondary structural noise will affect them during the operation period. The detour scheme at the west of Minggong Road is slightly far away from the Memory Tower for “Feb. 7th”, but the vibration during the operation period will still affect them. Furthermore, this line will down-traversing seven buildings of 6 to 7 storeys at the north of Jiefang Road, and many low buildings of 1 to 2 storeys. The demolition amount is large, and the social impact is great. Besides, buildings in the old housing estate are of brick-concrete structure, and the vibration resistance ability is poor, so the vibration and secondary structural noise will have large influence on them. The engineering cost of demolition is large, too. Based on the above analysis, this report suggests the use of the recommended scheme, which is the Minggong Road scheme.

For the comparison selection of line schemes down-traversing the planed National Highway No.107 Interchange, the recommend scheme is straight, its influence on existing railway is small, and the engineering cost is low. There will be interchange at this intersection, which requires the proper consideration of the positions of piers during the design process to connect with Line No.3. The alternative scheme is curved and obliquely-traversing the high-speed rail, so the engineering cost is high. Therefore, this report suggests the use of the recommended scheme.

(2) In the comparison and selection of key stations, Jinshui Road is the trunk road for east-west traffic of Zhengzhou. The passenger flow is large and it is very important. Therefore, the impact on the traffic of Jinshui Road during the construction and operation periods shall be considered in priority when selecting the position of station on Jinshui road. The recommended scheme has certain advantages both in passenger service and traffic influence. Its function is better. Although there are certain risks during the construction process and the engineering investment is slightly higher, certain engineering measures can be taken to guarantee the construction safety. Scheme II is recommended for this section with the principle of people oriented and function priority.

(3) The interval construction scheme conducts the comparison and selection to the shield method and the mining method. It can be seen from the engineering technology

that the shield method is relatively easy in passing through the geological fault, mature in construction method, high in automaticity and quick in construction, therefore it is smaller in construction hardness than the mining method, and is flexible in construction period, easy to control; The shield method is relatively easy in passing through the geological fault, mature in construction. Relatively in controlling the land subsidence and small in construction risk; From the aspect of impact to social environment and natural environment, the shield method construction is relatively good in controlling buildings around and the ground deformation, quick in construction, good in construction environment without any impact to environments such as underground water; In addition, the construction of this interval gives priority to the shield method taking the geologic characteristics of Zhengzhou into account.

(4) The station construction scheme conducts the comparison and selection to open deep excavation, covered excavation and subsurface excavation. The open deep excavation has larger environmental impact of ground traffic, land use, noise and dust than the covered excavation and subsurface excavation, however when the ground has adequate construction yard, the road can be occupied for long time by dispersing the traffic and the underground pipelines possess the modification and correction condition, construction method of the underground station should firstly consider the open excavation order method for its simplicity, quick speed, economy and safety. The open deep excavation has obvious advantages comparing to the subsurface excavation in construction safety, construction difficulty, and construction period, quality of structure waterproof and cost of civil work.

According to the environmental conditions, the traffic dispersing conditions, the underground pipeline modification and correction requirement, the geological conditions, the buried depth of the station, and other factors, and by drawing on the successful experience of domestic subway construction, it is suggested that the underground stations of this line shall be constructed by firstly selecting the open cut method. The segmented inverted edge construction method or open cut + local cover-excavation method can be adopted for traffic trunks which need dispersing the traffic or crossing intersections. The geology along Line No.3 is mainly alluvial plain, the groundwater level is high and the geology is poor. The construction difficulty is really large for the station of more than 20 m in width. Therefore, the undermining method is generally not considered for the main structure of the station. Therefore, the open cut method or cover-excavation method will be used for stations on rail transit Line No.3 according to the recommendation of surrounding environment. Jinshui Road is the trunk road for the east-west traffic in Zhengzhou. The adoption of cover-excavation method will have small impact on ground traffic. All other stations are constructed by the open cut method.

12.5 Conclusion on Environmental Risk Analysis

(1) Risk during construction period mainly occurs during digging of base pit or interval tunnel. Improper selection of construction methods tends to cause uneven settlement, ground collapse or bulging; Accidents such as collapse, roof fall, sand gushing water gushing, and water transmission etc. tend to happened during construction due to influences by multiple factors such as geological and hydrological factors etc.; Improper selection of construction methods and retaining program will

cause breakage of adjacent underground pipelines or cracking, leaning or even collapse of surrounding constructions. Major risk source during operational period: The major risks and accidents during operational period come from social hazards such as arson or terrorist attack etc., and the accidents due to improper operation by staff and mechanical failure etc.. The aforesaid accidents have not only caused huge economic losses and tend to cause personal casualty and significant social influences.

(2) The stratum are mainly earth with medium within the depth of 30m under the line(K0+0.000~K25+200) and underground stations(Xinliu Road Station, Shamen Road Station, Xinglongpu Road Station, Dongfeng Road Station, Nongye Road Station, Huanghe Road Station, Jinshui Road Station, Taikang Road Station, Er'qi Square Station, Shuncheng Street Station, Dongdajie Station, Chengdong Road Station, Future Avenue Station, South Fengtai Road Station, Zhongzhou Avenue Station, Tongtai Road Station, East Huanghe Road Station, East Nongye Road Station, Zhongxing Road Station, Boxue Road Station, East Hanghai Road Station), the characteristic are high compressibility, low strength and poor stability. The area belongs to area with medium risk level of geological disaster. The major categories of geological disaster are ground collapse, ground fissure, ground precipitation and uneven ground settlement. Meanwhile, the subway station is constructed by means of opening digging and cover digging, and extraction and drainage of a large quantity of underground water in base pit tends to cause sudden decrease in underground water level and drifting sand, regional ground settlement and collapse, and deformation and cracking etc. of surrounding buildings. As No.3 subway line runs across the bridge piles such as Beihuan and Nanyang Road approach bridge, Nanyang and Jinshui Road approach bridge, Zhongzhou Road and Shangdu Road approach bridge, the elevated bridge of Longhai railway line and Shiwu highspeed railway line etc,, and tends to cause settlement and deformation of the aforesaid buildings or structures, and many overturn the structures and endanger safety in serious cases.

(3) Carry out pre-construction investigation and design of risk sources during construction period, and establish environmental safety classification system for construction period, adopt new construction techniques and technology, strengthen monitoring and measurement during construction, establish environmental safety technical management system for subway construction, and formulate emergency measures to lower risk.

As No.3 subway line runs across the bridge piles such as Beihuan and Nanyang Road approach bridge, Nanyang and Jinshui Road approach bridge, Zhongzhou Road and Shangdu Road approach bridge, the elevated bridge of Longhai railway line and Shiwu highspeed railway line etc, and various of municipal fundamental pipes,, it is necessary to carry out strict monitoring and monitoring measures against structural deformation of the tunnel, ground settlement, structure deformation and settlement etc.. Adopt earth pressure balance shield and select optimal construction parameters to ensure stable cutting face; strength the synchronous grouting and necessary supplement measures to control the settlement of structures, meanwhile it is necessary to take ground reinforcement measures.

Supporting and water-stopping measures such as diaphragm wall, drilling hole pile plus water seal curtain etc. have been adopted for subway stations constructed by means of open digging and semi-cover digging of the project to control drainage and

extraction of underground water and prevent ground settlement. Meanwhile, observe settlement of the surrounding buildings of the base pit, and monitor the underground water level etc..

(4)Take risk management measures such as strengthening publicity and education for passengers and staffs; Equipping advanced equipment and testing system; Establishing monitoring and alarming system; Formulating emergency program; Carrying out mimic exercise; strengthening emergent evacuation of passengers after occurrence of accident to lower the possibility of risk and personal and property losses caused thereby;

12.6 Conclusion on Resettlement

(1) **The project will have social impacts related to the need for land acquisition and demolition of a number of structures like houses or enterprises. Based on the survey, about 767 people from 239 families will be affected by the acquisition of 55.3 ha of land, including 52.4 ha of collectively owned land; about 1,308 people from 449 families will be affected by the demolition of 35,347 m2 of private houses; and about 1,026 employees from 264 enterprises, institutes and small shops will be affected by the demolition of 66,313 m2 of structures.**

(2) Certain economic losses will be caused on the aforesaid units, shops and individuals due to land requisition and resettlement for the project, which will influence their life and employment as well. The major environmental impact caused during resettlement is the construction garbage and flying dust caused by house dismantlement. Certain impacts will be caused on vegetation due to resettlement, which will also cause noise as well.

(3) The major measures to reduce impacts on immigration and resettlement in the report are as follows: Immigration and Resettlement Office of Zhengzhou Rail Transit Group has held joint conference attended by various consultancy units and designing units during project planning and design to adjust and optimize the project design program and reduce the quantity of resettlement and land requisition. Make out compensation and reward program for the personal households with resettled houses, the families influenced by land requisition, and the enterprises, units and shops influenced by resettlement, and the employees of the shops influenced during resettlement. Feedback mechanism for public opinion has been formulated to lower the social impacts caused by resettlement. The environmental impacts caused by resettlement are reduced through rational arrangement of construction plan and traffic organization and design, water sprinkling to reduce dust and strengthening vibration and noise reduction measures during project construction.

12.7 Conclusions on Public Participation:

(1) Most of the public along the project line support construction of phase I project of RTL#3, Zhengzhou, and hold that the project construction will promote traffic and

economy of Zhengzhou, and expect earlier completion of the project.

(2) Through the public participation investigation, the citizens along the line have known about the project profile, the routing and the station locations proposed, the environmental problems that will arise from the project and the proposed mitigation measures to these.

(3) The public along the line understand and accept the environmental measures to deal with the impact basically, and expect to strengthen construction management and strictly implement the proposed environmental protection measures during the construction period in the report to avoid interference with the people due to traffic jam, sewage, slurry, construction dust and noise.

(4) The public hope the relevant parties to improve the transparency of the resettlement policies, strictly act on laws and rules, and inform the households to be resettled as early as possible to enable them to make sufficient preparation.

(5) Strictly take measures, and prevent ground settlement; strengthen monitoring on ground settlement during construction; formulate emergency plan with a certain aim.

(6) The opinions obtained through public survey are beneficial for the relevant construction, design, building, operation and management units and departments to pay more attention to the adverse influences the project may cause, and take comprehensive measures and win the understanding and support by the public along the project line so as to embody the social, economic and environmental benefits brought about by the project.

12.8 Conclusion on Comprehensive Assessment:

Construction of Phase I Project of Zhengzhou Rail Transit Line 3 will greatly alleviate traffic congestion in central urban area, contribute to improvement of the integral traffic structure of Zhengzhou and urban renewal and development, and possess remarkable social benefit, economic benefit and environmental benefit. As one type of advanced urban rapid transit system, rail transit is electric-driven without environmental problems such as atmospheric pollution along the Line, and it can reduce automobile exhaust due to replacement of some buses and improve urban atmospheric environment, so to speak rail transit is green transportation means.

Since urban center areas are located along the Line with centralized residential buildings and important environmental sensitive points such as historical and cultural sites under government protection and schools, project construction and train operation during operational period will produce certain degree and scope of noise, vibration and waste water, affecting social environmental elements such as urban traffic, resident income and residents' lives to some extent. Since the design takes corresponding control measures, and this report also puts forward targeted prevention measures and suggestions, as long as these environmental protection measures and main construction realize "Three Simultaneous" (simultaneous design, simultaneous construction and simultaneous putting into operation), at the same time, strengthen monitoring management, the influence of this project on the environment can be controlled and mitigated.

To sum up, this project conforms to the principle of coordinating and unifying social benefit, economic benefit and environmental benefit, so project construction is feasible in terms of environmental protection.