Kunming Urban Rail Project

Environmental Impact Assessment

Executive Summary

Kunming Rail Company
China Railway Eryuan Engineering Group
September 2010
Kunming Urban Rail Network Plan

<table>
<thead>
<tr>
<th>Urban Rail Network</th>
<th>Running Central Urban Population (1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lines</td>
<td>450</td>
</tr>
<tr>
<td>Line 1</td>
<td>34 (Trunk Line) 3.79 (1000/h) Large Volume</td>
</tr>
<tr>
<td>Line 2</td>
<td>22.4 (Trunk Line) 3.22 (1000/h) Large Volume</td>
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<tr>
<td>Line 3</td>
<td>19.1 (Trunk Line) 2.21 (1000/h) Large Volume</td>
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<tr>
<td>Line 4</td>
<td>42.9 (Inner Line) 2.02 (Mid Volume)</td>
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<tr>
<td>Line 5</td>
<td>17.6 (Inner Line) 1.05 (Mid Volume)</td>
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<tr>
<td>Line 6</td>
<td>16.6 (Inner Line) 0.99 (Mid Volume)</td>
</tr>
<tr>
<td>Total</td>
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Legend:
- Line 1
- Line 2
- Line 3
- Line 4
- Line 5
- Line 6
- Alternative Line 6
- 3-line Transfer
- Parallel Transfer
- Transfer
- Stations
- Depot/Park
Kunming Urban Rail Line 3
1. Introduction

Background

This document is an executive summary of the Environmental Impact Assessment and Environmental Management Plan documents for the proposed Kunming Urban Rail Project. It summarizes the key findings of environmental impact assessment and environmental management plan. According to both Chinese Environmental Assessment laws and regulations and the World Bank’s Operational Policy 4.01 Environmental Assessment, the proposed project is Category A for environmental assessment purposes, due to the scale and significance of potential environmental and social impacts. Therefore, a full environmental assessment report was required.

China Railway Eryuan Engineering Group Co., Ltd. (a Class A EIA license institute accredited by Ministry of Environmental Protection), under the commission of Kunming Rail Transit Co., Ltd., conducted the environmental impact assessment for the project. The EA preparation follows the requirements of Chinese environmental impact assessment laws/regulations and technical guidelines, as well as that of World Bank safeguards policies, specifically the OP4.01 Environmental Assessment, OP4.12 Involuntary Resettlement and OP4.36 Physical Cultural Resources.

The project is classified as category A as per OP4.01 Environmental Assessment. Full EA has been conducted, and the final EA documents include (1) a full Environmental Impact Assessment, and (2) a stand-alone Environmental Management Plan. These documents were submitted to the Bank for review, and found conform to Bank policy requirements in terms of environmental and social safeguards as well as public consultation and information disclosure. These documents have been made available locally in China and the Bank InfoShop.

As designed, the project (1) fully conformed to the Kunming Urban Rail Network Plan which is compatible with Urban Master Plan and has been endorsed by a Strategic Environmental Assessment; (2) adopted engineering measures (75% of underground tunnel through urban core area) to maximize project benefits and minimize significant grade impacts that would have occurred; (3) will not adversely affect or convert any critical natural habitats; (4) will not adversely affect resources of high cultural value; (5) will not adversely affect ethnic minorities; (6) have made great to effort minimize the need for resettlement and will provide adequate and just compensation and income restoration for affected peoples; and (6) includes an Environmental Management Plan (EMP) and a Resettlement Action Plan (RAP) for addressing environmental and social issues during construction and operation of the project.

Environmental Assessment Process and Legal Framework

A full Environmental Impact Assessment (EIA) and an Environmental Management Plan were carried out following terms of reference agreed with the World Bank, with
guidance and comments from the Bank task team. The EA documents comply with Chinese national environmental impact assessment law/regulations, and technically approved by the Ministry of Environmental Protection (MEP).

The project triggers the following World Bank policies: OP4.01 Environmental Assessment; OP4.12 Involuntary Resettlement; and OP4.11 Physical Cultural Resources. Compliance with these policies, and the World Bank’s disclosure of information policy, is summarized in Table 1.

<table>
<thead>
<tr>
<th>Safeguard Policies</th>
<th>Actions</th>
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<tr>
<td>Environmental Assessment (OP/BP 4.01)</td>
<td>- Category A project. Full EIA and EMP have been prepared as per OP4.01</td>
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<tr>
<td>Involuntary Resettlement (OP/BP 4.12)</td>
<td>- Resettlement Action Plan has been prepared</td>
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<td>Physical Cultural Resources (OP/BP 4.11)</td>
<td>- Cultural resources survey conducted with consultation of relevant authorities</td>
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<td></td>
<td>- Alignment tuning to avoid cultural sites</td>
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<td></td>
<td>- Engineer measures to minimize potential impacts</td>
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<td></td>
<td>- Chance procedures developed in EMP</td>
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<tr>
<td>Consultation</td>
<td>- A combination of opinion surveys and public meetings were held during preparation of the EIA and RAP, and EA documents disclosed locally and in Infoshop</td>
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2. Project Description

Kunming Urban Rail Project (Transit Line 3) is located in Kunming City, capital city of Yunnan Province in southwest China. The line is an east-west backbone line in the Kunming urban rail transit planning network. It starts from Shizui station in the west of Kunming, traverses through the urban core area via tunnel and ends at Eastern Passenger Terminal in the east.

This line length is 19.54km, including 14.7km tunnel through urban center, 4.4km viaduct sections on both ends and transition section of 0.44 km. There are total 19 stations, including 16 underground stations and 3 stations on viaduct. It also includes one rolling stock depot (Shizui rolling stock depot by the western end of Shizui Station) and one parking lot (Fangmaqiao parking lot by the eastern end of Eastern Terminal Station).

The Project will have Permanent land acquisition of 48.97ha (no basic farmland is taken) and a temporary land occupancy for construction sites of 36.51ha, which are mainly urban build-up areas and urban green space. The total volume of excavation is estimated to be 449.84×10^4 m³, of which 69.11×10^4 m³ can be reused for backfill, and about 308.76×10^4 m³ for disposal. The project will also have about 36.9×10^4 m³ construction wastes from resettlement and building demolition.

The total project construction is planned to be 58 months, starting in 2010 through 2015.
3. Environmental Setting

**Landscape:** The proposed urban rail Line 3 is located in the urban build-up of Kunming, crossing Xishan District, Wuhua District, Panlong District and Guandu District. Of total 19.54 km length, 14.7 km is underground tunnel through urban central area along major commercial streets. The viaduct section on both ends are mostly located in the median of existing urban trunk roads which reserved ROW for the rail. Land acquisition within the project will be mostly urban residential buildings, and a number of industrial enterprises, urban green areas and little farmland at the outskirts.

**Ecological Environment:** Since the proposed project line is located within the main city of Kunming with both sides as urban built-up area, there is no environmental sensitive sites such as natural habitats, protected areas, scenic spots or forest parks. The surface vegetation loss from the project will mainly include urban roadside trees, urban green spaces, and limited farmland crops and trees.

**Physical Cultural Resources:** Based on the cultural resources survey and consultation with relevant authorities, there are eight buildings identified which are classified as protected buildings (two of them are official cultural heritage) along the street, with horizontal distances of 14 – 60m from the underground metro tunnel. The tunnel and stations have been designed to avoid the officially designated construction protection buffer zone of these buildings.

**Ambient Acoustic Environment:** Baseline survey has identified 26 noise impact sensitive sites, including 8 schools, 1 hospital and 22 concentrated residential areas. According to the monitoring results, sensitive sites along the viaduct sections are all subject to standard-exceeding noise impact due to the existing road traffic and urban living noises. While most of other sensitive sites along the tunnel section comply with relevant standards.

**Vibration Environment:** Baseline survey has identified 99 vibration impact sensitive sites, including 7 schools, 13 hospitals, 8 heritage buildings and 71 residential buildings. Based on current status monitoring, environmental vibration sensitive points along the corresponding day and night can meet the standard limit requirements. While, the vibration level at the cultural buildings on both sides is slightly higher than the applicable standard.

**Electromagnetic Environment:** Baseline survey has identified 5 sensitive sites where residential TV signal may be subject to electromagnetic frequency impact during rail operation. Given the urban context, the TV signal is strong at all these sites, i.e. greater than the commonly recognized acceptable level of 35dB. As most of urban areas are served by cable TV, only some very small number of rural residents still use antennas to watch TV. Monitoring at two substations indicated very low electromagnetic field intensity.

**Water Environment:** There is rich groundwater resources in Kunming. Monitoring
on 10 groundwater wells along the line indicated substantial annual fluctuation of groundwater level in the area (2-10 m). The rail line will run under several urban river/canals, with poor water quality, according to existing monitoring data. While, there is no direct interaction from rail line and the surface river system.

**Solid Waste Management:** As a nationally famous tourism city, the city has strong commitment and capacity on urban environmental management, particularly urban waste management. Solid waste from urban construction are well managed in terms of contractor application/registration, approval of disposal destinations, transportation requirement and supervision.

### 4. Alternative Analysis

The project route and station location are determined based on the overall "Kunming Urban Rail Transit Development Plan" which has been approved by the NDRC and the Government of Yunnan Province. At the same time according to "The People's Republic of China on Environmental Impact Assessment Law", a Plan Environmental Impact Assessment has been conducted for the rail network plan, and approved by the Ministry of Environmental Protection (MEP). The option of rail strategy and alignment corridors have been intensively studied in the overall network plan with comprehensive considerations of economic, technical, and environmental and social development.

During project feasibility and design stage, various alternatives have been considered for specific sections and station locations. Comprehensive comparison has been conducted for environmental, social, technical and financial factors, and final selection is based on overall optimum consideration. Some major alternatives have been carefully studied, and summarized as follows:

**(1) Alternatives for Chunyu Road Section**

Two alternatives were considered, i.e. (i) viaduct in the median of Chunyulu road, or (ii) viaduct along the roadside. The final recommended option (in-median) is selected due to its less land acquisition, less noise impact to residential areas on both roadsides, and urban landscape considerations.
(2) Alternative Analysis for Xichanglu - Wenhugong Section

Two alternative locations were considered for Baihuodalou station, i.e. (i) under Kunming Department Store, and (ii) away from Kunming Department Store. The option 2 is finally determined due to better service to commercial areas and easy transfer with future No.5 rail line.
(3) Alternative Analysis for Dashuying Station - Taipingcun Station Section

Two alternative alignments were considered, i.e. (i) original alignment in the network (blue line), and (ii) a new alignment (red line) along East Dongfenglu road. Comprehensive comparison has been made and the new alignment was finally selected to accommodate the crossing of the existing 2nd Ring Road, and avoid massive resettlement.

5. Environmental Impact Assessment and Mitigation Measures

The project will have significant positive environmental and social impact by promoting mass public transportation which in turn alleviating urban traffic, reducing environmental pollution related to vehicle emission and traffic congestion, and improving urban life quality.

Manageable negative impacts of the project are mainly the environmental issues related to urban construction activities, i.e. urban utility and traffic disruption; tunnel construction safety; potential impact on surrounding buildings and proper disposal of spoil material, dust and noise nuisance during the construction stage. Other impacts during operation include noise/vibration impact, aesthetics integration, and waste management from rail operation facilities. These environmental and social impacts are thoroughly addressed by the EIA report, and necessary mitigation measures have been developed in EMP. It is concluded that these adverse environmental and social impact can be adequately avoided, minimized and mitigated with good management practice and mitigation measures as developed in EIA/EMP and RAP. The main conclusion of impact and mitigation measures are summarized as follows:
5.1 Construction Preparation

1) Land Acquisition and Resettlement

Major impacts relate to land acquisition and demolition of residential houses, enterprises/institutes and shops. The project will require the taking of about 85.3 ha of land, and 21.4 ha is collective-owned land, which will affect 36 people from 12 households. The project will also require demolition of 16,860 m² of housing areas which will affect 61 households, including 27 rural households 14 enterprises/institutes will be affected to certain degree, and the will affect 143 people. 134 small shops will be demolished which will affect 395 people.

A RAP was prepared in line with relevant Chinese laws and regulations, and World Bank OP 4.12 Involuntary Resettlement. The RAP covers the following key aspects:

- **Compensation Standards.** Land acquisition compensation will include land compensation, a resettlement subsidy, and compensation for standing crops. The land acquisition fund is calculated based on land output value according to local regulation. The compensation rates for structures are determined based on their replacement costs.

- **Affected public infrastructure.** Compensation based on replacement value will be paid to relevant government agencies or local governments to restore affected infrastructure and services.

- **Implementation arrangements.** A multi-level organization was established to implement the RAP. An independent monitor will be selected to monitor resettlement implementation and livelihood restoration. Participatory Monitoring Mechanism has been designed. The PMO will be responsible for internal monitoring and will provide semi-annual internal monitoring reports to the Bank. Details of staffing and their responsibilities are provided in the RAP.

- **Budget and funding arrangement.** RAP contains a detailed resettlement cost estimation that covers all the basic costs for resettlement, management, contingencies, surveys, design and monitoring. The basic resettlement cost includes compensation for land, standing crops and trees and reconstruction of affected infrastructure. The Borrower will allocate sufficient fund as per RAP from counterpart funding to conduct resettlement of projects.

- **Grievance mechanism.** A grievance mechanism was established during the preparation of the RAP. All relevant telephone numbers were disclosed to PAPs. The PAPs can prosecute any resettlement aspect, if needed. All prosecuted cases will be recorded in paper.

2) Project Design
Based on environmental impact assessment, a set of engineering measures have been designed prior to construction, including noise barriers (3x250m noise-absorption barrier, 4010m fully closed noise barrier) and vibration-reduction facilities (e.g. steel spring suspended slab, elastic sleeper and fastener) at sections close to sensitive sites such as residential buildings, schools and hospitals, and greening plan for alignment and stations/park/depot sites (total ca. 100ha green space designed, outweighing the loss of surface green belt of 9 ha). Special attention is given to landscape and aesthetic design of viaduct, stations, ventilation shafts, lighting and green space.

5.2 Environment Impact during Construction

1) Interference with traffic and daily life

The tunnel section will be constructed mostly through shield method, while most station will adopt open excavation method which will occupy urban roads, reducing road capacity and causing disturbance of urban traffic, inconvenience of accessibility. The Chunyu Road, Renmin Road and Dongfeng Road are all major trunk roads for Kunming with fairly large traffic. New construction of rail project will cause traffic disturbance around the station sites and urban roads at viaduct sections.

It is recognized that such traffic disruption due to construction is a serious and recurring negative impacts of all urban infrastructure construction. In recognition of this serious impact common to major urban construction projects, Kunming has developed a series of institutions, procedures, and practices to minimize and mitigate
the disruption related impacts on local residence and business. The construction of
the trial section of Rail Line 1 in Kunming has illustrated good management practice
in this regards. In general, for all major urban construction activities that may disrupt
the traffic, the project proponent (in consultation with traffic police and road
management agencies) need to develop traffic diversion plan for the specific road
section or locations, addressing (i) location characteristics; (ii) detailed traffic
diversion routes; (iii) implementation schedule; (v) other concurrent construction
projects in the area. Project proponent will publish notice for major construction
diversion to public.

Specifically, for this project, Kunming Rail Company, together with Traffic Policy
Department, Transport Research Institute and design institute, will develop the traffic
diversion scheme. The scheme will be submitted to Traffic Policy Department for
review and approved by Municipal Government. Then, the design institute will work
out detailed diversion plan, and implemented by the Contractors. Public notice must
be publicized in local newspaper before commencement of diversion plan. Traffic
police department will supervise and assist with the traffic management.

It is also recognized that urban utility disturbance and relocation is a major impact for
such infrastructure projects. In recognition of such negative impacts common to major
infrastructure projects, the city has established institutions and procedures to handle
these issues over the decades of urban development. In general, all major construction
projects that may disrupt/relocate urban utilities lines, the project proponent is
required to prepare utility relocation plan in consultation with urban utility
management bureau and utility companies. Relocation is conducted by professionally
licensed companies. Public notice will be announced in local newspaper by the utility
company, notifying public (i) time and duration of utility disruption; (2) location and
scope of disruption; (3) grievence channel for public concern.

For actual implementation in this project regards, Kunming Rail Company and
contractors will develop the pipeline relocation plan. Under the coordination of
Kunming Urban Utility Management Bureau (Utility Relocation Office), Rail
Company will consult with the utility owners who will review and approve the plan.
The relocation will be conducted by professional companies (contracted by Rail
Company), and supervised by the Rail Company and utility owner companies. Upon
completion, the utility Companies will conduct final acceptance inspection. Advanced notice for temporary disruption of utility supply will be publicized in local newspaper and posters in community to notify the public.

With these procedures implemented, the social disturbance impact of such urban infrastructure construction projects can be effectively managed. Kunming Rail Company has demonstrated good management performance to address the social disturbance issues during construction of a trial section of rail line 1. These practices will be continued and further enhanced. These measures mainly include:

- Follow the city procedures to develop and implement the traffic diversion and access plan in consultation with city police and road authorities;
- Provide temporary access for pedestrians and cyclist, ensure access to roadside shops. Site plan (including community and business access plan) will be prior approved by Environmental Supervision Engineer;
- Establish sufficient number of traffic control and safety signs;
- Enclose the construction site to avoid public entrance, and provide signs, night-light etc safety facility;
- Publicize advance notice through radio, television and newspapers about traffic diversion and management scheme;
- Optimize station construction scheme (e.g. phased and section-by-section) to minimize traffic disturbance;
- Arrange proper material hauling routes and time period to avoid peak hour and congested roads;
- Coordinate with utility authorities (water, gas, power, communication, sewage etc.), and follow the city procedures to develop relocation plans prior to construction, prepare emergency plans and provide advanced public announcement to minimize disturbance of utility service;
- Continue public consultation according to the Public Consultation Plan during construction stage to identify and address any public concerns;
- Contractors will establish bulletin boards to disclose project information, environmental measures, contact person and telephone number for grievance. Pamphlet will be distributed in local community providing detailed information about traffic diversion plan, bus route change etc

2) Waste disposal

During construction of the project, a large amount of spoil waste will be generated
from earth excavation and building demolition. If not well managed, these wastes may pose significant environmental impact on the city, in terms of soil erosion, airborne dust, landscape and aesthetics. Furthermore, it is expected that three rail lines will be constructed in the same timeframe, which implies larger amount of spoil material that need proper disposal. With three lines under construction during the same time in the near future, the total excessive spoil material will be about 7.43 million m$^3$. To address this issue, Kunming City government has conducted studies and issued a special document “Decision on Comprehensive Utilization of Spoil Material from Kunming Urban Rail Construction”, which designates 3 locations for comprehensive utilization as backfill material and landfill disposal. These three places have been evaluated by Kunming EPB with adequate measures and procedures to accommodate about 8 million m$^3$ spoil materials. The excessive material from Line 3 will be disposed of at two of the three locations, i.e. Guandu District Xiaogang Ling Qing construction waste landfill for disposal, and Changpo Industrial Park in Taiping Town for land leveling. These locations have been assessed during EA preparation and confirmed by due diligence review by the Bank team. Good spoil material handling has been illustrated in the trial section of Line 1 by Kunming Rail Company, in terms of professional transportation team with proper transportation vehicles, timely cleanup of spills etc.

With effective implementation of mitigation measures, the construction waste can be properly managed. These mitigation measures include:

- Tunnel spoil material will be reused as backfill in stations and parking/depot sites to the extent possible;
- According to Kunming Urban Environmental Hygiene Regulation and Kunming Construction Waste Disposal Regulation, the contractors are required to register with city Construction Waste Management Office for permit;
- Spoil material will be transported by the dedicated city construction waste transportation team as a paid city environmental service, following routes jointly assigned by the city Construction Waste Management Office and traffic police department;
- Backfill earth temporarily stored will be properly covered, or water-spayed regularly during dry season to suppress dust. Spoil materials will be timely cleaned and sent to disposal;
- Earth excavation or backfilling will be avoided during rainy days. Interception and collection ditches will be adopted to reduce runoff erosion. Trucks will be wheel washed before leaving the site;
- Transportation vehicles will be covered to avoid spill. Contractors required to
timely clean up any spoil spill on the roads.

3) Noise and Vibration Impacts

During construction, noise and vibration mainly comes from construction machines and vehicles, such as large excavators, air compressors, drills, hammers, heavy trucks, etc. If not well managed, the construction will influence the residential areas, schools, and hospitals and cultural buildings within 100m. Especially, when construction activities continue during nighttime, the noise impact on local residence would be of particular public concern.

The construction noise impact is common temporary nuisance for urban infrastructure projects. It can be readily mitigated by good construction management practices. To mitigate such noise impact, the following mitigation measures are included in the EMP:

- Noise and vibration impact on local communities will be strictly managed in line with local Kunming Construction Site Management Code through use of low noise equipment and construction technologies;
- Limiting intensive construction activities in daytime 6:00-22:00;
- Careful scheduling of construction activities near sensitive sites;
- Installation of temporary noise reduction facility at sensitive sites;
- Night-time construction will be restricted. Prior public notice as well as night-time construction permit from city EPB are required for activities that need continuous construction over nighttime;
- Shield tunneling and cover-and-cut method will be used for the tunnel and most of the stations to minimize noise and vibration impact.

4) Wastewater

Wastewater of construction projects mainly comes from rainfall runoff within construction site, construction wastewater and sewage. Construction wastewater includes slurry generated in the process of excavation or pile drilling, cooling water for mechanical equipment, and washing water and sewage water for construction workers. If not well managed, this may cause surface and groundwater water pollution, inconvenience to people’s daily life, and aesthetics impact.

This issue is a common issue for urban infrastructure construction, and will be properly mitigated by good construction management measures. The wastewater from construction site will be properly treated (settling and oil separation) and discharged into the municipal sewage network as per requirement of construction site management regulations in Kunming city. Random discharge of wastewater is strictly forbidden.

5) Air pollution

Air pollution sources during construction are: dust from demolition, excavation, backfill and transport vehicles, construction material storage and processing, and emission from construction machinery and transport vehicles. Dust pollution is a
major nuisance for urban road construction and will have adverse impact on public. Dust pollution is a common environmental issue for urban infrastructure construction, and can be adequately mitigated through good management measures, including:

- Frequent water spraying on construction site and access road to suppress dust;
- Covering of trucks transporting bulk materials and timely site clean up after construction;
- Hauling trucks will be wheel-washed before leaving the construction site;
- Material or waste hauling will avoid densely populated areas, and for densely populated areas transportation will be arranged during nighttime;
- Burning of construction waste is strictly banned; no on-site cement mixing facility is allowed;
- No on-site cement mixing facility is allowed.

6) Cultural Resources.

Based on comparative study, the shield tunneling construction method will have little vibration impact on surrounding buildings. The major concern will be ground subsidence above the tunnel. As all the 8 cultural buildings identified are by the roadsides, with horizontal distance of 10-50 m to the tunnel, the construction of tunnel will have little impact on the safety of these buildings. Though the rail line is designed avoid the protection boundary of these cultural buildings, precautious measures are to be implemented during construction:

- Shield method will be used for tunnel construction which has the minimum vibration impact to surrounding buildings;
- Land subsidence monitoring will be conducted for these building site in order to monitor the potential safety risk;
- Chance-find procedures will be followed: If cultural relic is found during the construction, the contractor must immediately stop earth excavation, and report the situation to the local cultural authority. Construction is not allowed to restart until competent authorities have investigated and/or explored the site, and authorized resumption of construction.

7) Groundwater.

The groundwater table in Kunming is 3.5 – 18 m deep, and the tunnel is mostly 15-20m under the ground (with minimum 7m). The underground tunnel of the urban rail will form a continuous barrier which may partially affect the groundwater hydrology. Groundwater table monitoring from 12 wells along the alignment indicated that the yearly fluctuation of groundwater table in the project area is 2.08 – 9.67 m. The rail tunnel will partially affect the flow of groundwater, but will not block the hydrological path of groundwater. Limited increase of groundwater table for the section that may block the groundwater flow is estimated to be within the order of 1 m, well within the yearly fluctuation scope, and hence will not result in swamp or land subsidence. During construction, dewatering will be conducted for several stations, and temporary decrease of groundwater table near these places will
be induced, while groundwater table will restore upon construction completion. Special engineering measures (such as curtain grouting) will be adopted to minimize dewatering during construction, and groundwater monitoring will be conducted during excavation to guide proper construction.

8) Vegetation

The project construction will require to occupy certain roadside trees, green spaces and some crops. The total loss of green area is about 9 ha along the corridor. In order to mitigate and compensate such losses, a set of measures have been developed in the project and EMP:

- Affected trees will be relocated. As per city regulations, occupying green area and trees must apply to the city forestry bureau for approval and payment for compensation before construction;
- Construction site and other temporary sites and Parking Lot and Shizui Depot will be timely re-vegetated;
- Effective implementation of the greening and landscaping plan as designed in the project.

9) Cumulative Impacts

Kunming City plans to construct the rail line 1, 2 and 3 simultaneously under the short-term schedule of Kunming Urban Rail Network Construction Plan. This will likely generate substantial impact for Kunming city in terms of urban traffic disturbance, pedestrian safety, noise and dust, and disposal of significant amount of tunnel waste. The disruption of traffic can be mitigated by proper arrangement of traffic diversion with involvement of police departments. Nuisance of dust, noise and pedestrian safety will be managed through good construction management practice and adequate supervision, for which Kunming has strong capacity and proven experience from pilot rail section construction and previous urban development projects. For the significant amount of tunnel spoil waste, Kunming Urban Management Enforcement Team has reviewed the situation and issued a special document of “Decision on Comprehensive Utilization of Spoil Materials from Light Rail Projects”, which designates two construction waste landfills (with approval from city EPB) and one new industrial park as backfill for land development. These places have adequate capacity to absorb the waste from all three rail lines, and are under management of local environmental authorities.

5.3 Environmental Impact during Operation

1) Land Use Change

As other cities in China, Kunming is also experiencing rapid economic development and urbanization. The Urban Planning Bureau is planning for significant growth in central Kunming (urban districts), with population projected to expand from the current 2.8 million residents to about 4 million by 2020. In response, the city has...
planned, and gained approval for, the large scale investment in urban rail network. The network has been carefully planned, in compatible with urban master plan and endorsed by a strategic environmental assessment (i.e. Plan EIA as per Chinese EIA Law).

The city’s vision includes the development of a compact urban form focused around new urban rail development. Kunming city has developed an *Adjustment Plan for Land Use along Short-term Urban Rail Network*, a fine-tuning of “detailed control plan”. It adjusted land use within 1km corridor of the rail lines (including line 3), integrating transport, urban function zoning and land use model. The key contents are: (1) optimization of urban spatial structure to promote a development axial, and to lead the land use change and new development, thus achieving integration of urban development and transport system; (2) location of stations and land use adjustment around stations allowing high-density development; (3) adjustment of area road transport system and improvement of surface transport system and facilities to maximize the integration of urban transit system.

Specifically for line 3, significant new development is planned—although the line passes mainly through existing urban areas. To the west, the line begins in an industrial that now contains mainly derelict buildings (see accompanying photos). This area is targeted for new growth of both commercial and residential buildings. In the central area, most sites are already highly developed (see photos, below), although a significant new CBD development is planned at the intersection of the two lines to be built during the first phase (line 3, and line 1/2).

The eastern section of the alignment, beyond the city’s second ring road, is less developed, with agricultural land still occupying a significant portion of the area. This is changing, however, as a major new road has recently been completed and new development has begun to move to the area. In addition,
a major new high quality intercity bus terminal has been constructed and will be connected to the final station of line 3. The city is anticipating major new residential and commercial development for this area. In total, the area immediately along line 3 is expected to add as many as 150,000 new residents by 2030.

In general, the city of Kunming expects the metro project to have significant land use impact - supporting higher density residential and commercial use within the vicinity of new stations. The city views this as one of the major positive benefits of urban rail construction, and has been proactively planning for its location and character well in advance of the metro’s opening for operations.

As a capital city of Yunnan Province, Kunming city has mature institutions and procedures to manage the land development to ensure that land development induced from rail network is in line with urban master plan, and conducted in an orderly and legal process. Specifically, the land development proposal is subject to review and approval of Development and Reform Commission, and the plan is subject to review and approval of Urban Planning Bureau as per Detailed Control Plan. Environmental impact assessment is legally required for development projects and approved by Municipal EPB. The completion acceptance must be inspected and approved by Urban Construction Bureau, Urban Planning Bureau, EPB, Fire Department, Urban Quality Supervision Bureau, Archive Bureau, Urban Park Management Bureau.

2) Noise Impact

During operation, the noise from rail will have impact on residential buildings, schools and hospitals. Noise impact modeling was conducted for 25 sensitive sites identified along the rail line, including 21 residential areas, 2 schools and 1 hospital. The model concluded that sensitive sites along the via-duct section are subject to noise impact over standard. To mitigate such impacts, a set of measures will be implemented, including:

- A total of 44,380m² noise barrier has been designed for the via-duct sections;
- Ventilation shafts will be installed with low noise equipment and silencer, and will be located at least 15 m from nearby residential areas;
- Enclosure wall and green belt plantation will be adopted in the parking and depot sites to minimize noise impact.

3) Vibration Impacts

Rail vibration is mainly related to traffic conditions, wheel track conditions, track
structure, the tunnel structure, tunnel depth, geological conditions, ground building type and distance. Since the project is located in urban areas with dense population and schools, hospitals, cultural and educational offices and other vibration-sensitive buildings, vibration impact is a main concern in the EIA. Modeling was used to assess the potential vibration impact during rail operation for 99 sensitive sites identified along the line. Based on the modeling results, vibration-reduction facilities will be installed for 26 sites with total length of 5.6 km, including state-of-art steel-spring floating slab track bed (1,750m X 2) for all cultural building sections, flexible short sleeper track bed (2,550m x 2) and vibration-reduction fastener.

4) Ecological environment

The project will result in loss of surface vegetation of urban roadside trees, green spaces and limited farmland crops and planted trees, in total 9.11 ha. During construction, affected trees and green belt will be relocated with approval of city authority according to local regulations. In addition, intensive greening plan has been developed within the project to offset the loss of green area, e.g. greening for parking and depot site and the areas under via-duct section. The total greening plan is about 100 ha, well outweighing the estimated loss of 9.11 ha green area.

5) Atmospheric Environment Impact

Adequate ventilation and filtration system is design for underground metro line. The surface ventilation shafts are properly sited with adequate distance from nearby residential areas. Waste gas emissions from parking and depot boilers and cooking facilities will be treated according to technical code and standards. Overall, the operation of rail will reduce substantial amount of emission which would otherwise be generated from surface transport for the same amount of passengers, and significantly reduce emissions from traffic congestion as well.

6) Wastewater

The main water pollution during operation comes from wastewater and sewage from rail stations and parking/depot sites. As the project area is well served by municipal sewer network and wastewater treatment plants, the domestic sewage and wastewater will be discharged into municipal sewer system after septic tank and/or oil separation/settling tank treatment.

7) Solid Waste

Solid waste during operation mainly includes garbage from rail train and stations, as well as garbage and waste from rail parking and maintenance depot. The garbage will be covered the by existing municipal garbage collection and disposal system. The waste from parking and depot will be properly treated accordingly, including recycling, landfill, and special treatment in licensed facility for small amount of oil containing hazardous waste.

8) Electromagnetic Frequency Impacts
The electro-magnetic frequency may have potential impact on TV signals, and human health nearby the transformer sub-stations. Based on field survey and analogical analysis, the residential areas are mostly served by cable TV system which is not subject to EMF impact, with only very few individual households use antenna for TV while the S/N of TV signal can still remain decent with minor impact of EMF. The power sub-stations are all within the subway stations, and located at least 15 m away from residential areas which presents negligible EMF impact according to national standards.

6. Environmental Management Plan

A stand-alone Environmental Management Plan (EMP) has been developed which detailed the environmental management organization and responsibilities, mitigation measures, capacity training plan, monitoring plan, and budget estimates of EMP implementation. The EMP measures will be incorporated into bidding documents and contracts in order to ensure effective implementation. Main components of the EMP are:

- **Environmental protection measures in design stage**: mitigation measures have been incorporated in project design: alignment fine-tuning, noise reduction, landscaping, and special design of terminals.
- **Environmental protection measures during construction**: environmental specifications for construction management on noise, dust, spoil material, wastewater, cultural resources protection, social disturbance etc.;
- **Environmental protection measures during operation**: greening plans, operation management of rail line, and monitoring programs.

Management Organization and Responsibilities

The project implementation will be managed by Kunming Urban Rail Company. Environmental management responsibility will be built into the relevant divisions of overall project management structure with dedicated management staff. Dedicated environmental staff will also be assigned in Supervision Engineers and Contractors to ensure effective implementation of EMP.
Kunming Urban Rail Company (PMO) is responsible for overall environmental protection management of the World Bank project, including:

- Responsible for overall environmental management during construction, including effective implementation of mitigation measures, supervision and monitoring, budget securing and reporting to the World Bank and local EPB;
- Ensure that the Environmental Management Plan measures are included in the Bidding Documents and construction contracts. Supervise the construction unit to carry out pollution prevention measures. Inform the construction team of any violation of these regulations immediately;
- Ensure that supervision of EMP implementation is included in the Bidding Documents and the contracts of Supervision Engineer. Supervise and participate in environmental supervision of the project;
- Entrust the environmental monitoring institutes to carry out environmental monitoring during the construction period. Support the work of environmental monitoring during the construction period;
- Organize environmental training to Contractors and Environmental Supervision Engineers.

Contractors are responsible for implementation of environmental mitigation...
measures as required by contracts and national/local regulations. Each Contractor will be required to appoint at least one full time (or part-time) environmental staff in each construction site, responsible for environmental management under its contract. Contractors are responsible for implementing the environmental mitigation measures as specified in the EMP and contract documents including the following:

- Develop a contractor specific environmental protection plan (including construction site plan to guarantee the community/business access) as part of contract provisions;
- Report to Supervision Engineer new environmental issues or chance-finds of any cultural relics encountered during construction;
- Carry out continued public consultations throughout construction.

Supervision Engineers are responsible for supervise the environmental performance of the contractors, besides supervision on engineering quality. At least one dedicated Environmental Supervision Engineer is required to be assigned by each Supervision Engineer Company to:

- Review and assess on behalf of the Kunming Rail Company whether the construction design meets the requirements of the EIA and EMP, particularly with regard to site environmental management and impact mitigation measures required;
- Review of the construction site plan prepared by the contractors to ensure that it includes all the measures to (i) guarantee access; (iii) minimize disturbances and other nuisances to communities.
- Supervise site environmental management of contractors including their performance of handling site environmental issues, and provide corrective instructions;
- Review the EMP implementation by the contractors, verify and confirm environmental supervision procedures, parameters, monitoring locations, equipment and results;
- Report EMP implementation status to Kunming Rail Company; and
- Approve invoices or payments with consideration of EMP performance.

Environmental Supervision

During the construction period, the environmental supervision is conducted by the Engineering Supervision Company, which is required to assign dedicated environmental supervision engineers. The environmental supervision will mainly focus on noise from construction machines, transport vehicles, earth excavation and other construction noise, construction dust, wastewater discharge and treatment, construction waste, solid waste collection, removal and disposal etc. The key aspects of supervision include:

- Supervision of transport of excess materials, traffic management, contractor’s plans for guaranteeing access to businesses and houses, pedestrian safety measures, etc.
Supervise soil conservation measures and minimize water pollution resulting from construction. This includes measures such as a) soil retention and conservation b) disposal of waste spoil, c) implementation of temporary and permanent erosion control measures d) implementation of measures to reduce sedimentation (settling ponds and silt fences), e) ensure that properly designed runoff control measures are in place and f) that all waste water treatment facilities area in good working condition;

Supervision of construction and domestic wastewater disposal: Verify sources of construction and domestic wastewater, construction progress of waste treatment and disposal facilities, and verify final disposal location and procedures. Inspect and supervise that treatment measures are in compliance with permitted discharge standards;

Environmental supervision of atmospheric pollution: air pollution in the work area mainly results from vehicle exhaust gases and dust produced during construction. Ensure that dust control measures are adequately implemented by the contractors;

Environmental supervision of noise: Noise abatement measures shall be implemented in accordance with project design parameters and permitted noise levels;

Environmental supervision of solid waste disposal: solid waste disposal must follow the requirements indicated in “Decision on Spoil Disposal for Kunming Urban Rail Construction”. Good housekeeping measures shall be implemented to ensure that construction sites are maintained in a clean and tidy condition;

Environmental supervision of greening plan: Measures for protection of vegetation, particularly protection and relocation of trees shall be implemented, as well as implementation of greening plan;

Environmental supervision of safety and health: Ensure adequate safety and health measures are in line with relevant codes, regulations.

Environmental Monitoring Plan

Environmental Monitoring Station will be contracted by PMO to conduct environmental monitoring as per monitoring plan in EMP, including noise and vibration, groundwater, land subsidence and building safety etc. during construction and operation stage. (Details in EMP monitoring plan)

At the same time, continuous monitoring will be conducted for Huguoqiao Bridge and Zhunti Temple, and other 6 six cultural heritage buildings to monitor the potential damages and, if necessary, adopt mitigation measures.

Environmental Training Plan

In order to ensure effective implementation of EMP, environmental training will be provided to all staff involved in the project, especially the contractors.

For construction stage, PMO will contract experienced consultant to provide environmental training for environmental staff from contractors and supervision
engineer companies. This training will be organized once contractors and supervision engineer companies are selected. The key contents of training include: (1) national and local regulations on environmental protection, soil erosion control, cultural heritage protection etc. for construction projects; (2) environmental mitigation measures included in the design and contracts, as well as other environmental protection requirements during construction; (3) environmental implementation plans for this project.

During construction, routine and ad hoc meetings among Kunming Rail Company and Contractors/Supervision Engineers will be used as chances for on-going environmental training, focusing actual environmental and social issues identified during the project construction.

Environmental training will also be incorporated into the domestic and overseas study tours organized during project implementation, with target participants from Kunming Rail Company and other municipal management staff.

During operation, Kunming Urban Rail Company will organize training for its management and operation staff in terms of environmental protection during rail operation.

**Budget Estimates**

In order to achieve economic development and environmental protection harmony, the project adopts a series of effective environmental protection measures, with a total cost estimate of 845.7425 million RMB. These environmental protection measures and investment estimates are summarized in the following table.

<table>
<thead>
<tr>
<th>Elements</th>
<th>Item</th>
<th>Investment (million)</th>
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</thead>
<tbody>
<tr>
<td>Ecological Landscape Restoration</td>
<td>Relocation of trees and urban green spaces</td>
<td>5</td>
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<tr>
<td></td>
<td>Greening measures for Fangmaqiao Parking Lot</td>
<td>3</td>
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<tr>
<td></td>
<td>Greening measures for Shizui Depot</td>
<td></td>
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<tr>
<td>Vibration</td>
<td>Hedi Village, Xinhua computer school etc. 20 sensitive points</td>
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<tr>
<td></td>
<td>Kunming Pharmaceutical Factory family area, Lujia Village, Qianghua nursing home, Yunnan Provincial Museum etc. 35 sensitive points</td>
<td>186.12</td>
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<td></td>
<td>National Security Bureau in Kunming area families, Lisa Hospital etc. 22 sensitive points</td>
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<tr>
<td>Noise</td>
<td>Chunyu Residential Area, Cuifeng Residential Area, Shizui Village etc. 7 sensitive points</td>
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<tr>
<td>Sewage Treatment</td>
<td>Wastewater treatment facility in Fangmaqiao Parking Lot</td>
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<td></td>
<td>Wastewater treatment facility in Shizui Depot</td>
<td>1.15</td>
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<tr>
<td></td>
<td>Wastewater treatment facility in 19 stations</td>
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<td>Electromagnetic protection</td>
<td>TVB received elevated section of the user</td>
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<td>Environmental Monitoring</td>
<td>Environmental Monitoring</td>
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<tr>
<td></td>
<td>Groundwater, surface subsidence observations</td>
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<tr>
<td>Elements</td>
<td>Item</td>
<td>Investment (million)</td>
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<tr>
<td>-------------------------------</td>
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<td>Long-term tracking and monitoring units to be protected</td>
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<td>Environmental training</td>
<td>Construction and operation of environmental protection personnel training</td>
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<tr>
<td>Final acceptance</td>
<td>Completion and acceptance of environmental impact report prepared</td>
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<tr>
<td><strong>Total</strong></td>
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<td>845.7425</td>
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</table>

*It should be noted that many important administrative measures listed in Table 2-1 are contractually built into the project contracts requirements, while they could not be meaningfully estimated and thus not specifically visible in the budget estimate table. These measures include, e.g. coordination with police/road department, development of traffic diversion plan, maintain pedestrian/cyclist access, site cleanup, etc.

7. Public Consultation and Information Disclosure

Two rounds of public consultation were conducted during EA preparation. The first round was conducted in January 2010 through meetings, field interview and questionnaire survey among project-affected people, local village committees, schools and hospitals, and establishment of a telephone hotline. Project information and commencement of EIA preparation notice were disclosed in local newspaper and website of Yunnan Environmental Protection Bureau. The main concerns raised from public are resettlement compensation, information disclosure, disturbance of traffic, nighttime construction noise etc. All these concerns were addressed in the RAP and EIA/EMPs. The second round of public consultation was conducted in March 2010 after the draft EIA reports had been prepared. Public meetings were held in local communities and total 210 questionnaires were collected. During consultation, the EA explained the key findings of draft EIA report and proposed mitigation measures, as well as the responses to the questions raised from the first round consultation. Concerns raised from public include proper traffic diversion, minimization of resettlement and adequate compensation, as well as timely information disclosure, enforcement of good construction management and vibration. Responses for these concerns were provided to the public during the meeting, and incorporated into the EIA/EMP and project design.

As required by Chinese EIA regulations, two rounds of information disclosure were carried out on January 1, 2010 and February 12, 2010 during which brief project information and commencement of EIA was published in Kunming Daily, and initial draft EIA is disclosed in website of Yunnan Environmental Protection Bureau(http://www.7c.gov.cn). The final EIA report, after review of Ministry of Environmental Protection, is disclosed in the website of Kunming Urban Rail Company (http://www.kmgdgs.gov.cn) since June 15, 2010.

<p>| Summary of Public Consultation |
|-------------------------------|----------------------------------------------------------------------|----------------------|------------------|---------------------------|
| Type                          | Implementation organization                                       | Inquiry objects                  | Time          | Main items                     |
| The first round               | EA institute and Environmental Protection                         | Jan. 2010                   | See the report |</p>
<table>
<thead>
<tr>
<th>Type of consultation</th>
<th>Agency and companies involved</th>
<th>Area of consultation</th>
<th>Date</th>
<th>Notes</th>
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<td>The second round of consultation</td>
<td>Kunming Rail Company, Agency, municipal authorities, the Water Conservancy Bureau, Cultural Relics Bureau, Planning Bureau</td>
<td>Kunming Rail Company Agency, municipal authorities, the Water Conservancy Bureau, Cultural Relics Bureau, Planning Bureau</td>
<td>Mar. 2010</td>
<td>See Report of Investigation visited 14.2.22</td>
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<td>The second round of the survey</td>
<td>EA institute and Kunming Rail Company</td>
<td>Jinma Street and Tuodong streets and streets community</td>
<td>Mar. 2010</td>
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<tr>
<td>The second round of individual interviews</td>
<td>EA institute and Kunming Rail Company</td>
<td>Shizui Village, Majia Village, Taiping Village, Jinma town, Provincial Tumor Hospital, Dashuying Village, Provincial Sports Institute</td>
<td>Mar. 2010</td>
<td>See Report of Investigation visited 14.2.24</td>
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### Summary of Information Disclosure

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<tr>
<th>Document</th>
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<th>Location</th>
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<tr>
<td>Project Information</td>
<td>Jan. 1st, 2010</td>
<td>“Kunming Daily”</td>
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<td>Jan. 1st~16th, 2010</td>
<td>Yunnan Provincial Environmental Protection Bureau website (<a href="http://www.7c.gov.cn">http://www.7c.gov.cn</a>)</td>
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<td>Feb. 12th~27th, 2010</td>
<td>Yunnan Provincial Environmental Protection Bureau website (<a href="http://www.7c.gov.cn">http://www.7c.gov.cn</a>)</td>
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