

SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

DALI-LIJIANG RAILWAY PROJECT

IN THE

PEOPLE'S REPUBLIC OF CHINA

July 2004

CURRENCY EQUIVALENTS

(as of June 2004)

Currency Unit	–	yuan (CNY)
CNY1.00	=	\$0.12
\$1.00	=	CNY8.2775

ABBREVIATIONS

AAOV	–	average annual output value
ADB	–	Asian Development Bank
BOD	–	biochemical oxygen demand
CO	–	carbon monoxide
COD	–	chemical oxygen demand
EA	–	Executing Agency
EIA	–	environmental impact assessment
EPMO	–	environmental protection and management office
GDP	–	gross domestic product
MOR	–	Ministry of Railways
PRC	–	People's Republic of China
NO _x	–	nitrogen oxides
NO ₂	–	nitrogen dioxide
ROW	–	right-of-way
SEIA	–	summary environmental impact assessment
SO ₂	–	sulfur dioxide
SSDI	–	Second Survey and Design Institute, Ministry of Railways
TSP	–	total suspended particles
TSS	–	total suspended solids

WEIGHTS AND MEASURES

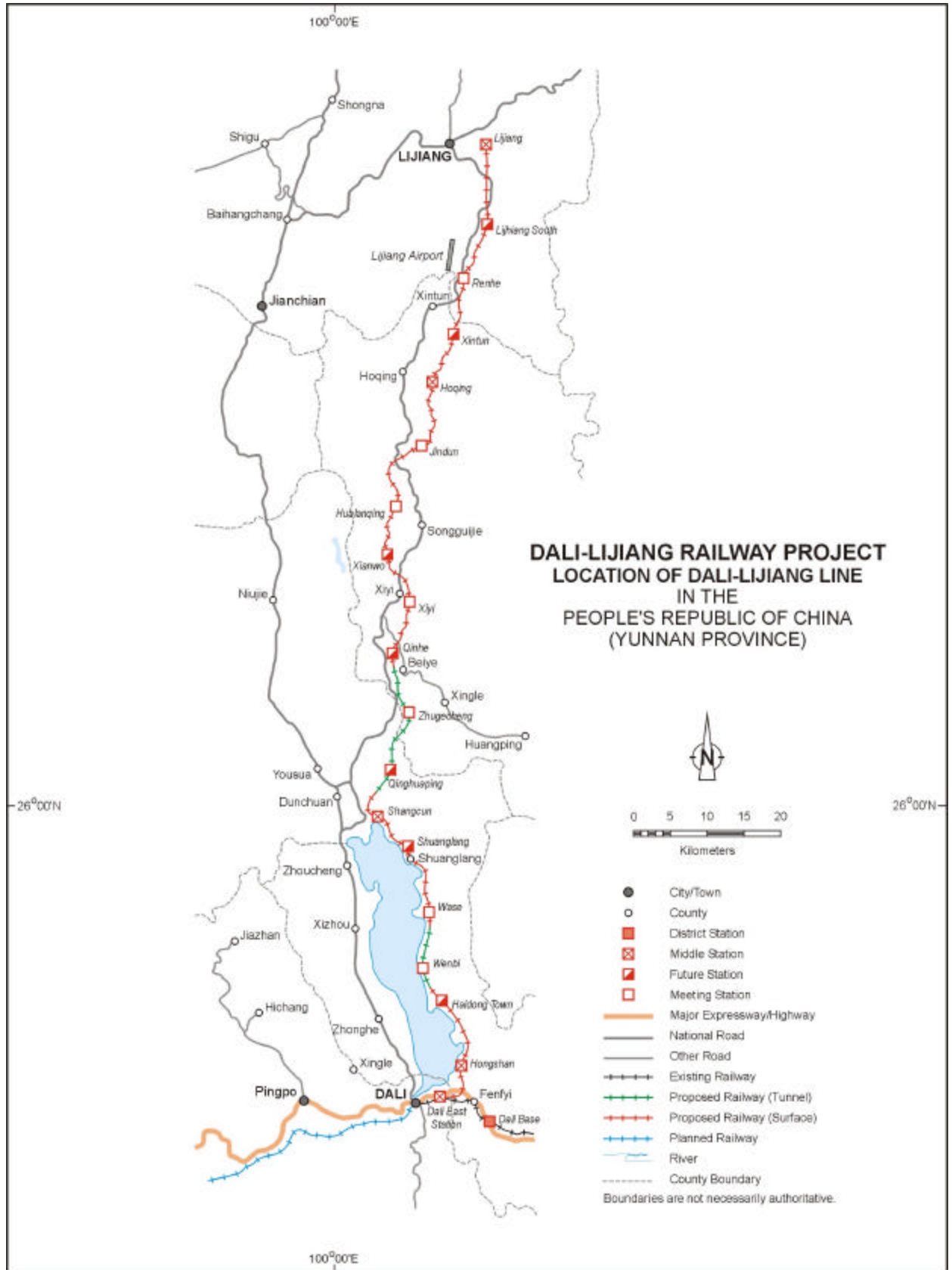
dB	decibel
ha	hectare
km	kilometer
km ²	square kilometer
kg	kilogram
m	meter
m ²	square meter
m ³	cubic meter
mg/l	milligram per liter
mu	0.067 hectare
t	ton
t/a	ton per annum

NOTE

In this report, "\$" refers to US dollars.

CONTENTS

	Page
MAP	i
I. INTRODUCTION	1
II. DESCRIPTION OF THE PROJECT	1
III. DESCRIPTION OF THE ENVIRONMENT	2
A. Physical Environment	2
B. Ecological Environment	3
C. Sociocultural Environment	4
IV. ALTERNATIVES	5
V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES	7
A. Air	7
B. Water	9
C. Solid Wastes	10
D. Noise and Vibration	10
E. Soil Erosion	11
F. Forest Resources	12
G. Protected Areas	12
H. Archaeological Artifacts	13
I. Toxic and Hazardous Chemicals	13
J. Land Acquisition and Resettlement	14
K. Public Safety and Health	14
L. Induced Impacts	15
VI. ECONOMIC ASSESSMENT	16
VII. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN	17
VIII. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE	21
IX. CONCLUSION	23
APPENDIX	
1. Summary Resettlement Plan	25



I. INTRODUCTION

1. The Government of the People's Republic of China (PRC) has requested assistance from the Asian Development Bank (ADB) to finance the construction of the Dali-Lijiang Railway Project (the Project). This summary environmental impact assessment (SEIA) has been prepared for ADB based on the environmental impact assessment (EIA) prepared for the Project by the Second Survey and Design Institute (SSDI) of the Ministry of Railways (MOR) in August 2003, and revised in January 2004. The scope of the EIA report includes ecological environment and natural resources, noise pollution, air pollution, water pollution, solid wastes, public safety and health, and socioeconomic aspects, as well as mitigation measures, a management plan, and a monitoring system. The EIA defines a corridor 200 meters (m) either side of the centerline of the right of way (400 m total width) for detailed investigation of impacts. The EIA further defines environmental protection targets that are national-level protected areas: (i) the Cangshan Mountain and Erhai Lake nature preserve, (ii) the ancient Lijiang City cultural heritage area, and (iii) the Yulong Snow Mountain scenic resort. Thus, the project area includes Dali City, Heqing County, and Lijiang City. The overall project assessment encompasses the project area and Eryuan, Jianchun, Lanping, Ninglang, and Zhongdian counties.¹

2. The SEIA has been prepared in accordance with ADB's requirements and format. It is based on (i) relevant project reports including the EIA report prepared by SSDI; the project feasibility study report, and resettlement plan; comments of various experts from environmental organizations, government organizations, and community representatives; (ii) discussions with the principal authors of the above documents from SSDI; (iii) field visits along the proposed right-of-way (ROW); (iv) discussions with and comments received from technical experts; and (v) findings of the EIA consultation workshop and a sample survey of stakeholders carried out during 19–27 December 2003, and a random sample survey of affected households along the railway line carried out in January 2004. A series of public consultations covering environmental and social issues was held from September 2002 through March 2004, including seven events specifically covering environmental issues (section 8). It also incorporates comments received from ADB on the project preparation technical assistance inception report during the first tripartite meeting held at the Ministry of Railways (MOR) on 17 December 2003, on the draft summary EIA on 6 February 2004, and during the ADB review mission in March 2004.

II. DESCRIPTION OF THE PROJECT

3. The proposed railway between Dali and Lijiang in northwestern Yunnan province has a length of approximately 166.2 kilometers (km), including 162.3 km of new construction, including about 135.4 km of new rail line in the Dali Bai minority autonomous prefecture, and about 26.9 km of new rail line in the Lijiang region. With a south-to-north orientation, the line starts at the Dali East Station of Guangdong-Dali (Guangda) Railway, passes along the Erhai Lake, Eryuan County, Heqing County, and ends at Lijiang Station. The Map presents the locations of the main elements of the Dali-Lijiang Railway Project. Construction of the Project is forecast to take 3.5 years, commencing in the second quarter of 2005 and finishing by the end of 2008, when it will become operational. The Project will be undertaken as a joint venture between MOR and the Yunnan provincial government (the Executing Agency [EA]). It is proposed that the new Dali-Lijiang Railway join the existing Guangda Railway and that this extended Guangda Railway will implement and operate the project.

¹ The overall assessment includes social and economic impacts of the project area.

4. The Project is designed as a second-grade, single-line railway. It will link to the Guangda Railway in Dali and proceed northwards to end in Lijiang. The Project includes: (i) reconstruction of the existing Dali East Station and the Dali passenger station and the construction of 18 proposed new stations, of which 7 will be built later, (ii) 66 bridges with total length of 17,903 meters (m), and (iii) 46 tunnels, with total length of 71.664 km, accounting for 42.6% of the entire rail line.

5. Freight traffic is forecast to be 5.4 million tonnes in 2010, 7.2 million tonnes in 2015, and 12.2 million tonnes in 2025. Annual volume of passengers is forecast to be 3.1 million passengers in 2010, 4.4 million in 2015, and 8.5 million in 2025.

III. DESCRIPTION OF THE ENVIRONMENT

A Physical Environment

6. The proposed railway line is located in the west region of Yunnan province, where the Yunnan-Guizhou plateau and Hengduan mountains converge. Elevations range between 1,900 m and 2,300 m, rising from east to west and south to north. The area is characterized by monsoon climate with distinct dry and rainy seasons, mild winters, and warm summers. The average temperature varies with latitude and altitude. Due to the topography, vertical differentiation of the climate is apparent. Meanwhile, there are minor annual temperature differences. The annual mean temperature is 12.6°C in Lijiang and 14.8°C in Dali. The average annual rainfall is 954 millimeters in Lijiang and 1,067 millimeters in Dali. The period from May to October is the rainy season, with the rainfall accounting for 85% of the annual total, and from November to April is the dry season. The prevailing winds blow from the southwest to the northeast, with a mean velocity of 2.5 meters per second in Dali, and from west to east, with a mean velocity of 3.3 meters per second in Lijiang.

7. There are two major river basins in the project area, the Lancang river basin and the Jinsha river basin. Each of the river systems has two tributaries that flow through the project area: the Boluojiang (Boluo River) and the Miqiehe (Miqie River) of the Lancang river basin, and the Luolouhe (Luolou River) and the Yanggongjiang (Yanggong River) of the Jinsha river basin. The Boluo River is 25.8 km in length, and 280 square kilometers (km²) in drainage area; the Miqie River is 68 km in length and 1,388 km² in drainage area; the Luolou River is 48 km in length and 958 km² in drainage area; and the Yanggong River is 84 km in length and 1,772 km² in drainage area. Deep riverbeds and large head drops characterize these mountain rivers. Erhai Lake, a natural impoundment formed on a geological fault, lies in the project area. The lake is 42 km from south to north and between 4 km and 9 km from east to west, and has a perennial surface area of 250 km².

8. The project area has a series of small- and medium-sized mountains of karst and denudation structures, with complex geological structures. There is considerable influence from folding, faulting, and magmatic intrusions. The earthquake intensity is between degree 6 and 7. Hydrogeologic conditions are complex; surface water and underground water are unevenly distributed, and some of the surface and underground water is acidic. In general, the unfavorable engineering geological conditions such as karst, landslides, collapses, faults, and mud and rock flows, are widely distributed. The strata with different ages along the line spread with many deposit types. The main strata include the Quaternary System, Tertiary System, Cretaceous System, Triassic System, Permian System, Carboniferous (Pennsylvanian and Mississippian) System, and Devonian System.

9. Soils vary with altitude, with red soil located at 1,500–2,400 m above the sea level, yellow and red soil and yellow soil at 2,400–2,600 m, yellow soil and yellow and brown soil at 2,600–2,900 m, brown soil at 2,900–3,200 m, dark brown soil at 3,200–3,800 m, and subalpine meadow soil over 3,800 m.

10. Soil erosion is serious within the Dali autonomous prefecture, and the area suffering from water and soil erosion accounts for a large portion of the land surface. Table 1 provides the current status of soil erosion along the line.

Table 1: Current Status of Soil Erosion

Place	Territorial Area (km ²)	Soil Erosion Area (km ²)	Percentage of Soil Erosion Area over Total Territorial Area (%)
Dali City	1,402	483	34.45
Eryuan County	2,866	1,225	42.77
Heqing County	2,353	1,181	50.18
Lijiang County	7,451	1,603	21.52

Source: "Telemetric Investigation Report Regarding Soil Erosion in Yunnan Province" (August 2000) by the Yunnan Provincial Department of Water and Hydropower and the Tianjin Hydroelectric Investigation, Design & Research Institute, Ministry of Water Resources.

B. Ecological Environment

11. The project area has complex landforms, varying climates, and differentiated vegetations. Land uses along the right of way consist primarily of farmland, woodland, water surface, and unused land ("wasteland"). The land use patterns in the project area are presented in Table 2. The area crossed by the right of way is subtropical evergreen broad-leaf forest zone. Forests and other vegetation along the line are mainly spread in the mountainous areas. Large tracts of primary forests can still be found in the high elevations of Cangshan Mountain and Yulong Snow Mountain; these primary forests are now under state protection and will not be affected by the Project. Secondary forests are widely distributed in the hills and plateaus, whereas woodland in the low-lying areas is mainly composed of economic timber and landscape varieties. The typical vegetations are the evergreen *C. delavayi*, Yunnan *cyclobalanopsis glauca* and *C. orthacantha*, and the coniferous species dominated by Yunnan pines. Meanwhile, there are also large areas of landscape trees like *Ficus altissima*, Yunnan Elm Trees and locust trees, ancient trees over 100 years old and famous trees. The percentage of forest coverage is: Dali City – 48%, Eryuan County – 46%, Heqing County – 21%, Lijiang County – 40%.

12. Northwest Yunnan province is endowed with many scenic spots, nature reserves, and cultural heritage sites. With a total area of 797 km², the Cangshan and Erhai National Nature Reserve in Dali is home to many attractive sightseeing spots such as Cangshan Mountain, Erhai Lake, Three Pagodas, Snake Bone Tower, Butterfly Spring, Gantong Temple, ancient Dali city, and the Bai Folk House Complex in Xizhou. In the Lijiang region, the Yulong Snow Mountain National Scenic Resort has a total area 1,056.33 km², and covers ancient Lijiang city, Yulong Snow Mountain, Lugu Lake, and Laojunshan Mountain. It is integrated with alpine ice and snow sceneries, plateau meadows, and primitive forests, and reveals ethnic culture, with key sightseeing spots and resorts covering Dayanzheng town of ancient Lijiang city, Helongtan (Black Dragon) Pond of Lijiang, Yulong Snow Mountain, the First Bend of the Changjiang (Yangtze) River, and Hutiaoxia (Tiger-Leaping) Gorge. The targets of protection in the Dali and

Lijiang areas are water conservation, forests,² fault-trough lakes, scenic spots, historical sites, and the ancient glaciers. The proposed alignment will run along the east side of Erhai Lake, but impacts are expected to be minimal (see paragraph 35).

Table 2: Land Use Pattern

	Dali City	Eryuan County	Heqing County	Lijiang County
Total Territorial Area	1,402	2,866	2,353	7,451
Farmland	228	279	290	574
Area (km ²)				
Share of total territorial area (%)	16.3	9.7	12.3	7.7
Garden plots	26	23	5	18
Area (km ²)				
Share of total territorial area (%)	1.8	0.8	0.2	0.2
Woodland	521	1,809	1,582	5,414
Area (km ²)				
Share of total territorial area (%)	37.2	62.9	67.9	72.7
Wild grassland	320	439	180	196
Area (km ²)				
Share of total territorial area (%)	22.8	15.3	7.8	2.6
Water area	215	77	17	172
Area (km ²)				
Share of total territorial area (%)	15.3	2.7	0.8	2.3
Other types	92	239	279	1077
Area (km ²)				
Share of total territorial area (%)	6.6	8.3	11.8	14.5

Sources: "Record of the Dali Bai Autonomous Prefecture, Volume I: Record of Natural Geology" (1998); "Updated Report of Overall Land Utilization Planning in Lijiang Naxi Autonomous County" (1998).

C. Sociocultural Environment

13. The Dali-Lijiang Railway Project will pass through Dali city, Eryuan county, Heqing county (under the administration of Dali autonomous prefecture) and Lijiang city.

14. Dali prefecture has a total land area of 29,000 km². The total population of Dali prefecture in 2000 was 3.3 million, of which the Bai and Yi minorities accounted for 49.2%. The non-agricultural population was 12%. Gross domestic product (GDP) reached CNY13.4 billion, of which CNY4.6 billion, CNY3.8 billion, and CNY5.0 billion came from industry, agriculture, and services, respectively. Average per capita GDP was CNY4,098. Tourist arrivals (person-days) reached 5.25 million in 2000, generating total income of CNY2.2 billion. Dali's 10th 5-year plan calls for the area to become one of the PRC's top tourist destinations.

15. Lijiang city has a total land area of 20,600 km². The total population in 2000 was 1.1 million, of which the Naxi, Yi, Bai, and Pumi minorities accounted for 57%. The non-agricultural population accounted for 12% of the total. GDP was CNY2.88 billion, of which CNY0.88 billion, CNY0.75 billion, and CNY1.25 billion came from industry, agriculture, and services, respectively. The average per capita GDP in 2000 was CNY2,618. In the same year,

² Forest cover in Dali City has increased from less than 30% in the early 1980s to 48% at present.

Lijiang received 2.9 million tourist arrivals, with total tourism income amounting to CNY1.67 billion. Tourism has become the most active and new economic growth point for the economic development of Lijiang prefecture.

IV. ALTERNATIVES

A. Alternatives to the Project

16. The alternative to the Project is the continued use of the existing highway between Dali and Lijiang. This mountainous Dali-Lijiang highway is classified as Class 2. It was completed and opened in 1999, with a total length of 179 km and a design speed of 40–60 km/h. It has four lanes in the Dali section and the Lijiang section, and two lanes in other sections. It is designed to take 5–6 hours to travel from Dali to Lijiang.

17. The highway is suitable for medium- and short-distance transportation of small volumes of goods, with the advantage of flexibility and convenience. However, compared with road transport, railway transportation has advantages such as lower cost, larger capacity for all weather conditions, lower unit energy consumption, lower pollution, greater safety, greater punctuality, and higher speeds. With rapid growth of tourism and local living standards, the region of Dali and Lijiang demands large-capacity passenger and cargo transportation to further social and economic development. The existing highway does not have sufficient capacity to satisfy the growing transport demand.

B. Routing Alternatives

18. Three alternatives have been proposed for routing the railway line: (i) the “against the mountain” scheme (Dali West Mountain Scheme), (ii) the “along the highway” scheme (Dali West Highway Scheme), and (iii) the Dali East Scheme. For the Dali West Mountain Scheme, the railway line would pass through the Hongpo No.1 Tunnel, and then go through a series of tunnels adjacent to the mountain, to connect with the “along the highway” scheme near Dengchuan station. The total investment of this scheme is estimated at CNY1,687 million. For the Dali West Highway Scheme, the rail line would turn southwest, after connecting at the west end of Dali Station, for 3.97 km to cross the Chuxiong-Dali Expressway, then turn north until it reaches Taihe village, then run between the Dali-Lijiang Highway and the Yunnan-Tibet Highway, go by the Dengchuan Village and finally to Meizijian. The total project investment for this scheme is estimated at CNY623 million. For the Dali East Scheme, the rail line would begin from the existing East Dali Station, run across the Boluo River and then heads northward along the east shore of Erhai Lake until it reaches Meizijian. The total investment of the scheme is estimated at CNY985 million.

19. **Dali West Schemes.** The Dali West Mountain Scheme would pass through 60 km of Dali Scenic Area between Cangshan Mountain and Erhai Lake where there are many picturesque spots. It would also involve more tunnel engineering works than the other alternatives, with large quantities of spoil that can only be dumped more than 10 km away. Similarly, the Dali West Highway Scheme would require substantial embankment works for which soil could only be taken from places over 10 km away. This would inevitably not only increase the project cost, but also result in dust, noise, and exhaust gases from construction machinery and transportation vehicles, greatly affecting the environment of the scenic areas as well as tourism.

20. The Dali West Mountain Scheme would cross the Eighteen Creeks, an important supplementary water source for Erhai Lake. Hence construction in this section would pose a certain degree of impact on the replenishment of the creeks and Erhai Lake. The Dali West Highway Scheme would pass by Butterfly Spring via tunnels. The construction of tunnel works would affect the groundwater supply, thus affecting the nature reserves.

21. Impact of Construction of Dali West Schemes on Ecological and Human Systems.

The Dali West schemes would be particularly close to the key scenic spots of the Chongshen Temple-Three Pagodas Park in Dali, the ancient city of Dali, and the Butterfly Spring Park. The Dali West Highway Scheme would have a distance of 1,500 m, 300 m, and 1,600 m, respectively, to the three scenic spots. Taihe station (for the Dali West Mountain Scheme) would be about 300 m from the ruins of Taihe city, and North Wuliqiao Station would be about 500 m to the Three Pagodas Park; and tourists would have to cross the railway line to go to these scenic spots, posing a safety risk. The construction of five new railway stations would also damage the integrity of the landscape of Cangshan Mountain and Erhai Lake.

22. The operation of the railway would produce air emissions, wastewater, noises, solid wastes, and other pollutants. Since the Dali West schemes would be situated within the scenic area, the impact of the pollutants on the environment would be significant. Moreover, they would pass through the densely populated residential districts at the exit end of Dali station, creating potentially significant noise to local communities, as well as the need for large-scale and costly land acquisition and resettlement.

23. Dali East Scheme. The Dali East Scheme would be located outside the nature reserves, and would be quite far from key scenic spots (see map). Except for limited impact on the Xiaoputuo Scenic Spot and the tourist route of one-day tour to Erhai Lake during the construction and operation of the Wenbi Station and the construction of the Songshuyuan Tunnel and the Haiying Tunnel, the railway construction in other sections would by and large produce no impact on scenic areas, the landscape, or tourism. Impacts will result from increased tourist traffic, in the form of increased small boat traffic and solid waste generation. The effects of these impacts can be readily mitigated.

24. In the areas where the Dali East Scheme line would pass, except for the section of East Dali station to Hongshan, where there is a relatively large population, most of the sections are sparsely populated. Therefore, only a small proportion of population would be affected by noise pollution, and by land acquisition and resettlement.

25. Table 3 provides the comparative analysis of environmental impacts for the alternative schemes.

Table 3: Comparative Analysis of Environmental Impacts for Alternative Schemes

Impacts	Scheme I (Dali East Scheme)	Schemes II and III (Dali West Schemes)
Construction on valued ecological and human systems	Not within the protected area of the national Cangshan-Erhai nature reserves. Engineering works will cause little impact on the reserves. There are many barren mountains and wasteland, providing good conditions for soil borrowing and spoil disposal.	Large tunnel engineering works. Volume of spoil is large and can only be disposed over 10 km away, and much construction machinery and transportation vehicles will be used in the scenic area. Construction dust, noise, and wastes will affect the environment and tourism. Construction in this section would cause certain impacts on the aquatic environment of the creeks and the Erhai nature reserve. Line would pass through the Butterfly Spring section via a tunnel. Tunneling engineering works would have an impact on groundwater and on the Butterfly Spring nature reserve.
Operation on valued ecological and human systems	The line is far away from key scenic spots and will have no impact on tourist paths; the railway is generally beyond the sight of tourists, without impact on scenic spots, landscape, or tourism.	Line crosses the Class 1 state-protection Dali scenic spots between Cangshan Mountain and Erhai Lake with a length of about 60 km in the area with the most tourist spots. Many inter-crossings between railway and tourist paths would damage landscape integrity and pose a safety risk.
	There are fewer cultural relics and historic sites in the zone.	There are many of key cultural relics and historic sites under national, provincial, prefecture, and municipal protection above and under the ground. Impacts are expected on historic and cultural sites.
	Less populated area along the line with few sensitive spots and little noise pollution. Fewer people than in Dali West schemes affected by land acquisition and resettlement	Population is dense along the lines with many sensitive spots and greater noise pollution than in the Dali East Scheme. More people are involved in land acquisition and resettlement.

Source: CANARAIL Consultants. 2004. Dali-Lijiang Railway Project (Yunnan Province) Environmental Impact Analysis. Kunming.

26. In light of the popularity of the Dali Scenic Area both at home and abroad, and its significance, as well as considering the possible impacts on the ecological and human systems, the two west line schemes between Cangshan Mountain and Erhai Lake are rejected. The Dali East Scheme is recommended for its smaller environmental and social impacts.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

27. The project alignment has been selected to minimize overall environmental impacts. Impacts related to construction are mostly short-term and reversible. Long-term irreversible impacts result mainly from acquisition of land for the right of way. Impacts, mitigation measures, and proposed monitoring are summarized in Section VII.

A Air

28. The project area is characterized by limited industrial development and an expanding tourist trade. The air quality meets the Class 1 and Class 2 standards as specified in the PRC Ambient Air Quality Standard (GB 3095-1996).³

29. During the construction phase, the atmospheric pollution sources include airborne dust from earthworks, and tail gases from construction equipment and vehicles. The dust will settle on trees and crops, and can cause respiratory problems for local residents. Experience has shown that frequent spraying of water in construction sites and on exposed earth surfaces, covering of transportation vehicles with tarpaulins, and training of equipment operators and drivers in fuel efficiency and anti-idling can effectively reduce the air emissions. With the adoption of these mitigation measures for this Project, the residual atmospheric impact is anticipated to be temporary and minimal.

30. In the operational phase, solar energy and hydropower will be used to supply hot water and heat to staff quarters, stations, and depots, generating no air emissions. The main atmospheric pollution will thus come mainly from emissions of operating locomotives. It is estimated that 3,544 tons per annum (t/a) of fuel oil will be consumed in the short term, resulting in the emission of 53.8 t/a of total suspended particles (TSP), 11.3 t/a of sulfur dioxide (SO₂), and 67.4 t/a of nitrogen oxides (NO_x) and 25.2 t/a of carbon monoxide (CO); in the long term 4,304 t/a of fuel oil consumption will emit 65.4 t/a of TSP, 13.8 t/a of SO₂, 81.8 t/a of NO_x, and 30.6 t/a of CO.

31. In consideration of the spread of the emissions from locomotives over a distance of 161.7 km and the strong wind conditions and the large absorptive capacity of the local air-shed, the residual impact on air quality is forecast to be slight but insignificant; the railway operation is not expected to exceed the Class 1 ambient standards for the project area.

32. Table 4 presents results of a comparative analysis of the emissions between the proposed railway and two other modes of transportation. As can be seen from the table, the proposed railway is estimated to reduce emissions of TSP by 23.1%, NO_x by 93.0%, SO₂ by 59.2%, and CO by 98.1%, in comparison with the "car plus truck" alternative. In comparison with the "bus plus truck" mode, the proposed railway is estimated to reduce emissions of TSP by 25.4%, NO_x by 92.9%, SO₂ by 56.0%, and CO by 93.4%. The railway project will result in substantial avoided atmospheric emissions compared to road-based alternatives. The socioeconomic and health benefits of the reduction in pollution would also be significant.

³ The PRC standards are comparable to the World Bank guidelines utilized by ADB for environmental assessments.

Table 4: Comparative Analysis of Emissions from Rail and Alternative Modes

Transport Mode	TSP (t/a)	NOx (t/a)	SO ₂ (t/a)	CO (t/a)
A. Rail	53.8	67.4	11.3	25.2
B. Car + Truck	70.0	969.2	27.7	891.0
C. Bus + Truck	72.1	954.2	25.7	383.7
D. Emissions Difference = (Car + Truck) - Rail	16.2	901.8	16.4	873.8
Emissions Ratio = Emissions Difference/(Car + Truck)	23.1	93.0	59.2	98.1
E. Emissions Difference = (Bus + Truck) - Rail	18.3	886.8	14.4	358.5
Emissions Ratio = Emissions Difference/(Bus + Truck)	25.4	92.9	56.0	93.4

t/a = ton per annum.

Notes:

- (1) The calculations are based on existing fuel efficiencies.
- (2) The average traveling distance for passengers and the average transport distance for goods are assumed to be 50% of the total length of the railway, i.e., 162.3 km x 50% = 81.15 km.
- (3) The average number of passengers in a car is assumed to be 3 persons.
- (4) The average number of passengers in a long-haul bus is assumed to be 40 persons, based on the fact that seating capacity of PRC long-haul buses ranges from 30 to 50 persons.
- (5) The average capacity of a truck is assumed to be 3,800 kg (between a light truck and a heavy truck).

Sources: Emission Estimation Technique Manual for Combustion Engines. 2003. Version 2.3. National Pollutant Inventory, Department of the Environment and Heritage, Government of Australia, 22 October, available: www.npi.gov.au (for Australian emission factors); Shi Zulin and Su Wangsheng. 2001. Energy Use and Environmental Pollution in China. South-North Institute for Sustainable Development, Beijing, PRC, July.

B. Water

33. During the construction phase, the wastewater will entail domestic sewage from construction camps and staff quarters, and industrial wastewater from washing of construction equipment and vehicles. The construction contractors will be required to adopt water-saving construction practices and conduct training of construction workers to minimize the discharge of wastewater. The small quantities of domestic sewage from staff quarters will be discharged to local urban sewerage systems and will be treated in local treatment plants. The construction sites will be located at least 100 meters away from water bodies; and settlement ponds of sufficient sizes will be used to treat the sewage from construction camps and from washing of vehicles before it is discharged. No significant impacts are anticipated on the aquatic systems.

34. The railway operation is estimated to produce a total of 217,905 m³/y of wastewater, including domestic sewage from staff living quarters and passenger stations and 25,550 m³/y of industrial wastewater mainly from locomotive depots. The wastewater will contain 15.2 t/a of COD, 4.6 t/a of BOD, 18.3 t/a of SS, and 0.1 t/a of oils after the application of treatment measures. The domestic sewage from the stations of East Dali, Hongshan, Wenbi, Wase, and Shangcun will be treated by bio-module methods, and from the remaining stations by anaerobic biological filter-tank technology. The industrial wastewater will be treated by tilted-plate oil-separation process. The effluent will meet first-level national standards.

35. Moreover, water-saving technologies (e.g., low-volume flush toilets, automatic taps, and high-pressure train washing) will be adopted for staff quarters, passenger stations, trains, and locomotive depots. These measures, combined with new water reuse and recycling efforts, are anticipated to reduce water consumption by 30–40% compared to current consumption. It is predicted that the wastewater discharges after treatment will not significantly affect the quality of

the receiving water bodies. In particular, no changes are forecast to the water quality classification of the receiving water bodies, including Erhai Lake.

C. Solid Wastes

36. During the construction phase, two types of solid wastes will be generated: spoils and domestic refuse. A total of 5.48 million m³ of spoils will be produced and will need to be disposed of. There is, though, a shortage of available unused land. Given these factors, a series of mitigation measures has been proposed. The first is to maximize the use of spoils as refill materials for the subgrade. Along the rail line, there are a few cement factories, such as Dali Hongta Cement Factory, Eryuan County Cement Factory, and Lijiang Cement Factory; there is the possibility of using limestone as raw material for cement production. Detailed plans will be discussed with the local governments. The sites for disposal of unused spoils will be determined during final design. Retaining walls and revegetation will be adopted for each disposal site to minimize erosion and safety risks. Small quantities of domestic refuse from construction camps will be collected and disposed of in the nearest landfill sites. The impact of construction spoils and domestic refuse on water bodies and the landscape will be minimal.

37. In the operational phase, the domestic garbage from stations and passenger trains, and wastes from regular working and living in the railway stations and depots includes dinner boxes, aluminum cans, plastic bottles, paper, nutshells, and fruit peels. The predicted generation of solid wastes for the whole rail line operation is about 1,920 t/a (1,646 t/a from passenger trains, and 274 t/a from living quarters and office buildings).

38. All of the solid wastes will be transported for centralized treatment by the local environmental sanitation department or disposed of in designated landfill sites. The garbage littered by passengers, if uncontrolled, would have a significant impact on the environment and landscapes along the railway line. Taking into consideration that the railway is a tourist line and mainly passes by famous scenic spots, a new training and public awareness program will be implemented along with development of the garbage collection and disposal systems. Dali station has an existing centralized collection and transport station for Guangda Railway that will be used for the Project. For Lijiang station, the construction of garbage disposal facilities (including one transportation truck) is proposed and an investment of CNY322,000 has been built into the project budget.

D. Noise and Vibration

39. The main noise sources during the construction phase will include blasting, heavy equipment, and transportation vehicles. To minimize the impacts, construction sites will be planned at a safe distance from villages and schools. In addition to choosing equipment of low noise and vibration, construction activities with noisy equipment near schools will be scheduled to avoid school class hours (09:00–12:00 and 13:30–15:00) and those taking place near residential areas will avoid the use of noisy equipment at night (22:00–06:00). With such engineering practices and management measures, no significant disturbance to local communities from construction-related activities is anticipated.

40. During the operational phase, the noise will come from the wheel-track friction from passenger and freight trains, whistling of locomotives, and stations and depots. Located in the 30- and 200-meter zone of the railway corridor are a number of sensitive spots, including three villages and five schools (dormitories and/or teaching buildings). Modeling results for railway

operations, on the basis of no-mitigation, have shown that the daytime noise levels of the schools are predicted to have a range of 54.7–59.5 decibel (dB), compared with the national standard of 60 dB. The projected nighttime noise level for the only school (one middle school) with boarding students will exceed the national standard of 50 dB by 6.2 dB. The projected nighttime noise levels for the villages exceed the national standard by a margin of 4.6–10.3 dB.

41. Noise mitigation measures proposed entail the establishment of greenbelts by planting bushes and evergreen trees with a height of over 5 m, along the rail tracks of all sensitive spots. Sound-proof windows are recommended for Shuanglang middle school where the daytime noise level is predicted to exceed the national standard by 6.2 dB. Locomotive operators will be required to avoid whistling when passing schools in the day and when passing villages during late-night hours. With the proposed noise reduction measures, the daytime and nighttime noise levels of all sensitive spots are anticipated to be within the allowable limits. Moreover, municipalities should restrict the expansion of the existing sensitive schools and residential quarters, and prohibit the construction of new schools and residential quarters, within 200 meters of the railway line.

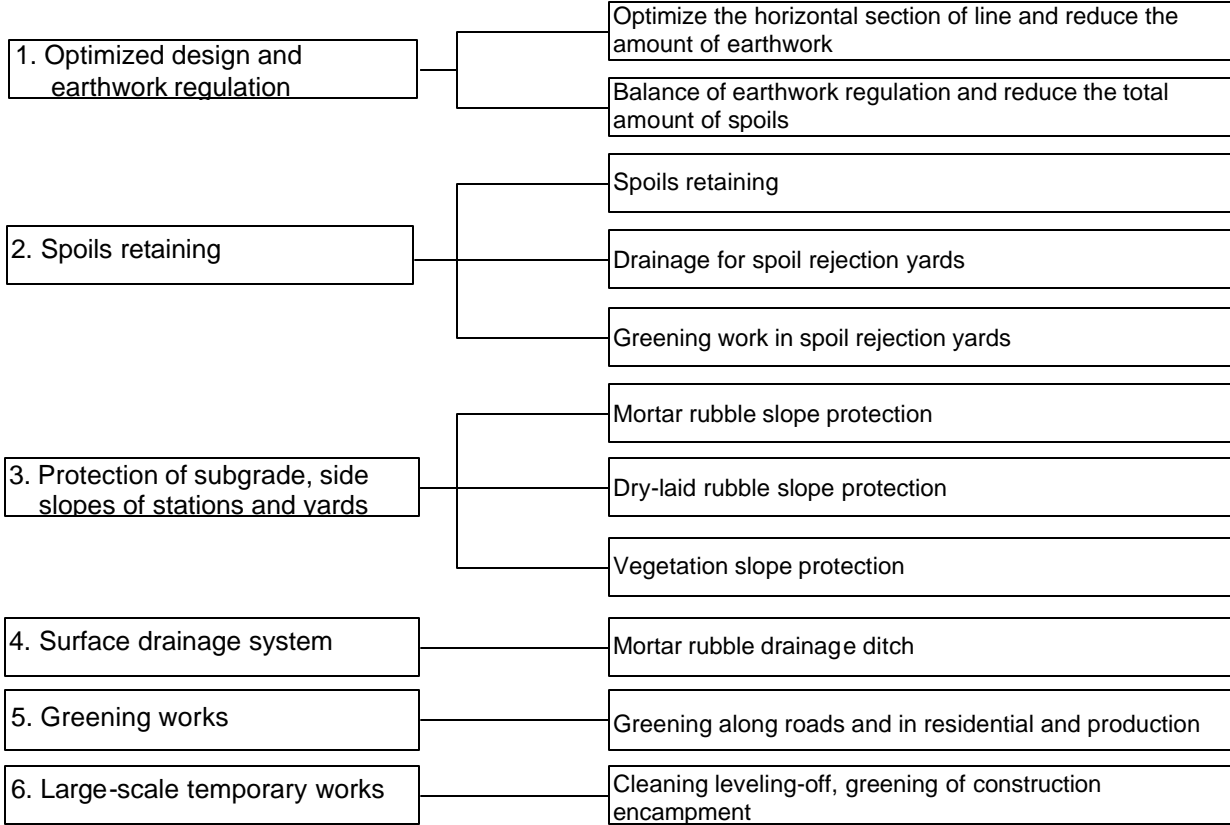
E. Soil Erosion

42. The Project will pass through relatively severe soil erosion-prone regions in Dali prefecture, which account for 34% to 50% of the total project area. The Project will require the construction of 46 tunnels, 62 bridges, 322 culverts, 16 new stations and yards, in addition to the subgrade, involving 3.82 million m³ of borrow material and 5.48 million m³ of spoils. The destruction of vegetation from excavation and the dumping of spoils will cause soil erosion. During construction, soil loss caused by the construction of the subgrade, stations, and yards will amount to 148,000 tonnes for a total of 446,400 tonnes over the construction period. Soil loss caused by the disposal of spoils will amount to 2,466,000 tonnes over the construction period.

43. During operations, soil loss is forecast to be only 1,253 tonnes per year, which is the minimum unavoidable amount. Several mitigation measures are proposed to minimize the loss of soil (see Figure 1). These include: (i) optimizing horizontal and vertical sections of the line; (ii) maximizing the use of spoils as refill materials; (iii) revegetating and reforesting exposed areas (792,100 m²) immediately upon completion of the earthworks; and (iv) establishing retaining walls (207,600 m³). With effective environmental management, the spoil retaining along the rail line will reach 95% and over 99% in the Erhai Lake section. The mitigation measures have been incorporated into the project cost and will be carried out at all relevant sites (see Section VII).

44. After mitigation measures are put in place, the volume of soil loss caused by the construction of the subgrade, stations, and yards will be reduced to 31,200 t/a, for a total of 93,600 ton over the construction period, while the volume of soil loss caused by the disposal of spoils will be reduced to 130,500 tons over the construction period.

Figure 1: System of Measures for Water and Soil Conservation



F. Forest Resources

45. Approximately 103.8 hectares (ha) of vegetated land including 52 ha of timber forest will be acquired for the Project permanently and 17 additional ha will be temporarily occupied for the construction of the Project. The permanent loss of forest land is irreversible. However, the loss of forest will be compensated fully by planting the same acreage of trees along the railway corridor, with an offset ratio of at least 1:1.

46. According to the environmental management plan, temporarily occupied forest land will be restored to its original state as soon as construction activities are completed. Existing tree species indigenous to the project area will be planted. The residual impacts are expected to be minimal.

G. Protected Areas

47. There are several major nature reserves in the larger project area. They include: the Cangshan Mountain and Erhai Lake National nature reserve, Yulong Snow Mountain provincial nature reserve, Lashihai Plateau Wetlands provincial nature reserve, Cibihu Lake city-level nature reserve, Xihu Wetlands city-level nature reserve and Mudunhai Wetlands city-level nature reserve. The shortest distance from the proposed rail line is 22 km to the boundary of the Cibihu Lake nature reserve, 20 km to that of the Yulong Snow Mountain provincial nature reserve, 9.1 km to that of the Lashihai nature reserve, 8 km to that of the Xihu nature reserve catchment area, and 4.2 km to that of the Mudunhai nature reserve. Moreover, the proposed rail line is outside the catchment areas of the Lashihai, Xihu, and Mudunhai nature reserves. Neither the construction

nor operation of the railway is anticipated to have any adverse effects on these nature reserves.⁴

48. The proposed rail line runs along the shorelines of the Erhai Lake nature reserve, with the closest distance being about 150 meters to the boundary of the nature reserve. The Erhai Lake has a total perennial surface area of 250 km², and is a Class 2 water quality protection area for tourism and drinking water supply source. Three stations to be constructed on the east side of Erhai Lake will generate small quantities of wastewater (Shangcun, 41 m³/d; Hongshan, 14 m³/d; Wase, 9 m³/d). This wastewater will be treated using bio-module methods, and the treated effluent will be used for dust suppression and watering green areas around the stations. This wastewater management will result in minimal or no impact on water quality in Erhai Lake. The provincial and local governments are implementing an integrated environmental protection program for the Erhai Lake nature reserve, which comprises land use restrictions, sewage collection and treatment (including biogas digesters), solid waste collection and transfer stations, and ecological greenbelt around the lakefront. These measures will successfully control any direct impacts resulting from Project construction and operations.

H. Archaeological Artifacts

49. The project area is rich in cultural and historical sites. In addition to the commonly-known Three Towers, Snake Bone Tower, Butterfly Spring, Gantong Temple, Ancient Dali City, Bai Folk House Complex in Xizhou, and the ancient city of Lijiang, there have been many archaeological finds along the Dali-Lijiang railway corridor. In particular, the shorelines of the Erhai Lake are home to many historical relics covering the New Stone Age, Bronze Age and the Qin and Han Dynasties. Located in along the foothills of the Cangshan Mountain are many historical sites of the New Stone Age; 21 sites have been discovered since the 1930s. The proposed alignment will not traverse any of the known sites.

50. The possibility exists for discovery of unexplored archaeological sites during excavation for site clearance. As part of the mitigation program, the cultural relic authorities will conduct additional surveys before the start of construction to determine if any potential sites exist. The local cultural bureaus will be invited to monitor site clearance, excavations and other soil disturbance areas and report any findings to relevant authorities for further investigation before construction work continues in the immediate areas of the site. If any cultural relics are found, work will cease immediately until relevant authorities have a chance to evaluate the significance and nature of such findings. In the unlikely event of a new archaeological discovery, the EA will consult with government agencies concerned to determine if changes in alignment are necessary.

I. Toxic and Hazardous Chemicals

51. The proposed Dali East Station locomotive turnaround depot and Lijiang locomotive turnaround depot will not involve repair and maintenance, which will be done at other locations (primarily the Guantong station) which have existing maintenance capacity. Therefore the Project will not involve the use of toxic and hazardous chemicals. Moreover, the railway, as primarily a tourist line, is not intended for use to transport toxic and hazardous chemical. Hence little or no risk of toxic or hazardous chemical spills is anticipated.

⁴ Three new protected areas have been proposed in northwestern Yunnan, in addition to existing nature and cultural reserves. Any increased tourism impacts in these areas related to the railway Project will be mitigated by strengthened protected areas management under leadership of local and provincial government.

J. Land Acquisition and Resettlement

52. The construction of the Project will involve land acquisition, removal of buildings, and population resettlement. A summary of the RP is included in Appendix 1. The total permanent land acquisition will involve about 439 ha (6,589 mu) required for construction of the railway line, railway stations, depots and yards, and other related facilities such as bridges, tunnels, and roads, as well as 175 ha of temporary land use. About 56.5% of the land to be permanently acquired is currently under cultivation. About 137,400 m² of private houses (680 houses total) will be demolished. Beixihe primary school in Heqing county and one enterprise building in Xiahe brick factory in Dali city, totaling 594 m², will be demolished. A total of 7,955 persons will be affected by the construction of the Project (including 3,150 persons affected by housing demolition, 3,705 persons by permanent land acquisition, and 950 persons by temporary land occupation). The impacts have been identified by use of the existing maps and surveys and have been verified by local officials. A final list of affected households will be prepared after the completion of the final location survey.

53. Land acquisition and resettlement will be carried out in compliance with the Land Administration Law of the PRC, the State Council's Regulations on Removing Urban Housing, Yunnan Provincial Land Administration Regulations, and local regulations. The land acquisition and resettlement will be implemented by the EA and Guangda Railway Company (GDRC) with the assistance of respective local governments and monitored by an independent monitoring agency. The GDRC through EA will report on the progress of implementation of the resettlement plan to ADB through quarterly progress reports and a final report on resettlement. The compensation and resettlement will be guided by the principal objectives that the affected people will have their former living standards and income-earning capacity improved or at least restored. The affected people will be provided with adequate support during the transition period.

54. The compensation for land acquisition consists of compensation for (i) agricultural crops, (ii) removal and construction of new houses and other buildings, and (iii) land acquisition and resettlement of affected people. The compensation and resettlement incorporates appropriate consultation process. The standards for compensation in the case of green crops or uncultivated land has been determined jointly by MOR and Yunnan provincial government with assistance from the local governments and the representatives of affected people and villages.

55. The compensation for both private houses and public buildings will be calculated based on real estate appraisals, following PRC regulations. The compensation for land acquisition is calculated by taking the average annual output value (AAOV) of different land uses over the 3 years prior to acquisition. It is 8–10 times AAOV for paddy land, 7–9 times AAOV for irrigated land, orchards, and lotus ponds, 6–8 times AAOV for rain-fed land and dry land, 6 times AAOV for rotation land, and 3–5 times AAOV for grassland and fish ponds; the resettlement subsidy per person is 4-6 times the value of the average output of the cultivated land per mu over the 3 years prior to acquisition. Income restoration measures to be implemented will include: redistribution of land, intensification, diversification, reclamation, and alternative employment. Employment generated by the Project will be allocated so that affected people have priority. The summary resettlement plan is attached in the Appendix.

K. Public Safety and Health

56. During the construction period, there is also a risk of in-coming workers spreading socially transmitted diseases (e.g., SARS and HIV/AIDS). A mobile health team is proposed to conduct regular health checks for the construction workers. Moreover, it is recommended that the construction sites and construction workers' dormitories be disinfected regularly. A sanitation

and hygiene officer will be assigned to large sites with more than 50 workers.

57. Construction safety to workers will also be an issue of concern. In order to avoid accidents, training will be provided to workers, especially machinery operators, on safety procedures and precautions. Helmets will be required at all construction sites. The contractors will be required to appoint a safety officer who will conduct regular safety inspections of the construction sites. Remedial actions consistent with PRC standards will be taken immediately when safety violations are discovered.

58. Railway travel is much safer than local highway travel in high mountainous areas. Consequently, there are net safety benefits in comparison with highway travel. On the other hand, people living in the isolated project area are less familiar with safety issues. The results of consultation indicate a lack of safety awareness among local residents. The results of the socioeconomic survey of 218 affected households in January 2004 also show that only 6.42% of the local population are well aware of railway safety issues, 26.15% have some awareness, 14.68% have little knowledge, and 52.75% have no knowledge. Therefore a railway safety education campaign is required to minimize the safety risk of the railway to the surrounding communities.

59. The new Dali-Lijiang Railway operators will collaborate with local school authorities and community leaders to find ways of integrating railway safety into their curricula and local people's daily living practices. Meanwhile, prominent advance warning signs should be erected at all intersections. Staffed safety booths with barricades will be set up at major intersections. In addition, pedestrian walkways are proposed for the 322 culverts for use by people and animals to reduce the risk of accidents.

60. The tunnels pass through six sections with underground coal seams that contain methane. However, the pressure and concentration of the methane gas (CH₄) do not constitute a safety risk, because of the thin coal layers and the natural release by well-developed karst geological structure, together with ventilation that will be provided for all tunnels during construction. Continuous monitoring of the CH₄ concentration for the six sections of tunnels will be carried out, and if necessary, mitigation measures (e.g., additional ventilation) will be implemented to maintain the CH₄ concentration in air within the safe limit.

L. Induced Impacts

61. The project area is rich in tourism resources and potential mineral, construction material, and hydropower resources. The new transport capacity made available by the Project will facilitate inward transport of manufactured products and the development of the industries that use railway as transportation for goods and materials. The new railway line together with the network of local roads will provide better access for local population to market their agricultural produce in other districts, counties, towns, and villages and obtain higher prices than before, and will promote the growth of township and village enterprises. Urban growth in Dali and Lijiang, and commercial growth around new stations, will be controlled by existing zoning restrictions and land use management plans. Dali and Lijiang have programmed additional investments in municipal wastewater and solid waste management to accommodate the anticipated urban growth.

62. The tourism industry is the major economic growth point for the project area, but it is constrained by inconvenient transportation. When the railway comes into operation, the transportation conditions will be improved greatly, and tourism resources will be further developed with benefits of increased passenger capacity at higher speed, better safety, and

lower cost relative to road transport; with all-weather operations and reduced pollution. The government has prepared a master plan for tourism development with assistance from the World Tourism Organization.⁵

63. The railway is expected to facilitate future investment in the Dali-Lijiang area, in sectors other than tourism. Agricultural and sideline business products will expand, which in turn will generate more employment and income opportunities for local people and facilitate poverty reduction efforts. Various hydropower and mineral resource development projects are in different stages of planning and construction in western Yunnan. However, in the project area, no large industrial development projects have been identified which are economically dependent on the Dali-Lijiang railway project.⁶

64. New projects in the northwest Yunnan area will be subject to a rigorous environmental review under the PRC's EIA law and regulations to ensure that such proposals do not produce any significant environmental impacts. A "stepped-up" review and approval procedure for new project EIAs is proposed; hence a project EIA normally approved by the municipal government will be subject to provincial approval. Under this more stringent EIA review and approval procedure, small and medium industrial projects will go through at least a county-level review and approval process.

VI. ECONOMIC ASSESSMENT

65. The preliminary estimate of the investment for environmental protection for the Dali-Lijiang Railway Project covers tree planting; noise abatement; residence wastewater treatment; solid waste treatment; masonry for soil disposal; water and soil erosion control for embankments, bridges, and tunnels; fees and reports; engineering design; construction supervision; management; consulting services for monitoring; and contingencies. The incremental investment for the proposed environmental management plan (EMP) was estimated by SSDI and reviewed by project preparation technical assistance consultants. The costs were estimated to be approximately CNY461.827 million. Details are provided in Table 5.

⁵ World Tourism Organization. 2001. *Yunnan Province Tourism Development Master Plan Pre-feasibility Studies*. Madrid.

⁶ Additional investigation of induced impacts is being undertaken prior to loan approval.

Table 5: Estimate of Environmental Protection Investment

Item	CNY (million)
Construction/Installation	
a. Tree planting along right-of-way and stations	10.203
b. Noise abatement	2.562
c. Residence wastewater treatment	59.595
d. Solid waste treatment	0.322
e. Masonry for soil disposal	95.234
f. Water and soil erosion control for embankment, bridges, and tunnels	232.222
g. Fees and reports	1.158
Subtotal	401.296
Consulting Services for Monitoring	
a. Environmental monitoring	0.484
Subtotal	0.484
Design, Supervision, and Management	
a. Engineering design	4.419
b. Construction supervision	13.258
c. Management	2.210
Subtotal	19.887
Contingencies	
Contingencies (10%, physical)	40.160
Subtotal	40.160
Total	461.827

Notes:

(1) Costs appearing under Construction/Installation will be spread over the 3.5 year construction period.

(2) Land acquisition and resettlement (LAR) costs are not included.

(3) The cost of tree cutting is included in the engineering cost estimate.

(4) The environmental monitoring cost includes only the costs for domestic consultant. It has been increased by an amount of CNY0.285 million from what was included in the Second Survey and Design Institute estimate.

Source: CANARAIL Consultants. 2004. Dali-Lijiang Railway Project (Yunnan Province) Environmental Impact Analysis. Kunming.

66. The benefits of the EMP are difficult to quantify in monetary terms. They include however: (i) maintenance of terrestrial ecology and protection of soil erosion; (ii) maintenance of water quality standards for receiving surface waters; (iii) maintenance of air quality within applicable state and provincial standards; (iv) noise abatement; and (v) safe disposal of solid wastes.

67. The costs and benefits of the EMP have been included in the overall economic analysis of the Project. The results of the global cost-benefit analysis of the whole project indicate that the Project will yield an economic internal rate of return of 17.1.

VII. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

68. To ensure that the negative environmental impacts can be controlled and mitigated effectively, a stringent and scientific environmental management and monitoring plan (EMP) is being formulated. A satisfactory EMP is required prior to ADB approval of the project. Table 6 summarizes the expected impacts and mitigation measures. Table 7 summarizes the proposed monitoring program. Table 8 summarizes the ecological protection works. Table 5 (above) summarizes the estimated costs.

69. The EA will establish an environmental protection and management office (EPMO), led by the project manager and consisting of at least three staff members with relevant qualifications and experience, to be responsible for ensuring that the overall environmental targets are

achieved and that the environmental responsibilities and obligations of the EA and the respective offices of railway stations and sections are satisfied during project implementation. In each station and section, an environmental officer will be appointed, who will be charged with responsibility for monitoring implementation of the environmental management and monitoring plan in the field. The Beijing Aoxishi Environmental Protection Technology Co., Ltd. has been identified to be the independent monitoring agency.

70. During project construction, periodic field environmental monitoring will be conducted by EPMO, construction contractors, local environmental protection bureaus, local water and soil erosion control offices, local production safety bureaus, nature reserve and scenic area management authorities, and independent monitoring agency. Table 8 summarizes the environmental monitoring parameters, locations, frequencies, and responsibilities. The environmental mitigation measures will be implemented by the construction contractors and EPMO. The independent monitoring agency will be responsible for the external monitoring activities during the construction of the Project. Land acquisition and resettlement will be carried out by the EA with assistance from the local governments and the project resettlement leading group.

71. During project operations, EPMO will be responsible for implementing mitigation measures. The independent monitoring agency will be responsible for external environmental monitoring. All monitoring results during the construction and operation of the Project will be reported to the EA. Advice and assistance will be sought from time to time from the State Environmental Protection Administration and the Environmental Protection Office of MOR. Together with necessary actions taken, the EA will provide quarterly progress reports and twice yearly reports on environmental management of the Project to ADB.

Table 6: Pollution Impacts and Mitigation Measures

Type of Pollution Sources		Pollution Sources	Location of Pollution Sources	Major Pollutant or Parameter	Treatment Measures	Applicable Standards
Air Pollution	Construction Phase	Blasting; construction machinery and vehicles	Construction sites; access roads and surrounding areas	TSP, NO ₂ , SO ₂	Dust control by frequent water spraying of construction sites and exposed earth surfaces; use of vehicle covers; vehicle and equipment well maintained, and operators trained in fuel efficiency and anti-idling	Local construction by-laws
	Operational Phase	Locomotives; staff living	Rail corridor; stations, depots, living quarters and surrounding area	Smoke, TSP, NO _x , SO ₂	Locomotive and vehicle operators trained in fuel efficiency and anti-idling; use of solar and hydropower for supply of hot water	Best engineering practices
Wastewater	Construction Phase	Construction camps; staff living; washing of construction equipment and vehicles	Work sites; staff quarters	TSS, COD, BOD, petroleum	Sewage discharged into municipal sewers when possible; construction camps located away from water bodies; wastewater from equipment and vehicle washing treated with settling ponds.	GB 8979-1996
	Operational Phase	Staff living; waiting passengers; offices; industrial wastewater; washing of locomotives and trains	Staff quarters; office buildings; stations; depots	TSS, COD, BOD, petroleum	Water saving and reuse and recycling adopted. Sewage and wastewater treated by anaerobic biological filter tank and sequencing batch reactor technologies.	GB 8979-1996
Solid Wastes	Construction Phase	Excavation; workers and staff daily living	Construction sites; workers camps; staff quarters	Spoils; domestic refuse	Spoils disposed in designated sites with retaining walls and greening; refuse collected and transported to local landfill sites.	
	Operational Phase	Staff daily living; waiting passengers; traveling passengers	Staff quarters; stations; depots; office buildings; trains	Domestic refuse	Collected and transported to local landfill sites	
Noise and Vibration	Construction Phase	Blasting; use of heavy-duty vehicles and equipment	Construction sites; access roads; surrounding areas	70–100 dB (30 m)	Scheduling operation to avoid school hours and late night hours; use of new and well-maintained equipment and vehicles	GB 12523-90
	Operational Phase	Train whistling, wheel-track friction, stations	Along the line; stations	70–100 dB (30 m)	Locomotive operators required to prevent whistling when passing near schools during day time, and near villages during night time; establishing green belts as sound barriers for sensitive villages and schools	Meet the standard for functional zones
Soil Erosion	Construction Phase	Earth excavation; sediment concentration in surface run-off	Construction sites; spoil disposal sites	Soil loss	Optimization of horizontal and vertical section of the line; maximizing the use of spoils as refill materials; revegetate and reforest exposed areas immediately upon completion of the earthworks; and build retaining walls	PRC Water and Soil Conservation Law
	Operational Phase	Run-off from subgrade and spoil disposal sites	Subgrade and spoil disposal sites	Soil loss	Regular maintenance of revegetation and reforestation areas	Best engineering practices

BOD = biochemical oxygen demand, COD = chemical oxygen demand, dB = decibel, GB = *guojia biao zhen* (national standard), m = meter, NO_x = nitrogen oxides, NO₂ = nitrogen dioxide, PRC = People's Republic of China, SO₂ = sulfur dioxide, TSP = total suspended particles, TSS = total suspended solids.

Source: CANARAIL Consultants. 2004. Dali-Lijiang Railway Project (Yunnan Province) Environmental Impact Analysis. Kunming.

Table 7: Details of Environmental Monitoring Program

Monitoring Scope	Parameter	Location	Frequency		Responsibility
			Construction	Operation	
Air	TSP, NO _x , SO ₂ , CO	Populated areas	Monthly for 3 consecutive days	Biannual	EPMO, local EPBs, independent monitor
Wastewater and surface water	TSS, COD, BOD, DO, pH, oil, phenol	Effluent outlets; local drinking water supply sources; important water bodies	Monthly for 3 consecutive days	Biannual	EPMO, local EPBs, independent monitor
Noise	dB	Sensitive spots	Monthly for 3 consecutive days	Quarterly	EPMO, local EPBs, independent monitor
Solid waste	Slag, domestic refuse, metallic scraps, sludge	Disposal sites	Quarterly	Biannual for first two years, then annual thereafter	Construction contractors, EPMO, local EPBs, independent monitor
Spoils	Visual inspection	Entire railway line	Biweekly	Twice a year at start and end of rainy season	Construction contractors, EPMO, independent monitor
Soil erosion	Visual inspection	Entire railway line	Biweekly	Biannual	EPMO, local water and soil erosion control offices, independent monitor
Methane gas in tunnel	Methane gas	Coal-bearing tunnels	Weekly	Quarterly	EPMO, construction contractors, local production safety bureaus, independent monitor
Public safety	Signs, culverts, public safety records	Entire railway line	Monthly	Quarterly for the first year, then annual thereafter	EPMO, construction contractors, independent monitor
Nature reserves and scenic areas	Wildlife species, landscape	Within nature reserves and scenic areas	Monthly	Biannual	EPMO, nature reserve and scenic area management authorities, independent monitor
Land acquisition and population resettlement	Compensation, income, housing, employment, social adaptation	Relocated families and receiving communities	Middle and end of LAR	Annual community survey in 1st 5 years; once every 2 years in 1st 10 years	EPMO, independent monitor
Induced socio-economic benefits	Increased shipment of local products; increased number of tourists; increased local revenue; and increased income of locals	Dali Bai Nationality Autonomous Region, Lijiang prefecture	—	Year 2, 5 and 10 of railway operation	EPMO, independent monitor
Community participation	Number of participants	Project communities	Semi-annually	—	EPMO, independent monitor

BOD = biochemical oxygen demand, CO = carbon monoxide, COD = chemical oxygen demand, dB = decibel, DO = dissolved oxygen, EPB = environmental protection bureau, EPMO = environmental protection and management office, LAR = land acquisition and resettlement, NO_x = nitrogen oxides, pH = measure of acidity/alkalinity, SO₂ = sulfur dioxide, TSP = total suspended particles, TSS = total suspended solids.

Source: CANARAIL Consultants. 2004. Dali-Lijiang Railway Project (Yunnan Province) Environmental Impact Analysis. Kunming.

Table 8: Quantities of Ecological Protection Works

Item	Works		Unit	Dali	Lijiang	Total
Subgrade side slope	Plant measures	Planting on both sides of the line	10 ⁴ m ²	45.29	12.04	57.33
	Construction measures	Mortar-laid rubbles	10 ⁴ m ³	22.83	6.08	28.91
		Dry-laid rubble	10 ⁴ m ³	2.89	0.77	3.66
		Shotcreting on prefixed mesh	10 ⁴ m ²	2.90	0.20	3.10
		Shotcreting with net	10 ⁴ m ²	0.60	0.00	0.60
Slag rejection yard	Plant measures	Greening with arbor, shrub and grass	10 ⁴ m ²	77.01	2.20	79.21
	Construction measures	Mortar-laid rubbles	10 ⁴ m ³	27.46	0.55	28.01
Borrow yard	Plant measures	Slope protection with seeding and planting	10 ⁴ m ²	2.55	0.50	3.05
		Slope protection with planting	10 ⁴ m ²	3.42	1.14	4.56
		Greening with arbor, shrub and grass	10 ⁴ m ²	20.28	5.07	25.35

Source: CANARAIL Consultants. 2004. Dali-Lijiang Railway Project (Yunnan Province) Environmental Impact Analysis. Kunming.

VIII. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

72. Public participation is the most important part of the project design. The EA and SSDI have conducted extensive communications with the relevant local government organizations and local communities in the form of meeting, surveys, household interviews, written communications, workshops, and so on. All the issues such as the selection of the line route, the outlet design for wastewater discharge, selection of water source, arrangement of borrow pits, spoil disposal siting, and sand and stone supply have been resolved by the mechanism of public participation.

73. The various public consultation and participation activities for the Project carried out since 2003 are documented in Table 9, which includes the public opinion surveys of local residents, tourists, and other stakeholders as well as the EIA consultation workshop.

Table 9: Stakeholder Consultation

Date and Location	Agency	Participants (Number)	Discussion/Responses
Apr–May 2003; Project area	SWJU and SSDI	Rural households in the project area (533)	<ul style="list-style-type: none"> Socioeconomic survey of 112 households done in preparation of the draft RP Secondhand data from 13 townships
22 Dec 2003; and 27 Dec 2003; Dali, Lijiang, Eryuan, and Heqing	PPTA consultants	Government at all levels, relevant line agencies, SSDI, environmental protection technology company, local schools, and villagers (87)	2-EIA workshop, and 2-consultations Topics discussed include: engineering work, EIA document, potential environmental impacts and mitigation measures, health and safety issues, reforestation program, animal species, land acquisition and resettlement

Date and Location	Agency	Participants (Number)	Discussion/Responses
28 Nov–1 Dec 2003; Project area	PPTA consultants	Government and relevant line agencies (7)	Review feasibility study (May 2003) Financial and economic analyses Safeguards, including EIA Railway structure and traffic forecasts GDRC's operating and accounting practices Potential traffic projections on DLR Connecting roads
Dec 2003–Feb 2004; Project area	PPTA consultants	Government, relevant line agencies, relevant bureaus (e.g., forest, tourism), and local groups (e.g., women's federation). (40)	Selection of railway line and discussion on station sites and layout Alternative comparisons with east-west line Engineering considerations, urban construction plan, and economic development Environmental projection Collection of public environmental information
Jan 2004; Project area	PPTA consultants, MOR, local contractors, and local government	Local villages and households (1,037)	Surveys done for the draft resettlement plan Village survey of 20 villages Households survey of 218 households
Jan 2004; Kunming	PPTA consultants	Representatives of provincial departments (20)	Consultation meeting with semi-structured questions to collect and verify data, and review project-related issues
Jan 2004; Dali, Lijiang, Eryuan, Heqing, and Ningliang	PPTA consultants	Leaders of prefecture and county level line agencies (60)	Consultation meeting with semi-structured questions Collect and verify data Identify local roads for improvement Appraise plans and development targets
Jan 2004; 15 townships in project area	PPTA consultants	Township government officials (40)	Work session/discussion Collect and verify data Identify local roads for improvement Appraise plans and development targets
Jan 2004; 37 villages in project area	PPTA consultants	Village leaders (100)	Semi-structured interview and discussions—role of leaders and villager participation Project benefits, adverse affects and mitigation measures
Jan 2004; 12 villages in project area	PPTA consultants	Male and female village groups (200)	Focus group discussions and mapping Women's needs and priorities Disaggregated Potential project impacts
Jan 2004; Kunming, Dali, and Lijiang	PPTA consultants	Train passengers (30)	Questionnaire

Date and Location	Agency	Participants (Number)	Discussion/Responses
Jan 2004; Project area	PPTA consultants	Villagers of different economic situations (500)	350 household questionnaire and interview Socioeconomic surveys that included assessments of potential benefits, impacts, and mitigation/enhancement measures Assess status of ethnic minorities and potential project impacts
Jan 2004; Dali, Lijiang, Heqing, and Eryuan	PPTA consultants	Market survey (20)	Market survey checklist Collection of information on trade volume, its direction, prices of commodities Assess the potential impacts on market from the project
Jan 2004; Dali, Heqing, Lijiang, and Eryuan	PPTA consultants	Mining and processing companies, tourism trader and service providers, village businesses, traders, sellers, agro-products processing and manufacturing companies (54)	Semi-structured and participatory interviews, and observations Assess how each would benefit from the project and their patterns of operation
Dec 2003, Mar 2003, and Feb 2004; Beijing and project area	ADB PPTA missions	Government, relevant line agencies, railway authorities, tending corporation, PPTA consultants, SSDI, and households (108)	Support for project Discussions about the objectives, scope, cost estimates, potential amount of loan, and safeguards
11–23 Mar 2004; Project area, Kunming, and Beijing	ADB loan fact- finding mission	Government, relevant line agencies, railway authorities, SSDI, local groups, and PPTA consultants (84)	Support for the Project and components Review ADB safeguards on resettlement, the environment and indigenous peoples Discussions on social and poverty issues Railway management

ADB = Asian Development Bank, DLR = Dali-Lijiang Railway, EIA = environmental impact assessment, GDRC = Guangda Railway Company, MOR = Ministry of Railways, PPTA = project preparatory technical assistance, RP = resettlement plan, SSDI = Second Survey and Design Institute, SWJU = Southwest Jiaotong University.
Source: CANARAIL Consultants. 2004. Dali-Lijiang Railway Project (Yunnan Province) Environmental Impact Analysis. Kunming.

74. In addition to the above formal and informal interviews, meetings, and workshops, a random sample socioeconomic survey of 218 affected households by land acquisition and resettlement along the railway line was also carried out by the local socioeconomic survey team in January 2004. The results of the household survey conducted indicate that the majority of the affected people (80%) support the construction of the Project. Of those interviewed, 88% were already aware of the Project. The affected residents considered the project as an opportunity to improve accessibility (61.4%), their regional economy (85.3%), and tourism development (65.6%). They expect the railway to be built as soon as possible. Public views with regard to the environmental impacts of the Project during construction and operational phases were solicited during the household survey. With regard to the anticipated potential environmental impacts during project construction, the responses of the 218 sample surveyed households demonstrated that noise is the most critical concern (84.4% of respondents), followed, in descending order, by air (74.3%), soil erosion (38.5%), surface water (37.2%), safety issues caused by the increased transportation vehicles (28.0%), agricultural land loss and relocation

(25.7%), impacts on flora and fauna (24.3%), and impacts on nature reserves and scenic spots (11.0%).

75. The responses relating to the anticipated environmental impacts during the Project's operational phase focus on wastewater pollution, followed, in descending order, by noise (80.7%), solid waste (68.4%), tail gas (61.5%), public safety (47.6%), increased transmission of diseases (45.0%), and impacts on nature reserves and scenic spots as well as flora and fauna (12.4%). No additional issues, other than those identified and addressed in the EIA, arose from the household survey.

IX. CONCLUSION

76. The project area is endowed with rich natural resources, particularly tourism, minerals, construction materials, and hydropower potential, but is served by poor transportation infrastructure that constrains resource development and use, which greatly hinders the socioeconomic development of the region. The Project, once completed, will stimulate such development by improving transportation infrastructure services and promoting the development of tourism and natural resources. The Project will create new employment and income-generating opportunities, and is expected to contribute to poverty reduction among local communities.

77. The potential adverse environmental impacts identified include spoil disposal, soil erosion, air pollution, water pollution, noise and vibration, solid wastes, and lack of public safety, as well as land acquisition, population resettlement, and induced impacts. Detailed mitigation measures were examined, along with alternatives to the Project and project alternatives. An environmental management and monitoring plan has been developed. Responsible institutions for implementation of the mitigation measures and of the environmental monitoring program were identified. An independent monitoring agency will be engaged to monitor the implementation of the environmental management and monitoring plan and the environmental effects. The monitoring reports will be submitted to the EA and ADB. The costs of impact mitigation and environmental monitoring were calculated and included in the overall project budget.

78. The EIA concluded that impacts from Project construction and operations will be minimal, and can be readily mitigated. After the mitigation measures are implemented, the Project is not expected to have significant environmental impacts. Internal and external monitoring and audit will be carried out to ensure that this is the case, and any departures from this will be corrected.

SUMMARY RESETTLEMENT PLAN

A. Project Area and Impact

1. The Project railway alignment will cross 56 villages in 13 townships from Dali City to Lijiang City in Yunnan. The lengths of the railway in Dali Prefecture and Lijiang City are about 138 km and 28 km, respectively. An estimated 6,589 mu (439 hectares) of land will be permanently acquired, of which about 56.5% is currently under cultivation. The number of affected people will be about 3,705 people, assuming that the total loss of cultivated land is based on average per capita land holdings. The Project will also temporarily require an estimated 2,626 mu (175 hectares), most of which is non-irrigated farmland and barren land. About 950 people will be affected by temporary land occupation. About 137,400 square meters of mainly residential structures will be affected, requiring relocation of about 680 households (3,150 people). Nearly all households to be relocated are included in the number of households that lose land. The relocation of one school and a brick-kiln will affect an additional 150 persons. The total number of persons directly affected is thus estimated at 7,955 persons.

2. Land acquisition and resettlement impacts were minimized by aligning the railway away from densely populated areas, and avoiding irrigated land and facilities, where possible. Consultations were held with communities and local officials to minimize the potential resettlement impacts from the railway construction.

B. The Resettlement Plan

3. The draft resettlement plan (RP) was prepared by Ministry of Railways (MOR), Guangda Railway Company (GDRC), and local government, with the assistance of PPTA consultants and Southwest Jiaotong University (SWJU). It is based on the preliminary design study, 20 village surveys, 218 household surveys, local government statistics, and consultations with local officials, village leaders, and affected households. The draft RP was discussed with county level offices and was endorsed by GDRC. The draft RP will be updated based on the detailed measurement survey. Any changes will be incorporated into the final RP, including associated cost changes. The RP will be submitted to Asian Development Bank (ADB) for approval prior to the commencement of compensation and land acquisition activities. Consultations were also conducted with the affected people, whose comments and suggestions were reviewed by GDRC and incorporated in project design.

C. Policy Framework and Compensation

4. For people unavoidably affected by the Project, the resettlement objective is to ensure that compensation and entitlement provided to APs are adequate to at least maintain their "without project" standard of living, with prospect of improvement, in line with the PRC's Land Administration Law (1998) and the ADB's *Policy on Involuntary Resettlement* (1995), and *Indigenous Peoples Policy* (1998). The draft RP is based on the Land Administration Regulation for Yunnan Province (1999). People losing land, housing, other assets or other means of production will be assisted in restoring their incomes and living standards to at least the levels without the Project's intervention. Lost assets will either be replaced or their owners compensated at replacement cost. In 2004, the PRC Constitution was amended to ensure that people are compensated according to law for land expropriated for public project.

5. The draft RP stipulates eligibility/entitlement provisions for affected people losing land, houses and income losses, and provides rehabilitation assistance. Permanent land losses will

be compensated either through land reallocation within villagers' group or through cash payments to the collective at rates of 8-10 times the average annual output value (AAOV) of the land over the past three years. A resettlement subsidy is calculated at 4-6 times AAOV. Compensation for temporary land loss will be paid directly to the affected people at a rate stipulated in the RP. Farmers will be paid for the period of occupation, and the land will be restored to farmland after use. Compensation for housing losses will be paid directly to the affected people in cash at replacement cost, free of demolition expenses and salvaged materials. Crop and tree losses will be directly paid to the affected people in cash at rates stipulated in the RP. Private shops will be paid compensation for relocation and reconstruction.

D. Ethnic Minorities and Vulnerable Groups

6. Resettlement will affect about 8,000 people in a poor area where minorities live. Ethnic minorities account for 83% of the affected people. Land acquisition will affect Bai, Lisu and Naxi villages. The railway alignment was routed to minimize the level of resettlement. The people affected by land acquisition are generally better off than average person in each county. However, special measures have been included in the RP and the EMDP to ensure compliance with ADB's social safeguard policies and guidelines and provide opportunities for affected people to directly benefit from the Project.

7. Out of 56 villages, 5 are classified as being seriously affected. Land loss at the household level may include complete loss of paddy land. However, none of the farming households will incur complete land loss. Income loss is thus less severe because planted crops typically account for less than 30% of the household's gross income. Vulnerable households are those that are orphans, widows, "Wubao" households, and the seriously disabled and mentally ill.

E. Implementation Framework

8. MOR, GDRC and local government, including the prefecture level and county level LAR Offices and Land Administration Bureaus (LAB), will be responsible for implementing and delegating resettlement activities to township officials and village committees affected by the Project. Village committees will assist in the implementation of land acquisition and resettlement, with guidance from township officials.

F. Stakeholder Participation, Disclosure of RP and Grievances

9. At various stages of the project planning, affected people have been informed and consulted about the likely impacts of the project. Stakeholders consulted include heads of affected households, village heads and representatives, local government agencies and departments, and vulnerable groups, including women and ethnic minorities. Information about the resettlement program will be disseminated to the APs to promote understanding and support from communities in the project area. A resettlement information booklet will be distributed to villages, groups, and households affected by land loss and/or resettlement. The resettlement information booklet contains sections on resettlement impacts, the resettlement policy, organizational arrangements, consultation and participation, and grievance procedures. Affected households will also be consulted in the resettlement activities, including the detailed measurement survey, location of underpasses, new housing sites, collective investment of compensation, and grievance redress.

G. Project Monitoring and Evaluation

10. The RP will have both internal and external monitoring. Methods for both are specified in the RP. GDRC, with the prefecture level LAR offices, in collaboration with the County LAR Offices, will be responsible for internal supervision and monitoring. The following activities will be monitored: (i) compensation payments; (ii) house rebuilding/relocation of affected people; (iii) land redistribution; and (iv) grievance redress. Progress reports will be prepared by GDRC and submitted to ADB through quarterly reports, until resettlement is completed. GDRC will then prepare a resettlement completion report for submission through the EA to ADB.

11. An institute or organization independent of MOR and GDRC, will be contracted to carry out the external monitoring and evaluation work under this RP. A preferred candidate for this task is an organization which already has experience in monitoring work for international agencies. The tasks include: (i) review and verification of the compensation payments; (ii) status of land acquisition and compensation payments; (iii) appraisal of grievance redress procedures; (iv) affected people's reaction/satisfaction with entitlements and compensation; (v) assessment of the restoration of livelihoods of affected people; and (vi) drawing lessons learned for future RP planning. The external monitor will prepare monitoring and evaluation reports for submission to MOR and ADB every six months until the completion of resettlement activities; thereafter, annual evaluation investigations will be conducted for at least two years and reported to GDRC and ADB. The external monitor may be the same one hired to monitor the ethnic minorities development plan.