SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

OF THE

CHONGQING EXPRESSWAY PROJECT

IN THE

PEOPLE'S REPUBLIC OF CHINA

May 1996
CURRENCY EQUIVALENTS
(as of 15 May 1996)

Currency Unit – Yuan (Y)

\[
\begin{align*}
\text{Y1.00} & = \quad \text{$0.120} \\
\text{$1.00} & = \quad \text{Y8.317}
\end{align*}
\]

On 1 January 1994, the PRC's dual exchange rate system was unified. The exchange rate of the yuan is now determined under a managed floating exchange rate system.

ABBREVIATIONS

Co - Carbon Monoxide
CODcr - Chemical Oxide Demand (chromium)
CTB - Chongqing Transport Bureau
EIA - Environmental Impact Assessment
EPB - Environmental Protection Bureau
NEPA - National Environmental Protection Agency
NO\textsubscript{X} - Nitrogen Oxides
PCU - Passenger Car Equivalent Unit
PRC - People's Republic of China
RCP - Resettlement and Compensation Plan
SEIA - Summary Environmental Impact Assessment
XHTU - Xi'an Highway Transportation University

WEIGHTS AND MEASURES

db(a) - Decibels ()
km - Kilometer
km\textsuperscript{2} - Square Kilometer
mg - Milligram
m\textsuperscript{3} - Cubic Meter
t - Ton

NOTES

(i) The fiscal year of the Government coincides with the calendar year.
(ii) In this Report, “$” refers to US dollars.
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>B. Description of the Project</td>
<td>1</td>
</tr>
<tr>
<td>C. Description of the Environment</td>
<td>2</td>
</tr>
<tr>
<td>D. Anticipated Environmental Impacts and Mitigation Measures</td>
<td>5</td>
</tr>
<tr>
<td>E. Alternatives</td>
<td>14</td>
</tr>
<tr>
<td>F. Environmental Benefit-cost Analysis</td>
<td>15</td>
</tr>
<tr>
<td>G. Institutional Requirements and Environmental Monitoring</td>
<td>16</td>
</tr>
<tr>
<td>H. Public Involvement</td>
<td>18</td>
</tr>
<tr>
<td>I. Conclusions</td>
<td>19</td>
</tr>
</tbody>
</table>
A. Introduction

1. This Summary Environmental Impact Assessment (SEIA) has been prepared for the Asian Development Bank as an evaluation and summarization of an environmental impact assessment (EIA) prepared for the Chongqing to Leishendian section of the Sichuan Expressway Project in the People's Republic of China (PRC). The EIA was prepared by the Xi'an Highway Transportation University (XHTU) under contract from the Chongqing Transport Bureau (CTB) between May and August of 1994. The SEIA was prepared by an association of international consultants from PRC, Japan, and United States. The SEIA is based on (i) the EIA; (ii) the Project feasibility study prepared by the Highway Planning Survey and Design Institute of the Sichuan Transport Department, under contract from CTB; (iii) discussions with the principal authors of the above documents; (iv) field visits along the proposed right-of-way; (v) discussions with officials of CTB; (vi) discussions with officials of environmental sector agencies in Chongqing and Beijing; and (vii) discussions with other technical and official personnel.

B. Description of the Project

2. Since 1979, the economy of Sichuan Province has developed rapidly, especially in the production of high-value-added goods in major industrial cities such as Chengdu and Chongqing. This rapid economic development has led to a significant increase in road transport demand in the province. Road freight traffic increased in Sichuan by 27 percent between 1980 and 1992, and road passenger traffic grew by 12 percent annually during the same period.

3. The existing 130-kilometer (km) road between Chongqing and Leishendian, which was built in the 1930s, is a two-lane winding road traversing a mountainous area and the heavily populated and industrialized region of southern Sichuan Province. It provides access to the major river ports in the middle reaches of the Yangtze River. More than 60 percent of the road was built to handle low-volume traffic. Despite repeated rehabilitation works, the pavement has deteriorated badly, and maintenance costs are steadily increasing. The present traffic on the road of about 6,700 medium truck equivalent units or about 13,400 passenger car equivalent units (PCU) per day exceeds the road's design capacity. Congestion is a serious problem, with mixed traffic and average travel speeds of 25-35 km per hour.

4. The proposed expressway Project will form part of the main high-standard arterial highway system connecting major industrial areas in Sichuan Province, and will connect with the newly completed Chengdu to Chongqing Expressway and the Second Chongqing Yangtze River Bridge. The expressway network will form part of a system of ring roads around Chongqing and will extend southward from Chongqing to Leishendian. The Project will constitute an 89-km section of the planned 1,250-km Chongqing to Zhanjiang trunk route of the National Trunk Highway System, which is to be completed by the end of the century. The proposed route will reduce travel distance between Chongqing and Leishendian by about 40 km. Access control will be provided to separate slow-moving, nonmotorized agricultural traffic from high speed traffic and thus improve road transport efficiency and safety.

5. The roadway construction period is anticipated to be from 1996 through 2000. The northern section near Chongqing (Tongjiayuanzi to Jieshi) is to be designed as a six-lane divided expressway for a length of 34 km. The south section (Jieshi to Leishendian) is to be designed as a four-lane divided first grade highway for 55 km. The northern section is projected to carry about 27,000 PCU in 2000, increasing to about 90,000 PCU by 2020. The southern section is projected to carry about 15,000 PCU in 2000, increasing to 62,000 PCU by 2020.
C. Description of the Environment

1. Physical Resources

   a. Geology, Topography, and Soils

6. In the northern portion of the study area, to the southeast of Chongqing Municipality, is the Chuandong parallel mountains area, formed by two parallel mountain ridges above the surrounding countryside. The shallow valley between these ridges is filled with karst depressions, sink holes, and limestone caves. A proposed long tunnel for the highway route passes under both ridges. On the west of the ridges, the topography slopes off to the Yangtze River valley in a series of low parallel ridges. The southern section of the study area is characterized by wide valleys and rolling hills. Soils in the hill slopes are composed mainly of weathered limestone residue and a thin, fine, windblown soil layer, with little organic content. On the lower slopes and in the river valleys, soils are mostly deep consolidated sediment that is fine and blue-gray to yellow with moderate to low organic content. In valleys adjacent to rivers and streams, soils contain a mixture of the described types, plus sedimentary deposits with higher organic content. Very few natural soil areas are left after centuries of farming. The soils in general are only moderately erodible as evidenced by the stability of steep uneroded slopes in areas of sparse vegetation and the relative absence of erosion gullies in exposed areas.

   b. Climate

7. Chongqing's climate is characterized by heavy fog (an average of 69 days of fog and a maximum of 148 per year); lack of sunshine; and generally low wind speeds (averaging 1.6-1.8 meters per second). The area has warm winters and hot, dry summers. Average temperatures are 17 to 18.8 degrees centigrade, and annual rainfall varies from 1,086 to 1,312 millimeters per year, with the rainy season occurring in the fall.

   c. Air Quality

8. Air quality in general is poor in the vicinity of Chongqing and improves gradually in areas toward the southern end of the route. Daily average concentration of carbon monoxide (CO) ranges from 8.9 milligrams (mg) per cubic meter (m$^3$) near Chongqing to 3.8 mg/m$^3$ in rural areas to the south. Average daily measurements of CO concentrations exceed national standards by about 1.1 times at Km 0 (the north end of the route at Chongqing); 1.0 times at Km 47; and 0.4 times at Km 73. Ambient levels of CO concentration around Chongqing are high because of pollution from industrial sources and heavy, congested vehicular traffic combined with almost continuous conditions of atmospheric inversion. Pollutants are trapped in a natural basin of the Yangtze River, and there are only low surface winds to provide dispersion.

   d. Noise Environment

9. Currently, daytime noise levels do not exceed national standards at any measuring points along the proposed routes. Nighttime noise levels exceed national standards slightly in
urban areas, by about 2.3 decibels (A)(dBA) in the vicinity of Chongqing and by about 0.4 dB(A) in Qijiang City.

e. Surface Water and Groundwater

10. The main surface water bodies are the Yangtze River, which parallels the northern section of the proposed route for about 30 km, and the Qijiang River, which crosses and parallels the proposed route at its southern end for about 20 km and flows into the Yangtze. There are no natural lakes or surface water impoundments of any significance in the study area. There are numerous small ponds used as irrigation water storage and fish ponds.

11. The Yangtze River is the main source of water of Chongqing Municipality, providing water for drinking and common industrial production. The river receives many pollutants, but the very large flow provides high dilution. The Qijiang River provides water for irrigation. Sampling data show that the pH is 6.5-8.5 (standard value), and the lead content is less than or equal to 0.05 mg per liter. Chemical oxygen demand (CODcr) and petroleum residues can meet the standards, giving a composite water quality standard of 2.42 (in a range of 1 to 4). Most CODcr contamination in the Qijiang River is from untreated sewage, while petroleum, lead, and some CODcr are from industrial sources.

12. Groundwater sources are abundant, particularly in the limestone formations of the northeast quadrant of the study area. Drinking water in rural areas is primarily from wells.

2. Ecological Resources

13. Natural flora and fauna have been severely reduced by centuries of agricultural uses of land in the area, so that there are essentially no natural areas of habitat remaining, no original species of vegetation, and no wildlife of significance. There are no sensitive areas such as wetlands, no protected natural reserves, and no protected species of plants or animals. Tree growth is mainly secondary coniferous forests (pine, fir, cypress) on the upper mountain slopes. These species are mixed with secondary bamboo forests and common subtropical plants on the lower slopes and in river valleys. Fauna is composed of common bird species, rodents and other small mammals, and amphibians in paddy fields.

3. Human and Economic Development

a. Population and Communities

14. Chongqing Municipality is divided into 9 districts and 12 towns. The major areas traversed by the proposed highway route are Chongqing Central District (the northern section of the highway); Baxian County (central section); and Qijiang County (southern section). The total population of Chongqing Municipality in 1993 was 15 million. The urban area of Chongqing is estimated to have four million people. The next largest city in the study area is Qijiang, about 80 km south of Chongqing, with an estimated population of about 200,000. Population density in the Chongqing urban area in 1993 was 4,044 persons per square kilometer (km$^2$), and overall density

\[\text{A-weighted decibels, a measure of sound weighted for frequencies heard by humans.}\]
for the municipality was 632 persons per km$^2$. About 76 percent of the people of Chongqing Municipality work in the agriculture sector, and there are about 1.3 million nonagricultural workers. The population is ethnically homogeneous, with 99.8 percent ethnically Han and the remaining 0.2 percent (about 30,000 persons) distributed among 36 other ethnic groups.

b. Industry and Economy

15. The gross output value of industry in Chongqing Municipality in 1993 was Y68,274 million. In 1992, gross national product in Chongqing Municipality was increasing at an annual rate of 13.4 percent. Per capita income in 1992 was Y1,580 and was increasing at 13.3 percent annually in real terms. Industrial output includes natural resources development, principally coal, natural gas, sulfur, gypsum, limestone, dolomite, clay, strontium, and iron. In the industry sector, the emphasis is on heavy industry. Local production includes steel, aluminum, automotive vehicles, refined petroleum, fertilizer, synthetic fibers, chemicals, cement, glass and other building materials, leather products, and textile products.

c. Infrastructure Facilities

16. The Chongqing Central District has municipal water treatment and distribution facilities as well as sanitary sewage collection and treatment. Qijiang has a municipal water supply. Most domestic water supply in rural areas is from wells. Chongqing Municipality has the capacity for producing 1.08 million kilowatt-hours of electricity per day, and most areas of the countryside have access to electric power service.

d. Transportation

17. Chongqing Municipality has 33,412 km of roads, of which 8,059 km are classified as highways. Three main rail routes and one feeder route connect Chongqing with other major regional cities, and 68 railway stations provide rail access throughout the municipality. The 12 navigable rivers in the municipality have 1,363 km of navigable waterways. This waterway network serves 30 ports, each having an annual throughput in excess of 10,000 tons (t), and many smaller terminals. Air transport is provided through the Chongqing Airport, with 40 scheduled flights per day.

e. Land Utilization

18. The Chongqing Central District is urbanized. The two counties southward through which the proposed highway route runs (Baxian and Qijiang) have a total land area of 4,725 km$^2$, which is utilized in the following proportions: cultivated land 39 percent; wooded land 23 percent; undevelopable land 15 percent; water surface area 8 percent; cities and towns 5 percent; transportation 4 percent; grassland 3 percent; gardens 2 percent; and industrial land 1 percent.
f. Agricultural Development

19. Chongqing Municipality has 7,133 km\(^2\) of cultivated land, or an average of 646 square meters per capita of agricultural population. In 1992, agricultural outputs were 5,553,000 t of grain, 627,000 t of pork, 185,000 t of fruit, 79,000 t of oil-bearing crops, 53,000 t of vegetables, 50,000 t of fish, 30,000 t of duck, 15,000 t of silkworm cocoon, 6,000 t of eggs, and 3,000 t of chicken.

4. Quality of Life

20. Table 1 shows indicators that give a perspective on quality of life factors. Figures are for Chongqing Municipality for 1993.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Number</th>
<th>Indicator</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income per capita per year (Y)</td>
<td>1,580</td>
<td>Health Services(no.)</td>
<td></td>
</tr>
<tr>
<td>Persons per household (no.)</td>
<td>4.59</td>
<td>Health agencies</td>
<td>2,633</td>
</tr>
<tr>
<td>Urban</td>
<td>3.31</td>
<td>Hospitals</td>
<td>809</td>
</tr>
<tr>
<td>Rural</td>
<td>4.59</td>
<td>Hospital beds</td>
<td>39,434</td>
</tr>
<tr>
<td>Living space per capita (m(^2))</td>
<td>7.5</td>
<td>Health technicians</td>
<td>53,076</td>
</tr>
<tr>
<td>Urban</td>
<td>7.5</td>
<td>Advanced health technicians</td>
<td>6,443</td>
</tr>
<tr>
<td>Rural</td>
<td>20.7</td>
<td>Causes of death (%)</td>
<td></td>
</tr>
<tr>
<td>Education level (%)</td>
<td></td>
<td>Respiratory diseases</td>
<td>27</td>
</tr>
<tr>
<td>Less than primary</td>
<td>31</td>
<td>Malignant tumors</td>
<td>16</td>
</tr>
<tr>
<td>Primary</td>
<td>43</td>
<td>Trauma and toxicosis</td>
<td>11</td>
</tr>
<tr>
<td>Junior middle</td>
<td>19</td>
<td>Heart diseases</td>
<td>10</td>
</tr>
<tr>
<td>Senior middle</td>
<td>6</td>
<td>Cerebrovascular diseases</td>
<td>16</td>
</tr>
<tr>
<td>College</td>
<td>1</td>
<td>Others</td>
<td>20</td>
</tr>
</tbody>
</table>

21. Per capita income is growing significantly faster than the rate of inflation. In the general vicinity of Chongqing and throughout Sichuan Province are a number of historic sites, such as the stone carvings near Dazu, and the large Buddha at Leshan. The area is also known for its mountain scenery. Even though the overall standard of living is rising rapidly, the distribution of facilities tends to concentrate on health, recreational, and cultural facilities and opportunities in the urban areas.

D. Anticipated Environmental Impacts and Mitigation Measures

1. Socioeconomic Considerations

a. Social and Resettlement Impacts
22. Relocation of people is the largest and most important type of impact that will result from the Project. Approximately 11,200 persons comprising 2,900 households will be displaced. See the Resettlement and Compensation Plan (RCP) that has been prepared for this Project for a detailed description of resettlement policies, compensation, organization, and monitoring.

23. Overall housing quality will be improved as older houses are replaced by new houses built to higher standards and will be served by water and electricity, while resettled persons will be paid cash to aid in their resettlement. Resettlement projects are now being viewed as economic development projects in the PRC, and improved living standards result. Residents generally approve of the removal of the old structures and the resultant upgrading. Families see the provision of additional housing, which allows younger members of extended families to establish separate households, as desirable.

24. However, the Project will separate communities from schools, health facilities, and other community facilities; it will also separate neighbors and families, and disrupt patterns of social interaction. Some temporary disruption will occur to schools, hospitals, and cultural facilities during construction. Institutions may experience continuing impacts from noise and air pollution. Initial surveys indicate that no schools, hospitals, or other institutions will be relocated. In addition, preliminary surveys indicate a need for removal of about 1,200 tombs. This may cause some negative social impact on the families involved.

25. It is estimated that the Project will create an average of over 11,700 jobs per year over a five-year period, approximately 70 percent of which would be in the laborer classification. Persons residing within the designated poverty areas would be provided job opportunities during construction. After construction is completed, CTB estimates that approximately 2,000 employment positions would be available for maintenance. Service areas to be constructed along the expressway will provide additional employment opportunities. Also, as new economic development zones are planned along the expressway, additional employment opportunities will arise in the service sector.

b. Production Impacts

26. The amounts and types of productive lands to be lost by Project construction are as follows: dry fields 2,489,000 m²; paddy fields 1,065,000 m²; vegetable fields 124,000 m²; fish ponds 104,000 m²; nursery land 22,000 m²; and orchards 21,000 m²; for a total of 3,825,000 m². No nonfarm enterprises (shops, factories) are located directly within the proposed highway right-of-way, and none have to be relocated. A small number will be partially affected, requiring some alteration or adjustment to accommodate the highway. The recommended alignment has carefully avoided disruption to commercial and industrial enterprises; those that will be affected will require partial alteration, but not total relocation. For example, disruption of the Chongqing Leather Factory was avoided for the most part by designing a flyover over a portion of the facilities. During construction, there may be some accidental or temporary disruption of electric power or water supply, or temporary blockage of access.

c. Transportation Impacts

27. During construction, traffic will be diverted temporarily along the existing road
network where the new highway crosses existing roads, and access to structures and roadside areas will be blocked temporarily. The existing road south of Leishendian will probably be severely congested after the new highway opens and before the receiving segment is improved to adequate equivalent capacity. This condition is expected to persist for several years before additional capacity is provided.

28. Congestion will be significantly decreased along the section of the existing road that will be parallel to the new route. This will provide time savings, decrease stress on drivers and passengers, decrease noise, and improve air quality along the existing road. Improved operating conditions on the exiting road and high design standards on the new highway will improve road safety and decrease the accident rate on the existing road. Reduction of congestion on the existing road will facilitate the operation of buses and other public transport used for short and medium distance travel on the existing road, decreasing travel time and improving the comfort level of passengers.

d. Mitigation of Socioeconomic Impacts

29. Mitigating measures for socioeconomic impacts are as follows:

(i) Removal of houses, relocation of population, and loss of productive land will be minimized by careful final route selection and design.

(ii) Provisions of the Resettlement Plan will be followed with respect to compensation, relocation, reallocation of land, training, and monitoring.

(iii) The impact of separation of communities and separation from fields and places of production will be minimized by providing 54 bridges and 57 pedestrian overpasses and underpasses, allowing crossings on an average at each 0.8 km.

(iv) The design will take into account the necessity for maintaining water flow and water storage for the irrigation system. It will maintain irrigation functioning by providing for water impoundment at appropriate places and by facilitating the flow of irrigation water under or alongside the highway.

(v) For nonfarm enterprises such as factories that will be affected, additional land will be made available for expansion of the enterprises, and loans will be available for technological improvements.

2. Air Quality

a. Construction Period

30. Dust from asphalt plants, and emissions from the operation of heavy diesel equipment will affect air quality during the construction phase. It is likely that impacts will be confined within 400 m downwind from construction sites.

31. Asphalt plants will be sited more than 400 m downwind from the nearest settlement areas. Dust suppression equipment will be installed on batch plants. Construction roads will be
watered on a set schedule depending upon weather conditions. Diesel equipment will be properly maintained, and unnecessary idling curtailed to help control emissions. To avoid the effects of air pollution, new construction will be prohibited within 100 m of the edge of the new highway.

b. Operational Period

32. The principal air quality impact during operation will come from vehicle exhaust pollutants. Monitored indicators include CO, nitrogen oxides (NOx), and lead. Chongqing averages 4.00 mg/m³ of CO daily. The methodology used in the EIA for predicting CO concentration is appropriate as deemed by an experts panel appointed by the National Environmental Protection Agency (NEPA). Average daily concentrations of CO are predicted to exceed the standard along all sections of the highway in 2010 and 2020. At 100 m from the highway, the average daily concentrations of CO are predicted to be 4.98-8.54 mg/m³ in 2010 and 5.25-8.60 mg/m³ by 2020, thus exceeding the standard by 25-115 percent.

33. The standard for NOx for Chongqing is an average daily concentration of 0.10 mg/m³. The prediction methods for NOx employed by the EIA are appropriate as deemed by the experts panel appointed by NEPA. Average daily concentrations of NOx are not predicted to exceed the standard at a distance of 100 m from the highway in any section by 2010. By 2020, average daily concentrations of NOx are predicted to slightly exceed the standard in some areas (predicted values at 100 m range from 0.10 to 0.12 mg/m³). The standard is not expected to be exceeded at a distance of 200 m from the highway.

34. Current CO concentrations in Chongqing are already quite high because of atmospheric conditions and pollutant sources; the CO level along the existing highway ranges from 4.80 to 8.25 mg/m³ (exceeding the standard by 17-106 percent). However, the pollutant levels will not be considered as significant additive factors. The new route does not closely parallel the existing route, and traffic analysis for the Project predicts a very high level of diversion of traffic from the existing road to the new highway. Therefore, to a large extent, pollution concentrations will be displaced from one route to the other.

3. Noise

a. Construction Period

35. Noise can be severe during construction resulting from construction activities in general and from operation of heavy machinery in particular. Other operations generating significant noise include concrete mixing plants, stone crushing, and stone screening plants. In addition, a significant amount of blasting is expected where rock is to be excavated and tunnels constructed. Noise intensities from these activities and equipment range from 80 to 100 dB(A) at the source. Sustained noise levels during construction are expected to exceed 70 dB(A) at a distance of 200 m from the sources.

36. To reduce noise at night, construction activities will be agreed upon by the Chongqing or local Environmental Protection Bureaus (EPBs) between the hours of 2400 and 0600 within 100 m of residences.

b. Operation Period
37. Noise impacts during operation will come from vehicular traffic. The noise standards in effect were issued in 1992. The standards for noise within 10 m of the roadside are 70 dB(A) in the daytime and 55 dB(A) at night. Beyond 10 m from the roadside, the standards are 60 dB(A) in daytime and 50 dB(A) at night. These standards are currently exceeded by a significant amount in urban areas, but not in villages or rural areas.

38. The analysis of future noise levels from road traffic indicates that noise levels generated along the new route will be fairly high. However, the net adverse impact from noise will likely decrease. The noise levels that are predicted to be generated along the new highway are not significantly higher than the current noise levels along the old road, much of which will be diverted to the new highway, thus decreasing traffic noise along the densely populated old route. Most of the new route, which does not closely parallel the old route, is through predominantly rural, sparsely populated countryside. The new route will have less congestion and fewer steep grades, which will allow for vehicle operations that generate less noise. Thus, the adverse noise impact will be less after the Project is completed than under the existing situation.

39. No schools or hospitals are within 200 m of the proposed highway, but there are residences and work places within this area of influence. The EIA lists 14 locations including villages, urban residential areas, and factories within 200 m of the highway. The two locations that need mitigation measures are Chongqing Leather Factory residential areas (at Km 4 of the highway) and the urban area of Guihan Xinchun, extending for about 3 km, from Km 9 to Km 12 of the highway.

40. The Project design will incorporate mitigation measures appropriate for noise-sensitive locations identified by subsequent survey. Solid masonry walls, earth berms, cuts in the natural terrain, and depression of the highway below the surrounding surface are effective noise attenuation methods. Vegetation screens alone do not suffice to mitigate noise. The cost of these measures are included as a part of the final design cost estimate.

4. Soil

a. Construction Period

41. During construction, erosion will occur as a result of runoff in areas of excavation, filling, or other earth disturbance. Failure to properly clean up and replant borrow areas, fill areas, and spoils disposal areas will lead to erosion. Some of the soils in the area of the highway are moderately erodible. The EIA estimates a potential area needed for disposal of waste soil to be about 234,000 m$^2$, but this needs to be confirmed by engineering analysis.

42. Borrow areas will be excavated and fill areas will be filled in such a way as to facilitate rehabilitation. The stability of slopes at cut faces will be maintained by "benching", i.e., staircase staged operation, and by installing erosion protection devices during construction such as silt barriers and sedimentation ponds. Trees along borrow pit edges will be protected. Random movement of heavy machinery at excavation sites will be prevented. Large borrow areas will be replanted or transformed into ponds. All cut slopes, embankments, and other erosion-prone working areas will be stabilized while work is going on to the extent that is feasible. All earth disturbance areas will be stabilized after earth movement has ceased at the site.
b. Operation Period

43. Continuing runoff from areas not properly resurfaced or revegetated along finished slopes of roadway cuts or embankments would lead to erosion. Long-term diversion of major drainage courses, or any significant alternation of surface water hydrology along the highway could also lead to erosion. Short-term or long-term diversion of rivers for bridge construction could lead to bank erosion unless properly carried out. Lead contamination of the soil from vehicle exhaust emissions is treated as a soil impact in the EIA, but as a resultant impact of air pollution in this SEIA (see para. 34).

44. For disposal of waste soil and rock, both the placement of the materials (not indiscriminate dumping) and the rehabilitation methods are important. Placement areas should be selected with aesthetic considerations in mind as well as for economy and distance of transport. Spoil placement areas should be designed with slopes that will be stable, considering the type of material to be placed. Rehabilitation should include surface compaction and stabilization as well as initial planting of vegetation types with root systems that will hold the soil at the early stages, then planting of trees and larger vegetation at later stages. Maintenance of highway slopes, cuts, and embankments such as watering, fertilizing, pest control, and replanting when needed should be continued. Maintenance of all such areas should be budgeted as a part of regular highway maintenance.

5. Water Quality

a. Construction Period

45. Unless hydrological studies for the design are adequate, natural drainage could be altered to induce erosion, flooding, and absorption of pollutants from areas not previously subject to flooding. In addition, local flooding could be caused by construction watering or flushing of construction sites. The irrigation flows in the paddy fields are a critical element in production. Any interruption of these flows during construction or any permanent alteration of these flows would have a direct effect on rice production.

46. Surface water or groundwater may be contaminated by improper utilization or storage of construction materials that are toxic or hazardous, such as chemicals or petroleum products. Contamination could also arise from lack of proper treatment and disposal of sewage from construction works camps. Likewise, workers need an adequate supply of safe drinking and cooking water. Groundwater could be contaminated from tunnel construction, and surface water from bridge construction (see paras. 61 to 68). Sand removal from riverbeds is not expected to have an adverse impact, because the sand will be taken from areas that have long been mined.

47. No toxic, hazardous, or harmful construction materials, including petroleum products, must be permitted to enter the surface or groundwater systems. Construction area drainage to water bodies must be controlled through settling basins or vegetated runoff areas, allowing contaminated water to be slowed or detained and the sediment or nonsoluble components to be filtered out as the water percolates into the soil.

48. To maintain adequate flow in the irrigation system, drainage installations (culverts,
side drains, bridges) will be based on hydrological studies and evaluations of irrigation flows. Contaminated highway runoff will be separated from irrigation water. Toilet facilities for construction workers will as a minimum be pit privies that are serviced and maintained, including removal and processing of sewage when they fill.

b. Operation Period

49. The principal impact during operation is expected to be surface and groundwater contamination from rainfall runoff from the highway. Roadway runoff will not be channeled directly into water courses but should be directed to detention and sedimentation basins or allowed to flow over grassed areas. This will permit fine materials to settle out, oily water to be detained, and volume and rate of flow to be reduced.

6. Plant and Animal Impacts

a. Construction Period

50. Loss of vegetation and natural habitat will occur. About 366,000 m$^2$ of forest land and 21,000 m$^2$ of orchards will be lost. The orchards will be replanted in new locations by the individual farmers with resettlement compensation payments. However, no major impact is expected on rare or endangered plants and animals, as the area has only some common species of birds, small mammals, and amphibians.

51. The highway roadsides will be replanted with a multispecies mix of local flora similar to the mix and composition in local forests. At least three times the number of trees lost to construction will be planted. This will be made a part of the highway contractor's responsibility, to be estimated and budgeted as a construction cost. Plants will be placed in the median strip, on embankments and slopes, in the inner areas of interchanges, and along the sides of the highways.

b. Operation Period

52. No major impacts to the fauna or flora are expected during operation other than the effects of vehicle exhaust emission.

7. Historic and Cultural Impacts

53. There are no known historic or cultural sites in the Project area.

8. Aesthetic Considerations

a. Construction Period

54. Spoils or waste soil areas are likely to have negative aesthetic impacts unless properly planned and managed. The Nanquan mountain scenery area (from about Km 5 to Km 29 parallel to the recommend highway route) could be damaged by route selection and design features, unless the area is avoided or design is handled sensitively.
55. The Nanquan mountain scenery area has been avoided by the route selected in the feasibility study and EIA. Any revision of the proposed route, which would entail encroaching into this area, will be carefully considered on the basis of potential adverse aesthetic impacts. Placement and rehabilitation of spoils and waste soil will be planned and executed with sensitivity to topographic and visual aspects, and will be carried out. Trees and vegetation along the highway will be well managed and be visually pleasing as well as functional.

b. Operation Period

56. No significant operational aesthetic impacts are anticipated.

9. Hazardous Materials Impacts

a. Construction Period

57. The most common hazards occur from the transport and use of petroleum products and chemicals, although occasionally problems occur with explosive, corrosive, or toxic materials. During construction and operation, there is a danger of spills in construction areas, in tunnels, on bridges, on soils, or into surface water. During construction, there is also the possibility of impact from improper usage or storage of hazardous materials.

58. During design, provisions have been included for paved side ditches, berms, channels, and detention ponds for runoff. Even though the primary function of these structures will be to control rainfall runoff, they are designed so that outlets can be temporarily blocked with soil or other materials to contain hazardous material spills. During construction, the proper transport, handling, and storage of hazardous materials, including petroleum products, will be undertaken and monitored.

b. Operation Period

59. The risk of a major spill of hazardous materials occurring on highway sections near major waterways is calculated at 0.68 to 0.99 times per year in 2020. The risk of spills occurring on the bridge over the Yangtze River is 0.18 per year in 2005, increasing to 0.43 per year in 2020. Available information indicates a substantial risk of spills. Of the freight traffic on the highway, 2.3 percent (or about 0.5 percent of total traffic) is estimated to carry chemicals which is equivalent to 40-50 vehicle trips per day in 2020, including fertilizer and petroleum products. Petroleum spills are the most likely type of spills, but other hazardous chemicals are produced and used in the area: sulfuric acid is produced in Chongqing but is currently shipped by rail. The risk of spills causing significant contamination will be less with the proposed Project than that prevailing with the existing road. Throughout its route the new highway will have paved side ditches, which are effective at intercepting runoff and preventing it from entering the soil or surface water.

60. A spill contingency plan will be prepared and put into effect. The plan will specify who should take action and what should be done in the event of spills. It will specify equipment and tools that must be available and material to be used to contain or control various types of spills. Operation and maintenance personnel will be trained to implement the plan and, in addition, management, supervisory, and administrative personnel will be trained regarding their responses
to such situations.

10. Tunnel Construction and Operation Impacts

a. Construction Period

61. Construction is proposed for a tunnel of two parallel tubes, each about 3,100 m long, between Km 14 and Km 18 of the highway. During construction, the risk of groundwater contamination from spills of hazardous materials inside the tunnel is not considered significant. Residents in the direction of groundwater flow for at least 20 km acquire their water from the Chongqing municipal supply, and do not use well water for drinking or cooking. Surface water and some pumped groundwater is used for irrigation, so there is some chance of crop contamination if groundwater is contaminated.

62. The groundwater hydrology could be altered if drilling for the tunnel taps into underground limestone caverns filled with water. Farmers use this water to supplement irrigation supply during dry periods when surface water sources dry up (but not for drinking and cooking). If the tunnel opens outflow channels that allow water to drain out of these caverns, the farmers will be deprived of this irrigation water source. There is also a possibility of soil erosion and adverse aesthetic impact if spoils from the tunnel excavation are not properly placed and rehabilitated. About 695,000 m$^3$ of soil and rock will be excavated, and this will be disposed of properly.

63. Construction will be monitored to ensure proper transport, handling, and storage of hazardous materials, including petroleum products, used in the construction process. During construction and operation, the groundwater supply drawn from limestone caverns and used for crop irrigation will be monitored to detect changes caused by tunnel construction. If changes occurs that will significantly affect the ability of farmers to produce crops, then the farmers will be compensated or resettled to areas where production has not been affected.

64. Spoils from tunnel excavation will be properly placed and rehabilitated in accordance with the principles given in para. 55. Protection from groundwater contamination caused by a hazardous materials spill or seepage of roadway runoff in the tunnel will be avoided by appropriate engineering measures.

b. Operation Period

65. During periods of two-way traffic operation in one tube, or in the event of a blockage of traffic in the tunnel, harmful or fatal concentrations of CO could build up without proper ventilation. Even under good operating conditions, diesel smoke and particulate matter can obstruct vision unless ventilation is supplied. Therefore, an adequate tunnel ventilation system will be designed, installed, and maintained.

11. Bridge Construction Impacts

a. Construction Period

66. Installation of bridges may require some river divisions, use of construction
equipment in riverbeds, transport and use of construction materials in and over water, and drilling for pilings. Downstream erosion and siltation may be caused by the river diversions. Hazardous material spills or other contaminants could be introduced into river water. Drilling for bridge pilings or piers usually uses drilling mud and produces dredge and piling hole waste material. If these materials are dumped into the riverbed or within the floodplain, fine particles will be reintroduced, and any hazardous substance in the sediment (such as mercury) could be stirred up. Navigable waterways could be blocked or their traffic flows disrupted temporarily.

67. To mitigate the likely impacts, bridge construction work in riverbeds will be done during low water conditions to the extent possible. All diversions of rivers will be executed so as to avoid erosion, and diversions will be removed as quickly as possible after work is complete. Dredge waste materials will be disposed of on shore in upland areas, not within the river or within the floodplain of the river.

b. Operation Period

68. During operation, no major adverse impacts are expected other than the risk of hazardous materials spills (see paras. 59 and 60).

E. Alternatives

69. In EIAs, alternatives usually include two levels, the first being alternatives to the Project (in this case, one alternative could be upgrading the rail line or widening the existing road, both of which would have the objectives and economic benefits of the Project). The second level of alternatives is focused mainly on technical aspects, which include route selection, engineering design, etc.

70. Seven alternative alignments were evaluated and compared in terms of their costs; transportation efficiency; and biophysical, social, and economic impacts. The alternative selected, which requires construction of a long tunnel, may contribute to slightly higher construction costs than the parallel alternative sections and will incur the potential environmental risks outlined under Tunnel Construction Impacts. However, the selected alternative is preferred because it (i) avoids the Nanquan mountain scenery area; (ii) will destroy slightly less productive agricultural land (about 0.5 percent less) than the adjacent parallel routes; (iii) will require relocation of a smaller number of people (about 5.4 percent less or about 600 fewer people) than adjacent parallel alternatives; and (iv) will avoid disrupting schools and work places. These are considered to be significant positive factors among all alternatives.

F. Environmental Benefit-cost Analysis

1. Cost and Benefits of the Project

71. Economic costs and benefits of the Project were estimated. Transport cost savings, vehicle operating cost savings, value of passenger and freight time savings, and congestion reduction cost savings were calculated. Table 2 gives the adjusted economic values based on the most current estimates.
Table 2: Economic Cost and Benefit

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Cost</td>
<td>Y1,991 million</td>
</tr>
<tr>
<td>Economic Value (at 12 percent discount)</td>
<td></td>
</tr>
<tr>
<td>Net Present Value</td>
<td>Y1,449 million</td>
</tr>
<tr>
<td>Benefit-cost Ratio</td>
<td>1.73</td>
</tr>
<tr>
<td>Internal Rate of Return</td>
<td>17.8 %</td>
</tr>
<tr>
<td>Investment Recovery Period</td>
<td>9.4 years</td>
</tr>
</tbody>
</table>

Source: Feasibility Study, 1995 prepared by XHTU.

2. Environmental Protection Costs

The difference in normal engineering and construction costs and environmental protection costs often lies in the manner in which the improvements are designed and installed, and in the sensitivity of design and construction to environmental issues. Drainage, land acquisition, and resettlement costs will be incurred irrespective of environmental and socioeconomic sensitivity. The cost of environmental protection improvements of various categories, in relationship to total Project costs, is shown in Table 3.

Table 3: Environmental Protection and Mitigation Costs

<table>
<thead>
<tr>
<th>Mitigation Measure</th>
<th>Y million</th>
<th>Percent of Economic Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering-related Drainage (preventing soil erosion and air and water pollution)</td>
<td>385.01</td>
<td>14.79</td>
</tr>
<tr>
<td>Land and Resettlement (land acquisition, resettlement, compensation)</td>
<td>132.32</td>
<td>5.10</td>
</tr>
<tr>
<td>Environmental Amenities</td>
<td>17.03</td>
<td>0.65</td>
</tr>
<tr>
<td>Pedestrian Overpasses and Crossings</td>
<td>10.27</td>
<td>0.39</td>
</tr>
<tr>
<td>Item</td>
<td>Cost (in thousands)</td>
<td>% of Total</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Planting and Landscaping</td>
<td>4.25</td>
<td>0.16</td>
</tr>
<tr>
<td>Noise Insulation Walls</td>
<td>2.50</td>
<td>0.09</td>
</tr>
<tr>
<td>Environmental Monitoring</td>
<td>2.00</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Total Environmental Sources</strong></td>
<td><strong>534.85</strong></td>
<td><strong>20.62</strong></td>
</tr>
</tbody>
</table>

Sources: Environmental Impact Study prepared by XHTU.

73. Table 3 indicates that total environment-related costs, including land, resettlement, and construction costs that would normally be included in the Project, whether they were identified as environmental or not (i.e., drainage), represent 15-20 percent of Project costs. Of this, the environmental amenities, or items without which the Project could function technically (pedestrian overpasses, plantings, noise walls) amount to 5-7 percent of total costs.

G. Institutional Requirements and Environmental Monitoring

1. Institutional Capability

74. Two types of environmental monitoring will be required: compliance monitoring and impact monitoring. Compliance monitoring determines whether (i) the contractor is complying with the conditions of the contract, and (ii) operational procedure requirements with respect to environment-related processes and activities are being met. It also determines whether the executing agency is complying with design requirements of the EIA, SEIA, and resettlement plan. Impact monitoring involves measuring environmental impacts to ensure that critical factors (such as CO levels in tunnels) are not exceeded, helps to determine whether mitigation measures should be increased or decreased, and helps evaluate impacts as an input to decisions on future Projects.

75. Two types of organizations or agencies are involved. One type is composed of environmental management agencies, which are responsible for formulating policies and implementing regulations. These agencies include (i) NEPA, (ii) Environmental Protection Office of the Ministry of Communications, (iii) Environmental Protection Department of CTB, and (iv) Chongqing EPB. The subsidiaries of these national and municipal bureaus and agencies—the Environmental Protection Department of Baxian County Transport Bureau, the Environmental Protection Department of Qijiang County Transport Bureau, the Baxian County EPB, and the Qijiang County EPB—are grassroots management agencies for the Project.

76. The other type of organization is composed of environmental monitoring agencies that gather and analyze data used for evaluating impacts and the effectiveness of mitigation programs so that the environmental management agencies can make effective decisions. These agencies include CTB and the Chongqing Environmental Monitoring Station at the municipal level; and the Baxian County Environmental Monitoring Station and Qijiang County Environmental Monitoring Station at the local level.
The staffing and technical capabilities of the EPBs and monitoring stations should suffice to carry out the monitoring program, with minor exceptions. The Chongqing Major Highway Construction Directorate, will carry out resettlement monitoring but not environmental monitoring. It will help coordinate monitoring activities among CTB, Chongqing EPB, and the monitoring stations.

2. Monitoring and Surveillance Program

The Environmental Protection Department of CTB will be responsible for preparing a detailed monitoring plan in advance of Project implementation. The assistance of the XHTU (the authors of the EIA) will be sought. The detailed monitoring plan will include (i) a description of the sampling design (location of sampling station, frequency of monitoring, number of samples to be taken each time at a given station, etc.); (ii) methods to be used in sample collection and sample handling from the field to the laboratory; (iii) the nature of the output expected in the monitoring reports; and (iv) the reporting schedule.

Chongqing EPB’s program on water quality monitoring will be coordinated with Project-specific monitoring for purposes of evaluation and reporting. The main aspects to be monitored will be the resettlement compensation plan; the siting of asphalt mixing plants, batch plants, mixing and screening plants for soil and sand, and rock crushing operations; the watering of construction roads and other construction works; and the waste disposal. The NO\textsubscript{x}, CO, and total suspended particulates will be measured twice a year for two years (in fall and summer). Ambient noise and transport noise will be measured four times per year (once each season) for five years at three major locations along the Project alignment.

During Project implementation, noise will be monitored within 200 m of residential areas, schools, hospitals, and other sensitive places once a month (once in the morning and once in the afternoon) in areas where construction is occurring. Noise will be monitored to ensure that construction is not ongoing between 2400 and 0600 hours within 100 m of residences without the local EPB's approval. Removal of kindergartens, primary schools, and hospitals that are within 200 m of the roadside, and their relocation beyond 200 m from the Project, will be monitored during the resettlement period. Other aspects to be monitored include erosion protection devices; the stabilization of borrow and fill areas and earth disturbance areas; the handling of harmful, toxic, or hazardous materials; and spoils placement, site clearance, and the effects of tunnel construction on groundwater used for crop irrigation.

A monitoring program will be established for air quality in the tunnel, including (i) continuous CO monitoring equipment, and (ii) training of staff assigned. An emergency response plan will be prepared and updated biannually. River diversions during bridge construction will be monitored to ensure that erosion is minimized and that dredge spoils and pile boring spoils are disposed of properly.

Progress reports will be prepared that summarize the results of all monitoring, and give monitoring data in a standard format. They will emphasize any significant violations of contract provisions by the contractors or any failure of the Executing Agency to implement requirements of the EIA, SEIA, or RCP. Any significant incidents of environmental contamination will be summarized, along with actions taken to mitigate them and to prevent reoccurrence.
Progress reports will be submitted to NEPA and the Bank every two months during construction and every six months during the first two years of operation. Background levels of impact (air quality, noise, water quality) will be monitored for the life of the Project (through 2020) and will be reported annually.

H. Public Involvement

83. As is the normal practice in the PRC, leaders of townships, villages, and districts were consulted and the local people were informed about the requirements and impacts of the Project. The process involved the selection of 21 villages and townships along the entire route of the Project (roughly one village every 4 km) in which to consult with local residents. Meetings and interviews were held with 36-40 people including township and village officials and others. Environmental experts familiar with the Project and with potential impacts were present at these meetings. In addition to the discussions, questionnaires were distributed, asking for comments and opinions.

84. Responses to the Project proposal were mostly supportive. The affected residents saw the Project as an opportunity to improve access and the local economy. Concerns focused on questions of route alignment and socioeconomic impacts of land utilization and relocation compensation. There was little concern expressed over physical environmental impacts.

85. Villagers desired that the route alignment occupy as little productive cropland as possible, as this land would be removed from the productive capacity of the communes. In response, the route was realigned in at least one location to avoid croplands. Another concern was that the Project should be brought closer to villages or that interchanges should be added to improve access and develop the local economy. The design changes were communicated to the villages. Still another concern was over the requisitioning of land and compensation for demolition of houses. These procedures were explained, and the residents were assured that regulations would be followed concerning the establishment of and amounts of compensation, and disbursement of payments, and that grievance procedures were available. There was little concern about moving from one location to another, since almost all of the moves would be within the same village.

I. Conclusions

86. The potential negative impacts of the proposed expressway Project are considered insignificant, provided the mitigation and monitoring function described in the EIA and RCP are followed, and that appropriate mitigation provisions are included in the contract documents. The residual negative impacts will be offset by economic and social gains for the affected communities.

87. A net reduction in adverse impacts on air quality and noise is anticipated from the relocation of traffic from the existing road which goes through densely populated areas, to the new highway, which will pass through more rural areas. The improved design standards and operating characteristics of the new highway will improve safety and reduce the frequency of accidents. The conversion of croplands to highway will not entail a net loss of productive land, but an exchange of the productive value of croplands for the productive value of transport efficiency.
The loss of croplands will be minimized by careful route selection that avoids productive lands. Residential areas will be avoided to minimize the need for relocation. Relocation will be compensated for, because people who are relocated will have improved housing and livelihood. Separation from fields and other work places will be mitigated by provision of overpasses and bridges, closely spaced. Noise barriers will be constructed in some locations. Soil erosion will be minimized by proper management of construction areas, placement and revegetation of spoils areas, and revegetation of slopes and embankments. Potential adverse impacts from air quality in the tunnel will be mitigated by designing and installing an adequate ventilation system and by continuous monitoring accompanied by an emergency response plan.