

ASIAN DEVELOPMENT BANK

SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

FOR

LIAONING EXPRESSWAY (TIELING-SIPING SECTION)

IN

LIAONING PROVINCE

PEOPLE'S REPUBLIC OF CHINA

15 May 1995

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A. Introduction

1. The Summary Environmental Impact Assessment (SEIA) of the Liaoning Expressway (Tieling-Siping Section) Project (LETP) is based on a review of the Environmental Impact Statement (EIS) prepared by the Xi'an Highway Transportation University (XHTU),¹ the project feasibility study,² extensive discussions with the senior authors of that document, a field visit along much of the proposed right-of-way (ROW), and discussions with the environment sector agencies in Shenyang and Liaoning Province³ in general.

2. In April 1992, the Liaoning Provincial Communications Department (LPCD) gave the Environmental Engineering Institute of XHTU the contract to undertake the Environmental Impact Assessment (EIA) for this project. In June 1992, the mandatory EIA outline was prepared and approved on 31 December 1992. The EIS was completed and submitted to LPCD in early March 1993 then reviewed and given preliminary approval by the National Environmental Protection Agency (NEPA) in late 1994. However, since approval the preferred alignment was modified after the EIS was completed.

3. To fill these shortfall, XHTU undertook to prepare an addendum to the document, addressing the major changes to the project since the EIA was prepared. This SEIA incorporates the new information and revisions prepared by XHTU.

B. Description of the Project

4. In order to maintain the northeastern PRC's economic growth, the transportation of goods and services must be improved. At present, the capacities of the roads and railways are exceeded, significantly reducing the region's output. Highway G-102 is the main road linking the three provinces of Hebei, Jilin, and Liaoning, and will be replaced by a controlled access toll road. The section for which this EIA was undertaken originally extended from Shenyang to Wulipo (see Appendix 1). Subsequently, the study area was shortened as the piece from Shenyang to Tieling was assigned using internal funding. The road section for which this SEIA and the revised EIS have been prepared extends from Tieling City to Wulipo, a distance of 111 km.

5. The road is proposed as a four-lane expressway linking the Shenyang to Tieling piece now under construction, with the road being built south from Siping just inside Jilin Province. The key features of the road (see Table 1) are that it will be a controlled access toll road with four interchanges, toll plaza complexes, and an estimated traffic volume of 29,000 vehicles per day.

6. The current implementation schedule calls for detailed design to be completed in 1995 and construction to begin in 1996. The expected completion date is the end of 1997. It is

¹ Prof. CaoShen Cun of Xi'an Highway Transportation University (located in central PRC), was retained by LPCD to undertake this EIA and was given full authority to complete the work. Apparently this unit was chosen since it is very experienced and is one of the Ministry of Communication supported universities.

² Beijing to Harbin Expressway (Shenyang to Siping Section) Feasibility Study Report; LPCD 1992.

³ Agencies included, Liaoning Provincial Environmental Protection Bureau, and the Chinese Academy of Science.

anticipated that over 800,000 person-days¹ of construction labor will be required to complete the roadway, most of it likely to come from within the study area. Two service zone are planned for the expressway, each with gas stations, restaurants, and hotels. Predicted average² daily traffic volumes range from 5,943 to 29,246.

C. Description of the Environment

1. The Biophysical Environment

a. Meteorology

7. The LETP lies in the northern part of Liaoning province and is subject to a temperate, continental monsoon climate. The area experiences four distinct seasons (see Table 3) and averages about 675 mm of precipitation per year concentrated mostly between June and September. In the winter there are few snow storms and the average snow deposition is less than 10 cm, with temperatures well below freezing. Critical to having a well functioning expressway is the inclusion of road design features capable of handling the meteorological conditions, the most important being surface runoff from the intense rains during the summer.

b. Topography, Geology, and Soils

8. The study area is within the Dongbei Plains, a flat and windy expanse, stretching north and eastward into inner Mongolia. The proposed roadway parallels the Donhei hills from Tieling to Wulipo (Siping) and passes through a number of hilly areas in the vicinity of Kaiyuan. About 40 percent of the new ROW will pass through slightly hilly terrain. Since the valleys have the most fertile lands, the roadway has been designed to traverse the less valuable low slopes of the hills. The average elevation is 71-127 m (Tieling to Siping) above sea level. Soils are 5-33 cm thick and, in the fertile agricultural areas, they are 30-60 cm deep and are rich with a high humic content. They are fine loessal plain material and large alluvial deposits. The area to the west of the railway line is plains with many Quaternary deposits while the east side of the railroad is increasingly mountainous with exposed or just below surface bedrock. High humic content makes the soils susceptible to water- and wind-induced erosion. In fact erosion is a major problem in the Tieling and Kaiyuan area where upwards of 30 percent of the cultivated land is now subject to serious erosion. The area south of Wulipo is slightly hilly and highly susceptible to erosion, particularly freshly disturbed cuts that are exposed to the summer monsoon rains. Since the area on both sides of the ROW is intensively cultivated, the potential for crop contamination from air and water pollutants generated by the new expressway needs to be monitored. Significant soil contamination with lead and benzo(a)pyrene(Bap), the volatized and highly carcinogenic component of bitumen, was found along the existing G-102.

c. Surface and Groundwater

9. The proposed ROW will traverse four major rivers with all but the Mangniu being crossed in their lower reaches. Dry periods are from September to May and monsoon rains occur from June through August. The rivers are all tributaries of the Liao River which drains the entire Donhei Plain into Liaodong Bay, the northern end of the Bohai Sea. All the rivers are rainfed and as such have extreme flood peaks, are very unstable, and have wide floodplains.

¹ Figure obtained from EIA addendum prepared by XHTU; secondary source the Project Feasibility Study.

² Data obtained from predictions made as part of the LPCD 1992 feasibility study and extracted from EIS, pg.118.

Since the rivers have for millennia been used as sources of sand and aggregate, they have been extensively mined without concern for the natural systems downstream. In addition, the rivers have been used as sewage and garbage dumping sites. Therefore, none of the surface water is fit for human consumption nor can it support anything but the most basic aquatic communities. Water quality samples taken at the locations where the road would cross indicated that for the 7 parameters collected (mostly inorganic), lead, oils, and Bap were of significant concern and exceeded the PRC's Level-3 standards (for industrial use only). Ambient water quality of the Cai and Mangniu rivers are considered to be seriously polluted (see Table 1).

Table 1. Average Ambient Water Quality Conditions in October-November 1992 in Three Rivers Crossed by the Proposed LETP

River Name	pH	Turbidity (degrees)	oil (mg/L)	Lead (mg/L)	COD (mg/L)	Bap (mg/L)
Cai River	7.19	16.7	0.118	2.23	5.59	0.0057
Sha River	6.84	4.5	##	3.95	2.06	0.0010
Mangniu River	6.83	9.3	##	0.79	2.01	0.0052
Level 2 & 3 Standard ^a	6.5-8.5	n/a	0.05	0.05	<15, 15	0.0025

^a Based on the PRC's regulation GB 3838 - 88 - Surface Water quality standards.

Source: Data from Liaoning Central Monitoring Station of Liaoning Environmental Protection Bureau.

10. The sampling was completed from October 14-16. Because this is an extremely short sample period, the results should not be used as a good indication of the rivers' water quality. Sampling was performed during low flow periods when groundwater discharges are normally highest. Therefore, the contamination levels would suggest that the groundwater in the study area are also contaminated.

d. Ambient Atmospheric (Air Quality) Conditions

11. Air quality sampling was completed at six stations (see Appendix 1) along the new roadway center line except for station 3, where samples were taken in the western part of Tieling City, which is not on the new alignment. Samples were taken according to NEPA procedures, and for a five-day period, four times per day. During this same time meteorological conditions were measured. For the five parameters monitored (carbon monoxide [CO], nitrogen oxides [NO^x], total suspended particulates [TSP], lead and Bap), lead exceeded the PRC standard at the Kaiyuan station 5.6 percent of the time and TSP exceeded the level 1 standard 100 percent of the time at all stations. Bap was also exceeded 100 percent of the time at the two stations sampled. From these data it is clear that the air quality in the rural ROW zone (except for Bap) meets PRC national standards. Degradation of the air quality at schools and villages along the expressway is possible and must be carefully considered when mitigation measures are being implemented.

e. Ambient Noise (Acoustic) Conditions

12. Of all the baseline investigations completed for this study, the noise analysis was the most comprehensive and the most clearly documented. There are 45 villages, 2 hospitals and 22 primary and secondary schools within 200 meters of the proposed ROW center line along its

111 km length.¹ An estimated 22,218 people live within the 400 m wide potential impact zone from Tieling to Siping (see Table 2), who in the future will be exposed to a new noise environment. For much of its length, the ROW is flanked by the Chang-Da Railway (one train every 10 minutes continuously) and the existing highway G-102 is within 400 m on the west side of the ROW. For a short distance, the ROW is between G-102 and the railway. Even with such noise generating activity, the day and nighttime noise levels in the 45 towns and villages² and the 22 schools monitored for background conditions were only exceeded in one location. The average noise levels were around 50 decibels A (dBA) during the day and 42 dBA during the night; at or below the PRC Standard Category 1.³ As most of the settled areas along the proposed ROW are small villages, their “urban” noise environment is equivalent to rural, non-industrial area levels.

Table 2. Inventory of People and Dwellings within a 400 m Wide Area Centered on the Proposed ROW Centerline

Variable	Population Numbers According to Distance from ROW Centerline			
	< 50 m	51-100 m	150-200 m	Total
No. of Villages	7	14	24	45
No. of Houses	1,555	1,452	2,591	5,598
No. of People	5,873	6,046	10,299	22,281
Ambient Noise Levels (day/night)	54/42	47/42	46/40	
PRC Noise Standard: Residential		50 dBA in day and 45 at night		
PRC Noise Standard: C 1 mixes		55 dBA in day and 45 at night		

^a Based on PRC regulation GB 3096-82
Source: Liaoning Provincial Government

f. Flora and Fauna

13. As in much of the PRC’s densely populated coastal “belt” provinces, the natural flora and fauna and most natural habitat has been severely degraded and put to “productive” uses such as the growing of agricultural crops or the production of other foods and products. The EIS indicates that there are no sensitive natural habitats, no rare and endangered flora except the wild ginseng (its distribution in the study area is unknown), and no wild animals to speak of.

14. Relatively common trees are oaks, larches, poplar, willow, Korean pine, locust, and camphor. The fauna includes a number of common bird species, rodents, and other small mammals such as the Aihu roe deer and the Mongolian hare. The EIS states that none of these species are threatened in any way by the proposed ROW but does not substantiate the claim. The EIS notes that the overall management of the natural environment has been “bad”, leading to worsening of desertification, alkalization, and the general serious loss of productive land. The few forests plantations and shelter belts have greened the countryside a bit and their management as biomass production facilities, may, in the long-term, help the natural forest recover. This is happening in some remote mountain areas of Liaoning.

¹ Data obtained from Tables 4-2-1, 4-2-2 and 4-2-3 of EIA by SHTU, 1993, pp. 30-34.

² Data source is Tables 4-2-9, 4-2-10 and 4-2-11 of the EIA Report, pp. 38-43.

³ Based on GB 2096-82.

2. Land Resources

a. Existing Land Use and Crops

15. The three administrative areas through which the ROW passes are predominantly agricultural, and 90 percent of the land is cultivated. Urban industrial land use accounts for only 2-3 percent of the land occupancy type but it provides the economic base for the region. Fertile agricultural land is scarce and all efforts need to be made to prevent taking a large amount of land out of production. Of the total 315 ha of land taken for the road, over 90 percent is agricultural, and 4 percent is forests and a variety of other land use types (see the Resettlement and Compensation Plan [RCP] for details). Land use zoning (matching the type of land use with the existing activities, so that, for example, vegetable crops, which concentrate lead levels easily, are not grown in high lead level areas) is not practiced in the PRC. However, it may be appropriate to consider taking such an approach within the expressway impact zone.

b. Mineral Resources

16. The study area is rich in mineral resources including iron, copper, zinc, and gold. There are a number of other important nonmetal minerals, the most important in this region being coal with local reserves of over 2.25 billion tons. Coal mining has indirect effects on the road construction in that designers must consider subsurface mine shafts and their influence on the stability of expressway structures. No known abandoned coal or other mining operations are being traversed by the proposed alignment.

17. Borrow sites in abandoned mining areas must be carefully excavated since they often contain highly acid drainage water that, if allowed to be released into the watercourses, could damage crops, wildlife, and people. The location of such pits was not identified by the EIA.

3. Social and Economic Environment

a. Social Profile of The Area

18. Relying on steady employment from a rich resource, food, and fuel base, the study area has a high level of prosperity. Coupled with a 98 percent literacy rate (see Table 3) the region has many of the necessary ingredients for continued economic development. Even though the area is predominantly agricultural, the major economic output is primary industry based, amounting to more than 2 times the agricultural output. The average annual income in Liaoning of Y2,860, well above the national average of Y1,800, reflects this condition. Even so, the farmers, who will no doubt be the most heavily impacted group in the ROW area, remain poor, with incomes far below the provincial as well as the national average. The RCP¹ should assist with the equitable treatment of this group of people who have the least flexibility in terms of absorbing losses, e.g., reduced growing seasons, lost crops, lost customers.

¹ Resettlement and Compensation Plan for the Liaoning Expressway Tieling-Siping Section Project, March 22, 1995, Draft No.2 Liaoning Provincial Communications Department (enclosed as Appendix 2).

**Table 3. Key Economic Indicators within the Tieling-Siping Study Area
(Data obtained from Liaoning Provincial Statistical Yearbook, 1993 (1992 data);
General Review of Counties in Liaoning Province, 1990)**

Indicator	Unit of Measure	Administrative Area		
		Tieling County	Kaiyuan	Changdu
Retail Amount of Consumer Goods	Yuan x 10 ⁴	37,440	54,221	81,063
Prov. Avg. Income	Yuan/person		2,660	
Average Income per farmer	Yuan/person	950	977	1,088
No. of Enterprises	each	6,813	3,997	8,575
Industrial Output	Yuan x 10 ⁴	156,917	198,902	164,624
Agricultural Output	Yuan x 10 ⁴	72,998	84,542	175,013
Univ. and Colleges	number	0	0	0
Technical Schools	number	1	5	5
Middle Schools	number	21	32	60
Primary Schools	number	264	362	519
Literacy Rate	%	98	97	98

Source: Liaoning Provincial Government

19. This project is totally under the direct jurisdiction of the Tieling City municipality, a mid-sized administrative region within the province. Administrative units below the city, which actually run the day-to-day functions of the area are Tieling County, Changtu County, Xifeng County, Tiede City, Kaiyuan City, Yinzhou District, and Qinghe District. Tieling municipality covers for 17,500 km² centered on Tieling and has population of 3.6 million (1990). Its economy is commodity- and grain-based with an emerging energy sector. In the PRC, this region is referred to as the "granary" that floats on a "sea of coal". There are confirmed coal reserves at around 2.25 billion tons, amounting to one-third of the province's total reserves. Tieda Coal Mine has become one of the major developing coal mines of the country. In 1989 its output exceeded 8 million tons, resulting in production exceeding Y266 million. Total cultivated land is more than 9.2 million mu amounting to 17.3 percent of the total province. In 1990, the total grain production of Tieling reached 3.75 million tons.

b. Gender Status

20. Of the total population to be resettled, about 46 percent are female and are also the least well off economically. Generally, unmarried women in the study area work in rural industrial enterprises while married women have a traditional role as family providers, and nurturers of children. Loss of work or the need to find new sources of basic staples, etc. for the families can have strong and long-term stresses on women and in turn the families they maintain. Given this situation, the RCP must give special consideration to the impact on women as employees and as home providers.

21. Therefore, the compensation payments to women should be made directly to them and should include "right-of-first-refusal" for new employment opportunities in the resettled area.

c. Economic Profile¹

22. The population falls into two quite distinct groups, the farmers, who lack many of modern conveniences, and the urban dwellers, who work in factories or local enterprises, deriving an income from industrial labor.

23. The Eighth Five Year Plan of Tieling aims at Y13.6 billion as its production value in 1995, a total grain output of 3.85 to 4 million tons, Y17 billion social output, Y8.1 gross national product (GNP), Y6.8 billion gross national income, and Y1.785 national income per capita. The population growth rate will be controlled at an annual 1.1 percent but will be kept steady at 3.8 million people by 1995.

D. Anticipated Environmental Impacts and Mitigation Measures

24. In this section the sequence for discussion of topics has been reversed from Section C, in order to address the more significant impacts first.

1. Resettlement, Social, and Economic Impacts

a. Resettlement

25. Potential impacts on people and communities in the way of and close to the ROW have been reduced through a conscious effort by the Executing Agency (EA) to consult with local community leaders and others to get assistance in identifying areas to avoid, such as densely populated areas, industries, agricultural lands, schools, and other institutional areas.

26. The EA has had to tread a fine line between economic feasibility and the reduction of social hardship. The proposed expressway will pass through Tieling City, Tieling County, Kaiyuan County, and Changtu County. A number of villages, schools, and hospitals are within 200 m of the proposed road center line and therefore fall within the environmental impact zone (Table 4).

Table 4. Distribution of Public Facilities within the 400 m Wide Expressway Zone of Impact

Admin. Region	Village		Schools		No.	Hospital		Industry Township Enterprises
	No.	Population	Middle School	Prim. School		Doctors	Beds	
Tieling County	3	6,300	-	3	1	2	2	9
Kaiyuan City	12	7,100	-	10	-	-	-	12
Changtu County	32	11,600	-	10	1	3	3	23
Total	47	25,000	-	23	2	5	5	44

27. Given that there are only four interchanges along the entire 111 km, benefits accruing to the 25,000 plus people within the impact zone (400 m wide over the alignment centerline), will not be direct but in terms of better resupply of goods, faster services, and possibly an improved public transportation system.

28. Specifically the project impacts will be:

- (i) the removal of more than 660 ha of productive farmland for use in the construction;

¹ For details on the economic condition, see the EIS addendum.

- (ii) the relocation of 2,123 people;
- (iii) the dismantling and reconstruction of 16,154 m² of brick houses and a number of other types of personal property; and
- (iv) the general disruption of their traditional movement and community life patterns of more than 20,000 people, a reduction in the ambient noise they experience, and decreased air quality.

29. Through the preparation of the RCP, the Government of Liaoning has committed to fairly compensate all direct losses (this involves only 14 percent of all potentially negatively affected people) according to a prescribed formula contained in the National Land Administration Law. It is the intention to provide enough money such that housing and basic services in the new homes will be better than what was left behind. Compensation payments for lost land will be pooled and redistributed such that the burden of lost land is shared equally within a community. Payments for lost crops will go directly to the owners (for estimated amounts see Tables 8 and 9 in the RCP).

30. The people to be relocated are predominantly farmers, therefore, until they are in production again, temporary farmlands will be provided immediately so as not to seriously jeopardize their harvests or meager incomes. However, no specific plan has been prepared. Mechanisms will also be established to provide alternative employment and livelihoods for resettled people. For example, township enterprises might be expanded to be able to employ added workers. Details of those allocations will be worked out within the town or village leading group.

31. Most of the relocation will be organized such that people will be moved within their own community, within a few kilometers of their original dwelling. The exact location of all moves has not been fixed. Jianshu Village, where the ROW will pass along its western edge, has allocated space for the relocated families on the southeastern edge of the town on community agricultural lands. The location appears to be more favorable than the present site, farther from the railroad tracks, at a higher elevation, and closer to the existing G-102. There are many unaccounted for negative effects, the most important being the social disruption of having to move into a new subcommunity and reestablish roots and a service industry that had local clients (see paras. 54 and 70-75 for suggested treatments).

32. Given the scale of the relocations in each of the three administrative areas (47, 34, and 59 families, respectively) there will be ample time to plan and complete the moves with care and tact. Schools, health services, and recreation facilities will for the most part not change for these relocated people.

33. During the construction of the expressway, large numbers of workers (over 1,000) will be needed, providing farmers in the area with off-season income opportunities. During the operation of the road, two service areas will generate small businesses and income for a wide range of industries such as food services, retailing, mechanical servicing, and lodging. The most significant long-term physical disruption aside from having to move will be the reduction in access from one side of the road to the other. This will present particular hardships to farmers who use land on both sides of the road. This will present particular hardships to farmers who use land on both sides of the road. The EA has mitigated this impact by committing to constructing 116 underpasses (about 1 every 950 m) designed to provide passage for farmers, their vehicles, animals, and any wildlife that cannot (or will not) cross the expressway. There will

be an additional 45 overpasses bringing the total passages to 161, or one passage every 690 m.

34. In addition to short-term work during construction and work on the service centers, other positive impacts of the project will include:

- (i) general reduction in travel time and fuel consumption for vehicles traveling between Tieling and Siping,
- (ii) a more reliable public transportation system for communities along the road;
- (iii) more efficient and rapid movement of goods to and from centers such as produce;
- (iv) fewer accidents (although on an expressway, due to the increased speed, those that occur are usually more severe); and
- (v) less risk of hazardous material spills.

35. It is anticipated that the entire resettlement activity will be completed within 1995 with the construction work starting in 1996 (See RCP Table 7 for schedule details).

b. Community and Socioeconomics

- (i) **Housing and Family.** The project is expected to have net benefit for housing since the PRC's policy of replacing requisitioned homes with better ones will be implemented as part of the RCP. In the PRC, there has been no evidence of the immigration phenomenon experienced on other projects in other countries. This may be because the roads are fully controlled access expressways.
- (ii) **Incomes.** Within the impact zone, incomes will certainly not decrease but in the long run will rise due to diversified employment opportunities fueled by the improved transportation system.
- (iii) **Cost and Availability of Goods.** Availability should improve as more effective and efficient transportation systems are put in place when the road network is adequate.
- (iv) **Transportation.** The public transportation system should improve since pressure on overcrowded trains will be relieved, buses will be able to travel at greater speeds, and larger buses will be able to move the public effectively.
- (v) **Health and Safety.** The expressway will permit more efficient emergency evacuations and the provision of health and medical services to distant areas.
- (vi) **Education and Other Public Services.** Unless carefully planned, the road, bringing additional workers and industry, will tax public services such as schools and recreational facilities, thereby penalizing the "host" communities. Proper planning and distribution of compensation payments (see the RCP) will be helpful.
- (vii) **Gender Issue.** Resettled women will be under far greater stress than the men as women must reestablish the various householder provider linkages vital to keeping

the family on an even keel during this stressful time of transition. Provision for such assistance in this project has not been identified.

36. Single women and women running households that are expected to move should be notified of services and funds available to them to help with their readjustment in the resettled area. To prepare for this, the EA must assign a social assistance person within each of the three counties who would be responsible for providing help if requested.

2. Air Quality

a. Construction Period

37. Dust from the aggregate production facilities, concrete mixing stations, and construction traffic; emissions from the asphalt plant; and the concentrated operation of heavy diesel equipment will affect the air quality during the construction phase. It is estimated that impacts will be confined to 300-400 m downwind of the jobsites.

- (i) Asphalt plants should be more than 400 m downwind from the nearest settlement.
- (ii) Dust suppression equipment should be installed on the aggregate and batch plants and construction roads should be watered on a set daily schedule (considering weather conditions).
- (iii) Proper maintenance of diesel equipment and curtailment of unnecessary idling will help with these emissions.

b. Operational Period

38. Given the type of modeling used by the EIA team, lead levels were predicted for the soils at varying distances from the edge of the expressway's pavement rather than atmospheric concentrations. However by simply applying the proportion increase in soils to the ambient air quality data collected for this EIA, one gets an approximation of the increases in atmospheric lead concentrations. Using this approach, atmospheric lead levels in the 400 m impact zone would range from 0.0007 mg/m³ to 0.0037 mg/m³ of air, at or far above the 0.0007 maximum acceptable for Level II locations.

39. Based on the modeling data provided, the entire 400 m wide impact zone from Tieling to Wulipo will have, by 2018, two to three times the soil lead levels considered as "serious" by Chinese specialists. By 2005, after six years of operation (assuming commissioning on January 1998) levels will have risen to "significant" pollution levels (see Table 5).

40. According to modeling, the levels of CO and NO_x from roadside to 200 m on either side were generally within the PRC's Level II air quality standards (for residential, commercial, cultural and rural production areas). The exceptions were minor (once per year) exceedences for NO_x at Fengdaogou and Changtu in 2018. However nighttime predictions were all below the threshold Level II standard. Future TSP or Bap levels were not reported on and constitute a gap in the analysis. However, since the existing TSP and Bap levels (Bap more regularly) sometimes exceed the Level II standards at present it can be assumed that the permissible levels for these two parameters will be exceeded in the future.

41. Within 200 m on either side of the road centerline, the land should not be used for leafy crop agriculture but rather for fuelwood, fiber and generally plants that will not concentrate pollutants to unsafe levels. Plant species to consider could be sunflowers, cotton, and trees such as mulberry, hazelnut, and walnut. The Institute of Applied Ecology (IAE) in Shenyang should be consulted to assist with the development of a planting plan. Such a plan would have a secondary benefit by providing a visual barrier and (with time) a wind and noise attenuation structure. Should the PRC eliminate lead as a fuel additive within the next few years, this pollution concern will not be an issue for the future.

3. Noise

a. Construction Period

42. Noise impacts during construction can be severe and result from construction activities in general and particularly from the operation of heavy machinery. Machinery commonly used in the PRC includes excavators, bulldozers, graders, stabilizers, and rollers. Noise intensity from these activities ranges from 80-100 dBA. Noise levels during construction will, during the day, exceed 70 dBA at 200 m from the source and 55 dBA at 500 m during the night.

43. Special noise generators will include concrete mixing plants, stone crushing and screening plants, and materials storage and warehouses (noise from the latter two sources generally comes from the moving of materials, heavy equipment, electronic sounds, etc.). To reduce night noise, work hours should be restricted to 06:00-07:00 to 21:00-22:00, and the special noise generators should be located at least 2 km from the nearest community or service area such as restaurants, hotels, or tourist sites.

b. Operational Period

44. Although serious future (2005 and 2018) noise exceedences were predicted in the EIS, names and locations were not provided. This is a significant omission from this document. Secondly, it appears that the fact that much of the road will be elevated above grade by 2.5-3 m and as such will help to broadcast noise was not added into the noise prediction equations making most estimates low by as much as 20 percent.

45. By 2005, daytime noise level limits may have been exceeded in 11 villages, 13 schools and 1 hospital, subjecting more than 10,000 people to excessive noise levels. At night these numbers may drop if traffic volumes drop at night on the expressway. Therefore, 4 villages and 3 schools may experience excessive noise levels. By 2018, these numbers may have risen to 14 villages, 14 schools, and both hospitals in the daytime, affecting about 16,200 people; and 20 villages, 12 schools, and both hospitals at night, affecting some 18,500 people, about 12 percent more than during the day. The predicted 2018 noise level exceedences at night are considered serious.

- (i) Noise calculations should be checked to confirm that the proper road grade configuration was assumed and, if not, the new noise levels estimated.
- (ii) All sites where noise levels may exceed standards should be identified and an appropriate noise mitigation measure planned for each site. These measures should include barriers, berms, tree/vegetation plantings, and soundproofing of buildings with acoustic glass and better walls, or depressing the road grade and cossetting as part of the final design cost estimate.

4. Topography, Geology, and Soils

a. Construction Period

i. Borrow Pits

46. Construction of the road will require at least 5.4 million m³ of borrowed fill material (this is net, minus the available cut materials). Such quantities will be obtained from the hills along the construction corridor. If unprotected and poorly managed, the borrow areas could trigger serious erosion, cause chronic siltation, generate dust, and become a permanent scar on the land. Therefore, all borrow areas should be located to be as minimally intrusive to the local community of the road users as possible. They should be excavated in such a way as to facilitate rehabilitation, e.g., by maintaining slope stability at cut faces by “benching” and installing erosion protection devices as needed and protecting trees along the pit edge and preventing random movement of heavy machinery at the extraction site, and not left open after the construction period is finished. Large borrow areas should be replanted or transformed into ponds or compost production facilities.

ii. Soil Erosion

47. Given the high rainfall during the peak construction season months, erosion rates will be extremely high. The EIS authors predict rates of 76, 93, and 103 tons/yr/ha for the Tieling, Kaiyuan, and Changtu areas, respectively. This is in comparison with an existing rate of 9.8, which means that, during construction, the potential erosion rates will be almost seven times greater than during preconstruction, taking place primarily at side slopes, borrow areas, and unprotected cuts and fills. All cuts slopes, embankments and other exposed erosion prone working areas must be stabilized while work is going on or within two days after all earth movement has ceased as a site.

b. Operational Period

48. No significant impacts on the topography, geology, and soils is expected during the operations period unless more fertile soils (agricultural land) are used for housing development along the road toll plazas and rest areas (strip development).

5. Surface Water and Groundwater

a. Construction Period

49. The proposed roadway requires 14 bridges, each over 125 m long, plus 40 minor bridges and 59 culverts. These installations will require diversions for the larger projects, construction equipment in the riverbeds and the transport and use of construction materials in and over the water surface. The Chinese technique of drilling and excavating the many pilings¹

¹ In order to get a first hand view of the management of these waste materials, a site on the Hue River near Shenyang was visited. There, the dredge materials were being dumped into backwater areas of the main river channel and allowed to percolate back into the river's water table. Although the fines were confined, as it was the dry season, at the onset of the rains and floods all these material would be washed

needed to support the bridge piers uses drilling mud and produces large quantities (120-180 m³ per hole) of dredge and piling hole waste material, which historically has been simply dumped into the riverbed or within the floodplain, permitting reintroduction of fine particles as well as any hazardous substances in the sediments into the water. If in-river work is done during the wet season, accidental spills, serious erosion, and other contaminants could enter the watercourse accidentally.

50. Over 1,000 people are expected to work full time on the project for the two-year period and will produce from 40,000 to 60,000 l of sewage per day.¹ Historically this sewage has been managed by provision of sewage pits, and as these facilities fill, the sewage is removed, mixed with soil, and used as fertilizer. Where more than 100 people are located, this approach may allow for significant spillage and overflows to occur.

51. Natural drainage of the area will be significantly modified by the road, which will act as long earthen dam, channeling runoff to the pedestrian underpasses and the rivers. Wherever possible, the drainage (it is generally from northeast to southwest, across the roadway) should not be hampered to the point where flooding patterns or background soil moisture levels are permanently altered.

- (i) Bridge work in riverbeds should be confined to the period from September 15 through May 1, the period with low and minimum flow conditions. The smaller rivers will be completely dry during this period. Wet period (June-August) bridge work should be confined to bridge superstructure or abutment work but if absolutely essential, dewatering techniques should be implemented at work sites.
- (ii) All toxic, hazardous, and harmful construction materials (caustic and acidic substances, petroleum products, heavy metals, etc.) must be handled so that they do not enter the water system. They should be stored away from watercourses and provided with soak pits to contain accidental spills.
- (iii) All toilet facilities should as a minimum be pit privies, which are serviced and maintained, including removal and processing of sewage as they fill, according to a defined schedule. At sites where more than 20 people are working continuously (e.g., on bridges near rivers), more effective sewage management, such as biogas digesters should be installed. The PRC Ministry of Agriculture's Biogas Institute in Beijing is a world authority in this field and has vast experience installing and operating systems of all sizes. The advantage here is that fuel for cooking, heating, and lighting could be produced as the waste is being treated.
- (iv) All diversions must be planned and executed so as to avoid erosion and must be removed and the river rehabilitated as quickly as possible after the work is completed.

downstream and any hazardous and toxic (nonwater soluble) materials, e.g., mercury would be resuspended.

¹ These figures are based on a per person production rate of 40-60 liters/day x 1,000 people (extremely conservative values in relation to other regions of the world).

- (v) Construction area drainage to water bodies must be controlled through the preparation of settling basin or vegetated runoff areas, allowing the contaminated water to be slowed or detained and the sediment and other nonwater soluble components to be filtered out as the water percolates into the surrounding soils.
- (vi) Dredge waste materials and drilling muds must be disposed of on shore, not within the river's high waterline area.
- (vii) To maintain adequate surface and subsurface draining, drainage installations (culverts, bridges, and underpasses) will be frequent (at least every 400 m) and based on hydrological engineering studies completed as part of the project.

b. Operational Period

52. Operational period impacts will likely be limited to direct roadway surface drainage into watercourses, improper maintenance of erosion protection works, inadequate management of solid and liquid waste for the permanent offices (at least five) along the expressway, and inadequate accidental spill management.

- (i) Roadway runoff should not be placed directly into watercourses, but allowed to flow over grassed or pervious areas in order to permit the settling out of fine materials, detention of oily water, and reduction in volume and rate of flow. This can be achieved through detention basins/depressions, and should be planned as part of the earthworks design.
- (ii) Erosion protection works, such as grassed or retained slopes, will need regular maintenance and inspection, particularly during the first year in operation, to be sure that the erosion protection measures are functioning (e.g., plants are still alive and adequately watered).
- (iii) Solid waste and sewage at permanent expressway offices should be managed through the installation of biogas digesters and/or other equally effective treatment systems as well as solid waste management through a contract for pick up and reuse and recycling.
- (iv) A spill contingency plan will be prepared giving clear instructions as to who has authority to act, what to do, and who must act in the event of a spill of the major hazardous materials carried on the expressway. The plan will be distributed to all key maintenance personnel and will be known to all expressway management staff. An experienced international consultant should be retained to prepare such a plan.

6. Flora and Fauna

a. Construction and Operational Period

53. Since the soils in this area are highly erodible, stabilization with plant material, will be necessary soon after work ceases. The use of fast growing local grasses, shrubs, hedges and trees is recommended. About 15,000 trees (mature, young, and flowering) and more than 400 ha of wooded lands will be lost to the project within the construction area of the expressway.

Most of these are owned by individuals, who will be compensated according to the RCP (see Tables 8 and 9 of RCP). The natural fauna, aside from the rodents, small mammals, and birds has long ago been eliminated; however, every effort should be made to not aggravate further the steady decline in available habitat. In addition to the compensation described in the RCP, replanting of trees along the ROW should be increased by at least 3-4 times the number of trees removed, since the survival of tree plantings is at best one in every four. Trees not only provide fiber, fuel, and food but reduce noise and erosion. They may help to re-create habitat.

7. Mitigation Measures

54. In Table 6 all key mitigation measures proposed are summarized.

Table 6: Summary of Mitigation Measures Proposed and Assignment of Responsibility

Area/Issue	Environmental Mitigation Measure	Implementor	When	Monitor
Resettlement and Sociocultural disruption	Prepare an RCP that is based on the PRC's Land Administration Law and implement this plan through a fair and careful set of steps, compensating the communities and people for their losses.	LHHCH has already completed the RCP and is starting to implement it.	1995 (d)	LPCD and the Bank
	Provide grievance mechanism so that local people who are experiencing economic hardships as a result of the resettlement	LHHCH and LPCD	1996-2000 D, C & O	LPCD and the Bank
Asphalt plant emissions	Site plant more than 400 downwind from nearest settlement.	LPCSDI, LPCD plan it. The Contractor must implement it.	1995-1997 (D & C)	LHHCH and LEPB
Dust	Dust suppression equipment to be installed on aggregate and concrete batch plants and construction roads to be wetted down according to schedule.	Contractor	1997-1998 ©	LPCD, LHHCH and local environmental protection unit
Diesel exhaust	Maintain all diesel equipment such that exhaust emissions remain within national standards; do not permit excessive equipment idling.	Contractor	Starting in 1997	LPCD, LHHCH
Lead contamination of roadside soils	Restrict land use within 200 m of the centerline to fuel and fiber production agriculture due to potential for chronic lead and other toxic contamination.	LPCD in association with Agriculture Bureau	EMB (O) starting in 1999	LHHCH in collaboration with LPCD, LEPB
Noise	Reduce future night construction noise by restricting work hours to between 06:00 and 21:00.	Contractor (C)	1995	LHHCH/LPCD
Noise	Locate special noise generators such as crushing plants at least 2 km from nearest community.	Contractor (C)	1996-1997	LHHCH/LPCD
Noise	Identify all communities, schools and public places where future noise levels are predicted to be excessive and plan and install noise reduction measures	LPCDI (D), Contractor (C)	1995 and during construction and early operation	LHHCH, LPCSDI And LPCD
Borrow areas	Locate borrow areas so that they are minimally intrusive to local communities.	Contractor (C)	1996	LHHCH, LPCD
	In preparing and carrying out the extraction consider best way to rehabilitate by stockpiling topsoils etc	Contractor (C)	1996-	LHHCH
	Transform large borrow areas into ponds or compost production facilities	Contractor (C)	1997-98	LHHCH
Soil erosion	Stabilize cut/exposed slopes at all	Contractor	1996-98	LHHCH

	times (max.2days after construction) highly erosive local soils.			
	Revegetate all disturbed areas as quickly as possible after construction	Contractor (C) EMB (O)	1996-1998	LPCD
Construction work in rivers	Bridge construction in rivers should be confined to Sept. 15-May 15, or use dewatering methods.	Contractor	1996-98	LHHCH
Construction area drainage	All drainage from the work areas to water bodies must be controlled through the preparation of settling basins or vegetated runoff areas.	Contractor (C)	1996-98	LHHCH and LEPB
Erosion protection works	Maintain erosion protection works through scheduled management and reporting	Contractor (C) LHHCH (O)	1996-98	LHHCH
River diversions	Diversions planned to minimize erosion and for as short a time as possible – rehabilitate as soon as possible after removal of diversion.	Contractor (C)	1996-98	LHHCH, LEPB
Sewage treatment and solid waste management	Construction camp sewage to be managed through pit privies and, for areas with more than 40 people, septic tanks or biogas digesters. Solid waste managed through contract with local waste reuse and recycling agent.	Contractor (C) Contractor (C)	1996-98	LHHCH, LEPB
	During operations all permanent facilities will have sewage treatment and solid waste management as above	EMB (O)	1998--	LPCD and LEPB
Accidental spills	A spill contingency remediation plan will be prepared, specifying who has the authority, what to do in the event of an accidental spill. It should be known to all engineers and managers involved in expressway.	EMB(O)	1998	LPCD and LEPB
Removal of trees	Replant all trees taken at a rate of at least 4 for each one taken.	Contractor (C) EMB (O)	1996	LHHCH & LPCD

Legend: D - Design LHHCH - Liaoning High Grade Highway Construction Headquarters
C - Construction Period LEPB - Liaoning Provincial Environmental Protection Bureau
O - Operational Period LPCSDI - Liaoning Provincial Communication Survey and Design Institute

Source: Liaoning Provincial Government

8. Risk Analysis

55. A cursory risk assessment of the probability of accidental spills was made using the standard spill probability approach. Parameters and constants used in the equation were not documented and sources varied from the PRC to 1974 values from the United States. On that basis, the findings showed that up to 2005 the risk of an accidental chemical spill on the expressway would be 0.49 times per year or one every 2.2 years. For the period from 2006 to 2018, the rate was estimated to be 0.91 or about one per year. To deal with possible spills, a spill contingency measure plan is being prepared in addition to the implementation of a number of preventative measures including speed limit enforcement, signage on trucks, and better notification of the transport of hazardous and toxic chemicals. In reality, the most practical mitigating measure will be a properly prepared and distributed spill contingency plan.

E. Alternatives

56. In EIAs, alternatives usually include two levels: the first being alternatives to the project (e.g., in this case, one alternative could be upgrading the rail line or widening the existing road), and the second could be alternative alignments and engineering designs.

57. Three alternative alignments (see Appendix 1) were examined and compared in terms of their cost; transportation efficiency; and biophysical, social, and economic impacts on the community. The preferred alternative was selected because it was the shortest route, required the least amount of resettlement, and removed the least amount of agricultural lands. The adopted alignment was planned to avoid cultivated lands by routing it along the edges of valleys where soil fertility is low and land is often not used. It also eliminated the lowest percentage of industrial enterprises. However, in terms of overall cost it came in at midway between the three proposals. Major problems with the first alternative were that its routing required the removal and replacement of the No. 325 Relay Station of the TV and Broadcasting Bureau and the construction of a major flyover over the Changtu Fuel Company Coal Storage yard, resulting in a large cost increase. The second alternative, taking a routing completely to the east of the existing railroad, was rejected since major resettlement would have taken place in three communities in the Liaohaaitun to Zhoggu section, two commercial livestock operations would have required relocation, and the road would have been 4 km longer than the chosen alignment.

58. The adopted alternative avoided the two installations in the Tieling section plus the houses in the vicinity of Tieling. The route from Wangguangfu northward will be identical to that of the first alternative (see EIS Addendum for details). In terms of overall impacts, costs, and benefits, the adopted alternative is the best choice.

F. Environmental Benefit Cost Analysis

1. The Benefits of Environmental Mitigation

59. With an estimated 25.4 percent internal rate of return,¹ this project's payback period is 12 years. Furthermore, an economic benefit cost ratio (EBCR) of 2.17 underscores the value of this investment and in turn its viability, at least from an economic standpoint. The major economic benefits over a 20-year projection period are given in Table 7.

Table 7: Economic Benefits

	Yuan
Tolls	11.1 billion
Reduction in unit traffic cost, e.g., fuel and maintenance savings	1.5 billion
Reduced travel distance, when compared to G-102 (fuel and use savings)	1.5 billion
Gained opportunity costs, i.e., time to do other things	0.9 billion

Source: EIS prepared by the XHTU.

¹ Obtained from the economic analysis completed as part of this study.

60. The following are a number of direct and indirect benefits from the expressway and the environmental mitigation measures:

- (i) Since the expressway will significantly reduce the volume of traffic on G-102, the noise environment should improve dramatically. As a result, fewer noise mitigation applications will have to be funded. Conversely the installation of noise barriers along the new expressway will reduce noise-induced stress in people, increase productivity, and at the same time reduce overall health costs of premature hearing loss.
- (ii) The faster overall traffic flow on G-102 as a result of less congestion and the high speed on the expressway will be the main reason for the overall reduction in the CO loading to the local atmosphere from exhaust gases. Predictive models showed that without the new expressway diverting a large amount of traffic, the G-102 airshed would have been seriously polluted beyond PRC standards by 2018.
- (iii) Erosion protection measures costing around Y893,000 are small indeed in relation to the cost of erosion, even for relatively small areas since that cost is a one-time expense whereas eroded soil never returns and economic losses continue every year in terms of lost production as well as rehabilitation. The many lessons learned around the world underscore the fact that preventative mitigation measures are far less expensive than repairs.
- (iv) Sewage treatment and the possible application of biogas technology could have multiplier benefits by treating the sewage, producing a clean burning fuel for cooking and light, preventing the contamination of water with bacteria and other pathogens, reducing the chances of local well contamination from tainted field runoff, and possibly introducing an income generating and environmentally-friendly technology to Liaoning.
- (v) The benefits of training are building a critical mass of knowledgeable and committed people. These people will maintain and improve the environmental investments but, more importantly, will help the contractor and the EA to become more aware of and conversant in practical environmental management as it applies to transportation projects.

61. These benefits clearly indicate that the mitigation measures proposed will be cost effective as long as the facility or process (once installed or initiated) is maintained. If compliance is not committed to, most measures will fail.

2. Costs of Environmental Mitigation

62. Capital and operating costs (see Tables 8 and 9) of putting in place and executing the environmental specifications in the EIS suggest that total environmental protection of Y73.9 million for capital and training expenses (excluding annual operational costs), would amount to only 0.04 percent of the total cost. The largest single item is the resettlement and compensation (RC) payments which amount to Y70.2 million (under revision as of April 1, 1995). A number of the costs are listed here for clarity but have not been included in these totals since they are more appropriately credited to the engineering costs (e.g., dust control equipment and stormwater control works and erosion protection measures).

Tables 8: The Capital Costs to Implement and Maintain Environmental Standards and Apply Protection Measures

No.	Item	Quantity	Rate (Y)	Amount (Y)
1.	Environmental Assessment	One	-	900,000
2.	Erosion Protection Works <ul style="list-style-type: none"> Slope Stabilization Works Slope Revegetation 	93 km	103,752.69	12,160,000 ^a
3.	Storm Water Management (including standard engineering works) <ul style="list-style-type: none"> Sediment Traps for Runoff During Construction Operational Period Runoff Detention System 	88 km	286,352.27	25,199,000 ^b
4.	Rehabilitation of Borrow Areas (estimated by consultant)			No budget item for this
5.	Noise Attenuation Measures: <ul style="list-style-type: none"> Berns, Barriers, Walls Plantings Acoustical Insulation 			300,000
6.	Sewage Treatment Facilities: <ul style="list-style-type: none"> During Construction at Camps and Worksites For Permanent Facilities During Operation 			500,000 no budget item for this
7.	Traffic Accident Response Equipment			300,000
8.	Environmental Monitoring Equipment			500,000
9.	Pedestrian Underpasses (included as Ref.No. 37 of Construction Costs)	1,896 m (116)	529,293.1	61,398,000 ^a
10.	Training <ul style="list-style-type: none"> Environmental Technician Environmental Manager 			50,000 (budgt increase needed)
11.	An Environmental Monitoring Station			No budget item for this
12.	Road Dust suppression Equipment (include in Ref.No. 1 of Construction Costing	3 (trucks)	100,000	300,000 ^a
13.	Asphalt/Batch Plant Dust Suppression Equip.			No budget item for this
14.	Engineering Costs for Environmental Traffic Control	-		150,000
15.	Resettlement and Compensation (RC)			70,194,954 ^b
16.	Afforestation of Berns, Prep. Of Retaining Walls and Interceptor Dikes (along new expressway).			1,000,000
	Environmental Costs Minus RC			3,700,000
	Environmental Cost (Capital Investments)			73,894,954
	Environmental Costs Including Items Marked as Included Construction in the Cost Estimates			172,951,954

^a These items are all included in the construction cost estimate.

^b These costs are now under revision due to changes to PRC law. The final draft will include new figures. Source: EIS prepared by the XHTU and Preliminary Design Document estimated by LPCD.

63. The budget for the training however does require careful review since, when compared to other projects similar to or slightly larger than this one, the amount (Y 50,000) is extremely low: an amount 4 to 5 times higher would be appropriate. Even with such amounts, international training, either from sessions held in the PRC or elsewhere would be unlikely. Annual environmental protection costs were not specified in the EIS document nor have they been established in the existing information to date.

Table 9: Annual Environmental Protection Costs During Construction and Operating Periods^a

No.	ITEM	COSTS (Y)	EXPLANATION
1.	Construction Period: Maintenance of erosion protection works, e.g., replanting and watering, storm water management system, sewage treatment, and solid waste disposal systems for new road.		Sewage system costs Y30,000/yr/ system for two systems for 2 years.

2.	Operating Period: Maintenance of erosion protection works, e.g., replanting and watering, storm water management system, sewage treatment, and solid waste disposal systems for new road.		Sewage system costs Y30,000/yr/ system for up to 5 systems (4 toll plazas and one administration office).
3.	Construction Period: Dust suppression operation and maintenance for roads and materials processing plants.	Included in Ref. Item 1 of Construct. Costs	Included under unclassified earthworks in the construction costing information.
4.	Construction period environmental tech. (Contractor) wages	7,200	Y3,600/person per year for 2 technicians
5.	Construction period environmental manager/monitor (LHHCH) wages	10,000 8,000	Y5,000/person per year for 2 monitors Y8,000/person per year for 1 manager
6.	Operating period environmental manager wages	8,000	Y8,000/person per year for 1 manager
7.	Operating period environmental monitor wages	10,000	Y5,000/person per year for 2 monitors
8.	Construction period lab costs		
9.	Operating period lab costs		
10.	Construction period management of environmental matters	105,000	Includes all processing and office costs; based on pro rata of Hebei costs for 195 km road.
11.	Operating period management of environmental matters	158,000	Includes processing and office costs; based on pro rata of Hebei costs for 195 km road.
TOTAL			

^A Cost based on averages taken from three PRC studies at several locations.
Source: EIS prepared by the XHTU.

64. The following budget items should be added to the capital costs:

	<u>Yuan</u>
(i) borrow area rehabilitation	600,000
(ii) STP for permanent facilities	1,000,000
(iii) environmental monitoring station	1,500,000
(iv) dust suppression for asphalt plant, etc.	300,000
(v) added to training	250,000

G. Institutional Requirements and Environmental Monitoring

65. This section describes the existing and required institutional capacity of the contractor and the Liaoning Highgrade Highway Construction Headquarters (LHHCH) and LPCD to undertake the environmental monitoring and management functions for this project. Secondly this section summarizes the proposed monitoring and surveillance program.

1. Institutional Requirements

66. To undertake a competent environmental effects and compliance monitoring program, four ingredients must be in place with the EA:

- (i) a management that believes in environmental management and monitoring;
- (ii) skilled environmental monitors/analysts who understand the purpose and implications of environmental degradation and who are committed to undertaking a thorough job;
- (iii) a clear system of reporting and method for responding to problems, compliance failures, etc.; and

- (iv) a system for collecting and organizing information quickly¹, permitting the monitor to see trends and prepare information rich reports that address important issues succinctly and can trigger action by managers.

67. Neither the LPCD, the LHHCH, or the EMB possesses the skills to begin to undertake this work. Furthermore, transferring responsibility for this work to the Liaoning Provincial Environmental Protection Bureau (LEPB), as has been talked about, needs to be seriously considered. That agency seems extremely overworked and this approach would defeat the objective of putting a few people into LPCD who could act as an interface with the environmental specialists from LEPB and their Central Monitoring Station. The Institute of Applied Ecology, Chinese Academy of Science in Shenyang would be an excellent source for training and technical assistance.

68. Secondly, skills also need to be with the various contractors who, for up to two years, will be executing the mitigation measures prescribed in the EIS and undertaking many tasks that, if poorly completed could make the environmental investments meaningless.

69. Therefore,

- (i) the contract documents should clearly set out the contractor's obligations to undertake environmental mitigation and monitoring activities (the contractor must prequalify on environmental grounds);
- (ii) the LHHCH and LPCD should jointly retain two experienced environmental monitors or nominate for training two people with requisite skills according to NEPA guidelines;
- (iii) the LPCD should retain or train an environmental manager, who will be responsible for overall reporting on project monitoring and interface with the LEPB;
- (iv) all monitors should be given a strong mandate to carry out their work and supplied with basic equipment to permit rapid turnaround of information, reporting, and action; and
- (v) the LHHCH and EMB must prepare a monitoring and reporting schedule as well as a clear reporting system for the monitor for the construction and operational period; the monitors, technicians, and the manager should be provided a training program with NEPA or another recognized environmental organization² in monitoring technology, information analysis, and environmental management principals; and this would be followed by on-the-job training in field monitoring and environmental compliance monitoring.

2. The Environmental Monitoring Program

¹ A rapid collection system using an electronic notepad and Global Positioning System (GPS) technology, as well as a customized spreadsheet, was demonstrated by the environmental specialist but was judged unnecessary by LPCD at the time.

² The Institute of Applied Ecology of the Chinese Academy of Science is a world class organization of more than 500 people, located in Shenyang, with all technical and training skills available to provide expert advice to LPCD, LHHCH, and EMB on all environmental matters.

70. The environmental mitigation and monitoring requirements for the construction of the expressway are to be included as specifications in the construction contract. The provisions will include measures to: (i) prevent and reduce erosion at all work sites at all times; (ii) properly manage and dispose of all sewage and waste such that it does not create health and disease problems; (iii) protect water bodies; and (iv) reduce noise through the construction of berms, barriers, and special plantings. Additional mitigation measures will include the construction of 116 pedestrian underpasses to reduce the problem of separation in communities between each side of the alignment and facilitate access to fields and pastures by farmers. Finally the ROW will be planted with a variety of trees to provide a pleasing visual barrier and to suppress noise and dust.

71. The monitoring will consist of two types: effects monitoring and compliance monitoring. Effects monitoring is done to track the level of certain pollutants as the road becomes operational with a view to making adjustments (to reduce or increase to the mitigation measure) as the data are obtained. Compliance consists of surveillance to check whether the letter of the contract is being met by the contractor and the EA (during the operational period).

72. The timing of the monitoring is important since it will have to be started at different times and continued in the case of the operational period through 2017. Broadly, the compliance monitoring will be done whenever mitigation measures are to be implemented throughout the construction and the operating period. Effects monitoring will be done every few months during construction and 1 or 2 times per year for the operating period. Monitoring for the RCP will have to start in 1995 since resettlement is scheduled to start in July 1995. Monitoring during construction will begin in 1996 and the operational phase in 1998. The effects monitoring will be completed by the Environmental Monitoring Station (established as part of the mitigation program) under the LHHCH and therefore reporting could be directly to the LHHCH managers.

73. The construction contract documents will list all required mitigation measures and a timetable for the compliance monitoring of these activities. The effects monitoring will be based primarily on the key pollutants that the EIS indicated as potential problems. These parameters were lead; Bap in air, soils, and agricultural products; TSP; noise; erosion; surface water and groundwater contamination (bacterial and construction materials). Table 10 presents the monitoring schedule as proposed in the EIS Addendum.

Table 10: Compliance and Effects Monitoring Program for the Resettlement (1995), Construction (1996-1997) and Operational Period (1998-2018) of the LETP (details found in EIS Addendum, 1995)

ITEM TO BE MONITORED	MONITORING DETAILS	TIMING	EXECUTING UNIT	REPORTING REQUIREMENT
RESETTLEMENT AND COMPENSATION PLAN				
Resettlement notification	Monitor if adequate time and information is provided to displaced people regarding the timing, relocation site, etc.	Interview once every month at a resettlement site chosen at random	LHHCH	Short reports should be filed after each interview with LPCD.
Compensation payments	Compare item, amount, schedule of payment in relation to contract and RCP implementation schedule prepared by LHHCH.	Random checks three times during the RCP period	LHHCH	Include statement as part of monthly RCP reporting.
Host community preparation	Determine extent to which hos community was consulted regarding resettlement.	Interview 3 locations during year	LHHCH	Include as part of RCP report to LPCD.
Reinvestment and use of communal	Examine financial stability of enterprises and other investments of compensation	Conduct informal financial audits 6,	LHHCH	Prepare informal audit statements

compensation payments	payments by communities	18, and 30 months after investment		regarding effectiveness.
ROAD CONSTRUCTION PERIOD				
Construction noise	Measure construction noise at varying distances from sources and near sensitive structures (schools).	Measure once every two weeks.	The new Environmental Monitoring Station of LHHCH	Include in Quarterly Monitoring Results Report to LHHCH and LEPB.
Air quality	Measure the area around sources and a prescribed receptors at various distances.	Same as above	Same as above	Same as above
Water Quality (surface and groundwater)	Collect samples at specific points for cretin prescribed testing.	Same as above	Same as above	Same as above
Erosion protection	Inspect whether erosion control measures are in place and functioning as specified.	Inspect sites as required by compliance monitoring schedule	Same as above	Same as above
Sewage treatment	Inspect functioning sewage treatment system as safe disposal of waste materials according to contract.	Same as above	Same as above	Same as above
Dust suppression	Inspect if schedule for dust suppression is maintained and is effective also for specific dust point sources (e.g., batch plant).	Same as above	Same as above	Same as above
ROAD OPERATIONAL PERIOD				
Noise	Monitoring at schools, hospitals, and villages	Two times each year	EMB and LPCD	Prep. annual monitoring report; copy LEPB, municip., county, village officials.
Air	Same as above	Two times each year (Summer and Winter)	Same as above	Same as above
Soils, crops	Lead content of soils from 30-400 m from road centerline.	One time each year in 1998, 2005, 2010, and 2017	Same as above	Same as above
Water quality	Sample water above and below two large bridges	One time in dry and once in wet season each year.	Same as above	Same as above
Erosion	Confirm compliance with EIS commitments.	Two times per year	Same as above	Provide as section in annual monitoring report.
Sewage and waste	Same as above	Same as above	Same as above	Same as above

74. Finally, if the effects of monitoring is to be successful a monitoring plan must be prepared by the EA in advance of project implementation. The requirements of NEPA's monitoring specifications must be used as the key guiding document. A monitoring plan¹/schedule should be prepared by LHHCH and EMB before the work begins and should:

- (i) contain a description of the sampling design, i.e., location of sampling stations and frequency of visits and number of samples taken each time at any station;
- (ii) define the method of collection and sample handling from the field to the lab; and
- (iii) describe the organization and type of output expected in the quarterly monitoring report and include a reporting schedule.

¹ The Institute of Applied Ecology could guide in the projection of such a plan.

75. The procedure for reporting and acting on any environmental problems or compliance violations should be specified in the contract documents.

H. Public Involvement

76. Public participation as is required in EIA is only now evolving in the PRC; therefore, the extent and sequence of events in involving the “public” is less formal and structured than in other locations. Formal notifications, press releases, and public meetings are not yet a part of the process in the PRC.

77. The public involvement included notifying affected residents, through their leaders and municipal, county, and township governments and briefing them on the actions to be taken. At these meetings, impacts and possible compensation were discussed. Present at these meetings were environmental experts familiar with the study area’s biophysical setting. The “Appraisal Unit”¹ of LPCD undertook the majority of the work. The type of involvement included informal discussions, field investigations, distribution of surveys, as well as formal consultation meetings.

78. The first set of meetings, more in line with public involvement, occurred from September through December 1992 and at the time the Appraisal Unit distributed surveys to more than 200 people asking standard demographic questions as well as leaving space for notes on opinions regarding the project.

79. The majority of respondents were in favor of the project and wanted it completed as soon as possible. The notion of the expressway bringing prosperity to those who had to give up home and land was rejected since, as they put it, the road would be fenced off from access. As a result the overall interest in the road among farmers was minimal. Most wished that as little agricultural land as possible would be taken and that compensation would be prompt. They also suggested that payments for home demolition compensation should be made in advance of the demolition and resettled people should have a say in where they will be moved, and the value of homes should be carefully assessed, e.g., in Changtu where most houses to be dismantled are new.

80. Conspicuously absent from all reporting was any comment on environmental impacts, concern about noise, air quality, waste management, etc. This would suggest that this information (as is normally provided in other countries) was not presented. In essence, the public does not appear to be aware of (or is not concerned with) the future impacts and any implications for them. There was no indication that host communities or districts within towns and villages receiving displaced people were consulted.

81. The Appraisal Unit together with the LHHCH has acted on the suggestions made by the “public” and, for example, revised the selected alignment to reduce the amount of agricultural lands to be taken and reduce the extent of resettlement. The public involvement process was certainly a good start but could use considerable improvement, particularly in the provision of information to those directly affected and in getting host communities involved.

I. Conclusions

¹ The “Appraisal Unit” is thought to mean the LHHCH, but no clear definition has been provided.

82. The potential negative impacts of the proposed expressway project are considered minimal provided that mitigation and monitoring functions as prescribed in this SEIA and the RCP are implemented and are included in the construction contract documents. The “residual” impacts will be easily offset by the long-term social and economic gains for the area. The extensive afforestation program, coupled with the long-term (1996-2017) effects monitoring work will assist with raising awareness of the rate at which the environmental conditions in the area are deteriorating and hopefully will generate “spin-off” actions. The new expressway will reduce congestion on the existing G-102 and at the same time reduce air pollution, noise, and accidents in that corridor.

83. The expressway should have a strong positive economic impact on the road corridor between Tieling and Siping. The alignment chosen has the least negative impact on the corridor in terms of effects on the biophysical environment, the human environment and resettlement. It also requires the least amount of cultivated lands of the three options examined.

84. The EIS (and Addendum) data should be used as the basis of the effects and compliance monitoring program. Monitoring is planned to continue through the operating period of the project and will be conducted by the Environmental Monitoring Station, established within the LHHCH as part of this project.

85. Increased noise and air pollution along the expressway as traffic volumes build up will be offset by appropriate noise attenuation measures, vegetation belts, and monitoring of engine exhausts.

86. Soil, crop, and surface water quality will be monitored to detect any health implications from lead. During construction, water quality will be protected through the use of settling ponds and diversion channels specified in the contract documents. Long-term protection will be provided through replanting and the use of engineered erosion protection on steeper slopes.

87. The demolition of homes and industries has been kept to a minimum through careful routing of the selected alignment. The RCP is the key guiding document that established the total compensation and sets out the resettlement schedule outline. Detailed plans are to be prepared by leading groups in each community who will disburse the funds equitably and according to the law. An important mitigation measure will be the construction of 116 pedestrian underpasses to permit the passage of community members to fields pastures and work areas cut off by the ROW.

88. A comprehensive monitoring and reporting schedule will be prepared by the LHHCH (in consultation with LPCD) and will form the permanent record of how well the EA has met its commitments as specified in the EIS, its addendum, and the RCP.