16.6 Financial Revenue and Cost Analysis

16.6.1 Assumption for Financial Analysis

Following units were used as assumption for financial analysis. Amount of toll collection cost was assumed at 20 % of toll revenue. This is based on the data that toll collection cost is 22 % of toll revenue of Thang Long Bridge and 15 km highway, and 15 % for Chuong Duong bridge. Refer to Appendix table A16.6.1 Revenue and Expenditure of Chuong Duong & Thang Long Bridge.

Following figures are assumptions related to cost.

- Total capital investment cost: 4,586,589 million Dong
- Yearly allocation of investment (1999 - 2003): 3 %, 8 %, 23 %, 38 %, 28 %
- Toll collection period: 2004 - 2028 25 years after completion of the construction
- Periodic repairing cost: 0.1 % of investment cost, 5 years interval, 4,587 million Dong
- Routine maintenance cost: 0.6 % of investment cost, 27,520 million Dong
- Operation cost for toll collection: 20 % of toll revenue

Viability of investment is proved by the comparison between toll revenue and expenditure. Expenditure consists of i) Capital investment cost, ii) Facility maintenance cost, iii) Operation cost for toll collection, and of iv)Tax levied on profit.

Amount of profit can be obtained from toll revenue minus (a) Depreciation cost of capital, above ii) and iii), and (b) Interest.

Following is the assumptions for expenditure for calculation of profit.

- Depreciation: Redemption period for 20 years with same rate
- Fund sources:
  - Government base: 70 % of soft loan for 30 years repayment period with 10 years grace period at 2.3 % interest, and 30 % of government certificate bank loan for 15 years at 10 % interest
  - Private base : 30 % of equity and 70 % of bank loan for 15 years at 10 % interest
- Interest during construction period: Included in repayment amount
- Tax: 10 % tax to profit

16.6.2 Comparison between Maintenance / Operation Cost and Toll Revenue

Table 16.6.1 is the result of comparison of routine/periodic maintenance cost of project road and operation cost for toll collection, with toll revenue from 2004 to 2028. Costs and revenue are compared by present value of 1998 price discounted by 15 %, average interest rate of market. Following revenue and cost ratio were obtained;

	Cost	Revenue	Revenue/cost ratio
Case 1 (Charging 45 % of Benefit)	234 billion	779 billion	3.32
Case 2 (Charging 45 % of Benefit in 1998 ~ 70 % of Benefit in 2020)	290 billion	1,055 billion	3.64

Revenue of both case 1 and case 2 can cover the maintenance and operation cost, and gets enough revenue of more than 3 times. Next chapter will analyze revenue and investment cost.

16.6.3 Revenue and Investment Cost Analysis - Financial Internal Rate of Return

The financial internal rate of return (FIRR) is the discount rate in which total discounted present value of toll revenue equals to the total discounted value of cost. If the FIRR turns out higher than the interest of market, investment is proved to be feasible.

Table 16.6.2 shows the result of calculation of FIRR in Case 1 of government base, and Table 16.6.3 shows Case 2 of government base. The result of FIRR of the private base is shown in Appendix table A16.6.3 and A16.6.4. Four cases of FIRR are summarized as follows:

		Case 1	Case 2
Government base	Soft loan 70 % and bank loan 30 %	2.83 %	5.64 %
Private base	Equity 30 % and bank loan 70 %	2.80 %	5.63 %

Table 16.6.1 Comparison Between Maintenance/Operation Cost and Toll Revenue

Unit: Million Dong

	Year	Case 1				Case 2				Discount Factor 15%	Case 1 Present Worth		Case 2 Present Worth	
		Cost			Toll Revenue	Cost			Toll Revenue					
		Maintenance	Operation	Total		Maintenance	Operation	Total			Cost	Revenue	Cost	Revenue
1	1998									0.870				
2	1999									0.756				
3	2000									0.658				
4	2001									0.572				
5	2002									0.497				
6	2003									0.432				
7	2004	27,520	33,847	61,367	169,235	27,520	37,947	65,467	189,737	0.376	23,070	63,622	24,611	71,329
8	2005	27,520	36,589	64,108	182,944	27,520	41,819	69,339	209,097	0.327	20,957	59,805	22,667	68,354
9	2006	27,520	39,619	67,139	198,095	27,520	46,173	73,692	230,863	0.284	19,085	56,311	20,948	65,626
10	2007	27,520	42,976	70,496	214,882	27,520	51,082	78,602	255,412	0.247	17,426	53,116	19,429	63,134
11	2008	32,106	46,707	78,813	233,534	32,106	56,640	88,746	283,199	0.215	16,940	50,197	19,075	60,872
12	2009	27,520	50,864	78,383	254,318	27,520	62,953	90,473	314,766	0.187	14,650	47,534	16,910	58,832
13	2010	27,520	55,510	83,029	277,549	27,520	70,153	97,673	350,767	0.163	13,495	45,109	15,875	57,009
14	2011	27,520	58,275	85,795	291,377	27,520	75,193	102,712	375,964	0.141	12,125	41,180	14,516	53,134
15	2012	27,520	61,437	88,957	307,185	27,520	80,995	108,514	404,974	0.123	10,932	37,751	13,336	49,769
16	2013	32,106	65,049	97,155	325,246	32,106	87,697	119,803	438,483	0.107	10,382	34,757	12,803	46,858
17	2014	27,520	69,177	96,697	345,886	27,520	95,464	122,983	477,318	0.093	8,986	32,142	11,428	44,355
18	2015	27,520	73,897	101,417	369,485	27,520	104,495	132,015	522,477	0.081	8,195	29,856	10,667	42,219
19	2016	27,520	79,299	106,819	396,496	27,520	115,033	142,553	575,166	0.070	7,506	27,860	10,017	40,414
20	2017	27,520	85,490	113,009	427,448	27,520	127,368	154,888	636,842	0.061	6,905	26,117	9,464	38,911
21	2018	32,106	92,594	124,700	462,969	32,106	141,854	173,960	709,268	0.053	6,625	24,598	9,243	37,684
22	2019	27,520	100,759	128,279	503,797	27,520	158,916	186,435	794,579	0.046	5,927	23,276	8,613	36,710
23	2020	27,520	110,135	137,655	550,676	27,520	179,025	206,544	895,123	0.040	5,530	22,123	8,298	35,961
24	2021	27,520	111,384	138,904	556,922	27,520	185,102	212,621	925,508	0.035	4,853	19,456	7,428	32,332
25	2022	27,520	112,651	140,170	563,253	27,520	191,402	218,921	957,009	0.030	4,258	17,110	6,650	29,072
26	2023	32,106	113,934	146,041	569,672	32,106	197,934	230,040	989,670	0.026	3,858	15,048	6,077	26,142
27	2024	27,520	115,236	142,755	576,178	27,520	204,707	232,227	1,023,536	0.023	3,279	13,235	5,334	23,510
28	2025	27,520	116,555	144,074	582,774	27,520	211,731	239,250	1,058,654	0.020	2,878	11,640	4,779	21,145
29	2026	27,520	117,892	145,412	589,462	27,520	219,014	246,534	1,095,072	0.017	2,526	10,238	4,282	19,020
30	2027	27,520	119,249	146,768	596,243	27,520	226,568	254,088	1,132,842	0.015	2,217	9,005	3,838	17,109
31	2028	32,106	120,624	152,730	603,118	32,106	234,403	266,510	1,172,017	0.013	2,006	7,921	3,500	15,392
		710,921	2,029,749	2,740,670	10,148,744	710,921	3,203,669	3,914,590	16,018,343	15.00%	234,609	779,006	289,787	1,054,896

Table 16.6.2 Cost and Toll Revenue Analysis of the Project Government Base (Case 1)

Internal Financial Rate of Return: 2.83%

Unit: Million Dong

No.	Year	Capital Cost	Toll Revenue	Maint.& Repair	Opera-tion	Depreci-ation	Loan		Profit BeforeTax	Tax	Net Inflow	Discount Factor	Present Value
							Soft	Bank					
1	1999	123,517							(Before		-123,517	0.972	-120,118
2	2000	361,329							Tax)		-361,329	0.946	-341,714
3	2001	1,054,047									-1,054,047	0.920	-969,394
4	2002	1,740,617									-1,740,617	0.894	-1,556,768
5	2003	1,307,079									-1,307,079	0.870	-1,136,849
6	2004		169,235	27,520	33,847	229,329	0	170,245	-291,705	0	107,868	0.846	91,238
7	2005		182,944	27,520	36,589	229,329	0	158,895	-269,389	0	118,836	0.823	97,748
8	2006		198,095	27,520	39,619	229,329	0	147,545	-245,918	0	130,956	0.800	104,753
9	2007		214,882	27,520	42,976	229,329	0	136,196	-221,139	0	144,386	0.778	112,317
10	2008		233,534	32,106	46,707	229,329	0	124,846	-199,454	0	154,721	0.756	117,045
11	2009		254,318	27,520	50,864	229,329	0	113,496	-166,891		175,935	0.736	129,430
12	2010		277,549	27,520	55,510	229,329	0	102,147	-136,956	-13,696	208,215	0.715	148,962
13	2011		291,377	27,520	58,275	229,329	0	90,797	-114,544	-11,454	217,037	0.696	150,999
14	2012		307,185	27,520	61,437	229,329	0	79,447	-90,548	-9,055	227,283	0.677	153,777
15	2013		325,246	32,106	65,049	229,329	0	68,098	-69,337	-6,934	235,024	0.658	154,638
16	2014		345,886	27,520	69,177	229,329	75,036	56,748	-111,924	-11,192	260,382	0.640	166,607
17	2015		369,485	27,520	73,897	229,329	72,449	45,399	-79,108	-7,911	275,979	0.622	171,727
18	2016		396,496	27,520	79,299	229,329	69,861	34,049	-43,562	-4,356	294,033	0.605	177,926
19	2017		427,448	27,520	85,490	229,329	67,274	22,699	-4,864	-486	314,925	0.588	185,324
20	2018		462,969	32,106	92,594	229,329	64,686	11,350	32,904	3,290	334,979	0.572	191,699
21	2019		503,797	27,520	100,759	229,329	62,099		84,090	8,409	367,109	0.557	204,305
22	2020		550,676	27,520	110,135	229,329	59,511		124,180	12,418	400,603	0.541	216,810
23	2021		556,922	27,520	111,384	229,329	56,924		131,765	13,176	404,842	0.526	213,073
24	2022		563,253	27,520	112,651	229,329	54,336		139,417	13,942	409,141	0.512	209,410
25	2023		569,672	32,106	113,934	229,329	51,749		142,553	14,255	409,376	0.498	203,764
26	2024		576,178	27,520	115,236		49,162		384,261	38,426	394,997	0.484	191,196
27	2025		582,774	27,520	116,555		46,574		392,126	39,213	399,487	0.471	188,048
28	2026		589,462	27,520	117,892		43,987		400,063	40,006	404,044	0.458	184,958
29	2027		596,243	27,520	119,249		41,399		408,076	40,808	408,667	0.445	181,926
30	2028		603,118	32,106	120,624		38,812		411,577	41,158	409,231	0.433	177,163
		4,586,589	10,148,744	710,921	2,029,749	4,586,589	853,859	1,361,956	605,670	200,017	2,621,468	2.83%	0

Table 16.6.3 Cost and Toll Revenue Analysis of the Project Government Base (Case 2)

Internal Financial Rate of Return: 5.64%

Unit: Million Dong

No.	Year	Capital Cost	Toll Revenue	Mente.& Repair	Opera-tion	Depreci-ation	Loan Soft	Loan Bank	Profit BeforeTax	Tax	Net Inflow	Discount Factor	Present Value
1	1999	123,517							(Before Tax)		-123,517	0.947	-116,920
2	2000	361,329									-361,329	0.896	-323,760
3	2001	1,054,047									-1,054,047	0.848	-894,007
4	2002	1,740,617									-1,740,617	0.803	-1,397,477
5	2003	1,307,079									-1,307,079	0.760	-993,353
6	2004		189,737	27,520	37,947	229,329	0	170,245	-275,304	0	124,270	0.719	89,398
7	2005		209,097	27,520	41,819	229,329	0	158,895	-248,466	0	139,758	0.681	95,170
8	2006		230,863	27,520	46,173	229,329	0	147,545	-219,704	0	157,171	0.645	101,311
9	2007		255,412	27,520	51,082	229,329	0	136,196	-188,715	0	176,810	0.610	107,882
10	2008		283,199	32,106	56,640	229,329	0	124,846	-159,722	0	194,453	0.578	112,310
11	2009		314,766	27,520	62,953	229,329	0	113,496	-118,533		224,293	0.547	122,625
12	2010		350,767	27,520	70,153	229,329	0	102,147	-78,382	-7,838	260,932	0.518	135,037
13	2011		375,964	27,520	75,193	229,329	0	90,797	-46,875	-4,687	277,939	0.490	136,155
14	2012		404,974	27,520	80,995	229,329	0	79,447	-12,317	-1,232	297,691	0.464	138,042
15	2013		438,483	32,106	87,697	229,329	0	68,098	21,253	2,125	316,555	0.439	138,949
16	2014		477,318	27,520	95,464	229,329	75,036	56,748	-6,779	-678	355,013	0.415	147,506
17	2015		522,477	27,520	104,495	229,329	72,449	45,399	43,285	4,329	386,134	0.393	151,867
18	2016		575,166	27,520	115,033	229,329	69,861	34,049	99,374	9,937	422,676	0.372	157,360
19	2017		636,842	27,520	127,368	229,329	67,274	22,699	162,652	16,265	465,689	0.352	164,113
20	2018		709,268	32,106	141,854	229,329	64,686	11,350	229,943	22,994	512,314	0.334	170,901
21	2019		794,579	27,520	158,916	229,329	62,099		316,715	31,672	576,472	0.316	182,031
22	2020		895,123	27,520	179,025	229,329	59,511		399,738	39,974	648,605	0.299	193,869
23	2021		925,508	27,520	185,102	229,329	56,924		426,634	42,663	670,224	0.283	189,631
24	2022		957,009	27,520	191,402	229,329	54,336		454,422	45,442	692,645	0.268	185,507
25	2023		989,670	32,106	197,934	229,329	51,749		478,551	47,855	711,775	0.254	180,448
26	2024		1,023,536	27,520	204,707		49,162		742,148	74,215	717,094	0.240	172,086
27	2025		1,058,654	27,520	211,731		46,574		772,830	77,283	742,121	0.227	168,579
28	2026		1,095,072	27,520	219,014		43,987		804,551	80,455	768,083	0.215	165,158
29	2027		1,132,842	27,520	226,568		41,399		837,355	83,735	795,019	0.204	161,818
30	2028		1,172,017	32,106	234,403		38,812		866,696	86,670	818,838	0.193	157,764
		4,586,589	16,018,343	710,921	3,203,669	4,586,589	853,859	1,361,956	5,301,349	651,179	6,865,985	5.64%	0

Table 16.6.4 shows that FIRR should be higher than 4.61 % in the case operated by the Government. Therefore it should be higher than 8.50 % in the case operated by private company, which includes 10 % of interest, around 2 % of dividend and 3 % of profit.

Table 16.6.4 Average Interest Rates for Cases Implemented by the Government and Private Sector

Unit: Million Dong

Sources	Component	Amount	Interest Rate	Amount	Av. Interest Rate
1) Implementation by Government					
Soft Loan	70 %	3,210,612	2.3 %	73,844	
Bank Loan	30 %	1,375,977	10 %	137,598	
	100 %	4,586,589		211,442	4.61 %
2) Implementation by Private Company			(Dividend+Profit)		
Equity	30 %	1,375,977	(2 %+3 %)	68,799	
Bank Loan	70 %	3,210,612	10 %	321,061	
	100 %	4,586,589		389,860	8.50 %

Financial viability can be concluded as follows:

i) Case 2 is financially feasible since FIRR is 5.64 % which is higher than the average interest of 4.61 % in the case operated by the Government with soft loan providing gradual increase of toll charge from 45.2 % of benefit in year 1998 to 70 % in 2020.

ii) FIRR of Case 1 is 2.83 % for the case operated by the Government and 2.80 % for the case operated by a private company which are less than 4.61 % and 8.50 % respectively. Therefore, level of toll needs to be decided according to Case 2 that gradually increases toll charge from 45.2 % of benefit in year 1998 to 70 % in 2020.

iii) In both cases of private base FIRRs are lower than those of government base and less than the average interest rate 8.50 %, that indicates the Project by private participation will not be financially feasible even if a company's equity is utilized as much as 30 % of total investment.

16.6.4 Sensitivity Analysis

i) Sensitivity analysis was done for the Case 2 which is financially feasible with FIRR 5.64 %, operated by the Government. Increase in capital investment cost reflects increase in facility maintenance, depreciation and interest cost, and decrease of profit and tax. On the other hand, decrease of toll revenue reflects decrease of operation cost, profit and tax.

The result of sensitivity analysis between investment cost and toll revenue is as follows:

	Description	Variation	FIRR	Judgment
-	Base case:		5.64 %	Feasible
-	Revenue:	10 % decrease	4.91 %	Feasible
		15 % decrease	4.52 %	Not Feasible
-	Cost:	10 % increase	4.97 %	Feasible
		15 % increase	4.67 %	Feasible
		10 % decrease	6.40 %	Feasible
-	Revenue decrease 10 % and cost increase 10 % :		4.26 %	Not Feasible

ii) Project is financially feasible even if revenue decreases by 10 %, or cost increases by 10-15 %. But project will not be feasible at 10 % decrease of revenue and at 10 % increase cost.

iii) The percentage of toll to benefit is preferable at around 70 % up to the year 2020. The annual rate of increase of toll is preferable if less than 3.16 % on average.

CHAPTER 17
ENVIRONMENTAL IMPACT STUDY

CHAPTER 17 ENVIRONMENTAL IMPACT STUDY

17.1 Study Objectives and Method

17.1.1 Objectives of the Study

The Study consists of the initial environmental examination (IEE) and the Environmental Impact Assessment (EIA). The objective of the IEE is to identify the significant environmental elements for the following three alternative routes.

- Alternative-1: (Shorter Bridge Length Scheme)
- Alternative-2b: (Least Affected Inhabitant Scheme)
- Alternative-3: (Least Land Acquisition Scheme)

The EIA of SHTRR is carried out for the selected route of the project. The objectives of the EIA are to analyze and to forecast the impacts of the significant environmental items and also to consider the mitigation measures for the possible serious adverse impacts.

17.1.2 Study Area and Study Method

The Study area includes the three alternative routes of this project and the adjacent area of the southern section of Ring Road No. 3 between the intersection of National Highway Route No. 1 and the intersection of National Highway Route No. 5 in Hanoi. The study area encompasses the same area as the project site of this feasibility study.

The IEE was carried out for the proposed three alternative routes. At first, based on available data/information by data collection to relevant agencies and field observations, an overall evaluation of possible environmental impacts for three alternative routes was carried out by using a checklist method. Second, based on the results of the IEE and the other available information, the existing environmental conditions in the selected route and the adjacent area were identified. Third, the expected significant environmental impacts at construction phase and operation/maintenance phase were analyzed and were forecasted. Fourth, based on the above mentioned analyses, countermeasures which mitigate the possible serious adverse impacts were proposed.

With respect to resettlement issues, the detailed analyses and recommendations are also described in Chapter 18 as relocation plan.

17.2 Description of the Existing Environment of the Study Area

17.2.1 Social Environment

(1) Population

In rural areas including the study areas of the Hanoi City, the population trends diverged by district. In Tu Liem and Gia Lam Districts, the population increase accelerated during 1989 to 1995 while in Soc Son, Dong Anh and Thanh Tri Districts, the rate of increase slow down. Thanh Tri is a district located south-east corner of Hanoi and the major area of the proposed road section. This area reveals low population density even though next to the urbanized districts, since it is subject to frequent flooding and lakes/fishery ponds comprise a large proportion of the district.

(2) Employment

The labor structure in Vietnam was nearly stable from 1990 to 1994; 73 % for primary sector, 13 % for secondary sector, and 14% for tertiary sector. However, there is no current data on labor structure of Hanoi. An estimation indicates 884.0 thousand employment in 1989 and 1,133.2 thousand in 1996. Composition by sector in 1989 reveals a quite different feature from that of whole country; 51.6% for primary, 20.4% for secondary and 28.0% for service sector, respectively. Table 17.2.1 shows the number of employment by province. The number of employment has gradually increased in every province since 1979.

(3) Economic Activity

The project site consists of two rural districts (Thanh Tri district, Gia Lam district) in Hanoi City. Table 17.2.2 shows the latest labor structure of these district. Agriculture is still dominant economic sector in both districts.

Table 17.2.1 Employment Trend by Province

Province	Employment (thousand)		Population (thousand)		Employment /Population	
	1979	1996	1979	1996	1979	1996
Hanoi	749.2	1,133.2	1,732.1	2,268.4	0.43	0.50
Ha Tay	742.2	1,161.8	1,708.0	2,330.5	0.43	0.50
Vinh Phuc	302.3	525.6	745.3	1,066.3	0.41	0.49
Thai Nguyen	296.6	493.4	720.0	952.0	0.41	0.52
Bac Ninh	262.0	471.3	661.1	925.1	0.40	0.51
Hung Yen	319.5	569.0	847.1	1,083.5	0.38	0.53
Total Study Area	2,671.8	4,354.3	6,413.6	8,625.8	0.42	0.50
Whole Country	23,035.5	35,397	52,742.0	75,355.2	0.44	0.47

Source : General Statistical Office

Table 17.2.2 Labor Structure of Thanh Tri district and Gia Lam district

Sector	Thanh Tri district			Gia Lam district		
	households	workers		households	workers	
Agriculture	29,767	122,046	94.5%	36,862	149,659	91.1%
Fishery	477	1,907	1.5%	63	256	0.2%
Others	2,581	5,236	4.1%	7,177	14,354	8.7%
Total	32,825	129,189	100%	44,102	164,269	100%

Sources: Thanh Tri District - District survey in July 1997
Gia Lam District - District survey in December 1996

However, according to a recent additional agricultural household survey, most of the agricultural households at both Thanh Tri district and Gia Lam district are dependent on non-agricultural employment for the major portion of the income. In both districts, the agricultural income did not exceed non-agricultural income. However, the river plain area is usually fertile land due to yearly flooding and more crops than in the area outside of dikes can be expected.

Thanh Tri district is also famous for aquaculture such as Tilapia in the small fish ponds. In Gia Lam district, pottery products, handicrafts and other products contribute for subsistence in the residents.

(4) Traffic/Public Facilities

There are several kinds of transportation services such as road, railway, inland water way and air transport in Hanoi City. Each mode has a different role and significance. The network of National Highways (NHs) composed of NH1, NH3, NH5 and other NHs contributes significant land transportation and major local and regional economic activities. In the project site, there are some bus routes and stations, one domestic airport in Gia Lam but it is seldom used it, and a river port as main traffic facilities.

Every community has a primary or primary/secondary school. Particularly, the Tran Phu school consists of primary and supplementary schools of the Thanh Tri District at the same place. Main schools are shown in Figure 17.2.1.

(5) Communities

Based on the data from these district people's committee, Thanh Tri district is divided into 25 communes which includes one town. Gia Lam district is divided into 36 communes which includes four towns. These communes also have their people's committee as administrative organization. Each commune can be further divided into smaller units. Each unit are consists of about 40 to 70 households. There are woman's union and youth community in all communities.

Generally, the residents live in the Yen So, Tran Phu, Linh Nam communities with a quite high standard of living. About 35% of the families are the rich (the average income per person is about VND 300,000/month). But the majority of them are middle class (the average income per person is about VND 100,000/month).

Most of them use their big brick tanks to store the rainfall water for cooking through year, and well water only for cleaning, washing, etc. However, a few families have to use well water. Coal is often burned for cooking.

(6) Cultural Property

In Vietnam, there is a regulation for the preservation of heritage. There are several local cultural heritage such as pagodas and churches in the project site. Figure 17.2.1 also shows the location and distribution of the important cultural properties in the project site. The data are collected from the Cultural Information Division in the Hanoi People's committee at Thanh Tri district and Gia Lam district and field observations.

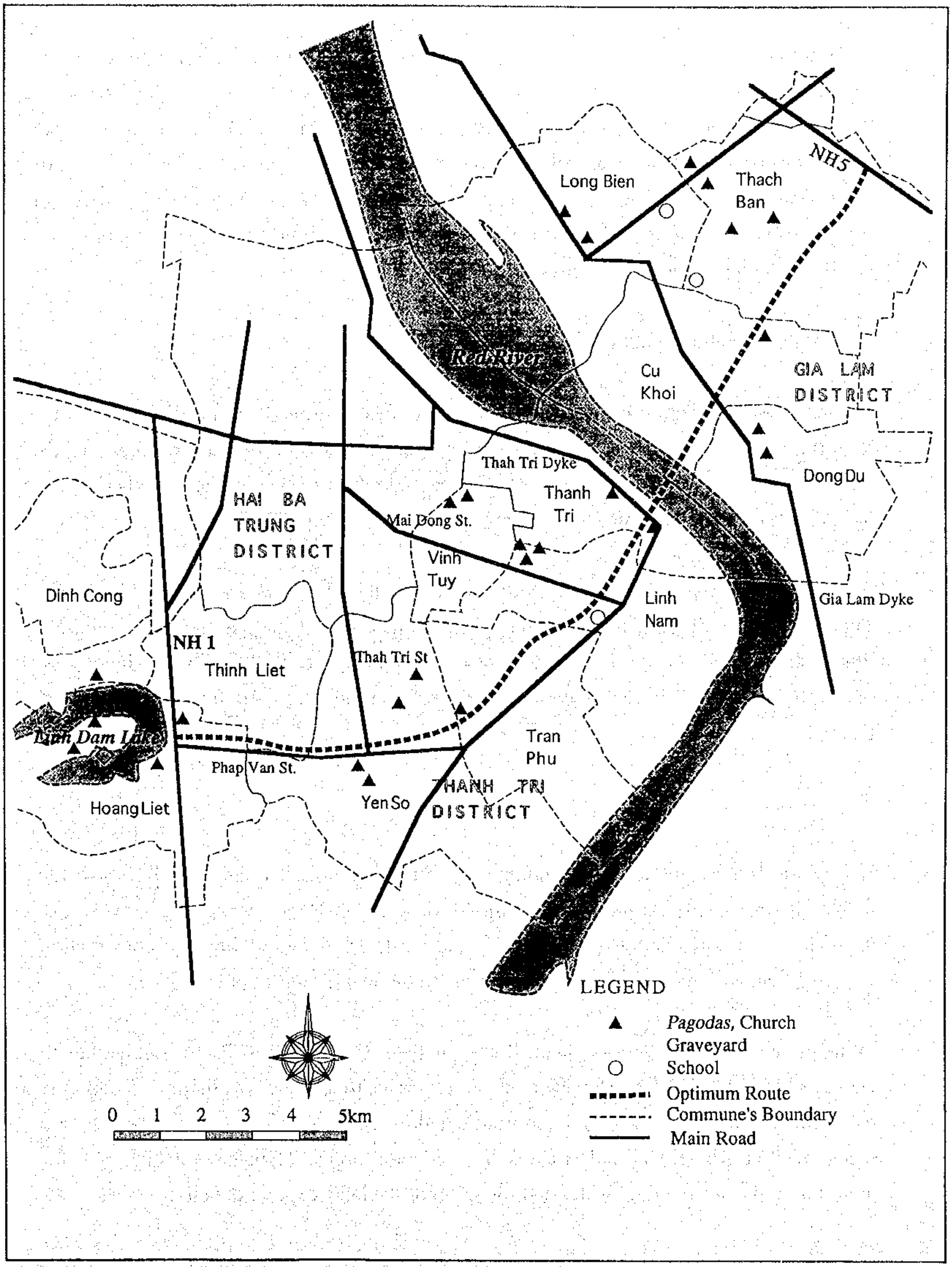

Figure 17.2.1 Important Cultural Properties and the Optimum Route

contributes significant land transportation and major local and regional economic activities. In the project site, there are some bus routes and stations, one domestic airport in Gia Lam but it is seldom used it, and a river port as main traffic facilities.

Every community has a primary or primary/secondary school. Particularly, the Tran Phu school consists of primary and supplementary schools of the Thanh Tri District at the same place. Main schools are shown in Figure 17.2.1.

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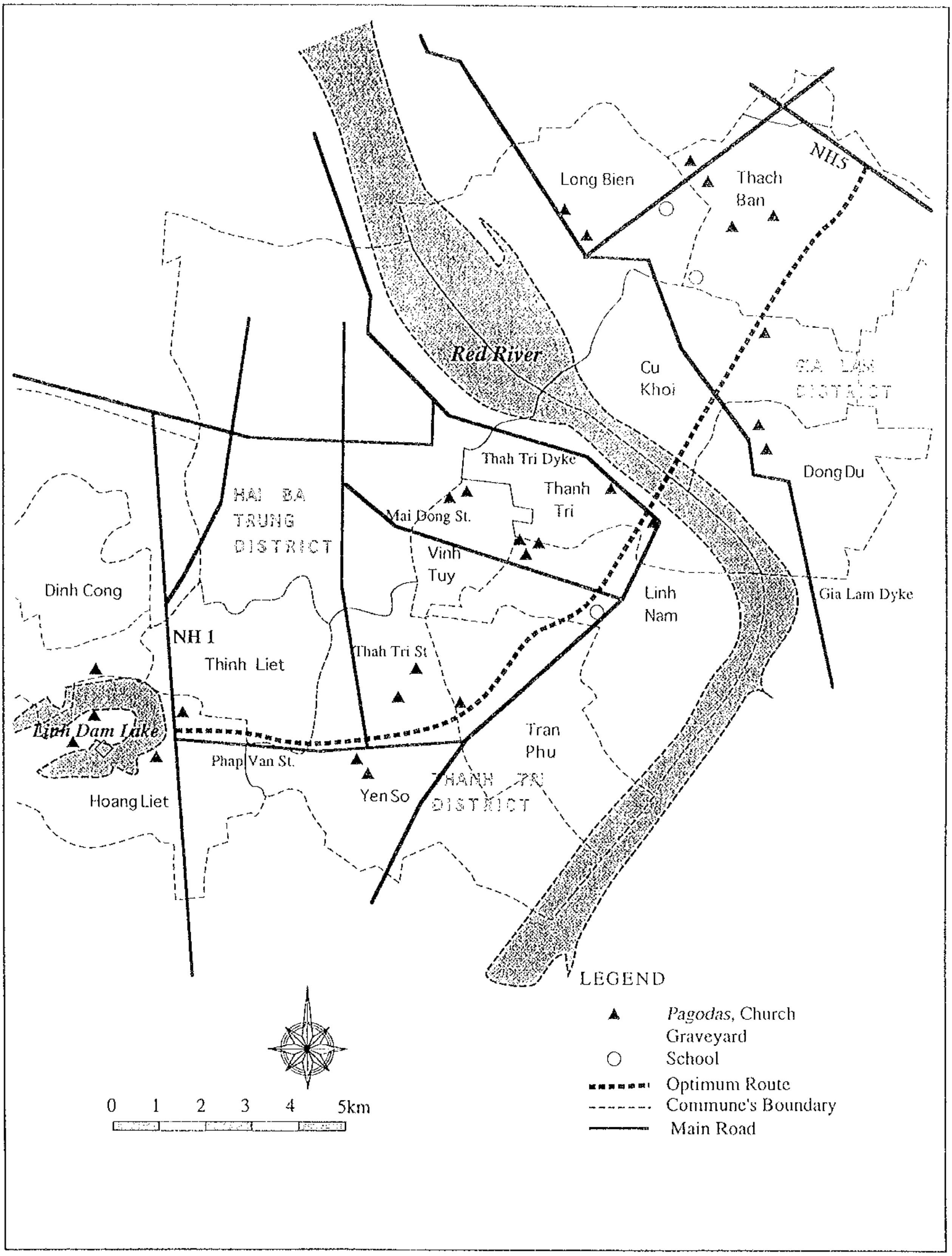

Figure 17.2.1 Important Cultural Properties and the Optimum Route

(7) Water Rights/Right of Common

In principle, all land is owned by the government in Vietnam and the people have the right to use the land. There are no specific local regulations for water and land resource use in the project sites. All matters related to water and land resources are under state regulations. For example, water rights in the project site are based on the "Regulations of Protection and Development of Aquatic Products and Resources" which was approved in 1989. In general, water resources in the project site are mainly used for irrigation and small scale fishery and other domestic purposes.

(8) Public Health Conditions

It is reported that public health conditions have been improved recently in Hanoi City. Waterborne diseases such as Diarrhea and Dysentery have been recently reduced mainly due to newly supplied fresh water in the area. According to the Ministry of the Health, infant mortality rate in the Red River Delta area was 4.4 % in 1996.

Every community has a dispensary with some patient beds and 5 doctors working there. This is a place mainly for assisting in the birth, infecting vaccine and treating some light illness. If it is a serious case, the patient would be taken into the hospital in Hanoi. The people living in the Gia Lam District are poorer than the people living in the Thanh Tri District.

(9) Waste

According to a recent study, the municipal waste in Hanoi accounted for 82% and the industrial waste 18%. At present, the amount of waste in Hanoi was about 3,000 m^3 per day. The main composition is stale fruits and waste from food shops and construction wastes. Waste volume has increased rapidly with the increase of population.

In the project site, there are two landfill sites at Tam Hiep in Thanh Tri district and at Bo De in Gia Lam district. However, it is reported that none of them satisfies the requirement for technology and environmental hygiene. The uncollected wastes are scattered along the rivers and streams in residential areas. They have a high risk for pollution to the surrounding water and the harm of the landscape of the city.

(10) Hazards and Risks

Inundation is the one of the most considerable hazards in Hanoi City. In the study area, much flooding has occurred during rainy seasons in the past. For example, heavy storm caused floods and heavy inundation in most of the Thanh Tri district and a half of Gia Lam district in 1994.

In terms of traffic safety, there is very little cultural awareness of many safety issues in the wider population. For example, bicycles, motorcycles and vehicles are mixed in the same traffic lane and most of the people do not follow the basic traffic rules. Very few motorcyclists wear a safety helmet traveling from place to place in the major roads including the existing roads in the project site.

(11) Land Use

At present, most of the land is agricultural fields and fish ponds in the project site. Table 17.2.3 shows present land use in the study area. The category of "Others" includes agricultural lands and water areas of river and lakes.

Table 17.2.3 Present Land Use in the Study Area

unit: ha.

District	Commercial	Industrial	Institutional	Residential	Others	Total
Thanh Tri	1	16	1	20	10,967	11,005
Gia Lam	3	36	1	248	17,590	17,878
Hanoi City	163	202	262	2,729	90,335	93,691

Sources: Thanh Tri District survey in July 1997
Gia Lam District survey in December 1996
JICA Study Team

17.2.2 Natural Environment

(1) Topography and Geology

The topography of the project site is mostly flat with an average elevation of five meters. The site is belong to the Red River Delta terrain. The feature is sloping from the North to the South. The Red River Delta is composed of deposits mainly transported by the Red River in the period of Quaternary, from the Pleistone to the Holocene ages.

(2) Soil

The soil of the Hanoi City consists of clay and silt in the upper 20 m layer and sand in lower layer. The Red river and the tributaries generated mostly soil that shows a little acid to neutral and rich in mud contents and nutrients, suitable for growing many kinds of trees. In the project site, the alluvial sediments and soils are relatively well structured and are not readily erodible.

(3) Groundwater

Groundwater bearing formation in Hanoi City consists of loose and alternating quaternary sediments. Groundwater is one of the main sources for water supply in the project site. In Hanoi City, groundwater is monitored by the Hanoi Water Business Company (HWBC) in dry season and rainy season in each year. Groundwater quality generally meets the Vietnamese standards except for the presence of iron, ammonia in some areas of the city. For example, the groundwater contains high iron especially in Gia Lam area.

(4) Hydrological Situation

The Red River passes through the center of the project site. The project site has several natural and fish ponds and small lakes and a network of small rivers and canals. The lakes and ponds have advantage to adjust flow volume, to reduce volume of water in flood season, and to increase volume of water in dry season.

In the Red River system, the annual run-off varies little. The Red River and its tributaries have similar monthly flow pattern (i.e., highest flow in August and the lowest flow in March).

In rainy season, the discharge of the Red River is quite large and the flow velocity of the river channel is swift. In terms of water level, Hanoi Measuring Station have been monitored annual maximum water levels of the Red River for the past 52 years.

(5) Flora and Fauna

In Vietnam, a list of 87 protected areas including 8 national parks, 50 nature reserves and 29 cultural-historical and environmental reserves with total area of 956,585 ha. was announced in 1993. Most of the precious and rare wildlife species are found in these protected area.

According to the list of the protected areas, there is no protected area such as national parks, nature reserves in the study area. The project site mainly comprises agricultural fields of rice and other crops, and fish ponds. The trees are only found in a few villages. There are no rare wildlife species and plants in the project site.

In the project site, a few of common wild birds are observed still alive on the river plain. In the surrounding lakes and ponds, water hyacinth and water spinach are very common, but living mussels, snails and small crabs are very few.

(6) Meteorology

The location of the study is under the sub-tropical monsoon regime. The climate is humid and hot from May to September. The winter brings little rain and is cold from November to March. According to the long-term monitoring meteorological data at Lang station in the Hanoi City, the main features of meteorology at the study area are as follows:

- Annual average temperature: 23.4 ℃
- Maximum average temperature of a month: 28.8 ℃ (July)
- Maximum average temperature of a month: 16.6 ℃ (January)
- Annual average humidity: 83 %
- Annual average rainfall: 1680 mm
- Maximum monthly average rainfall : 323 mm (August)
- Minimum monthly average rainfall : 18 mm (January)
- Average rainy day in a year : 142.2 days
- Wind direction frequency in summer: East to South
- Wind direction frequency in winter: East to North

(7) Landscape

Most of the open spaces in the project site are paddy fields and ponds for agriculture and fisheries activities. Theses places provide recreation and relaxation for the peoples who includes tourists. In terms of cultural landscape, historical properties such as pagodas which are located at Trung Mau village in Gia Lam and at Van Dien in Thanh Tri also provide an inheritance of local and traditional atmosphere.

17.2.3 Pollution

(1) Air Quality

Industrial plants and mixed transport are great causes of air pollution in Hanoi City. Vehicles always have to slow down, or idle for long time due to a large number of the bicycles or motor cycles in the urban districts. The amount of gases discharged by vehicles is great. Air quality of the study area which is including the urban districts of Hanoi City is changing towards worse. However, the project site is located in rural districts which are consist of agricultural lands or rural residential areas, and few industrial factories.

In order to collect the baseline data and to analyze the air quality impact, the air quality sampling of the following pollution items were conducted:

Air quality sampling items

SPM, CO, SO_2, NO_x, CO, and Pb were monitored at each sampling point (see Figure 17.2.2).

Table 17.2.4 Concentration of SPM, SO_2, NO_2, in the Project Site

Sampling Points	SPM, mg/m^3		SO_2, mg/m^3		NO_2, mg/m^3	
	1 hr-max.	24 hr-avg.	1 hr-max.	24 hr-avg.	1 hr-max.	24 hr-avg.
1	0.49	0.36	0.2500	0.1813	0.0720	0.0511
2	0.35	0.25	0.0400	0.0203	0.0480	0.0328
3	0.20	0.16	0.0120	0.0041	0.0060	0.0019
4	0.39	0.32	0.2500	0.1850	0.0670	0.0431
Vietnamese Standards	0.30	0.20	0.5000	0.3000	0.4000	0.1000

Table 17.2.5 Concentration of CH, CO, Pb in the Project Site

Sampling Points	CH, mg/m^3		CO, mg/m^3		Pb, mg/m^3	
	1 hr max.	24 hr-avg.	1 hr-max.	24 hr-avg.	1 hr-max.	24 hr-avg.
1	1.8200	1.2613	3.55	2.45	0.0007	0.0004
2	1.2300	0.9063	1.75	1.37	0.0007	0.0003
3	0.0350	0.0139	0.34	0.36	0.0003	0.0001
4	1.6700	1.1488	2.87	2.35	0.0007	0.0004
Vietnamese Standards	5.0000	1.5000	40.00	5.00	-	0.0050

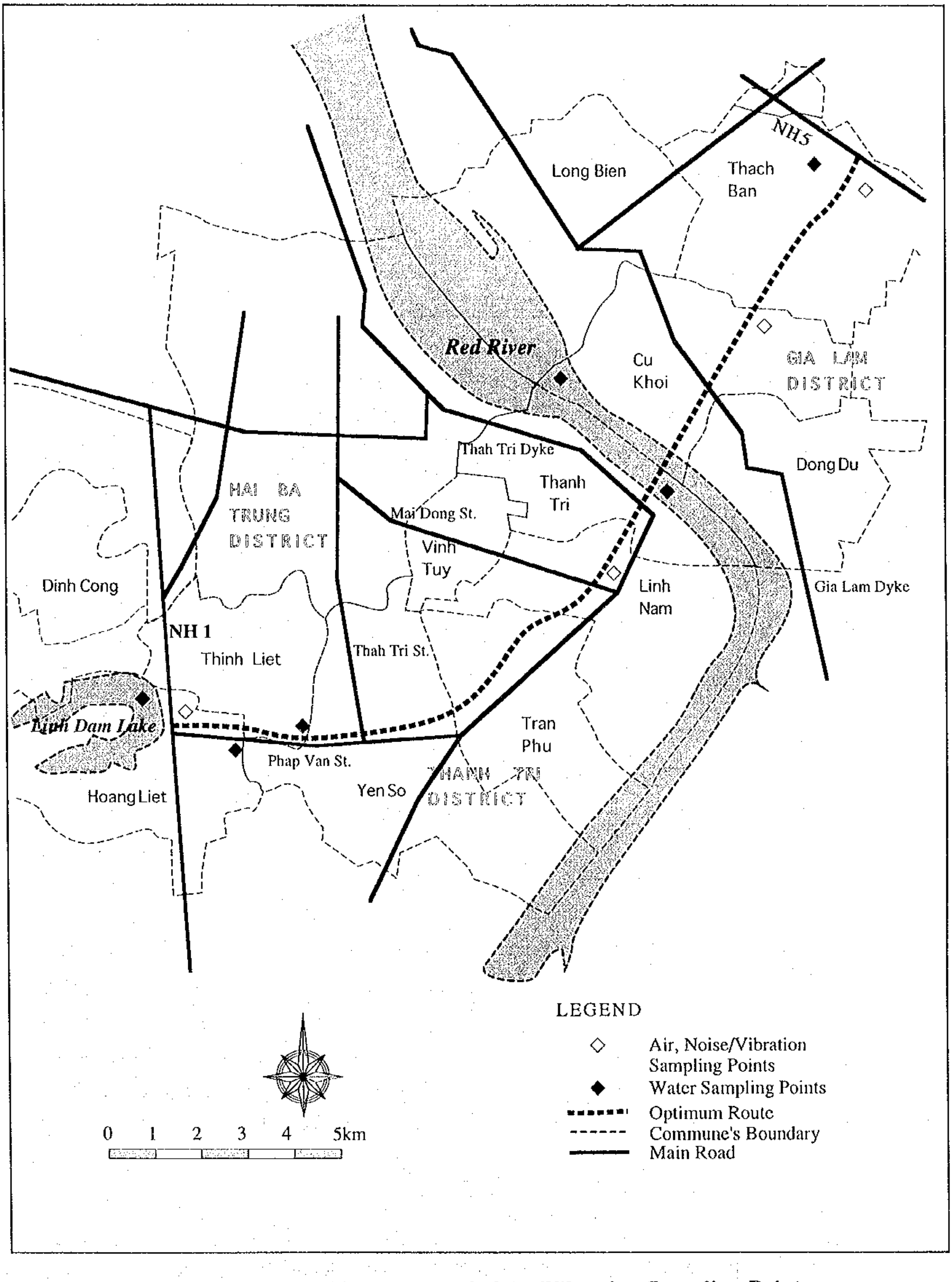

Figure 17.2.2 Air, Water and Noise/Vibration Sampling Points

Comparing observation data with allowable values specified in the standard TCVN 5937 - 95 and standard TCVN 5938 - 95, the concentration of SPM at the sampling points 3 is lower than the standard value.

However, at the remaining sampling points of the concentration of SO_2, NO_2, CO, and CH at all sampling points were lower than the standard values.

(2) Water Quality

In Hanoi City, the pollution level of the surface waters is not so serious, although some rivers go through big cities and towns such as Kim Nguu River and Cau River. These two rivers, which go through project site, are heavily polluted. The pollution of the Red River where Thanh Tri bridge will be built across, is not so serious. The following water quality sampling was conducted in order to analyze the water pollution level in the project site:

Water quality sampling items

pH, TS, SS, Turbidity, COD, BOD_5, NO_3^-, NO_2^-, SO_4^{2-}, PO_4^{3-}, Cr_4^{3+}, Ni^{2+}, Cu^{2+}, Pb^{2+}, and Oils.

The water sampling was conducted at each water sampling point in the project site (see Fig. 17.2.2). The sampling was conducted on March, 1998. On the basis of the sampling the water quality in the project site was assessed as follows:

- Oil and Grease

The pollution level of the lakes and small rivers do not exceed Vietnamese Standard which allow us to consider those lakes and rivers unpolluted. Oil is observed at the only two sampling points of the Red River. The oil concentration is lower than permitted level: under 0,02 mg/l for all of 4 samples. This can be explained by the low density of motorized inland water way traffic on the Red River especially in dry season, when the sampling was conducted.

- Electric Conductivity

There is a large difference between data on electric conductivity at distant sampling points. The conductivity of the Red River is the lowest, which is around 200 μδ/cm. That of the Kim Nguu River is the highest over 700 μδ/ cm, which proves that this river is seriously polluted. Besides these Cau Bay River, Linh Dam and other lakes and ponds in Phap Van area have the pollution level higher than the permitted level.

Toxic heavy metals such as Cr^{3+}, Ni^{2+} (contained in disposal water from electrical plate factories) and Pb^{2+}, Cu^{2+} etc. are found at all sampling points. Their concentrations are far lower than the permitted value in comparison with the standard for disposal water while they are far higher than the standard value for intake water.

The surface water at Thanh Tri bridge project site, for example Kim Nguu River is seriously polluted. Such unhealthy water can only be used for irrigation rather than for human intake.

(3) Noise and Vibration

In the project site, it was observed that noise and vibration are concentrated along the existing roads near the NH1 and the NH5 and near the border river. In order to collect the noise and vibration level in the project site, the following background noise and vibration level sampling were conducted on March, 1998:

Noise Sampling

L_{eq} and L_{50} were used for noise levels, while L_{10} was used for vibration level at the same as the sampling points of air quality survey (see Fig. 17.2.2). The noise levels are summarized in Table 17.2.6.

Average background noise levels were at their maximum during the morning and afternoon, drop slightly during the lunch hour, and drop markedly during the night for four or five hours. The noise values near the NH-1 (Sampling Points 1 and 2) and close to the NH-5 (Sampling Points 3) were higher than the one at the remaining point (Sampling Points 4) during all the day.

Noise at the four sampling points of the study area was noticed higher than permitted value of the Vietnamese Standard TCVN 5949-1995.

Table 17.2.6 Noise Level Data in the Project Site

Sampling Points	Leq [dBA]	
	night (22h-06h)	day (06h-22h)
1	69.4	75.8
2	69.6	75.9
3	59.0	65.4
4	68.6	74.9
Vietnamese Standard (TCVN 5949-1995)	45(1) 50(2)	60(1) 70(2)

Notice : (1)- For residential area: hotels, administrations offices, houses, apartment, houses, etc.

(2)- For commercial and service areas and mix.

<u>Vibration Sampling</u>

There was no Vietnamese acceptable criteria for road vibration. In this case, the German Standard [DIN 4150/2] was taken in the assessment of vibration on people in residential buildings. The measured value of (principal harmonic) vibration together with the frequency was used to calculate a derived intensity of perception factor KB using the formula :

$$KB = d.*0.8\, f^2 / 1 + 0.032\, f^2 / \sqrt{1+0.032\, f^2} \quad (17\text{-}1)$$

where: d = displacement amplitude [mm]
f = principal vibration frequency [Hz]

Table 17.2.7 shows values of vibration at observation sites measured in KB and calculated by the formula 17-1.

Table 17.2.7 Perception Factor KB Values Calculated

Sampling Point	KB	
	night	day
1	0.1218	0.1994
2	0.1084	0.1903
3	0.0306	0.0810
4	0.0982	0.1632
German Standard DIN 4150/2	0.2000	0.3000

In comparison with the standard DIN 4150/2 , the vibration level is concluded lower than the allowable values.

(4) Soil Contamination

The information of soil contamination in Hanoi City is very scarce. The amount of herbicide use and their effects should be investigated more carefully due to present food supply situations such as rice and other crops in the study area. However, it was not observed that soil contamination occurred in the project site.

(5) Land Subsidence

Groundwater exploitation seems to have lowered groundwater level and caused land subsidence in Hanoi City. However, relationship between groundwater exploitation and land subsidence has not been clarified yet. In the project site within a few kilometers along the Red River and the other rivers, there is a close relationship between groundwater and rivers. Groundwater level has not been considerably lowered by exploitation in the areas, because the river water seems to recharge groundwater.

17.3 Environmental Impact Assessment

17.3.1 Socio-Economic Environment

(1) Resettlement

Although the selected route was carefully selected taking into account resettlement issues in the project site, some small scale resettlement may be inevitable at construction phase.

Especially in Thanh Tri district, typical small houses and shops are located within around 200 meters from the NH1. More than 100 houses and shops need to be relocated due to the project. It is possible to be relocated along the frontage road of SHTRR in order to sustain the present daily life and maintain the present commercial business opportunities. However, it will be difficult to provide the present agricultural fields such as paddy field and fish pond due to the location of the site.

In Gia Lam district, more than 10 houses and shops are located on the proposed intersection of the NH5 and the optimum route. In this case, it will be difficult to find the relocation site of the similar conditions, because they are fully lined with houses along the NH5.

Questionnaire and Interview Survey

In order to analyze and forecast the possible socio-economic impacts, total 100 households which may be resettled by the project were selected to be surveyed with a questionnaire sheet. The questionnaire asked for information on family structure, occupations, employment status, household income, water use, access to public facilities, land ownership, affected land/property, building structure and year built, and attitudes towards the project.

Also, several interviews were conducted with the district leaders of Gia Lam and Thanh Tri and the leaders of the Tran Phu, Yen So and Linh Nam Communes.

Table 17.3.1 summarized the results of the Questionnaire and Interview Survey.

(2) Economic activities

After the bridge is completed and put into operation, the economic activities of the project site will be strongly developed. The communication, transportation will benefit, the goods exchange of the two districts with Hanoi will increase. Agricultural products of the district such as vegetables, fruit and flowers will be quickly transported and sold in Hanoi, this will encourage development of gardeners in this area.

On the other hand, farmers and fishermen in the project site will lose production opportunities such as paddy fields and fish ponds caused by the project implementation.

(3) Traffic/Public facilities

During the construction phase, it is inevitable that the local residents will be affected by the factors which are the increase of traffic volume by construction vehicles, waste material transportation and other construction works.

In order to mitigate these impacts, it is necessary to make a diverted road section for the road users, and to set a reasonable time table for construction vehicles and waste material transportation aiming at avoiding rush hours in the section with dense traffic of the National Road No.1 and National Road No.5 at the project vicinity.

Table 17.3.1 Summary of the Socio-Economic Environmental Resources in the Project Site

Areas	Number of houses affected			Area of land-use (m^2)			Area of land be affected(m^2)			Number of school		Pagoda/Temple		Cemetery	
	Have to move	Markedly Affected	Slightly Affected	Paddy fields	Fish Ponds	Other	Paddy fields	Fish Ponds	Other	Have to move	Affected	Have to move	Affected	Have to move	Affected
Yen So	29	107	104	41,245	38,312	138,317	276,875	241,562	288,942	0	1	0	1	0	1
Tran Phu	52	79	69			77,250			234,675	0	1	0	1	0	0
Linh Nam	8	8	13			75,700			284,125	0	0	0	0	0	0
Thanh Tri District Total	89	194	186	41,245	38,312	291,267	276,875	241,562	807,742	0	2	0	2	0	1
Cu Khoi		5	27	47,550		132,490	173,562		482,404	0	0	0	0	0	0
Thach Ban		2	6	26,950		47,810	136,937		200,945	0	0	0	0	0	0
Gia Lam District Total		7	33	74,500		180,300	310,500		683,350	0	0	0	0	0	0
Total	89	201	219	115,745	38,312	471,567	587,375	241,562	149,109	0	2	0	2	0	2

(4) Impacts on Cultural Heritage

In the project site, there are many places of historical and cultural value such as temples, pagodas, and commune houses. At the time of setting up plan, more attention should be paid to avoid these places, but impact during construction may be unavoidable. When the route is put into operation, the vibration of vehicle running on the route will affect structure of temples, pagodas or commune houses. The noise will affect the people who come to visit pagodas, temples, etc.

It is predicted that the noise level at area along the route will greatly affect tourism if there is not a method for minimising. Increased dust volume and decreased quality of air at temples and pagodas along the route will reduce attractiveness.

(5) Public Health Condition

Some minor adverse public health impacts need to be considered. Air pollution is mainly caused by dust. Gases discharging from automobile, motorcycle may cause much diseases to respiratory systems in people living near construction site. Solid waste produced during the construction will accelerate the water pollution and may cause digestive diseases of residents living around this area.

17.3.2 Natural Environment

(1) Impact on Land and Soil

The alluvial sediments and soils of the project site are relatively well structured and are not readily erodible. Also, the road and bridge construction methods are already taking into consideration ways to avoid soil erosion. However, for the long-term sustainability of the proposed bridge and road, it will be necessary to ensure that the bridge approaches and associated roads are built to remain stable.

The area outside the dyke, where the access road is built, must be protected from losing fertility. The excavation and filling work during construction may mix the nutritious cultivated soil on the surface and the poorly nutritious below. Consequently, when the construction and land rehabilitation are completed, the land may not be cultivable because most remaining soil may be clay sand or gravel.

(2) Impact on Water Resources and Hydrological System

Although the construction site must be used for some years, the construction can not be stopped in the wet and storm seasons. Therefore the drainage can hardly be prevented from blockage. Waste materials may cause surface and ground water contamination.

After the initial operation of the bridge and road, a hydrological system can lessen impacts. The direction modification may appear at some small stream, which may possibly affect the system of sewage, drainage, or ground water tables in occurrence of heavy long-lasting rain. However, the impact is negligible.

(3) Impact on Terrestrial and Aquatic Ecology

Cultivated lands, where vegetables flowers and fruit trees are gown will be affected at the project construction phase. Oil leaking or over flowing from boat, ship or equipment used for building bridge may deteriorate water quality and aquatic ecology system. However, these impacts are inconsiderable in the project site.

(4) Impact on Flora and Fauna

Vegetational cover such as rice fields, crop plants (e.g., onion, garlic, tomato, potato, vegetable), and flower gardens in Tho Khoi commune, apple orchard and other fruit trees will be indirectly affected by some pollutants such as dust. However, the impacts are negligible.

17.3.3 Pollution

(1) Impact on Air Quality

During the construction phase, the actual traffic volume is generally increased due to the additional traffic of construction vehicles which are powered with heavy diesel engines. In addition, heavy construction vehicles running slowly at local narrow road would lower the average velocity of the whole traffic flow. These would generate higher level of air pollution, noise, and vibration. The batching plant would generate a considerable volume of dust.

After the bridge is completed, the number of vehicles using bridge will increase. It is inevitable that the air quality at the proposed bridge site will be worse than nowadays.

Suspended Particulate Matter (SPM) on the road is generated by friction between such surfaces as rubber tyres - road, brake shoes - wheel rims and even by emission from engines etc.

In order to forecast the SPM density on the project bridge for the years 2000 and 2010, an experimental formula set up by Center for Environmental Protection in Transportation (CEPT) based on the results of the studies on several routes in Vietnam was applied. The method result would be acceptable as long as proportion of types of vehicles, quality of vehicles and climate conditions are not different much from those existing ones.

Figure 17.3.1 describes the relationship between SPM density and the number of vehicle in a certain time interval.

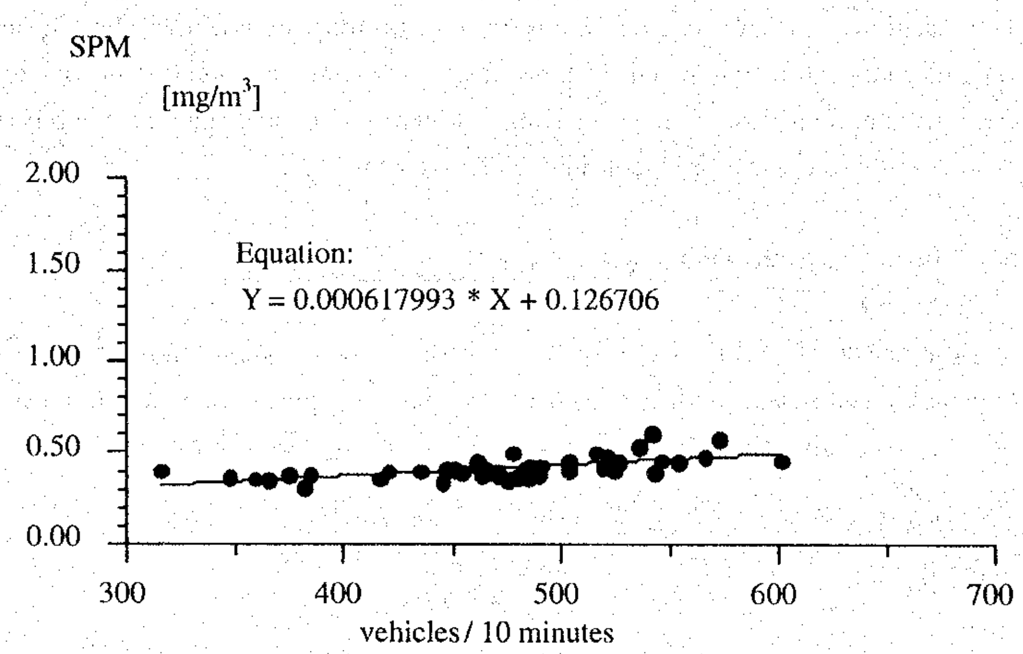

Figure 17.3.1 Relationship between SPM Density and the Number of Vehicles

On the basis of the above-mentioned experimental formula:

$$Y = 0.000617993*X + 0.126706 \quad (17\text{-}2)$$

where : Y = SPM density, mg/m^3
X = vehicle numbers per 10 minutes

The forecasted vehicle number which was estimated by the JICA Study Team is shown in Table 17.3.2. The estimated SPM densities at each point are shown in Table 17.3.3 (Section 1) and Table 17.3.4 (Section 2).

Table 17.3.2 Traffic Volume Forecasted by Section

Year / Type of Vehicle	2010		2020	
	Section 1	Section 2	Section 1	Section 2
Motorcycle	88,620	94,320	51,370	55,120
Passenger Car	5,960	7,480	33,680	37,740
Bus	3,910	5,520	5,460	8,000
Truck	8,610	13,160	13,210	20,700
Total	107,100	120,480	103,720	121,560
Total in PCU	57,580	73,130	86,430	111,680

Source: JICA Study Team

Table 17.3.3 Estimated SPM Density for the years 2010 and 2020 in Section 1

Year	2010		2020	
	avg	max	avg	max
Forecasted number of vehicle [vehicles/10 minutes]	743.8	2677.5	720.3	2593.0
Particulate matter [mg/m^3]	0.59	1.78	0.57	1.73
Vietnamese Standard (TCVN 5937-95)	0.20	0.30	0.20	0.30

Table 17.3.4 Estimated SPM Density for the years 2010 and 2020 in Section 2

Year	2010		2020	
	avg	max	avg	max
Forecasted number of vehicle [vehicles/10 minutes]	836.7	3012.0	844.2	3039.0
Particulate matter [mg/m^3]	0.64	1.99	0.65	2.01
Vietnamese Standard (TCVN 5937-95)	0.20	0.30	0.20	0.30

where : avg - average-day estimated SPM density
max - estimated SPM density at rush-hours

It must be noticed that all the estimated SPM densities are 3 to 7 times higher than the Vietnamese Standard values.

Carbon monoxide (CO), Nitrogen Oxides (NO_x), Hydrocarbons (CH)

The concentration of the three poisonous components of exhaust gas - CO, NO_x and CH - was forecasted for the years 2010 and 2020 at two sections of the proposed bridge area. The forecast applies the following formula :

$$C = 0,8 * E * [\exp[-\frac{(z+h)^2}{2.S_z^2}] + \exp[-\frac{(z-y)^2}{2.S_z^2}]] / (S_Z * U) \quad (17\text{-}3)$$

where :

- C: the concentration of CO or NO_2 (mg/m^3)
- E: emission source (mg/m.s)
- Z: height of forecasted point
- h: the difference in height between road and the surrounding earth surface (m)
- U: wind velocity (m/s)
- S_z: factor of vertical diffusion

S_Z is an equation of the distance along wind direction and can be calculated as follows:

$$S_Z = 0.53 * x^{0.73} \quad (17\text{-}4)$$

where: x (m) is the distance from emission source to the forecasted point along wind direction.

The quantity of the poisonous components (CO, CH and NO_x) from 1 kg fuel consumption is shown in Table 17.3.5. The average fuel consumption and the average velocity of vehicles are shown in Table 17.3.6.

Also, The calculating factors E(CO), E(CH) and E(NO) for the proposed bridge site are shown in Table 17.3.7 and Table 17.3.8.

Table 17.3.5 Poisonous Components of Exhaust Gas (g) per 1 kg Fuel Consumption

Poisonous Components of exhaust gas	Kind of Fuel	
	Gasoline	Diesel Fuel
CO	378.00	20.81
CH	21.10	4.16
NO_X	14.50	18.01

Table 17.3.6 Average Fuel Consumption and Velocity of Vehicle

Type of vehicle	Average Fuel Consumption, litre/100 km		Average Velocity
	Gasoline	Diesel	
MC	1.8	-	50 km/h
PC	8	-	60 km/h
LB(50% Bus)	15	-	60 km/h
HB(50% Bus)	-	30	60 km/h
LT(30% Truck)	-	15	55 km/h
MT+HT(70% Truck)	-	25	55 km/h

Note : - MC: motorcycle
- PC: passenger car
- LB: light bus
- HB: heavy bus
- LT: light truck
- MT: medium truck
- HT: heavy truck

Table 17.3.7 Emission source factor E of the CO, CH and NO (2010)

E	Section 1		Section 2	
	avg	max	avg	max
CO	3.8845	13.9841	4.4488	16.0156
CH	0.2607	0.9694	0.3259	1.1731
NO	0.3847	1.3848	0.5234	1.8842

Table 17.3.8 Emission source factor E of the CO, CH and NO (2020)

E	Section 1		Section 2	
	avg	max	avg	max
CO	7.2795	26.2062	8.3158	29.9367
CH	0.4854	1.7476	0.5859	2.1094
NO	0.6233	2.2438	0.8652	3.1154

where : avg - *average-day*
max - *at rush-hours*

Designations E(CO), E(CH) and E(NO) are respectively factor for the components CO, CH and NO_x.

Based on the above-mentioned analyses, the following can be concluded.

- The concentrations of CH, in most cases, are lower than that regulated by the Vietnamese Standard TCVN 5938-1995.

- The concentrations of CO at the distance more than 4m from the road center line are lower than permitted value stated in the Vietnamese standard TCVN 5937-1995. In some cases, the concentrations of CO at the distance less than 4m from the road center line and at the height below 1m are higher than permitted value stated in the Vietnamese standard TCVN 5937-1995.

- The concentrations of NO at the distance more than 38m from the road center line are lower than permitted value stated in the Vietnamese standard TCVN 5937-1995.

This proves that those pollution components do not have considerable influence on roadside residents. However, the pollution components such as CO and NO will have negative impacts on road users such as drivers, passengers.

(2) Impacts on Water Quality

Adverse impact on water by the construction work will occur over cultivated land. The water deterioration results from the following main factors.

- The work site establishment will create a high density of heavy lorries and construction appliances. Those construction vehicles will inevitably drop or waste oil and grease to the surrounding area. If they are not collected and properly treated, they will pollute the surface water and ground water table.

- Another main factor resulting the risk of water deterioration is the clay excavated in embankment filling work. Clay always contain a small proportion of ferrita sulfuric (FeS_2). When exposed to rainfall and oxygen from blue air, it may generate sulfuric acid (H_2SO_4)which pollute water resources.

(3) Impact of Construction Noise

The construction noise impact is temporary. The following construction activities and machinery are associated with possible noise:

- Piling, sheet piling
- Vehicles, other equipments, personnel on construction sites

During the bridge construction phase, the major noise source will be pile driving. The driving methods normally used for piling and sheet piling are:

- Ramming
- Vibration
- Drilling
- After excavation in situ-casting in a tube or ground slot

Earthworks equipment may also generate high localized noise levels and will be concentrated where fill is required. Workers and people living near the proposed bridge site and the approach roads would be affected by excessive noise during construction phase.

One elementary school in Thanh Tri District, which is located close to the construction site would be remarkable affected. But, on the whole, the number of affected residents is small.

(4) Impact of Construction Vibration

The following construction activities and machinery are associated with possible vibrations:

- Vehicles on construction sites
- Piling, sheet piling
- Vibratory compaction
- Excavation by heavy equipment

(5) Impact of Waste from Construction Site

Most of waste core is miscellaneous material such as rock, sand, and gravel. They are not only unusable but also hamper traffic and harm cultivated soil. Therefore, the material storage site must be carefully planned. The inevitable waste materials should be fully utilized, for example, for filling road embankment. Also, they have a high risk for discharging toxic substances which may cause soil contamination and water pollution.

The above-mentioned wastes are all forbidden from disposal to the river or the surrounding area or from fixing in the ground without treatment, according to Vietnamese Environmental Standards.

(6) Impact of traffic noise

The next items are forecast on noise in the project bridge site when the bridge will be put into operation. The following formula was used for calculating noise level :

$$L_A = 10 \lg (N_c + E.N_t) + 20 \lg V - 10 \lg (d+W/3) + 10* \theta/180 + \Delta rg + \Delta_p + 14 \quad (17\text{-}5)$$

where:
- L_A: equivalent noise level (dB_A) at a point which is d (m) from the border of the road.
- N_c: number of vehicles calculated in terms of number of cars per hour (vehicle).
- N_t: number of vehicles calculated in terms of number of lorries per hour (vehicle).
- E : multiplier for the effectiveness of noise generated by cars and lorries.
- V : average velocity of the traffic flow (km/h).
- W : road width (m).
- Δrg : adjustment factor for road gradient.
- Δ_p : adjustment factor for road pavement.
- θ : vision direction from observatory point toward the road.

Based on the above-mentioned formula, the result of the forecasted noise level for the year 2010 and 2020 in the bridge site is shown in Table 17.3.9 and Table 17.3.10.

Table 17.3.9 Forecasted Noise Level for the years 2010 and 2020, Section 1

Year		2010		2020	
		avg	max	avg	max
Forecasted noise level		86.1	91.7	86.8	92.3
Vietnamese Standard	(1)	45	60	45	60
	(2)	50	70	50	70

All those forecasted noise levels are higher than the maximum permitted noise level of Vietnamese Standard TCVN 5949-1995 (Maximum permitted noise level in public and residential areas).

Table 17.3.10 Forecasted Noise Level for the years 2010 and 2020, Section 2

Year		2010		2020	
		avg	max	avg	max
Forecasted noise level		87.1	92.6	88.1	93.6
Vietnamese Standard	(1)	45	60	45	60
	(2)	50	70	50	70

where: (1) - for residential area: hotels, administration offices, houses, apartment, etc.
(2) - for commercial and service areas and mix
avg - average-day noise level
max - noise level at rush-hours

The result of the forecast makes it necessary for the project to take some measures for reducing noise level along the proposed bridge in the coming years, especially for the section near the school, and resident's houses, etc.

(7) Impact of vibration

In the course of the time, the spans of large bridges have continually increased. The fundamental frequency of bridge is in general rather low and depends of course strongly on the span length and the type of the bridge construction. For highway bridge, that fundamental frequency maybe simply estimated as :

$$f = 100 / L \text{ [Hz]} \qquad (17\text{-}6)$$

where L = span length in [m]

Besides their static weight, the bridge is strongly affected by dynamic actions. This is due to the wind, to the vehicle moving over a flexible structure and this gives rise to time dependent variable deflection. These forces act in different directions and at various locations. Many of the bridges lie within the frequency range of 2 to 4 Hz. Vibration of the bridge deck may cause the following effects :

- endangering the load-carrying capacity of the bridge
- impairing the fatigue behaviour of the bridge and its installation
- impairing the safety of the vehicles
- impairing the serviceability of the bridge and its installation
- impairing the serviceability of adjacent structures

17.3.4 Environmental Evaluation

Based on the above-mentioned analyses, the following environmental evaluation at construction and operation/maintenance phase could be summarised as shown in Table 17.3.11.

17.4 Mitigation Measures and Monitoring

17.4.1 Recommended Mitigation Measures

(1) Construction Phase

All construction support activities should be set back behind the level where possible, and should be designed to mitigate the disturbance to the banks and their associated erosion control.

A residents' liaison group in the local communities near the construction site should be established during the construction phase. Regular on-site meetings should be held to ensure that local communities are able to understand the construction progress, and can be reassured concerning the duration of temporary negative impacts. The existing Village People's committees could be used to identify appropriate 'sub-groups' of affected residents.

The following mitigation measures could be discussed by the existing village people's committees and contractor.

Erosion and sediment control

The following steps could be proposed to minimize the impacts of sediment disturbance and erosion during the construction phase:

Table 17.3.11 Environmental Evaluation

No.	Environmental Item	Evaluation	Impacts and Reasons
Social Environment			
1	Resettlement	▲ (C)	About 100 dwellings and about 12 hectares of agricultural lands will be demolished by the project.
2	Economic Activity	△ (C) ○ (O)	Paddy fields and fish ponds will be lost in some portions by the project. However, regional economic activities will be vitalized by the project.
3	Traffic/Public Facilities	△ (C)	The optimum route is designed to pass very close to some public facilities such as primary school.
4	Community Severance	-	The optimum route is planned to avoid passing the densely inhabitant area .
5	Cultural Property	-	The optimum route is keep distance to important cultural property.
6	Rights of Common	-	There are no government regulations for fishery right.
7	Public Health Condition	-	Public health issues will not occurred by the project.
8	Waste	△ (C)	Waste management at construction phase should be considered.
9	Hazards(Risk)	-	Risk of hazards will not increased by the project.
Natural Environment			
10	Topography and Geology	-	As the project scale is not large, change of topography and geology will not occurred by the project.
11	Soil erosion	△ (O)	Mitigation measures for topsoil erosion by rainfall after vegetation removal will be needed.
12	Groundwater	-	Change of the distribution of groundwater will not occurred.
13	Hydrological Situation	-	Change of the river discharge and riverbed condition will not occurred.
14	Coastal Zone	-	The project site is not included in coastal zone.
15	Fauna and Flora	-	There is no endangered/rare species in the project site and the impacts on the existing ecosystem by the project will be very few.
16	Meteorology	-	Change of meteorological conditions will not occurred by the project.
17	Landscape	△ (C) ○ (O)	Although aesthetic deterioration may occurred due to the construction wastes and etc., the bridge's design is taking into account a harmony with local natural view.
Pollution			
18	Air Pollution	△ (C) △ (O)	As the traffic volume will be increased slightly, air pollution caused by the project at construction and operation phase may slightly occurred. Mitigation measures should be considered.
19	Water Pollution	△ (C)	Slight increase in water pollution by the project at construction phase mainly due to construction wastes. Mitigation measures should be considered.
20	Soil Contamination	-	As the construction methods will be considered the countermeasures for soil contamination, the impact will be very few.
21	Noise and Vibration	△ (C) △ (O)	As the optimum route is designed to pass close to houses and existing properties in some sites, the slight traffic noise and vibration impacts by the project should be considered.
22	Land Subsidence	-	As the construction methods will be considered the countermeasures for land subsidence, the impact will be very few.
23	Offensive Odor	-	There is very few factors generating offensive odor by the project.

Note: 1) Evaluation Categories

●: Significant favorable impact is expected. ○: Slight favorable impact is expected.

▲: Significant adverse impact is expected. △: Slight adverse impact is expected

2) (C) = Construction Phase, (O) = Operation/Maintenance Phase

- All disturbed and unpaved areas should be re-vegetated within thirty days of final land shaping. The construction works therefore should be phased so that land disturbance is always limited to areas of a workable size;
- Construction should be scheduled so that large areas of soil are not laid bare during the wet season;
- Storm water runoff from construction areas should pass through a gross pollutant trap (to filter plastics, cans and other solid wastes) and a settlement basin before discharge. Water hyacinth plots should be considered for use as a final filtration medium, as they are already used locally for this purpose; and,
- Storm water from non-construction areas should be diverted around the construction areas in order to keep natural flow separate from construction run off.

Control of Water Pollution

In order to ensure water quality and waste controls, the following measures be implemented at concrete batching plants and similar construction areas:

- The plant operating surfaces should be built up on a sediment platform to ensure that all runoff can be isolated from the regional water table;
- Clean and dirty runoff must be kept separately; The dirty runoff area (from truck washing, batching area, materials unloading area) must be isolated by a bound or mounded barrier;
- Dirty runoff water must be channeled to a settling pit, to collect fine sediment and slurry;
- Water from the settling pits could be recycled, by pumping back to the bathing or washing areas;
- More than one pit will be required so sediment could be dry out for removal. Some sediment and slurry could be reused;
- Susceptible surface should be protected with mulch or fabric, and to plant erosion surfaces as soon as possible to mitigate water degradation by increased sediment;
- Recyclable lubricants should be collected, and spills avoided carefully to mitigate water contamination by oil, grease, fuel and paint in equipment yards and asphalt plants; and
- Toxic waste from construction works should be prevented from flowing into the river by some temporary dykes.

For floating batching plants no contaminated water will be discharged to the river. The water from this barged plant should be recycled where possible, and that wastewater should be pumped ashore for appropriate disposal, or stored in containers on the barge for later disposal.

In order to minimize the impact of sewage and waste disposal from construction camps and to ensure the maintenance of environmental health during the bridge construction, the following requirements will be recommended:

- Sewage should be disposed into hygienic pit latrines or into a septic tank system. In either case, it may be necessary that the latrine areas will be elevated, and be constructed on, and septic effluents drained into a mound of sandy sediment; and,
- Solid waste should be disposed of in a landfill or similar system.

<u>Control of Air Pollution</u>

For concrete batching plants and other construction areas, the following air pollution impact mitigation measures should be taken place:

- Sealing of local access roads;
- Supply of aggregate and sand in damp condition in covered trucks in order to avoid airborne dust;
- Fitting the tipping point with water sprays in order to allow the dampening of materials during dry weather condition;
- Enclosing the conveyors that transfer the raw materials; and,
- Waste wood could be burned on-site and away from preserved vegetation only when applicable permits have been secured. Toxic and polluting materials should not be used to start or maintain fires. Burning should be maintained to produce minimum amounts of nuisances and air pollution.

<u>Control of Construction Noise and Vibration</u>

For concrete batching plants and other construction sites, the following noise and vibration impacts mitigation measures could be proposed:

- Transportation of as much raw material as possible by barge rather than truck;
- Ensuring the time schedule and places (e.g., unloading of sand and aggregate

into storage bins should be conducted during daylight hours. Loading trucks, mixing operations and pumping should be carried out during normal working hours); and

- Utilization of low noise/low-vibration type of construction equipment and work methods.

The following measures are recommendable for the residents around the construction sites:

- Installation of physical barriers against noise in plants, and enhancement public transportation and traffic management in order to mitigate air and noise pollution from vehicle operation;
- During the construction phase, continuos noise logging measurements should be taken at locations along the proposed bridge/roadwork; and,
- When the bridge and approach route design is completed, noise impacts during the construction period should be estimated.

Management of Procurement / Dumping of Construction Materials

During construction phase, concrete batching plants will be required only for the construction of the bridge piles, piers and sections of the roadway. A determination for the plant location must conform to the following conditions:

- Transportation of raw material by barge is more convenient; and,
- Prohibition of fishery on immediate downstream from the plant.

Management of procurement/dumping of construction materials must conform to conditions as follow:

- Loading trucks, mixing operation and pumping are carried out during normal working hours, or away from residential areas;
- Supply of construction materials in order to keep for damp condition covered trucks and barges in order to mitigate dust.

Maintenance of Temporary Works

When the bridge construction is completed, it will be important to return all working areas to a useful estate, and to ensure that no long-term environmental impacts of the construction activities. Appropriate measures should be included in contract documents.

- This will involve the removal of concrete batching plants, and other facilities which are not required by the national or provincial governments;
- This will involve the complete removal of minor plant, waste materials from all construction sites, oil containers, discarded machine parts and fencing materials. Inorganic waste should be disposed at landfill sites away from the construction area. Any remaining organic non-toxic wastes should be plugged into the soil layers.

Instruction for the Workers Concerning the Importance of the Cultural Properties

When a construction supervising consultant chose the site supervisors and workers the consultant should be instructed on the nature and importance of existing archaeological materials which could be located during site excavations.

Workmen be advised that if they locate any archaeological materials in the course of construction activities, these should be reported immediately to the construction site supervisor, who can arrange for their scientific assessment by an archaeologist.

If the bridge construction requires opening a new quarry or a major extension to an existing quarry, the project managing contractor should ensure that a quarry management plan is prepared. This plan should address environmental management and rehabilitation, and archaeological significance.

Recommendation for the Socio-Economic Adverse Impacts

The construction of the bridge Thanh Tri and Ring Road No.3 will have some potential adverse impacts, but all the potential adverse impacts can be either eliminated, or significantly reduced, by careful planning. The following recommendations for their mitigation can be proposed.

- In order to mitigate the impact on residents who lose their dwelling to the project, a resettlement plan should be prepared during the detailed design stage in advance of the construction;
- Arrangements should be negotiated for some assistance with the relocation process to be given to households. In order to reduce the cost of rebuilding, detachable materials should be brought from the house on the land to be acquired.
- Prior agreement should be reached with farmers as to how much notice they

need to be given to move, and this agreement strictly adhered to. Since families who will have to relocate will need money for deposits on new land or houses, it is suggested that the full amount of compensation should be paid about four months before the households actually have to move;

- Moving of farming households require careful planning, and it is agreed that moving in the dry season could reduce loss of crops and damage to property;
- All households interviewed claimed that they would never move family tombs if even a very small piece of land could be retained. If necessary, a cemetery should be considered for resettling any tombs on land resumed.

(2) Operation and Maintenance Phase

Erosion Control

In order to maintain the riverbank stability, the following measures should be considered.

- Re-vegetation of the river banks, using local shrubs and grasses;
- All hard structure be kept away from the immediate river banks wherever possible;
- Traditional methods employed by local landowners for bank erosion control could be used.

Control of Water Pollution

In order to avoid contamination of the Red River from accidental spills, or pollutants deposited by vehicles on to the bridge pavement, the following measures should be taken:

- Runoff is collected in gutters and directed into a rubble/sand drain (to filter oils) before discharge via a grassed or vegetated channel (to filter nutrients). The rubble drain should be able to be closed off to contain major liquid spills on the bridge.
- If this runoff control mechanism is rejected as being too expensive, the design should be modified to minimize the inevitable contamination of the river. In this case drainage scupper outlets should direct storm water runoff to the areas immediately downstream of the bridge piles, into the zones of maximum water turbulence.

Control of Air Pollution, Traffic Noise and Vibration

Air pollution or noise/vibration along the project site will be caused by future industrial/agricultural development around the site or increase of traffic on Ring Road No. 3 due to economic growth in the whole country. Obviously, most of the future environmental impacts in the operation phase are not purely due to Thanh Tri bridge project. On the contrary, the Project will contribute to improvement of air quality and to mitigation of noise/vibration around the project site, because traffic flow will be smoother.

In terms of noise impacts, it is often desirable to involve the community in the noise-barrier selection process. Some homeowners may have definite opinions on materials, pattern, and other features which should be considered in the selection process.

17.4.2 Monitoring Program and Mitigation Measures

(1) Monitoring Program

The following environmental monitoring program for the project is recommended. In the monitoring system, information/data on individual/families related to their living standard is the baseline to examine effects of the managerial measures.

1) Water Quality

Location :	3 sites (at bridge, on downstream 500m from the bridge, and on upstream 500m from the bridge)
Period :	2 times/day (at ebb-tide and at flow-tide) the day for a week during construction phase for a month during 2 years operation/maintenance phase, for 6 months on continual time
Sampling Items :	pH, SS, COD, BOD, DO, P_{total}, Al, Fe

Monitoring Cost

One time for monitoring : 3 sites x 8 items x US$ 3= US$ 72

Construction Phase : for 5 years (a year include 12 months or 52 weeks)

US$ 72 x 2 times x 52 weeks x 5 years = US$ 37,440

Operation/Maintenance Phase for 5 years :

During the first two years, one day two times water quality sampling will be done every month. During the remaining three years, one day two times water quality sampling will be done every six months. The total cast is:

US$ 72 x [(2 x 12 x 2) + (2 x 12/6 x 3)] = US $ 4,320

2) Air Quality and Noise Level

Location :	5 sites (the two sites at bridge and the three sites at residential area)
Period :	1 day/ month during construction phase, 1 day/6 months during operation/maintenance phase after 5 years
Sampling Items :	TSPM, SO_2, NO_x, HC, CO, Pb and $L_{10,}$ $L_{50,}$ L_{eq}

Monitoring Cost

One time of monitoring for air quality sampling :
5 sites x 6 items x US$ 3= US$ 90
One time of monitoring for noise sampling : US$ 70
Construction Phase for 5 years (a year include 12 months or 52 weeks) :

An air quality monitoring is conducted 8 times per month. The cost for this item is:

US$ 90 x 8 times x 12 months x 5 years = US$ 43,200

A noise level monitoring is conducted for every month. The cost is:

US$ 70 x 12 months x 5 years = US$ 4,200

Operation/Maintenance Phase for 5 years :

For air quality monitoring during the first 5 years at operation/maintenance phase, it will be measured a day (8 times) for every 2 months. The cost is:

US$ 90 x 8 times x 2 months x 5 years = US$ 7,200

Noise level will be monitored during the first 5 years at operation/maintenance phase, and will be measured one day every year. The cost is:

US$ 70 x 2 x 5 = US$ 700

The above-mentioned total cost for the monitoring programs :

37,440 + 4,320 + 43,200 + 4,200 + 7,200 + 700 = US$ 97,060

(2) Environmental Mitigation Measure

Noise Barrier Wall for a School (Total 220 m length) along the Tran Phu Primary School should be considered. The cost is:

US$ 680 x 220 m = US$ 149,600

The grand total (Monitoring Program and Mitigation Measure Cost) is:

<u>97,060 USD + 149,600 USD = US$ 246,660</u>