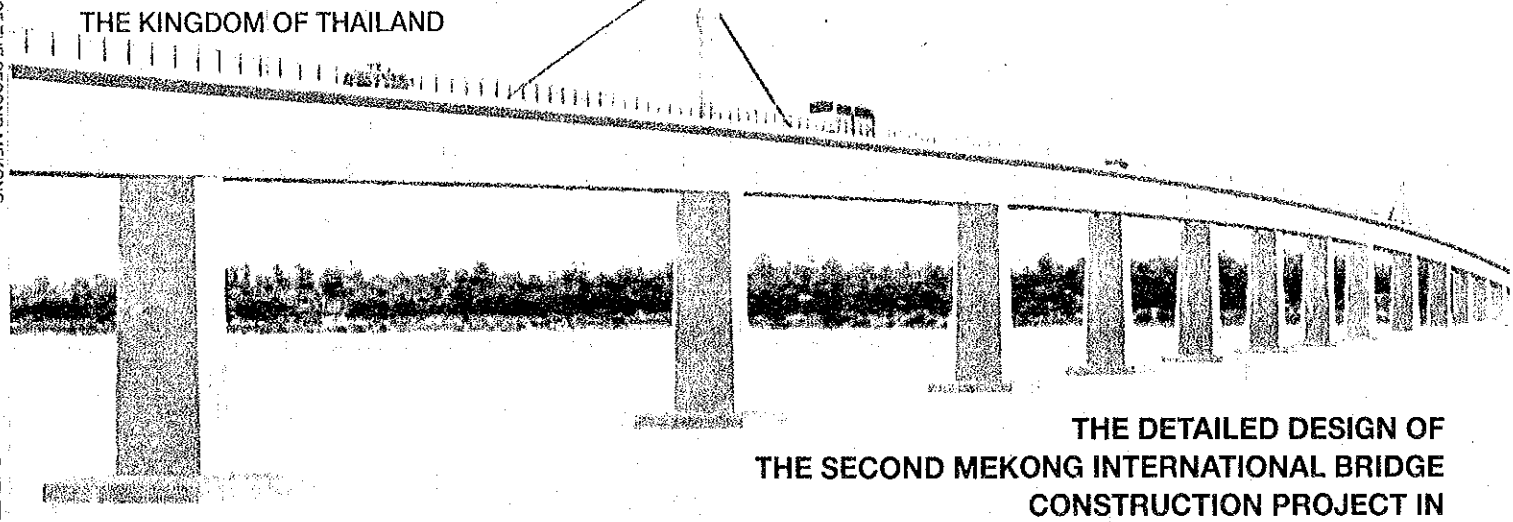
社会開発調査部報告書

No. 11

JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF COMMUNICATION, TRANSPORT, POST AND CONSTRUCTION
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
DEPARTMENT OF HIGHWAYS
THE KINGDOM OF THAILAND



THE DETAILED DESIGN OF THE SECOND MEKONG INTERNATIONAL BRIDGE CONSTRUCTION PROJECT IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC AND THE KINGDOM OF THAILAND

FINAL REPORT

JUNE 2000

ORIENTAL CONSULTANTS COMPANY LIMITED
NIPPON KOEI CO., LTD.

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ENVIRONMENTAL STUDY

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TABLE OF CONTENTS

1. GENERAL

The Second Mekong International Bridge Construction Project is considered as one of the most important projects in the East West Corridor planned by the ADB. This bridge will cross the Mekong River connecting the border cities of Savannakhet in the Lao PDR and Mukdahan in Thailand.

In the EIA system of Thailand, there are 29 types of projects for which an EIA is required. This bridge and approach road construction project corresponds to a "Highway or road" as defined by the Highway Act. However, it will not pass through the sensitive areas such as; (a) Wildlife sanctuaries and Wildlife Non-Hunting Areas as defined by the Wildlife Conservation and Protection Act, (b) National park as defined by the National Parks Act, (c) Catchment area classified as class 2 by the Cabinet Resolution, (d) Mangrove Forest Designated as the National Forest Reserve, (e) Coastal Area within 50 meters from the Maximum Sea level". Therefore, it is not necessary to carry out an EIA for the Project in Thailand.

While in the Lao PDR, the Law on Environmental Protection was approved by the parliament in May 1999. The Regulation on the EIA is currently being prepared. There would not appear to be any necessity for an EIA on this Project, because the site in the Lao PDR is in flatland predominantly used for cropping along the Mekong River and does not include any wildlife reservation area, national park, wetland and cultural property which require international protection.

In the JBIC (OECF) Guidelines for environmental consideration, large new or rehabilitation projects of road and railroad construction corresponds to "Category A: Submission of an EIA report is required and the Project is to be appraised in the light of the Guidelines." Therefore, this environmental study is based on the JICA Guidelines and the objectives are to evaluate the environmental impacts and to establish the mitigation plan as well as the monitoring plan for this project.

This Environmental Study is divided into two bodies, that is, Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA). In the phase of the Basic Design of the Project, the Initial Environmental Examination (IEE) has been carried out with review, analysis and assessment of the previous studies and field reconnaissance survey results, together with the studies on the environmental administration systems in the Lao PDR and Thailand. Then this study has been followed by a detailed field survey of the Environmental Impact Assessment (EIA) for the Detailed Design of the Project.

The study areas are the Project sites of the Bridge and connecting roads in the Area of Savannakhet in the Lao PDR and Mukdahan in Thailand.

2. INITIAL ENVIRONMENTAL EXAMINATION (IEE)

2.1 Objectives and Procedures of IEE

The purpose and procedures of the Initial Environmental Examination is outlined as follows;

- To reveal conditions of the environment in the Area.
- To focus on the elements which have relevances to the Project and the environmental conditions in the Area.
- To consider the relationship between the Project actions and Environmental Conditions and to prepare the Initial Environmental Examination Matrix.

In this section, prediction of impacts is a preliminary estimate to determine the necessity of the detailed environmental investigation and the study for mitigation measures at the Detailed Design stage of the Project.

2.2 Project Components and Activities

The project site of The Second Mekong International Bridge is located approximately 4.0 km north of Savannakhet city in the Lao PDR and approximately 6.6km north of Mukdahan city in Thailand.

The project comprises:

1) A bridge across the Mekong River connecting Savannakhet in the Lao PDR and Mukdahan in Thailand. The length of the Bridge is approximately 1,450 meters and the width of the Bridge is 12 meters, with provision for a 2-lane highway.
2) A traffic change-over and Border Control Facilities in the 1.7 km connecting road to the national highway Route No.212 on the Thailand side.
3) Border Control Facilities and a 3.1km connecting road to the national road Route 9 on the Lao PDR side.

2.3 Environmental Parameters and Potential Impacts

The environmental parameters for the IEE are confirmed through the examination of the Project activities during the Basic Design Study period. Impacts and influence on these parameters due to implementation of the Project were examined based on the results of the environmental survey in the Lao PDR and Thailand considering the relationship of the Project activities.

Through the examination, a few environmental components could be affected by the planned Basic Design of the Project as given in Table 2.1 which shows the IEE Matrix (Project Activities-Environmental Parameters Matrix), mainly considering the negative impacts caused by the Project.

Table 2.1 IEE Matrix

Activities which may cause impacts / Category of environmental	Construction Period		Operational Stage	
	Passage of Construction Vehicles	Construction of Bridge and Connecting Roads	Existence of Bridge and Connecting Roads	Passage of Vehicles
1.Social Environment				
Social Aspects				
Resettlement		□		
Community severance			□	
Substantial changes in way of life				
Conflict among communities or people				
Land use		□		
Landscape			□	
Water supply system				
Transportation and Traffic				
Land transportation	□			
Local navigation				
Economic Activities				
Relocation of bases of economic activities				
Occupational change, loss of labor opportunity				
Increase in income disparities				
Fishery		□		
Public Health				
Outbreak of contagious diseases		□		
Prevalence of epidemic diseases		□		
Increase in domestic and other human waste		□		
Cultural Issues				
Impairment of historic remains and cultural assets		□		
2.Natural Environment				
Biological and Ecological Issues				
Deterioration or degradation of vegetation			□	
Degradation of flora/fauna/ecosystem			□	
Degradation of aquatic life		□		
Proliferation of exotic and/or hazardous species				
Soil and Land Resources				
Soil erosion		□		
Hydrology and Air and Water Quality Issues				
<Hydrology>				
Changes in water flow conditions		□	□	
Soil sedimentation		□		
Riverbed degradation				
<Water Quality and Temperature>				
Water contamination and deterioration of water quality		□	□	
<Atmosphere>				
Air pollution	□	□		□
Noise and Vibration	□	□		□

Note: □ : The activity which has a potential environmental impact

2.4 Overall Evaluation

The overall evaluation of the environmental impacts of The Second Mekong International Bridge Construction Project is concluded to be minor. The reason for this conclusion of the environmental evaluation is given as follows:

With regard to the impacts on the natural environment, there is no sensitive area such as wildlife sanctuaries, national parks or nationally declared significant conservation areas in the Project sites. Since these project sites are located in the Area along the Mekong River which is highly modified by intensive human use for agriculture and cropping such as rice paddy, secondary forest and stocked forest, the original natural resources are not considered to remain in these Project sites.

With regard to impacts on the social environment, a few households will be included in the Area for land acquisition in the Lao PDR. However, major resettlement would not be required because the land acquisition will be carried out through cash compensation and relocation of households within the same village.

With regard to the pollution impacts, since some villages are close to the bridge construction site, certain houses and facilities would receive certain impacts of dust fall, noise, and vibration during piling works and other activities in the construction period. Therefore, the effect of high noise and vibration work should be minimized with adequate mitigation measures. In the operation stage of the Bridge, it is estimated that a traffic level of 255 vehicles per hour in 2020 would occur and this volume is quite small.

The environmental evaluation and mitigation measures are summarized in Table 2.2.

Table 2.2 Overall Environmental Evaluation and Mitigation Measures

		Items	Precondition	Impact without measures	Mitigation measures	Evaluation
Construction period	1)	Resettlement	Resettlement will be minimal.	+	-	+
	2)	Land use	Resettlement will be minimal.	+	-	+
	3)	Water supply system	Discharging sediment during piling activity	++	Adoption of steel stand piping method	+
	4)	Land transportation	Increase of construction traffic on local road	+++	Construction of access road and preparation of traffic management	++
	5)	River navigation	The project sites don't interfere with the local ferry service.	+	-	+
	6)	Fishery	There are no professional fisheries	+	-	+
	7)	Public health	Risk of diseases in labor camp	++	Ensuring proper sewage treatment and disposal etc.	+
	8)	Cultural assets	There are no significant cultural assets in and around the Project sites	-	-	-
	9)	Soil erosion	Earth work of the connecting road	+++	Installation of sediment collection ponds	++
	10)	Water contamination	Arising from the sediment discharge in piling activity	+++	Adoption of steel stand piping method	++
	11)	Air pollution	Impact of dust fall to some village located near the construction site	+++	Dust elimination measure	++
	12)	Noise/Vibration	Impact of noise/vibration to some village located near the construction site	+++	Restriction of piling driving work during daylight hours	++
Operational period	1)	Community severance	The bridge and connecting roads will interfere with traffic on the major local roads.	++	Construction of underpass for human use	+
	2)	Landscape	Part of connecting roads might be visible from surrounding villages and temples.	+++	Replantation	++
	3)	Land transportation	The connecting road will connect national roads in both countries, so there is no effect on local traffic conditions	+	-	+
	4)	Flora/Fauna/Eco-system	No reserved forest, wildlife sanctuary, national park or nationally declared significant conservation area in the Project sites.	++	-	++
	5)	Aquatic life	The bridge piers will not impede ability of fish to migrate.	++	-	++
	6)	Changes in water flow conditions	The total cross-sectional area of the bridge is estimated as small.	+	-	+
	7)	Air pollution/Noise/ Vibrations	The estimated traffic volume level is light.	++	-	++

Note:

++++ : Significant
+++ : Moderate
++ : Minor
+ : Insignificant
- : None

3. ENVIRONMENTAL IMPACT ASSESSMENT

3.1 General

The IEE results showed that the environmental impacts of The Second Mekong International Bridge Construction Project were considered to be minor. In order to establish an integrated environmental protection program in the Detailed Design stage of the Project, it was necessary to carry out a detailed environmental study of the present situations and examination of mitigation and/or elimination of the negative impacts which might be attributed to the subject development. The environmental factors which were subject to further detailed environmental study have been identified based on the IEE results.

The environmental factors identified for further investigation and framework of technical specifications are as follows:

(a) Water Quality

Water contamination impacts in the construction stage were evaluated as minor due to mitigation measures. However, it is necessary to measure the present water quality for establishment of an environmental protection plan which has been examined in this stage.

(b) Aquatic Life

The effect of suspended solids on aquatic life can occur in the water column as well as the bottom of the water body from sedimentation. To assess the present condition of aquatic life in the Mekong River, the analyses given below have been conducted.

- Plankton sampling
- Benthic sampling

(c) Air Quality/Noise/Vibration

The impact of air quality /noise /vibration on this Project was evaluated as minor in both the construction and operation periods. However, it is necessary to measure the present conditions for the establishment of the environmental protection plan which will be examined in this stage.

(d) Social Environmental Survey

Land acquisition is unlikely to be a major issue on this Project. The Project seems to be well accepted with goodwill towards it. The social environmental survey has been carried out to study household socio-economic conditions and business enterprises for evaluation of their ability to cope with the expected positive and negative impacts from the Project.

3.2 Existing Environmental Study

3.2.1 Water Quality

(1) Objectives

- To investigate the existing water quality of the Mekong River.
- To evaluate changes in water quality due to the Project.
- To recommend appropriate mitigation measures and monitoring program during the construction and operation phases.

(2) Methodology

Methodology of the study will identify the Mekong River at 2 sampling stations (see Figure 3.1) as 1,000 m. upstream and 1,000 m downstream of The Second Mekong International Bridge Construction Project. Water sampling was conducted at the mid-depth level of the river. Parameters for water sampling consist of temperature, pH, turbidity, conductivity, DO, COD, BOD_5, SS, oil & grease, lead and fecal coliform bacteria. Analysis methods of these parameters are accepted by Ministry of Science, Technology and Environment (MOSTE).

The results of water quality should be compared with international standards or MOSTE surface water quality standard in order to determine whether water quality is poor, acceptable or very good.

(3) Results of the Study

The water sampling for surface water quality testing was undertaken on November 19, 1999 (in the winter season) in the Mekong River at 2 stations. The analysis results as shown in Table 3.1 indicated that all of surface water was of similar quality in some parameters such as water temperature (24.5 °C) and the pH value was slightly alkaline (7.83-7.86). Conductivity level of surface water in the Mekong River was 196.8-199.7 mS/cm.

The level of dissolved oxygen (DO) was very high, ranging from 7.76-7.94 mg/l. This is because oxygen can be dissolved easily along the water body due to the geomorphological characteristics of the riverbed. BOD_5 of 3.6 mg/l is considered high. Although the parameters are lower than the MOSTE surface water quality standard, the water quality is considered to be poor. This is due to discharge of polluted water from the communities, industrial and agricultural areas. The water samples collected from the representative waterway demonstrated a relatively high concentration of suspended solids due to the influence of additional silt from upstream. The SS content (283.5-352.0 mg/l) and turbidity (321-339 NTU.) were significantly high. The representative waterway were found not to be contaminated by oil & grease. A low level of lead contamination was found at both sampling stations (0.0014-0.0044 mg/l).
Comparing water quality of both stations with OEPP surface water quality standard (Appendix 3.1), it was found that the water quality of the sampling was within class 4 (for industry or consumption but special water treatment is required before use).

Table 3.1 Existing Water Quality

ITEMS	UNIT	Station 1	Station 2
Temperature	C	24.5	24.5
pH		7.83	7.86
DO	Mg/l	7.94	7.76
Turbidity	NTU	339	321
Conductivity	MS/cm	199.7	196.8
Suspended Solids	Mg/l	352	283.5
Fat, Oil &Grease	Mg/l	N.D.	N.D.
BOD 5 days	Mg/l	3.6	3.6
COD	Mg/l	15.74	27.56
Lead (Pb)	mg/l	0.0044	0.0014
Fecal Coliform Bacteria	MPN/100ml	23	33
Class		4	4

Remark : Station 1 = 1,000m upstream of the Mekong Bridge
Station 2 = 1,000m downstream of the Mekong Bridge

3.2.2 Aquatic Life

(1) Objectives

Objectives of the study are to collect the existing aquatic ecology to evaluate some impacts on aquatic lives, to recommend appropriate mitigation measures and monitoring program during construction and operation phases.

(2) Methodology

Methodology of the study is to collect sampling water organisms comprising plankton organism and benthic organism. Sampling was conducted along the Mekong River at 2 sampling stations (see Figure 3.1) i.e. 1,000 m. upstream and 1,000 m. downstream of The Second Mekong International Bridge Construction Project. These stations are the same as those used for water sampling stations.

For plankton sampling, samples were collected by using a 70 micron mesh size plankton net. Thirty liter of water sample were poured through the plankton net. The plankton samples that remained in the plankton net were collected and preserved in 4% formalin solution for identification analysis in laboratory. The characteristics of the plankton samples determined included species composition of the plankton population and abundance of the population.

The benthic organism sampling was undertaken using an Eckman dredge (0.5 sq.ft.). Samplings was conducted 3 times at each station. The sediments were sorted through a series of wire sieves to separate benthic size (the minimum size was approximately 85 micron). The samples were preserved in 7% formalin solution for later identification analysis in laboratory. The characteristics determined for the benthic samples were the same as those of the plankton samples.

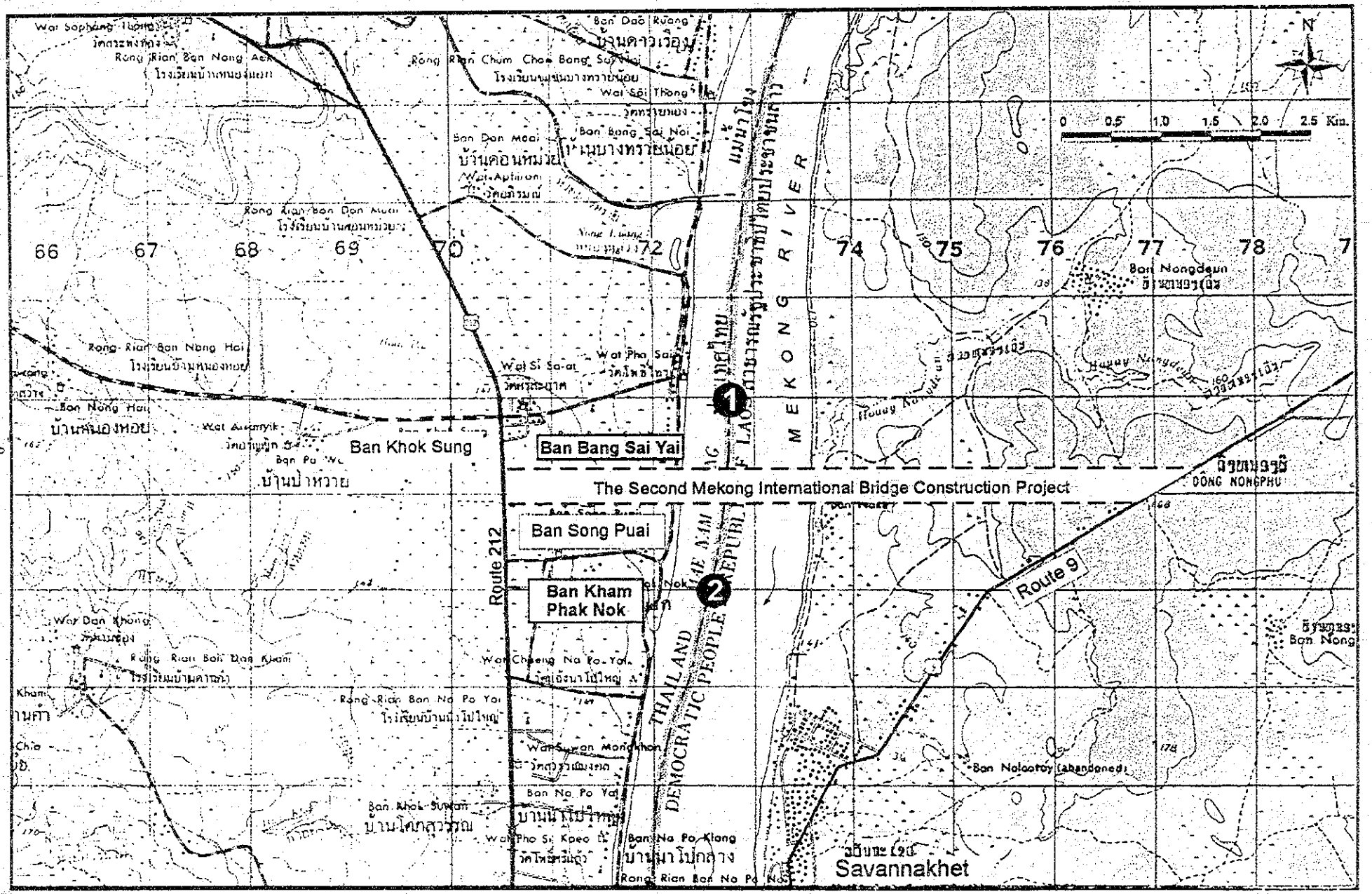

Fig. 3-1 Sampling Stations of Water Quality and Aquatic Life

(3) Results of the Study

- Plankton Organisms

Concerning identification analysis of plankton samples that were collected on November 19, 1999, the results showed total of 1 phylum of phytoplankton and 3 phyla of zooplankton (Table 3.2) comprising Phylum Bacillariophyta (Diatoms), Phylum Protozoa (Protozoans), Phylum Rotifera (Rotifers) and Phylum Arthropoda (Arthopods). The dominant species in order of relative abundance were *Diatoma elongatum* Agardh, *Surirella robusta* var. splendida (Ehr.) van Heurch and *Centropyxis aculeata* Stein. Phytoplankton dominated zooplankton in total number of cells. The phytoplankton constituted 50% of the total number of species, and most of them were diatoms of Phylum Bacillariophyta. The zooplankton which were present in low concentration in this investigation consisted of protozoan (*Arcella vulgaris* Ehrenberg, *Centropyxis aculeata* Stein, *Difflugia globulosa* Dujardin), rotifer (*Nothoca acuminata* Ehrenberg) and insect larva.

Table 3.2 shows the abundance and percentage of phytoplankton and zooplankton in the Mekong River. Abundance of plankton at the downstream station (187,000 cell/m^3) was higher than those of the upstream station (103,500 cell/m^3). Shannon-Weiner Diversity Index which shows the diversity of community of plankton are 1.24 and 0.69, respectively. According to the index, the abundance of phytoplankton and zooplankton in the Mekong River belongs to the level of the diversity of "low" to "moderate".

- Benthic Organism

No benthic organisms were found at either sampling station. The water current in the Mekong River was very rapid and the bottom of the Mekong River was mostly sand and gravel. Therefore, the benthic organisms are flushed downstream easily. These results are not uncommon in the flood season.

Table 3.2 Existing Aquatic life

Scientific Name	Station 1	Staion 2
PHYTOPLANKTON		
Phylum Bacillariophyta (Diatoms)		
Diatoma elongatum Agardh	49,500	143,000
Melosira granulata (Ehrenberg) Ralfs	-	5,500
Navicula radiosa Kuetzing	-	5,500
Surirella robusta var. splendida (Ehr.) Van Heurck	22,500	11,000
Synedra acus Kuetzing	4,500	11,000
Subtotal Phytoplankton	76,500	176,000
Diversity Index	0.81	0.73
ZOOPLANKTON		
Phylum Protozoa (Protozoans)		
Arcella vulgaris Ehrenberg	-	5,500
Centropyxis aculeata Stein	13,500	5,500
Difflugia globulosa Dujardin	4,500	-
Phylum Rotifera (Rotifers)		
Nothoca acuminata (Ehrenberg)	4,500	-
Phylum Arthropoda (Arthropods)		
Insect larva	4,500	-
Subtotal Zooplankton	27,000	11,000
Diversity Index	1.24	0.69
Grandtotal	103,500	187,000
Percentage	35.6	64.4

Remark : Station 1 = 1,000m upstream of the Mekong Bridge
Station 2 = 1,000m downstream of the Mekong Bridge

Shannon-Weiner Diversity Index

$$H = \sum_{i=1}^{s} \frac{n_i}{N} \ln \frac{n_i}{N}$$

H = Community Diversity Index
N = Total Number of Organisms
n = Number of Individual per Taxon
s = Total Number of Taxon

Diversity Index	Level
<1	Low
1-3	Moderate
>3	High

3.2.3 Air Quality

(1) Objectives

- To collect and analyze the local meteorological data around the Project area which influence air pollutants dispersion.
- To evaluate the existing air quality around the Project area which may be affected.
- To predict air pollution emission from the Project activities both in the construction and operation phases and to estimate air quality impacts due to the Project operation via mathematical model.
- To recommend the mitigation measures and the monitoring programs during both construction and operation phases.

(2) Methodology

- Collecting meteorological data of a period from 1966 to 1995 at Mukdahan weather station which is the nearest station to the Project site and then analysing the stability class, frequency of wind direction and speed by the pre-processing meteorological program.
- Measuring the existing air quality around the Project areas at 3 stations (2 stations in Thailand and 1 station in the Lao PDR) for 3 consecutive days at each site. The existing air quality measurement stations were representative of the Areas, particularly the sensitive receptors. The sampling stations are presented in the following table (refer to Figure 3.2)

Sampling Station	Location	Station Name
Station 1	Thailand	Ban Song Puai
Station 2	Thailand	Ban Khok Sung
Station 3	The Lao PDR	Interchange of Route No.9 & Kaysone Road

The parameters measured carbon monoxide (CO), nitrogen dioxide (NO_2), total suspended particulate (TSP), particulate matter (PM-10), lead (Pb) and sulfur dioxide. Carbon monoxide is the gas resulting from incomplete combustion of fuels, and it is toxic gas which is colorless, odorless, and tasteless. It can combine with hemoglobin in the blood and cause oxygen insufficiency in persons who are exposed to the high concentration gas which result in dizziness and fainting. Nitrogen dioxide is the result of high temperature combustion which causes reaction between oxygen and nitrogen to form nitrogen oxides. Nitrogen dioxide has been reported to have an effect on respiratory function although the evidence concerning effects has been mixed and conflicting. Total suspended particulate can cause respiratory problems as well as visibility disturbance. Lead is a highly toxic substance which can cause gastrointestinal disturbance as well as effects on the nervous systems. Sulfur dioxide is toxic and causes irritations to respiratory system as well as damages to vegetation and properties. In North America and Europe, it causes acid rain which destroys forests and wild lives.

The analytical methods were based on the standard method specified by the Office of Environmental Policy and Planning (OEPP) of Thailand as presented in the following table.

Parameters	Measurement Period	Analytic Method
CO	1-hr.	Non-Dispersive Infrared Detection
NO_2	1-hr.	Chemiluminescence
TSP	24-hr.	High Volume Gravimetric Sampler
PM-10	24-hr.	High Volume Gravimetric Sampler & Cyclone PM-10
Pb	24--hr.	Atomic Absorption Spectrometer
SO_2	24--hr.	Pararosaniline

Air quality impact assessment study due to The Second Mekong International Bridge Construction Project were classified into 2 phases, namely, construction and operation phases. The negative impacts on air quality due to the construction activities are fugitive dust and toxic gas from heavy machinery, equipment and material transportation vehicles which can be summarized below.

- Fugitive Dust
  Activities that produce fugitive dust are land preparation, grading, etc. The volume of dust depends on various factors such as soil characteristics, soil moisture, wind speed and construction time. The particulate concentration can be calculated by following equation (i) ;

$$C\ (mg/m^3) = \frac{Q\ (mg/sec)}{D\ (m) \times W\ (m/sec) \times M\ (m)} \qquad (i)$$

where C = Concentration (mg/m^3)
Q = Emission (mg/sec)
D = The area width perpendicular to wind direction (m)
W = Wind Speed (m/sec)
M = Mixing Height (m)

- Toxic Gas from Equipment and Heavy Machines
  The gases emitted from vehicles, equipment and machinery such as CO, NO_x, HC and TSP will be assessed using the ambient air standards of US. EPA, "Compilation of Air Pollutant Emission Factors," Publication No. AP-42 and calculate by equation (i) .

The impact assessment of air quality during the operation phase will utilize the mathematical models of "MOBILE-5 Model" to estimate pollutant emission rate from vehicles and "HIWAY Model of US. EPA" to estimate air quality level along the Project. "HIWAY Model of US. EPA" is a linear source air quality model that is widely accepted and used. The results of simulations are used to compare with the standard (1995) of the Ministry of Science, Technology and Environment in Thailand.

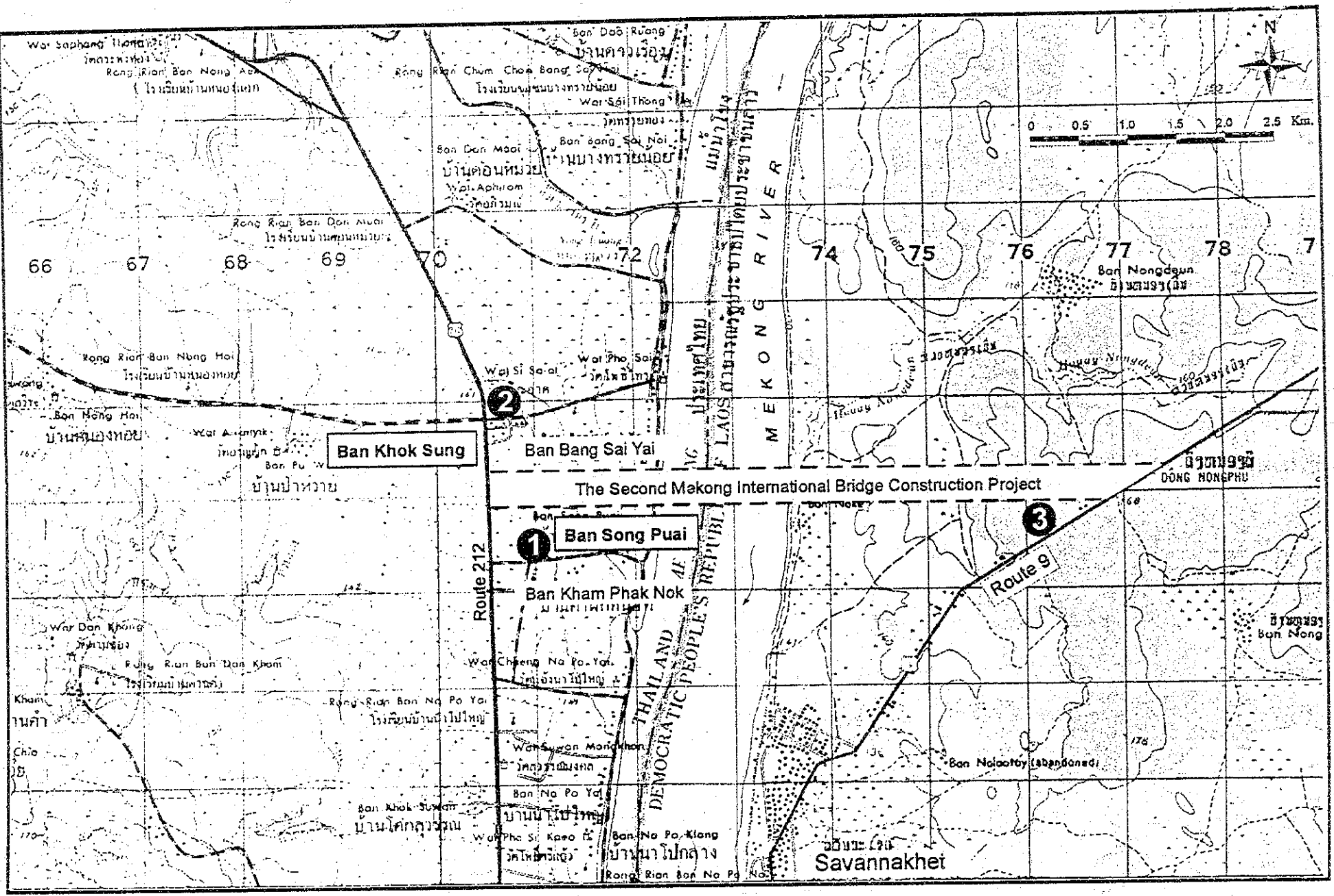

Fig. 3-2 Sampling Stations of Air Quality,Noise and Vibration Level

(3) Results of the study

(a) General Climatic Conditions

Climatic conditions in the northeastern provinces, including the Project area, is tropical climate which is influenced by the seasonal wind systems, namely, the southwest monsoon and the northeast monsoon. The southwest monsoon originates from the atmospheric pressure of the southern pole in the Indian Ocean and the Australian Continent. When it passes through the equatorial zone, it transforms to be the southwest monsoon and carries high humidity. This phenomena covers from May to September which is the rainy season. Tropical hurricanes and depressions often originate from the South China Sea and cause heavy rains from June to October. The northeast monsoon originates from the atmospheric pressure in China which carries the cold and dry climate to this region from February to May. During this winter period, temperature and humidity decrease. Summer season starts in February until April when the southwest wind which carries the hot and humid climate from the equatorial zone to this region.

The study of the transportation of gases and particulate matter in the atmosphere is important in evaluating the air pollution resulting from the Second Mekong International Bridge emission source. Air quality impact can be determined by using climatological parameters. The Mukdahan weather station is closer, being about 5 km southwest of The Second Mekong International Bridge Construction Project. Therefore, the statistical climatic data used in our study is taken from this station. The 30 year statistics of the climate in this region (1966-1995) obtained from the Climatology Division, Department of Meteorology are shown in Appdendix 3.2.

- Temperature
  Temperatures ranged from 22.0°C to 29.6°C, the highest temperature range was 28.3°C-35.6°C and the lowest temperature range was 15.5°C-24.7°C

- Relative Humidity
  Relative humidity is generally moderate up to high, and the annual average is about 72.0%. It reaches maximum in August (at 83.0%) and minimum in March (at 60.0%).

- Wind Speed and Direction
  It can be seen that the prevailing wind in the Mukdahan area during June to September is the south-westernly and north-easternly wind which bring humidity and rainfall from the Andaman Sea due to influence of southwest monsoon. For the other months, the prevailing winds are either from the east or northeast direction. The average velocity of the wind varied from 2.1 to 4.9 knots.

- Rainfall
  Appendix 3.3 shows the 30 year (1966-1995) statistics of the average rainfall of Mukdahan weather station. Average annual rainfall is 1,502.2 mm. The maximum rainfall is in August with an average of 353.1 mm. followed by June with 262.3 mm. The minimum rainfall is in December with an average of 3.0 mm and the average number of days of rainfall in a year is 115.4 days.

- Pressure
  There is little variation in the value of average monthly pressures within the range of 1,004.92 to 1,015.16 mbs. The extreme maximum values were in the range of 1,012.57 to 1,027.81 mbs. while the extreme minimum values ranged from 992.19 to 1,003.86 mbs.

(b) Existing Air Quality

The measurement of existing air quality was carried out on November 19, 1999 at 3 sampling stations (2 stations in Thailand and 1 station in the Lao PDR). The six air quality parameters, TSP, PM-10, NO_x, CO, Pb and SO_2 were measured continuously for 3 consecutive days at each site. The results of air quality are shown in the table below and described as follows :

Existing Air Quality

Concentration	Station No.1	Station no.2	Station No.3	Standard of MOSTE
TSP@	0.046 – 0.056	0.070 - 0.086	0.069 - 0.106	0.330@
PM-10@	0.030 – 0.038	0.052 - 0.053	0.042 - 0.085	0.120@
NO2@@	0.003 – 0.005	0.003 - 0.012	0.002 - 0.003	0.320@@
CO□	0.40 – 0.70	0.40 - 0.80	0.40 - 0.70	30.0□
SO2@	0.001	0.001	0.001	0.300@
Pb□□	0.040 – 0.063	0.051 - 0.061	0.040 - 0.064	1.50□□

Note : @ Average Concentration –24hr., mg/m^3
□ Average Concentration – 1hr., ppm
@@ Maximum Concentration – 1hr., mg/m^3
□□ Average Concentration – 1 month, $\mu g/m^3$

- Total Suspended Particulate (TSP)
  The concentrations of TSP at 3 sampling stations were below standards given by The Ministry of Science, Technology and Environment (0.330 mg/m^3 in 24 hr.). The TSP values in 24 hour period ranged from 0.046 to 0.106 mg/m^3 or 13.9% to 32.1% of allowable standards. TSP can come from many sources, and it is generally high in rural areas near dusty roads and along highways.

- Particulate Matter (PM-10)
  The concentrations of PM-10 at 3 sampling stations were below standards given by The Ministry of Science, Technology and Environment (0.120 mg/m^3 in 24 hr.). The average PM-10 values in 24 hour was 0.030 mg/m^3 to 0.085 mg/m^3 or 25.0% to 70.8% of the allowable standard.

- Sulfur Dioxide (SO_2)
  The average SO_2-24 hr. at all sampling stations was 0.001 mg/m^3 which was less than allowable standards given by The Ministry of Science, Technology and Environment (0.300 mg/m^3). Levels of SO_2-24 hr. were generally very low and below detectable limits. In such rural areas, SO_2-24 hr. is not a concern in terms of vehicle emission, but it is only a concern from large industrial sources, such as lignite-fired power plants.

- Nitrogen Dioxide (NO_2)
  The NO_2-1 hr. at all sampling stations ranged from 0.002 mg/m^3 to 0.012 mg/m^3 which was less than the allowable standards by The Ministry of Science, Technology and Environment (0.320 mg/m^3). These are generally very low levels, and are related to motor vehicle emissions and meteorological conditions.

- Carbon Monoxide (CO)
  The CO-1 hr. at all sampling stations ranged from 0.40 to 0.80 ppm. which was less than the allowable standards by The Ministry of Science, Technology and Environment (30.0 ppm). Sources of CO are understood to be motor vehicles, and there appeared a correlation between proximity of traffic roads and CO levels.

- Lead (Pb) : The Pb-24 hr. at all sampling stations ranged from 0.040 to 0.064 $\mu g/m^3$. These are generally very low levels, and they related to motor vehicle emissions and meteorological conditions. There is no 24-hr. standard for Pb; the 1-month standard of The Ministry of Science, Technology and Environment is 15 $\mu g/m^3$.

From this study of air quality, it may be concluded that the existing air quality is acceptable by the emission standards of The Ministry of Science, Technology and Environment because the air pollution parameters such as TSP, PM-10, SO_2, NO_2, CO and Pb values are much lower than the given standards or only 0.33% to 70.80% of standard values.

3.2.4 Noise

(1) Objectives

- To measure the existing noise level around the Project area.
- To predict the noise level during the construction and operation phases.
- To evaluate the noise impact due to the Project development.
- To recommend appropriate mitigation measures and monitoring programs during the construction and operation phases.

(2) Methodology

Measure the existing noise level (equivalent sound level 24 hours) along the Project at 3 stations (2 station in Thailand and 1 station in the Lao PDR) for 3 consecutive days especially at the following sensitive receptors. The sampling stations are shown in the following table (Table 3.2):

Table 3.2 Sampling Stations

Sampling Station	Location	Station Name
Station 1	Thailand	Ban Song Puai
Station 2	Thailand	Ban Khok Sung
Station 3	The Lao PDR	Interchange of Route No.9 & Kaysone Road

Estimated noise level due to the construction activities at the receptor within 10 to 100 meters of distance from source will be calculated by the following equation (i) and (ii).

$$\text{Leq } 12 = 10^{\sum_{i=1}^{n}} [\%ti/100 \times 10(Leqi/10)] \quad \text{(i)}$$

where Leq 12 = Average noise level at 12 hour
$\%t_i$ = % time usage of construction equipment (i)
i = Type of construction equipment

$Leqi$ = Noise level of construction equipment (i)

$$L_i = L_0 - 20 \log (D_i/D_0) \quad \text{(ii)}$$

where L_i = Average noise level at distance (i)
L_0 = Average noise level at the reference distance (10 m.)
D_i = Distance from the receptor source
D_0 = The reference distance from source

The above predicted noise level will be compared with ISO (International Organization for Standardization) and OSHA (Occupational Safety and Health Act, United State Labor Department, 1975) criteria.

- For estimated noise level due to the operation phase, STAMINA Model which use the same method to the Federal Highway Administration Model (FHWA) will be used to predict noise level. The predicted noise levels can be estimated by the following equation (iii).

$$Leq\ (h_i)=(L_o)_{Ei} + 10 \log (N_i D_o/S_i T) + 10 \log (D_o/D)^{1+\alpha} - 25 + \Delta_s \quad \text{(iii)}$$

Where

$Leq\ (h_i)$ = The estimated noise level (dB) at hour "h" due to the vehicle "i"
$(L_o)_{Ei}$ = Reference mean energy level (dB(A)) of the i^{th} class of vehicles
N_I = The number of class i vehicle passing during time T
S_I = The average speed for the i^{th} class of vehicles (km/h)
T = The duration for which Leq is desired and must correspond to N_i
D_o = The reference distance (15 m.)
D = The perpendicular distance from the centerline of the traffic lane to the receptor.
α = A factor which relates to the absorption characteristic of the ground cover between the roadway and the receptor
Λ_s = The shielding factor as provided by a noise barrier

In the case of predicted noise levels from vehicles such as light automobiles (Leq_A), medium trucks (Leq_{MT}) and heavy trucks (Leq_{HT}), the total Leq can be calculated logarithmically as follows.

$$Leq\ (h)_{total} = 10 \log (10^{LeqA/10} + 10^{LeqMT/10} + 10^{LeqHT/10}) \quad \text{(iv)}$$

Where $Leq\ (h)_{total}$ = The total Leq (dB(A)) from light automobiles, medium truck and heavy truck
Leq_A = Leq (dB(A)) from light automobiles
Leq_{MT} = Leq (dB(A)) from medium truck
Leq_{HT} = Leq (dB(A)) from heavy truck

The above predicted noise level will be compared to the existing conditions, OEPP and PCD (Pollution Control Department) recommendations to assess the existence and severity of potential noise impact.

(3) Results of the study

The existing noise level in terms of Leq-24 hr. and Ldn for 3 consecutive days and the 3-day average for each sampling station are shown in Appendix 3.4 and are summarized as follows :

Sampling Stations	Duration	Noise Levels (dB(A))	
		Leq-24 hr.	Ldn.
Station 1	15-18 Nov. 99	52.7-53.4	57.9-59.4
3 Day Average		52.97	58.40
Station 2	15-18 Nov. 99	52.6-53.1	56.5-57.0
3 Day Average		52.77	56.83
Station 3	20-23 Nov. 99	53.0-53.2	59.6-60.1
3 Day Average		53.13	59.87

Note : Station 1 : Ban Song Puai
Station 2 : Ban Khok Sung
Station 3 : Interchange of Route No.9 & Kaysone Road

From the above table, it was found that day-to-day variations of Leq-24 hr. and Ldn were very small within 0 to 0.70 dB(A) and 0.10 to 1.50 dB(A), respectively. This indicates that the monitoring stations are acceptable as there were no irregular loud noises during the monitoring. The 3 day average noise levels (Leq-24 hr.) for Ban Song Puai, Ban Khok Sung, and Interchange of Route No.9 & Kaysone Road were 52.97, 52.77 and 53.13 dB(A), respectively.

From the noise level measurement (Leq-24 hr.) on November 19, 1999, it can be concluded that the noise level was still within the standard of The Ministry of Science, Technology and Environment (MOSTE 1997, Leq-24 hr.= 70 dB(A)), the Ministry of Interior (MOI, 1976) as 91 dB(A) for a high density population area at day time, the Occupational Safety and Health Act (OSHA, 1975, Leq-8hr=90dB(A), and the community noise level standard of ISO (Leq-24 hr. = 70 dB(A)).

3.2.5 Vibration

(1) Objectives

- To measure the vibration along the Project at the same stations of noise measurement.
- To evaluate the vibration impact during the construction and operation phases.
- To recommend appropriate mitigation measures and monitoring program during the construction and operation phases.

(2) Methodology

The vibration along the proposed route is measured by velocity transducer at 3 stations (2 stations in Thailand and 1 station in the Lao PDR) for 3 consecutive days at each site. The existing vibration measurement stations are representatives of the Area, particularly the sensitive receptors. The sampling stations are shown below (refer to Figure 3.2).

Sampling Station	Location	Station Name
Station 1	Thailand	Ban Khok Sung
Station 2	Thailand	Ban Bang Sai Yai
Station 3	The Lao PDR	Interchange of Route No.9& Kaysone Road

To evaluate the vibration impact for both construction and operation phases, Martin method (1980) and vibration data of the Environment Agency Japan (1975) are used to compare with Reichter and Meister Scale, and DIN 4150 for human perception and structural protection, respectively.

- Vibration Criteria for Human Life
  Each body will respond differently to vibration levels based on the feeling and nervous system. In addition, psychological responses vary at different levels of age, health and characteristics. However, we can classify the reception due to vibration into 6 groups as follows : imperceptible, just perceptible, clearly perceptible, annoying, unpleasant or disturbing, and painful.

- Vibration Criteria for Building
  The components used to determine the building effect level are the amplitude, type, building age and material usage. The criteria of vibration effect on building of DIN 4150 is presented below.

Peak Particle Velocity	Effect on Building
2 mm/s (0.079 IPS)	Not severe to ancient building
5 mm/s (0.197 IPS)	Possibility of plaster cracks
10 mm/s (0.394 IPS)	Probable damage to load bearing units
20-40 mm/s (0.787-1.575 IPS)	Damage to load bearing units

IPS: inch per second

According to the vibration study, Rudder, F.F. (1978), the vibration levels can be presented with the following equation (i).

$$L(\gamma) = Lo + 10 \log (do/\gamma) - 8.69k (\gamma - do) \qquad (i)$$

Where $L(\gamma)$ = The vibration level in dB at an distance of γ from source

Lo = The reference level, measured at distance of do

do = The distance of reference level Lo

γ = The distance from source

k = The internal attenuation coefficient of the ground (see Appendix 3.5)

- The mitigation measures and monitoring programs will be recommended (if necessary).

(3) Results of the Study

The results of vibration study are presented in Appendix 3.6 to Appendix 3.8 and are summarized as follows :

Sampling Stations	Duration	Vibration Levels (mm/s.)
Station 1	15-18 Nov. 99	0.20-0.90
3 Day Average		0.37
Station 2	15-18 Nov. 99	0.30-0.60
3 Day Average		0.42
Station 3	20-23 Nov. 99	0.70-1.20
3 Day Average		0.97

Note : Station 1 : Ban Song Puai
Station 2 : Ban Khok Sung
Station 3 : Interchange of Route No.9 & Kaysone Road

From the table above, it is found that for all sampling stations, the peak particle velocity of the existing vibration level were very low along The Second Mekong International Bridge Construction Project (0.20 to 1.20 mm/s). The maximum peak particle velocities measured were generally below 1.0 mm/s, and in 17 cases (in the Lao PDR side) out of 216 cases they were greater than 1.0 mm/s. The peak particle velocities were generally well below 0.37 to 0.97 mm/s. The highest measurements were at sampling station No. 3 (Interchange of Route No. 9 & Kaysone Road), 100 m from The Second Mekong International Bridge Construction Project (1.20 mm/s). However, most of the vibration levels at the 2 sampling stations in Thailand and 1 sampling station in the Lao PDR were lower than 3.0 mm/s, which is a level easily noticeable to persons.

3.2.6 Social Environmental Survey

(1) Objectives

- To study household socio-economic conditions that are directly and indirectly affected by the Project
- To evaluate people's awareness and attitudes toward the Project and the expected impacts of the Project; to adopt measures to minimize the negative impacts
- To collect opinions and suggestions benefiting the Project operation particularly those concerning compensation payment

(2) Methodology

(a) Study areas and sampling technique

There are no requirements for resettlement against land acquisition necessary for this Project. In the Lao PDR, 38 households within the Project site area may be partly or wholly damaged and may have to be relocated to another area within the same village through the coordination of the DCTPC.

Meanwhile, the Project site on the Thailand side is exclusively occupied with agricultural land, mainly paddy field. Accordingly, all of the interviewees were indirectly affected people.

Therefore, the interviewees were divided into two types, namely, directly affected people and indirectly affected people.

In the Lao PDR side, total 38 directly affected households were interviewed and a further 68 households were selected as samples of indirectly affected persons (total 106 samples)

In Thailand, 120 persons were selected for interview as a sample of indirectly affected persons.

Details of the number of the samples in the Lao PDR

Impact Group	Villages	No. of Sampling
Direct Group	Ban Huamouangtha	1
	Ban Nake	5
	Ban Phonsavang (North)	26
	Ban Thamouang	1
	Ban Oudomvilai	2
	Ban Viengsavanh	1
	Sayamoungkun	1
	Ban Chomkeo	1
	Sub-Total	38
Indirect Group	Ban Nake	22
	Ban Phonsavang (North)	46
	Sub-Total	68
	Grand-total	106

Details of the number of the samples in the Thailand

Impact Group	Villages	No. of Sampling
Indirect Group	Ban Khok Sung	30
	Ban Song Puai	30
	Ban Bang Sai Yai	30
	Ban Kham Phak Nok	30
	Total	120

(b) Content of Questionnaire Form (see Appendix 3.9)
(For directly affected people)

- Household members
- Religious affiliation
- Educational attainment
- Occupation
- Income and expenditure
- Land holding
- Price of land/house/tree
- Awareness and attitude towards the Project including expected impacts and suggested mitigation measures.
- Opinions on present communication conditions, future land price (with and without Project), land utilization (with and without the Project) etc.

(For indirectly affected people)
- Baseline data of the interviewees
- Awareness and attitude towards the Project including expected impacts and suggested mitigation measures.
- Opinions on present communication conditions, future land price (with and without Project), land utilization (with and without the Project) etc.

Although all of the interviewees were indirectly affected people in Thailand side, the interview form for directly affected people were applied to extract information on social facilities and public services, housing conditions and so on.

(3) Results of the Study

The results of the interview survey are shown in Appendix 3.10-11 and are summarized as follows:

(the Lao PDR)
- The average size of the households was approximately 6 people.
- The average age of the members of the households was 45 to 50.
- The majority of respondents (47.4%) were farmers and 84.2% of the respondents owned land.
- They were generally satisfied with the environment of the living place in terms of convenience, safety, community relationship and so on.
- All respondents were well aware of the Project.
- They expected additional information on compensation.
- With respect to the compensation, 65.8% of the directly affected group preferred compensation paid by cash, and 21.0% required that the government find a new place to live close to the present residence and the house should be of the same style. Regarding land price evaluation, 100% of them proposed to follow the market price.
- As an advantage of this Project, they pointed out better transportation and communication and the local economy improvement. On the other hand, they pointed out the air and noise pollution as disadvantages.
- Over 90% of the respondents approved of the Project.

(Thailand)
- The average size of the households was approximately 5 people.
- The average age of the members of the households was the middle of forties.
- 80.0% of the respondents are farmers and 95.8% of them owned land.
- They were generally satisfied with the environment of the living place in terms of convenience, safety community relationship and so on.
- All respondents were well aware of the Project.
- They requested additional information on the Project details.
- With respect to land expropriation, 73.4 % of interviewees anticipated no problems under the condition of fair compensation
- As an advantage of this project, 54.2 % of them pointed out the improvement in the local economy. On the other hand, they pointed out the loss of land as a disadvantage.
- Over 90% of the respondents approved of the Project.

3.3 Impact Assessment

3.3.1 Water Quality

(1) Construction Period

The Second Mekong International Bridge Construction Project activities that may pose some impacts on water quality in the surrounding areas are as follows : mobilization of heavy machinery, right-of-way clearing and leveling, Border Control Facilities (BCF) construction, Bridge construction, Connecting Road and wastewater from the construction camp and maintenance shop etc. The dominant landform of the Project area is middle highland and flood plain of the Mekong River with a slope of less than 5%. Therefore, the dominant soil types are mostly sandy loam and sandy clay loam with high resistance to erosion. Owing to the above circumstances, the only portion of top soil that will be subject to erosion will be materials from the Connecting Road construction, e.g., laterite, gravel, sand, etc. The ROW of the Second Mekong International Bridge is 60-600 m.(see Figure 3.3) Considering the longest distance in Thailand side is of 1,675 m. (total areas of 0.4492 km^2) and 2,850 m. in the Lao PDR side (total areas of 0.3780 km^2), the concerned construction were 0.8272 km^2 with an assumption that this runoff will flow into the Mekong River.

Calculation of additional suspended solids into the waterways can be made as follows :

Concerned construction	=0.8272 km^2
Amount of the eroded silt (see Appendix 8.3.12)	=17,000x0.8272= 14,062.40 ton/year
Rainfall	=1,500mm./year
Amount of water flow through construction site	=1.50x0.8x0.8272x10^6
	=992,640 m^3/year
Silt concentration in water	=14,062.40x10^6/992,640
	=14,166.67 mg/l

B. Khock Sung

B. Sai Yai

Package 3, L=951.023m

Connecting Road L=520m

Barder Facilities L=436.023m

Traffic Change Facilities L=394.572m

Approach Road, Approach Viaduct L=79.428m, L=250m

Package 1, L=2701.661

Main Bridge L=1600m

Approach Viaduct L=200m

Mekong River

BEGINNING OF PROJECT STA.0+012.089

B. KHOK SONG

Border Line Fence L=400m H=250m

Guard House 10mx10m

Guard House 10mx10m

PROPOSED R.O.W.

80.00

100.00

60.00

2+000

3+000

400.00

250.00

Worker Quarter 20mx10m

Worker Quarter 20mx10m

Contractor Office (30mx10m)

300.00

150.00

Conc. Plant

Re-bar Yard

Consultant, Contractor Office (300m², 300m²)

Inclaind Road 250mx5m (Ferry)

Concrete, Segment Plants

B. SONG PUAI

200.00

Store House 50mx30m

Worker Quarter 20mx40m

Consultant Job-Office 10m

Water Supply P 10cm.

Inclaind Road 250mx5m (Ferry)

B. Nake

Irrigation

Existing Water T

Intake

Road No.

B. NA KE

Route 212

H. PO

140

K. SONG NAM

THAILAND SIDE

B. Sung Pal

B. Kham Phak Nok

B. KHAN PHAK NOK

0 100 200 300 400 500 m.

Thai Side

Connecting Road.	:	530 m.
Border Control Facility	:	400 m.
Traffic Change Facility	:	370 m.
Approach Road. with viaduct	:	384 m.
Total	:	1684 m.

REV.	DATE	DESCRIPTION	APPROVED	PROJ

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DATE OF ISSUE:

DWG. NO. | SHEET NO.

DWG. STATUS

B. Nong Deun

2701.661

Approach Viaduct L=200m

Approach Road L=177.66m

Border Facilities L=650m

Package 2, L=2513.620m

Connecting Road L=1863.620m

Existing Trans. Line

Border Line Fence U=600m H=250m

Guard House 10mx10m

PROPOSED R.O.W.

EXISTING R.O.W.

3+000

60.00

80.00

Water Supply P 10cm.

Consultant Job-Office 10mx10m

500.00

250.00

Bonded Warehouse

200

150.00

250.00

Proposed Area for Bonded Warehouse

5+000

160.00

ROAD A3

EXISTING R.O.W.

Existing Concrete Plant

Inclaind Road 250mx5m (Ferry)

B. Nake

Irrigation canal and road

Stock house 20mx40m

Contractor office 10mx10m

Contractor office 30mx10m

Guard house 8mx5m

Stock Yard 10mx15m

Existing Transmission Line 2.5 KVA

LAO PDR SIDE

Existing Water Treatment

Intake

Access Road 1000mx5m

B. HOUA MUANG-NEUA

B. NA KE

Road No. 2

ROUTE 9

TO SAVANNAKHET

END OF PROJECT

B. LAK HOK

KAYSONE ROAD

Lao Side

Connecting Road.	:	1850 m.
Border Control Facility	:	600 m.
Approach Road.	:	400 m.
Total	:	2850 m.

REV.	DATE	DESCRIPTION	APPROVED

PROJECT STUDY TEAM

ORIENTAL CONSULTANTS CO., LTD.

in association with

NIPPON KOEI CO., LTD.

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

LAO PEOPLE'S DEMOCRATIC REPUBLIC
MINISTRY OF COMMUNICATION, TRANSPORT, POST AND CONSTRUCTION

KINGDOM OF THAILAND
MINISTRY OF TRANSPORT AND COMMUNICATIONS
DEPARTMENT OF HIGHWAYS

THE SECOND MEKONG INTERNATIONAL BRIDGE CONSTRUCTION PROJECT

	NAME	SIGNATURE	DATE
QUALITY RECORD			
DESIGN			
DESIGN CHECK			
SUBMITTED	A. Hirotani		
APPROVED	P. Wrapbanth		
	S. Tanrfyabutra		

DWG. TITLE:

FIGURE 3.3
GENERAL TEMPORARY
CONSTRUCTION FACILITIES PLAN

Concerning the existing SS level in the Mekong River, the field investigation conducted on November 19, 1999 (winter season) revealed that the SS level was at 352 mg/l, with the average flow of 7,416.76 cu.m./s (640.81×10^6 m^3/day). With the above assumption, the estimated SS in the Mekong River downstream from The Second Mekong International Bridge Construction Project will be calculated from the following equation :

$$C = \frac{C_1Q_1+C_2Q_2}{Q_1+Q_2}$$

Where
- C = SS concentration downstream from construction site (mg/l)
- Q_1 = Flow in the Mekong River (m^3/day)
- C_1 = SS concentration in the Mekong River (mg/l)
- Q_2 = Flow in construction site (m^3/day)
- C_2 = SS concentration from construction site (mg/l)

$$\text{Then, } C = \frac{352 \times 640.81 \times 10^6 + 14{,}166.67 \times 992{,}640/360}{640.81 \times 10^6 + 992{,}640/360} = 352.06 \text{ mg/l}$$

The calculated SS is only 0.017% higher than the existing conditions of SS. Therefore, the actual impact of additional SS in the waterway is insignificant.

During the construction phase, approximately 200 workers per month on the average will be required. There are likely to be many camps. Construction camps will be constructed based on the following criteria.

- Located at least 50 m from the Mekong River/waterways.
- Equipped with sanitary latrines (15 workers/1 unit).
- Equipped with temporary retention pond to collect domestic wastewater prior to overflow into the Mekong River/waterway.
- Workers be adequately provided with clean water at the rate of 120 liters/person-day.
- Located away from villages or communities.

With the above criteria, establishment of construction camp will not cause any adverse impact on the nearby waterway.

Construction of the Second Mekong International Bridge Construction Project will require use of a number of large plant and equipment items. This construction equipment requires a regular maintenance program which includes oil changing, lubricating and others. All of the above activities will be performed only in the maintenance facilities that will be located near the site office. They will be equipped with containers for waste oil, and a wastewater treatment system for oil separation. In addition, the garage will be indoors to prevent any surface runoff contaminated with oil being washed into the waterway. With this provision, the potential impacts from oil contamination will be negligible.

(2) Operation Period

During the normal operation of the Second Mekong International Bridge, there should not be any adverse impact on water quality. At the Border Control Facilities area (BCF), the sanitary latrine will be equipped to treat human waste from working rooms. Therefore, no contamination on nearby waterways is expected.

3.3.2 Aquatic life

(1) Construction Period

The main impact due to construction of the Second Mekong International Bridge will be in form of additional silt during the rainy season. For this matter, it was shown in the water quality assessment in section 3.3.1 that these occurrences will be short-term and the amount of SS concentration increased will be a small increment of the existing SS concentration level in the wet season (0.017%). Therefore, the blockage of photosynthetic reaction due to additional suspended particle will be minor. Focusing on the benthic population, the drifting action will take place in the rainy season with high flow and velocity, thus, the land cover-up due to siltation from surface runoff is not expected. Temporary impacts from construction activities will not be harmful to aquatic ecology in the concerned waterways.

Another type of discharge from the construction site (600 m^2) will be domestic wastewater. This type of waste will be directed to the treatment facilities, e.g., sanitary latrine, and domestic wastewater treatment facility, to properly treat wastewater from toilet and kitchen/restaurant, respectively. Under installation of such facilities, discharge of BOD and additional nutrient into the Mekong River/waterway are not expected.

(2) Operation Phase

During the normal operation of the Second Mekong International Bridge, it should not have any adverse impact on aquatic ecology. At the Border Control Facilities area (BCF), the sanitary latrine will be equipped to treat human waste from the working rooms. Therefore, no contamination on or nearby the Mekong River/waterway is expected.

3.3.3 Air Quality

(1) Construction Phase

The negative impacts on air quality due to construction activities of The Second Mekong International Bridge Construction Project are fugitive dust and toxic gas from heavy machinery, equipment and material transportation vehicles which can be summarized below.

- Fugitive Dust
  Activities which produce fugitive dust are land preparation, grading, etc. The volume of dust depends on various factors such as soil characteristics, soil moisture, wind speed and construction time. The particulate concentration can be calculated by following equation (i) ;

$$C\ (mg/m^3) = \frac{Q\ (mg/sec)}{D\ (m) \times W\ (m/sec) \times M\ (m)} \qquad (i)$$

Where C = Concentration (mg/m^3)
Q = Emission Rate (mg/sec)
D = Space width perpendicular to wind direction (m)
W = Wind Speed (m/sec)
M = Mixing Height (m)

US. EPA. (1975) reported that approximately 30% of silt soil and precipitation evaporation index 50% will generate fugitive dust into the atmosphere at 1.20 ton/acre/month or 0.010 $g/m^2/d$ at general construction activities with moderate level. Considering the working hour per day at 12 hours, with 827,200 m^2 of the concerned construction area (Q = 0.1915 g/sec) and with assumption that the wind speed (W) equals to 1.58 m/s, the width of area (D) equal to 600 m. and mixing height (M) equals to 20 m. Calculation of additional fugitive dust into atmosphere can be made from equation (i) as follows :

$$C\ (mg/m^3) = \frac{0.1915 \times 10^3\ mg/sec}{600\ m \times 1.58\ m/sec \times 20\ m} = 0.0101\ mg/m^3$$

From the above calculation, the total fugitive dust will not exceed 0.0101 mg/m^3 which is much lower than the limit of the standard of The Ministry of Science, Technology and Environment (0.330 mg/m^3). Therefore, the impact due to particulates dispersion is negligible.

- Toxic Gas from Equipment and Heavy Machines
  During the construction phase, gases will be emitted from vehicles, equipment and machinery such as CO, NO_2, HC and TSP. US. EPA., "Compilation of Air Pollution Emission Factors", Publication NO. AP-42 determined the pollutant emission rate for construction equipment in the following table:

Item	Pollutant Emission Rate (kg/unit/hour)			
	CO	NO_2	HC	TSP
Backhoe	0.250	1.090	0.090	0.080
Bulldozer	0.350	2.300	1.050	0.080
Truck Loader	0.050	0.250	-	0.050
Roller	0.100	0.450	-	-
Motor Grader	0.100	-	-	-
Scrapper	0.660	2.830	0.290	0.190
Diesel Truck	0.610	3.460	0.200	0.120
Car and Pickup Truck	1.040	0.020	0.050	0.003

From the above emission rate, if the working time was assumed at 12 hours, the width of 600m and a wind speed of 1.58 m/s, concentration of the concerned parameters will be indicated as in the table below:

Item	Concentration ($\mu g/m^3$)			
	CO	NO_2	HC	TSP
Backhoe	3.663	15.969	1.319	1.172
Bullozer	5.128	33.697	15.383	1.172
Truck Loader	0.733	3.663	-	0.733
Roller	1.465	6.593	-	-
Motor Grader	1.465	-	-	-
Scrapper	9.670	41.462	4.249	2.784
Diesel Truck	8.937	50.692	2.930	1.758
Car and Pickup Truck	15.237	0.293	0.733	0.044
Standard of MOSTE	34,200	320	-	330
Period	1 hr.	1 hr.	-	24 hr.

These concentrations in the air quality are much lower than the limit in the standards of The Ministry of Science, Technology and Environment (1995). Therefore, the impact due to particulates dispersion is negligible.

(2) Operation Phase

Main pollutants are from the exhaust gases emitted from vehicles including carbon monoxide (CO), nitrogen dioxide (NO_2), total hydrocarbon (THC) and particulates (TSP, PM-10). The amount of pollutant emission varies with the traffic volume, driving conditions and vehicle speed.

Assessment of air quality impact during the operation phase will utilize the mathematical models "HIWAY Model" to estimate air quality level along the Second Mekong International Bridge.

Input Data :

The input data requirements of the HIWAY Model can be classified into 2 groups as follows.

- Emission Source :

Vehicle type and traffic volume used in the model are presented in the following table.

Vehicle Type	Vehicle/Day		
	Year 2005	Year 2010	Year 2020
Truck			
- Long Distance	210	385	1,300
- Local	34	63	206
Shuttle Bus	119	222	735
Car	132	247	816
Total Vehicle	495	917	3,057

Source : SAPROF, 1998.

The most important pollutants in terms of emission quantity and impact on health are carbon monoxide (CO) and nitrogen dioxide (NO_2) which have the highest emission quantity as shown in the below table

Pollutant	Emission Rate (kg./km./hr.)		
	Year 2005	Year 2010	Year 2020
Carbon monoxide (CO)	0.462	0.850	2.806
Nitrogen dioxide (NO_2)	0.215	0.351	1.109

- Scenario Simulation :
  D Class of Prevailing Wind (Northeast Monsoon) : There are 3 designed years to be simulated, namely, year 2005, 2010 and 2020 with the worst case at daytime.
  F Class of Prevailing Wind (Northeast Monsoon) : There are 3 designed years to be simulated, namely, year 2005, 2010 and 2020 with the worst case at nightime.

Predicted Pollution Concentrations

The results of 3 designed year of maximum co-concentration at ground level average 1 hr. of CO and NO_2 are demonstrated as isopleth maps and tables. They are summarized in the table below.

Status	Maximum Concentration (mg/m^3)		
	Year 2005	Year 2010	Year 2020
Carbon Monoxide (CO)			
Existing Condition	0.920	0.920	0.920
Model Simulation			
- D Class	0.021	0.038	0.127
- F Class	0.071	0.130	0.428
Model Simulation+Existing			
- D Class	0.941	0.958	1.047
- F Class	0.991	1.050	1.348
CO-1 hr. Standard of MOSTE	34.20 mg/m^3		
Nitrogen Dioxide (NO_2)			
Existing Condition	0.012	0.012	0.012
Model Simulation			
- D Class	0.010	0.016	0.050
- F Class	0.033	0.054	0.169
Model Simulation+Existing			
- D Class	0.022	0.028	0.062
- F Class	0.045	0.066	0.181
NO_2-1 hr. Standard of MOSTE	0.320 mg/m^3		

Carbon Monoxide (CO) Prediction

The maximum ground level concentrations (CO-1 hr.) from the simulation in case of D Class (model simulation +existing) in year 2005, 2010 and 2020 are 0.941, 0.958 and 1.047 mg/m^3, respectively (Appendix 3.13 to Appendix 3.15). Regarding the ambient air quality standard of MOSTE (1995) for CO-1 hr. at 34.20 mg/m^3, the maximum value of this simulation is much lower than the standard above.

The maximum ground level concentrations (CO-1 hr.) from the simulation in case of F Class (model simulation+existing) in year 2005, 2010 and 2020 are 0.991, 1.050 and 1.348 mg/m^3, respectively (see Appendix 3.16 to Appendix 3.18). Regarding the ambient air quality standard of MOSTE (1995) for CO-1 hr. at 34.20 mg/m^3, the maximum value of this simulation is much lower than the standard above.

Nitrogen Dioxide (NO_2) Prediction

The maximum ground level concentrations (NO_2-1 hr.) from the simulation in case of D Class (model simulation+existing) in year 2005, 2010 and 2020 are 0.022, 0.028 and 0.062 mg/m^3, respectively (see Appendix 3.19 to Appendix 3.21). Regarding the ambient air quality standard of MOSTE (1995) for NO_2-1 hr. at 0.320 mg/m^3, the maximum value of this simulation is much lower than the above standard.

The maximum ground level concentrations (NO_2-1 hr.) from the simulation in case of F Class (model simulation +existing) in year 2005, 2010 and 2020 are 0.045, 0.066 and 0.181 mg/m^3, respectively (see Appendix 3.22 to Appendix 3.24). Regarding the ambient air quality standard of MOSTE (1995) for NO_2-1 hr. at 0.320 mg/m^3, the maximum value of this simulation is much lower than the above standard.

From the results of the simulation under both worst cases (D Class and F Class), the maximum ground level concentration of CO and NO_2 in year 2020 will be 1.348 and 0.181 mg/m^3, respectively. They are within the standard of air quality on the atmosphere of MOSTE (1995). Therefore, the impact on air quality due to The Second Mekong International Bridge Construction Project will be minor.

3.3.4 Noise

(1) Construction Period

According to the criteria of BS 5228 part I (1997), the range of noise levels for construction equipment is presented in Appendix 3.25. The noise produced from interaction between the machine and the materials often contributes greatly to the noise level. In case of The Second Mekong International Bridge Construction Project, the maximum noise level of construction activities from the point source is 100 dB(A) at a distance of 10 m (diesel hammer and drop hammer). The noise level due to these activities at the receptor with a distance of 10 to 100 m from the point source can be calculated from equation (i) and (ii) of Section 3.2.4. The results of this study are presented in Appendix 3.26.

The noise level at distance of 50 m from the noise source at construction activities are predicted to be 78.9 to 89.3 dB(A). The predicted noise levels will be acceptable in comparison to ISO criteria and OSHA criteria (1975) as shown in the following table.

Noise Level	Time		Noise Level	Time	
dB(A)	Hour	Minute	dB(A)	Hour	Minute
90	8	00	103	1	15
91	7	00	104	1	7.5
92	6	00	105	1	00
93	5	00	106	-	52
94	4	30	107	-	45
95	4	00	108	-	37
96	3	30	109	-	33
97	3	00	110	-	30
98	2	30	111	-	26
99	2	15	112	-	22
100	2	00	113	-	18
101	1	45	114	-	16
102	1	30	115	-	15

Source: Occupational Safety and Health Act, United State Labor Department, 1975.

(2) Operation Phase

The predicted noise levels from traffic are calculated from STAMINA Model at 3 design years (2005, 2010 and 2020) for 3 sensitive receptors based on the predicted traffic volume. The average vehicle speed used in this model is 50 km./hr. The existing noise level is also included in this study. The results of this are presented in the following table.

Location	Noise Level (Leq-24 hr., dB(A))				
		Existing	Year 2005	Year 2010	Year 2020
Ban Khok Sung	Leq-24 hr.	53.4	53.5	53.6	54.2
	Ldn	59.1	59.4	59.6	59.6
Ban Song Puai	Leq-24 hr.	53.1	53.4	53.6	54.7
	Ldn	57.0	57.5	57.8	59.2
Interchange of Route	Leq-24 hr.	53.2	54.2	54.9	57.3
No.9 & Kayson Road	Ldn	60.0	60.0	60.0	60.0

Regarding the noise levels at each distance from curb at 3 design years using the traffic volume criteria, the calculated noise levels are shown in the following table (see Appendix 3.27).

Distance (m.)	Noise Level (Leq-24 hr., dB(A))		
	Year 2005	Year 2010	Year 2020
1	63.3	65.9	71.2
10	61.4	64.0	69.3
20	59.4	61.9	67.2
30	57.9	60.5	65.8
40	56.8	59.4	64.7
50	55.9	58.5	63.8
100	52.9	55.5	60.8
150	51.0	53.5	58.8
200	49.5	52.1	57.3
250	48.3	50.9	56.1
1,000	39.4	42.0	47.2

By the year 2020 which is expected to reach the maximum capacity of traffic volume, the maximum noise levels at a distance of 10 m., 30 m., 50 m., 100 m. and 1,000 m. from the curb are predicted to be 69.3, 65.8, 63.8, 60.8 and 47.2 dB(A), respectively. This study indicates that it is unlikely to cause loud noise levels to affect sensitive receptors according to the standard of ISO criteria and The Ministry of Sciences, Technology and Environment (1997).

3.3.5 Vibration

(1) Construction Period

(a) Pile Driving Activity

The main potential impact from vibration level during The Second Mekong International Bridge Construction Project is pile driving. The main types of construction pile driving are presented below, along with impacts for clay and silt soil types.

- Steel case displacement piles for main bridge foundations are concrete bearing piles with permanent steel tubular casings, driven by a drop hammer operating inside the casing. After the casing is driven to the required depth, it will be filled with concrete. Martin (1980) has shown that vibration levels from this type of pile driving can be as high as 2.50 mm/s (vertical) peak particle velocity at 15 m. from the pile for a 2.50 ton drop hammer used to drive 356 mm. diameter pile with 45 kJ energy input. This level is considered, according to the Reichter and Meister Scale, as "clearly perceptible to persons" without damage to structures. Martin's data is based on clay, which is common along these areas.

- Driven and cast-in-place concrete displacement piles are open-ended steel driven tubes placed at the required position, charged with aggregates or dry mix concrete, inserted and compacted by the drop hammer. At the required depth the plug and mix concrete is driven out to form an enlarged base. The steel tube is then withdrawn. Martin (1980) has shown that vibration on hard compacted soil can be as high as 7.0 mm/s.

- Linked sheet piles of 7.5 m to 15.0 m length with U-shape cross sections are hammered to the desired depth to form a linked steel panel. Martin (1980) found that an 8-ton drop hammer with energy input of 48 kJ can produce vibration as high as 12.90 mm/s at a distance of 10 m.

- Sheet piling operations on silt soil at an energy input of 30 kJ can produce vibration of 4.30 mm/s at a distance of 10 m.

- Diesel hammer on clay produced about 7.0 mm/s at a distance of 10 m. This is significantly lower than the 8 ton drop hammer but comparable to a 5-ton drop hammer (on clay and silt). The peak vertical velocity in mm/s was found to be related to the inverse of distance powered to 1.40 for clay and powered to 0.80 for silt soil, respectively.

A recommendation here is to maintain peak particle velocity at less than 2 mm/s, which is the level required to protect historical/ancient buildings by the criteria of vibration effect on building of DIN 4150 (see Section 3.2.5). Most types of pile driving will produce vibration less than this level at a distance of 30 m. The level is defined, according to the Reichter and Meister Scale, as hardly perceptible to people. To protect structures, a 7.0 m distance is recommended for a wooden floor building on clay, and 12.0 m to 16.0 m on silt soil. Concrete floor buildings will require a distance of 6.0 m. on clay and 11.0 m on silt soil. It is safe to separate pile driving operations from historical/ancient buildings by at least 30.0 m to 40.0 m on clay and 45.0 m on silt soil.

(b) Other Construction Activities

Minor potential impacts from vibration level during The Second Mekong International Bridge Construction Project are generated from land clearing, site grubbing, soil and material excavation and hauling, concrete mixing, and movement of heavy equipment etc. According to vibration study of Environment Agency Japan (1975), the vibration levels are presented in the following table.

Type of Activity	Vibration Level (dB)			
	5 m	10 m	20 m	30 m
Diesel Pile Hammer	84	78	72	68
Vibration Pile Hammer	80	73	66	63
Drop Hammer	84	76	67	62
Steel Ball Crusher	79	69	60	-
Pavement Crusher	77	72	68	-
Breaker	71	61	-	-

The vibrational acceleration level of 84 dB at 10 Hz at a distance of 5 m will give peak particle velocity of 1.427 mm/s which is assumed to be the worst case. In Japan, large size trucks produce only 70 dB or less at this distance. However, levels up to 84 dB were recorded at 28 sites in the central rigion of Thailand (Team Consulting Engineers Co., Ltd., 1991). It should be noted that vibration is judged from each event, not from the average of all events, so only the worst case event need be studied. The results of predicted vibration levels at each distance from curbs are presented in the following table.

Distance (m)	Peak Particle Velocity (mm./s)
0.1	10.858
1.0	3.388
2.0	2.360
3.0	1.898
4.0	1.619
5.0	1.427
6.0	1.283
7.0	1.170
8.0	1.078
9.0	1.001
10.0	0.936
20.0	0.570

From the above table, the vibration levels at larger distance will be lower than those of shorter one (see Appendix 3.28). The predicted vibration level at 3.0 m. and over should not be greater than 1.898 mm/s which will not trouble any persons or any buildings by the Reichter and Meister criteria (see Appendix 3.29) and DIN 4150, respectively. Furthermore, there are no schools, hospitals, laboratories or ancient buildings nearby within a distance of 20 m from the Second Mekong International Bridge Construction Project. Therefore, vibration effect to human lives and properties is unlikely.

(2) Operation Period

According to the vibration study by Rudder, F.F. (1978), the main factors are based on road surface, previous soil characteristics, vehicle speed, vehicle weight, traffic volume etc. The vibration levels due to the traffic during the operation phase can be calculated with the previous equation (i) using the criteria of the average vehicle speed of 50 km/hr. and vehicle weight of 25 ton. The predicted vibration levels at 3 design years (2005, 2010 and 2020) for 3 sensitive receptors are presented in the following table.

Location	Vibration Level (PPV, mm/s)			
	Existing	Year 2005	Year 2010	Year 2020
Ban Khok Sung	0.60	0.60	0.60	0.60
Ban Song Puai	0.90	0.90	0.90	0.90
Interchange of Route No.9 & Kayson Road	1.20	1.20	1.20	1.21

Regarding the vibration levels at each distance from curbs at 3 design years (2005, 2010 and 2020) using the criteria of traffic volume, the calculated vibration levels are shown in the following table (see Appendix 3.30).

Distance (m.)	Peak Particle Velocity (mm./s)		
	Year 2005	Year 2010	Year 2020
1.0	0.099	0.132	0.239
2.0	0.069	0.092	0.166
3.0	0.055	0.074	0.134
4.0	0.047	0.063	0.114
5.0	0.042	0.056	0.101
10.0	0.027	0.037	0.066

By the year 2020 which is expected to be the maximum traffic volume, vibration levels at a distance of 1 m, 3 m, 5 m and 10 m from curb are predicted to be 0.239, 0.134, 0.101 and 0.066 mm/s, respectively. Therefore, they are unlikely to cause vibration effect to human lives and properties according to Reichter and Meister Scale and DIN 4150.

3.3.6 Social Environment

(1) Construction period

- Impacts From Land Expropriation
  There are 38 households in the Lao PDR in the ROW which are directly affected by this Project. The government of Lao PDR will solve this problem through relocating these houses to other places in the same village. As for the land, the government will compensate in cash. The criteria for the compensation established by the Savannakket Provincial Office is shown below.

(Cost for land: 7 categories)

Items	Area(m^2)	Unit cost($)	Maximum Amount ($)
Rice fields	102,775	1-1.7	174,718
Under the trees	2,100	0.8-1.3	2,730
Orchard land	47,543	0.7-1	47,543
Residential area	31,589	0.18-4.3	135,327
Bush or thicket	72,415	0.5-0.7	50,691
Dense forest	36,700	0.5-0.7	25,690
Others			
Total	293,122		436,699

(Cost for buildings: 8 categories)

Items	Area(m^2)	Unit cost($)	Maximum Amount ($)
House (Concrete)	1,275	130-175	223,125
House (Concrete+Wood)	335	125-165	55,275
House (Wood)	915	120-160	146,400
Factory	6,243	95-130	811,590
Guest house	189	130-175	33,075
Hut	189	30-50	9,450
Shop	283	150-200	56,600
Others (fence)		20-40	
Total			1,335,515

No households will be included in the ROW of the Project in Thailand. The land required for the Project will be compensated in cash. Therefore, it can be calculated that the impacts caused by land expropriation will not be a serious issue in each country.

- Impact on Intra- and Inter-Community Traveling
  The construction activities may affect convenience of travelers who use roads passing through the Area being constructed. In addition, construction equipment and materials may obstruct usage of roads considerably if not properly managed.

- Expected Conflict Between Local People and Construction Workers
  In the construction period, conflicts between construction workers and local people may occur mainly from cultural differences and lack of disciplines in construction workers who mostly come from other regions. Conflicts can be prevented or minimized by using efficient operation and management including proper training and control of the Project workers. Moreover, relevant authorities should inform local people about the project's nature sufficiently and the information must be reliable and accurate.

- Impact on Occupation of the Agricultural Living Close to the Construction Areas
  Impacts on farmers' occupation can be expected if the construction activities obstruct the water ways for farming or interrupt the on-farm activities. The Contractor should be aware of this fact and supervise the construction properly.

- Impact on Local Trading
  Positive impact expected to be derived from the Project during construction period is expansion of the local trading especially on consumer goods, due to the increasing demand from the construction workers. The increased money from worker's salary in the local area will stimulate local trading in consumer goods as well as other commodities.

(2) Operation period

- Impact on Farmers' Occupation
  On-farm activities of agriculturists whose farmlands are being divided by the alignment will be more difficult. The main problems are inconvenience on travelling across the approach road to the other part of agricultural land. This problem can be remedied by providing underpasses. However, the access to some of these areas may pass through land of other

people where conflicts between the agriculturists are possibly induced.

- Impact on Inter-Community Travel
  Negative impact on inter-community travelling is expected especially inconvenience of the people living along the alignment to travel between their residences and other places. However, this problem also can be remedied by providing underpasses.

- Impact on Land Price
  Due to improvements in road conditions, the land price along the Project site will be increased.

3.4 Mitigation Measures

3.4.1 Aims of Environmental Conservation

In order to examine the mitigation measures for negative impacts caused by the Project, it is necessary to establish aims of environmental conservation. In general, mitigation strategies are focused on avoidance, minimization, restoration or rehabilitation, preservation and/or compensation or replacement. In this Project, the basic policy of minimization of the negative impacts caused by the Project has been mainly adopted.

With the aim of environmental conservation, the items mentioned below have been established.

- *In the construction period: To reduce the negative impacts of water quality, air* quality/noise/vibration as much as possible

- In the operation period: To maintain the existing environmental quality referring to the existing data and environmental standards

- With respect to the social environment: To ensure security, amenity and convenience of lives of the local population.

3.4.2 Water quality

(1) *Construction period*

- Not to wash equipment in the river.
- Inspect machinery and equipment weekly to prevent any oil leakage.
- Store construction materials at least 10m from the water course.
- Construct wastewater treatment system for maintenance facilities
- Prohibit any waste dumping into waterways.
- The Contractor must raise the dike 30-50cm above the level of the land surrounding the construction areas, must provide for a drainage system and settlement pond along the construction areas and must maintain the drainage system to prevent clogging.
- The Contractor has responsibility to provide hygienic bath and sanitary latrines for workers. Wastewater from those sources must meet with the standard for wastewater effluent as defined by OEPP.

- Stop construction activities in front of waterway bank to prevent silt laden water entering the water course.
- Locate construction camp at least 50 m from the waterway.
- Leave the undisturbed vegetative area at about 1m from the waterway as a buffer zone.
- Plant native vegetation at the disturbed the Mekong River bank to speed up the recovery period.

(2) Operation period

- Inspect the wastewater treatment facilities at the Border Control Facilities (BCF) every year.
- Monitor effectiveness of the garbage collection system in the Border Control Facilities (BCF) every week to prevent any waste dumping into the Mekong River/waterway.

3.4.3 Aquatic life

(1) Construction period

- Store construction material at least 10 m from the water body.
- Construct wastewater treatment system for the maintenance facilities
- Prohibit any waste dumping into waterways.
- The Contractor must raise the dike by 30-50 cm above the level of the land surrounding the construction area, must provide for a drainage system and settlement pond along the construction areas, and must maintain the drainage system to prevent clogging.
- The Contractor has responsibility to provide hygienic bath and sanitary latrines for workers (15 workers/1 unit). The wastewater from those sources must meet with the standard for wastewater effluent as defined by OEPP.
- Stop construction activities in front of waterway bank to prevent silt laden water entering the water course.
- Locate construction camp at least 50 m from the Mekong River/waterway.
- Leave the undisturbed vegetative area about 1 m from the waterway as a buffer zone.
- Plant native vegetation at the disturbed riverbank to speed up the recovering period.
- Not to wash construction equipment in the river.

(2) Operation period

- Inspect the wastewater treatment facilities at the Border Control Facilities (BCF) every year.
- Monitor effectiveness of the garbage collection system in the Border Control Facilities (BCF) every week to prevent any waste dumping into the Mekong River/waterway.

3.4.4 Air quality

(1) Construction period

- Fugitive dust dispersion from the construction activities may disturb the nearby communities, temples or schools. Therefore, water should be sprayed twice a day to minimize particulate from the construction activities
- Install temporary fencing in construction areas which are close to the buildings, temples and schools.

- The speed of vehicles for transportation of construction materials and those to and from the Project site shall not exceed 40 km./hr. This is to reduce the amount of dust particles and pollutants from the exhausts.
- Have the workers who work in the more intense dusty areas wear masks for dust protection.
- Apply *Additional proposed measures to minimize the decline in air quality include storage* of bulk construction materials in closed silos with appropriate dust preventing filters, shrouding the aperture for dry mix batching, and confining working vehicles to designated routes only.
- Replant or plant trees as a vegetation screen in the Areas close to sensitive receptors to create a buffer zone for minimization of fugitive dust and noise pollution.
- Remove construction materials and waste from the construction area as soon as possible
- Check the equipment and machinery regularly at least once a week to minimize the pollutant emissions.
- Control dust dispersion in the transportation of construction materials by covering the trucks with canvas.

(2) Operation period

-Fuel quality and emission control should be improved in order to reduce the predicted impact.
-In case of lead due to use of gasoline, it is not expected to be affected since use of lead-free gasoline will be enforced.
-To reduce pollution emission from exhaust system, the regular flow and speed should be maintained.

3.4.5 Noise

(1) Construction period

- Design the noise level not exceeding 90 dB(A) for each machine type. If the concrete mixing site is operated for most of the day, it shall be located at least 150 m away from sensitive receptors, such as communities or hospitals or temples.
- In the process of pile driving, the head of pile shall be covered with a sack or suitable materials to reduce noise level and vibration.
- Workers who work continuously in noisy areas of over 90 dB(A) shall wear ear protection devices such as ear muff and ear plug to reduce the noise level. Therefore, they shall be rotated so that they will not expose for too long time in the noisy areas.
- Restrict the speed of vehicles in and out of the Project site not to exceed 40 km./hr
- Inspect and do maintenance of equipment regularly to reduce noise to the lowest level and not to exceed 90 dB(A) at the noise source.
- Suggest the construction supervisors to use equipment which generates lower noise levels
- *Properly warn to the public before starting the activities in case of unavoidable noise level.*
- Give information to the community nearby or along the Project about the nature of construction, time periods and the mitigation measures to be provided.

(2) Operation Period

As the results of calculation from STAMINA Model, the predicted noise level at a distance of 10 m and over from alignment are mostly less than 70 dB(A) which is still within the standard of The

Ministry of Science, Technology and Environment (MOSTE, 1997, Leq-24 hr.= 70 dB(A)), and the community noise level standard of ISO (Leq-24 hr. = 70 dB(A)). Therefore, it is anticipated that The Second Mekong International Bridge Construction Project will not generate higher noise levels than the above standards. In case of the sensitive areas such as schools, hospitals, or communities at a distance of 10 m. and over, the standards shall be used for judgment. If the noise level from the monitoring program is higher than the standards above and it disturbs the sensitive receptors, mitigation measures shall be carried out such as tree plantation. Trees plantation is not a very effective noise reduction measure since about 1 to 2 dB(A) attenuation is obtained for every 10 m. of dense-leaf vegetation such as Asoke India trees.

3.4.6 Vibration

(1) Construction Phase

Low vibration generating pile driving machines and methods, e.g. hydraulic pressure and vibratory pile drivers (frequency up to 100 Hz), as well as bore piling, are recommended at sensitive areas. In addition, the appropriate design and construction methods shall be employed to minimize vibration.

(2) Operation Phase

Vibration mitigation is not necessary if the design buffer zone is maintained and the road surface condition is maintained regularly. As part of regular maintenance procedures, potholes shall be promptly repaired, and connecting junctions between sections maintained to provide a smooth interface. Over-weight vehicles shall not be allowed because road/bridge surface damage is mainly caused by these vehicles in the operation phase.

3.4.7 Socio-economic Conditions

(1) Construction period

(a) Impacts from Land Expropriation (relocation and compensation)
Before compensation fee is paid, there should be a meeting between the people who are affected by the Project and the relevant authorities. The process of compensation in details such as price assessment or the process of paying the compensation should be clearly explained to them to avoid any misunderstandings.

The process of compensation paying should be as quick as possible. The compensation should be paid by lump sum and only at one time under a check note in the name of each person being relocated.

(b) Impact on Intra- and Inter Community Travelling During Construction

- The Contractor should be careful not to cause inconvenience to local people except where absolutely necessary. Damage to surfaces of existing roads and local tracks as well as road usage obstruction should be avoided. If unavoidable, the damage should be minimized and should be repaired as soon as possible.

- The public should be informed before activities that cause inconvenience to normal travelling are carried out; signs indicating change of ways should be shown clearly.

(c) Conflict between Affected People and Project's Officers and Workers

- Before commencement of construction activities, local people should be informed through their village leaders /communities or be directly informed, if possible.
- The Contractors should strictly supervise their workers and officers not to interfere with local affairs or quarrel with local people.

(d) Impact on Occupation During Construction

The Project should have a definite construction schedule and inform the schedule to owners of farmland close to the construction site before doing any activities. During the construction, the Project should be operate carefully and should not interrupt farm activities. If there are complaints from affected people about the problems caused by the Project, they should be solved or remedied as soon as possible.

(2) Operation period

- As for those who have such difficulties that they can't do their occupation as usual and/or wish to sell/exchange the problematic land caused by the Project, the authority should assist them by purchasing the land or cooperating with appropriate agencies to exchange the problematic land with other farmers' land if possible.

3.5 Environmental Monitoring Plan

The purpose of the Environmental Monitoring Plan is to ensure that the mitigation measures proposed during the construction and operation stages of the bridge and approach roads are carried out in an environmentally sensitive and responsible manner, and to ensure that institutional structures and responsibilities are in place so that the Project is monitored adequately for environmental compliance.

The monitoring activities should be carried out by the Contractor during the construction period. During the operation period, the activities should be followed by the authorities of both countries (DOH in Thailand and MCTPC in the Lao PDR). It is recommended that the authorities will be supported in terms of technical aspects by The Science, Technology and Environment Organization (STENO) in the Lao PDR and Ministry of Science, Technology and the Environment (MOSTE) in Thailand, respectively.
In this section, cost estimation for the monitoring activities was conducted for future reference (see Appendix 3.31).

3.5.1 Water Quality

(1) Period and Frequency

- Construction period: 3 times per year, once each in the dry season (February to May), the winter season (November to January) and the rainy season (June to October).

- Operation period: 3 times per year, once each in the dry season (February to May), the winter season (November to January) and the rainy season (June to October) for the first 3 years of operation period, after that, the sampling frequency will be modified. Modification will depend on the first 3 years results.

(2) Sampling Station :

There are two sampling stations in the Mekong River (see Figure 3.1) as 1,000 m. upstream and 1,000 m. downstream of The Second Mekong International Bridge Construction Project.

(3) Parameter :

Parameters for water sampling consist of temperature, pH, turbidity, conductivity, DO, COD, BOD_5, SS, oil & grease, and fecal coliform bacteria.

(4) Expense :

50,000 baht /station /time (300,000 baht /year)

(5) Responsible Agency :

- During construction phase by the Contractor
- During operation phase by DOH & MCTPC

3.5.2 Aquatic Life

(1) Period and Frequency

- Construction period: 3 times per year, once each in the dry season (February to May), the winter season (November to January) and the rainy season (June to October).
- Operation period: 3 times per year, once each in the dry season (February to May), the winter season (November to January) and the rainy season (June to October) for the first 3 years of operation period, after that, the sampling frequency will be modified. Modification will depend on the first 3 years results.

(2) Sampling Station

Two sampling stations in the Mekong River (see Figure 3.1) as 1,000 m. upstream and 1,000 m. downstream of The Second Mekong International Bridge Construction Project.

(3) Parameter

Parameters for aquatic ecology sampling consist of plankton and benthic organisms.

(4) Expense :

40,000 baht /station /time (240,000 baht /year)

(5) Responsible Agency

- During construction phase by the Contractor
- During operation phase by DOH & MCTPC

3.5.3 Air Quality

(1) Period and Frequency

- Construction period: 2 times/year, once each in the dry season (February to May) and the winter season (November to January). Each sampling period must be carried out for 3 consecutive days.
- Operation period: 2 times/year, once each in the dry season (February to May) and the winter season (November to January) for the first 3 years of operation period, after that, the sampling frequency will be modified. Modification will depend on the first 3 years results (Each sampling period must be carried out for 3 consecutive days).

(2) Sampling Station

Two sampling stations (see Figure 3.2) in Thailand (Ban Song Puai, Ban Khok Sung) and one sampling station in the Lao PDR (Interchange of Route No. 9 & Kaysone Road).

(3) Parameter :

Parameters for air quality sampling consist of total suspended particles (TSP-24 hr.), particulates matter (PM-10 (24 hr.), nitrogen dioxide (NO_2-1 hr.), and carbon monoxide (CO-1 hr.).

(4) Expense :

150,000 baht /station /time (1,350,000 baht /year)

(5) Responsible Agency :

- During construction phase by the Contractor
- During operation phase by DOH & MCTPC

3.5.4 Noise Level

(1) Period and Frequency

- Construction period: 2 times/year, once each in the dry season (February to May) and the winter season (November to January). Each sampling period must be carried out for 3 consecutive days.
- Operation period: 2 times/year, once each in the dry season (February to May) and the winter season (November to January) for the first 3 years of operation period. After that, the sampling frequency will be modified. Modification will depend on the first 3 years results (Each sampling period must be carried out for 3 consecutive days).

(2) Sampling Station

Two sampling stations (see Figure 3.2) in Thailand (Ban Song Puai, Ban Khok Sung) and one sampling station in the Lao PDR (Interchange of Route No. 9 & Kaysone Road).

(3) Parameter :

Parameters for noise level sampling consist of Leq-24 hr., and Ldn.

(4) Expense

120,000 baht /station /time (720,000 baht /year)

(5) Responsible Agency

- During construction phase by Contructor
- During operation phase by DOH & MCTPC

3.5.5 Vibration

(1) Period and Frequency

- Construction period: 2 times/year, once each in the dry season (February to May) and the winter season (November to January). Each sampling period must be carried out for 3 consecutive days.
- Operation period: 2 times/year, once each in the dry season (February to May) and the winter season (November to January) for the first 3 years of operation period. After that, the sampling frequency will be modified. Modification will depend on the first 3 year results (Each sampling period must be carried out for 3 consecutive days).

(2) Sampling Station

Two sampling stations (see Figure 3.2) in Thailand (Ban Song Puai, Ban Khok Sung) and one sampling station in the Lao PDR (Interchange of Route No. 9 & Kaysone Road)

(3) Parameter :

Parameters for vibration level sampling consist of peak particle velocity (PPV), and frequency.

(4) Expense:

120,000 baht /station /time(720,000 baht /year)

(5) Responsible Agency

- During construction phase by the Contractor
- During operation phase by DOH & MCTPC

3.5.6 Socio-economic Conditions

(1) Parameters

- The Project information perception
- The impact during construction period
- Opinion and attitude toward the Project
- Problems, desires and suggestions proposed for the Project's consideration

(2) Method

Socio-economic survey by interviewing

(3) Sampling population

Households nearby the construction site

(4) Sample size

About 100 samples

(5) Frequency

- During construction period: Every 6 months
- During operation period: Every 6 months for the first 3 years of operation period. After that, the sampling frequency will be modified. Modification will depend on the first 3 years results.

(6) Budget

50,000 baht /time (100,000 baht /year)

(7) Responsible Agency

- During construction phase by the Contractor
- During operation phase by DOH & MCTPC

APPENDIX (ENVIRONMENT)

Appendix 3.1 OEPP surface water quality standard

No.	Parameter	Statistic Value	Unit	Standard Value of Surface Water for Class				
				1	2	3	4	5
1	Colour, Odour and Taste	–	–	n	n	n	n	–
2	Temperature	–	°C	n	n'	n'	n'	–
3	pH Value	–	–	n	5–9	5–9	5–9	–
4	Dissolved Oxygen	P 20	mg/l	n	< 6.0	< 4.0	< 2.0	–
5	BOD (20 °C, 5 days)	P 80	mg/l	n	> 1.5	> 2.0	> 4.0	–
6	*Total Coliform Bacteria*	*P 80*	*MPN/100 ml*	*n*	*< 5,000*	*< 20,000*	–	–
7	Faecal Coliform Bacteria	P 80	MPN/100 ml	n	> 1,000	> 4,000	–	–
8	NO_3–N	Max. allowance	mg/l	n	not more than 5.0			–
9	NH_3–N	Max. allowance	mg/l	n	not more than 0.5			–
10	Phenols	Max. allowance	mg/l	n	not more than 0.005			–
11	Copper (Cu)	Max. allowance	mg/l	n	not more than 0.1			–
12	Nickel (Ni)	Max. allowance	mg/l	n	not more than 0.1			–
13	Manganese (Mn)	Max. allowance	mg/l	n	not more than 1.0			–
14	Zinc (Zn)	Max. allowance	mg/l	n	not more than 1.0			–
15	Cadmium (Cd)	Max. allowance	mg/l	n	not more than 0.005*			–
					not more than 0.005**			
16	Cr (hexavalent)	Max. allowance	mg/l	n	not more than 0.05			–
17	Lead (Pb)	Max. allowance	mg/l	n	not more than 0.05			–
18	Hg (total)	Max. allowance	mg/l	n	not more than 0.002			–
19	Arsenic (As)	Max. allowance	mg/l	n	not more than 0.01			–
20	Cyanide (CN)	Max. allowance	mg/l	n	not more than 0.005			–
21	Radioactivity							
	– Gross	Max. allowance	Becquerel/l	n	not more than 0.1			–
	– Gross	Max. allowance	Becquerel/l	n	not more than 1.0			–
22	Total Organochlorine Pesticides	Max. allowance	mg/l	n	not more than 0.05			–
23	DDT	Max. allowance	ug/l	n	not more than 1.0			–
24	BHC	Max. allowance	ug/l	n	not more than 0.02			–
25	Dieldrin	Max. allowance	ug/l	n	not more than 0.1			–
26	Aldrin	Max. allowance	ug/l	n	not more than 0.1			–
27	Heptachlor & Heptachlor epoxide	Max. allowance	ug/l	n	not more than 0.2			–
28	Endrin	Max. allowance	ug/l	n	none			–

Remark : P = Percentile value
n = naturally
n' = naturally but changing not more than 3°C
* = when water hardness not more than 100 mg/l as $CaCO_3$
** = when water hardness more than 100 mg/l as $CaCO_3$
> = not more than
< = not less than
MPN = Most Probable Number

Source : Notification of the National Environmental Board No. 8, B.E.2537 (1994) issued under the Enhancement & Conservation of National Environmental Quality Act B.E. 2535 (1992), published in the Royal Government Gazette, vol. III, Part 16 d, dated February 4, B.E. 2537 (1994)

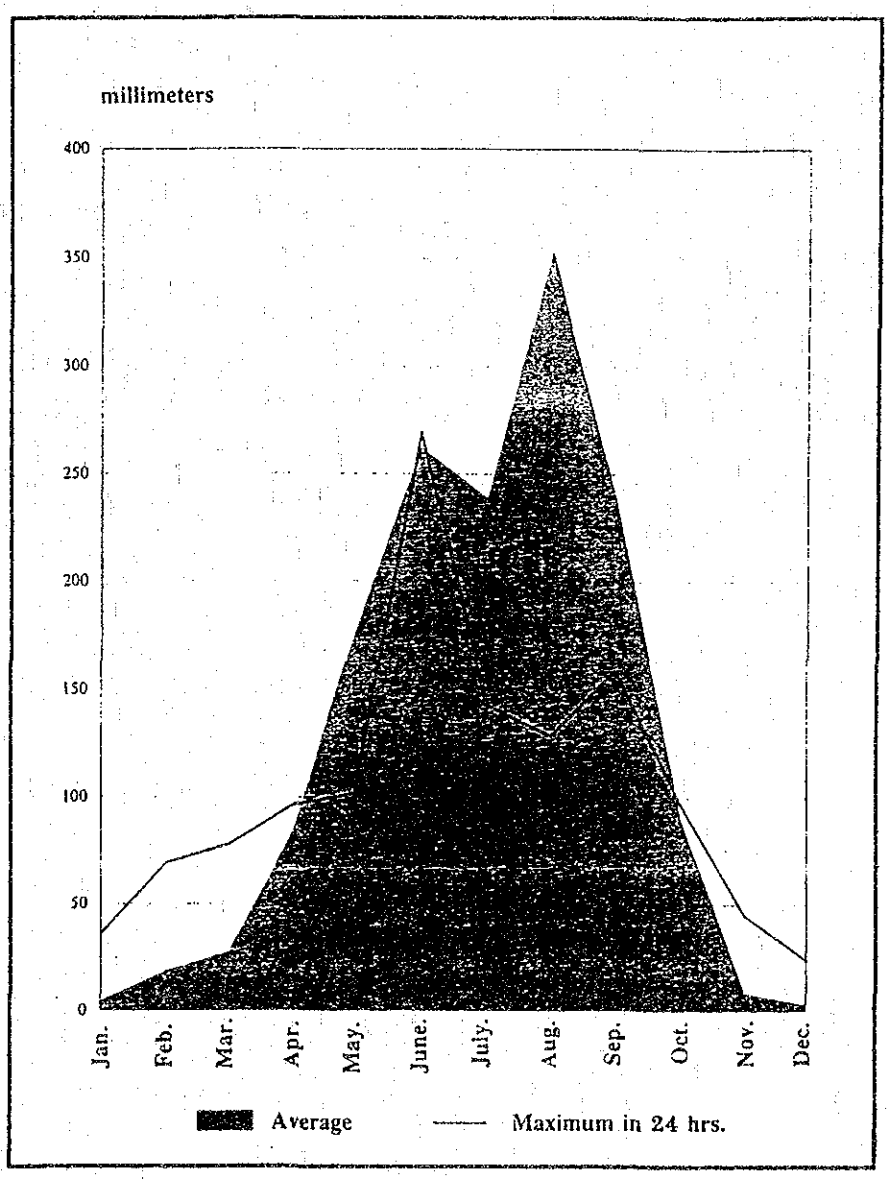
Appendix 3.2 The 30 years statistic of the climate in this region (1966-1995)

Station	MUKDAHAN	Elevation of station above MSL	138 Meters
Index station	48383	Height of barometer above MSL	139 Meters
Latitude	16 32 N	Height of thermometer above ground	1.50 Meters
Longitude	104 43 E	Height of wind vane above ground	11.00 Meters
		Height of raingauge	0.80 Meters

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pressure (Hectopascal)													
Mean	1014.29	1012.05	1009.81	1007.94	1006.50	1005.00	1004.93	1004.92	1007.25	1010.39	1013.43	1015.16	1009.31
Ext. max.	1027.81	1025.86	1026.68	1022.02	1015.73	1013.34	1012.57	1012.92	1014.70	1020.27	1024.61	1025.40	1027.81
Ext. min.	1001.72	1000.23	998.77	997.16	997.40	994.95	996.36	992.19	996.00	998.22	1003.01	1003.86	992.19
Mean daily range	5.39	5.91	6.09	5.76	5.05	4.17	3.97	4.05	4.52	4.53	4.44	4.75	4.89
Temperature (Celsius)													
Mean	22.5	24.9	28.0	29.6	28.9	28.2	27.8	27.3	27.3	26.2	24.2	22.0	26.4
Mean max.	29.4	31.7	34.4	35.6	34.0	32.3	31.9	31.1	31.4	30.8	29.4	28.3	31.7
Mean min.	15.5	18.3	21.7	24.1	24.6	24.7	24.4	24.1	23.7	21.9	19.0	15.8	21.5
Ext. max	36.3	38.7	40.6	41.9	41.2	40.0	36.2	35.0	35.3	35.6	35.1	35.0	41.9
Ext. min.	5.3	9.4	11.1	15.3	19.3	21.2	21.3	20.9	17.7	14.7	9.4	5.3	5.3
Relative Humidity (%)													
Mean	66	63	60	63	74	79	80	83	81	75	69	68	72
Mean max.	89	86	81	82	89	92	93	94	94	90	87	89	89
Mean min.	43	41	39	43	55	64	66	69	64	59	53	48	54
Ext. min.	9	18	16	19	28	28	46	44	39	33	29	25	9
Dew Point (Celsius)													
Mean	15.0	16.7	18.6	21.1	23.3	24.0	23.9	24.0	23.5	21.2	17.9	15.3	20.4
Evaporation (mm.)													
Mean-pan	130.1	132.3	176.0	181.0	158.6	125.7	125.3	110.9	118.1	125.9	128.0	122.1	1634.0
Cloudiness (0-10)													
Mean	3.1	3.6	4.1	5.4	7.2	8.2	8.3	8.7	7.6	5.9	4.5	3.4	5.8
Sunshine Duration (hr.)	NO OBSERVATION												
Visibility (km.)													
0700 L.S.T.	4.6	4.5	4.4	6.0	9.4	10.2	10.4	9.2	8.4	8.0	6.7	5.0	7.2
Mean	8.1	6.4	5.6	7.4	10.9	11.5	11.5	10.7	10.5	10.1	9.6	8.6	9.2
Wind (Knots)													
Mean wind speed	3.5	3.3	3.3	3.0	2.4	2.5	2.6	2.4	2.1	3.6	4.9	4.3	–
Prevailing wind	NE	E	E	E	SW	SW	SW	SW	NE	NE	NE	NE	–
Max. wind speed	33	35	55	75	45	38	33	33	40	33	50	32	75
Rainfall (mm.)													
Mean	4.3	18.5	27.2	83.7	175.9	262.3	238.3	353.1	238.4	89.1	8.4	3.0	1502.2
Mean rainy day	0.8	2.4	3.6	7.0	15.8	17.9	18.6	22.0	16.5	8.7	1.5	0.6	115.4
Greatest in 24 hr.	35.9	69.4	78.0	96.3	101.5	269.4	142.6	128.5	159.0	96.4	44.8	23.8	269.4
Number of days with													
Haze	20.1	23.3	26.1	21.2	3.2	0.2	0.0	0.0	2.9	8.7	11.9	16.6	134.2
Fog	2.7	1.7	1.1	0.3	0.1	0.1	0.1	0.4	1.0	0.7	1.3	3.0	12.5
Hail	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Thunderstorm	0.1	1.4	3.8	9.9	16.1	11.9	12.2	11.6	10.2	3.6	0.3	0.0	81.1
Squall	0.0	0.1	0.0	2.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5

Computer Section
Climatology division
Meteorological department
20-Jan-97

Appendix 3.3 The 30 years (1966-1995) statistic of the average rainfall of Mukdahan Weather station



Appendix 3.4 The existing noise level

(15–23 November 1999)

Sampling Stations		Duration	Noise Level (dB(A))	
			Leq–24 hr.	Ldn
Station No. 1	Ban Song Puai	15–16 Nov. 99	53.4	59.4
	(High Residential Area, 300 from the project site)	16–17 Nov. 99	52.8	57.9
		18–19 Nov. 99	52.7	57.9
Station No. 2	Ban Khong Sung	15–16 Nov. 99	52.6	56.5
	(Mukdahan Vittayanukol School, 500 from the project site)	16–17 Nov. 99	53.1	57.0
		18–19 Nov. 99	52.6	57.0
Station No. 3	Interchange of Route No. 9 & Kaysone Road	20–21 Nov. 99	53.0	60.1
	(Moderate Residential Area, 100 from the project site)	21–22 Nov. 99	53.2	60.0
		22–23 Nov. 99	53.2	59.6
Standard of MOSTE (1997)			70.0	–

Note : MOSTE = Ministry of Science Technology and Environment, 1997

Appendix 3.5 The internal attenuation coefficient of the ground

Soil Characteristic	Velocity, m/s	Internal Attenuation Coefficient of the Ground
1. Moist Clay	152	0.025–0.250
2. Silty Clay	152	0.019–0.430
3. Wet Clay	152	0.310–0.500
4. Dry Sand	152–396	0.007–0.070
5. Dense Sand and Gravel	250	0.015–0.045
6. Gravel Plus Sand and Silt	250	0.023–0.053
7. Fine Grained Sand		
– Water Saturated	110	0.090–0.300
– Water Saturated and Frozen	110	0.050–0.170

Note : Nelson (1987)

Appendix 3.6 Existing vibration level (station 1)

(15–18 November 1999)

Duration	Vibration Level (mm/s)			
	15 Nov. 99	16 Nov. 99	17 Nov. 99	18 Nov. 99
00.00–01.00	–	0.30	0.30	0.40
01.00–02.00	–	0.30	0.30	0.40
02.00–03.00	–	0.30	0.30	0.40
03.00–04.00	–	0.30	0.40	0.40
04.00–05.00	–	0.30	0.40	0.40
05.00–06.00	–	0.30	0.40	0.40
06.00–07.00	–	0.20	0.40	0.40
07.00–08.00	–	0.30	0.40	0.40
08.00–09.00	–	0.30	0.50	0.40
09.00–10.00	0.30	0.30	0.30	–
10.00–11.00	0.30	0.30	0.30	–
11.00–12.00	0.20	0.30	0.50	–
12.00–13.00	0.40	0.50	0.60	–
13.00–14.00	0.40	0.30	0.30	–
14.00–15.00	0.40	0.40	0.30	–
15.00–16.00	0.70	0.30	0.30	–
16.00–17.00	0.40	0.50	0.50	–
17.00–18.00	0.30	0.30	0.40	–
18.00–19.00	0.40	0.90	0.80	–
19.00–20.00	0.30	0.30	0.30	–
20.00–21.00	0.40	0.30	0.40	–
21.00–22.00	0.30	0.30	0.40	–
22.00–23.00	0.30	0.30	0.40	–
23.00–24.00	0.30	0.30	0.40	–
3 Day Average			0.37	mm/s
3 Day Minimum			0.20	mm/s
3 Day Maximum			0.90	mm/s

Appendix 3.7 Existing vibration level (station 2)

(15–18 November 1999)

Duration	Vibration Level (mm/s)			
	15 Nov. 99	16 Nov. 99	17 Nov. 99	18 Nov. 99
00.00–01.00	–	0.40	0.40	0.50
01.00–02.00	–	0.40	0.40	0.40
02.00–03.00	–	0.40	0.40	0.40
03.00–04.00	–	0.40	0.40	0.40
04.00–05.00	–	0.40	0.40	0.50
05.00–06.00	–	0.40	0.50	0.50
06.00–07.00	–	0.40	0.50	0.50
07.00–08.00	–	0.40	0.40	0.60
08.00–09.00	–	0.40	0.50	0.60
09.00–10.00	–	0.40	0.50	0.60
10.00–11.00	0.40	0.40	0.50	–
11.00–12.00	0.40	0.40	0.40	–
12.00–13.00	0.40	0.40	0.40	–
13.00–14.00	0.40	0.40	0.40	–
14.00–15.00	0.30	0.40	0.40	–
15.00–16.00	0.30	0.40	0.30	–
16.00–17.00	0.30	0.40	0.40	–
17.00–18.00	0.30	0.40	0.50	–
18.00–19.00	0.40	0.40	0.50	–
19.00–20.00	0.40	0.40	0.50	–
20.00–21.00	0.40	0.40	0.50	–
21.00–22.00	0.40	0.40	0.40	–
22.00–23.00	0.40	0.40	0.50	–
23.00–24.00	0.40	0.40	0.50	–
3 Day Average			0.42	mm/s
3 Day Minimum			0.30	mm/s
3 Day Maximum			0.60	mm/s

Appendix 3.8 Existing vibration level (station 3)

(20–23 November 1999)

Duration	Vibration Level (mm/s)			
	20 Nov. 99	21 Nov. 99	22 Nov. 99	23 Nov. 99
00.00–01.00	–	0.80	0.90	1.10
01.00–02.00	–	0.80	1.00	1.10
02.00–03.00	–	0.90	1.00	1.10
03.00–04.00	–	0.90	1.00	1.10
04.00–05.00	–	0.90	1.00	1.10
05.00–06.00	–	0.90	1.00	1.10
06.00–07.00	–	1.00	1.00	1.20
07.00–08.00	–	1.00	1.00	1.10
08.00–09.00	–	1.00	1.00	1.10
09.00–10.00	–	1.00	1.00	1.00
10.00–11.00	–	1.00	1.10	1.00
11.00–12.00	–	1.00	0.90	1.10
12.00–13.00	–	0.90	0.90	1.00
13.00–14.00	–	0.90	0.90	1.00
14.00–15.00	–	0.90	1.00	1.00
15.00–16.00	0.70	0.90	1.10	–
16.00–17.00	0.70	0.90	1.00	–
17.00–18.00	0.70	0.90	1.10	–
18.00–19.00	0.70	1.00	1.10	–
19.00–20.00	0.70	1.00	1.00	–
20.00–21.00	1.00	1.00	1.00	–
21.00–22.00	1.00	1.00	1.10	–
22.00–23.00	0.80	0.90	1.10	–
23.00–24.00	0.80	0.90	1.20	–
3 Day Average			0.97	mm/s
3 Day Minimum			0.70	mm/s
3 Day Maximum			1.20	mm/s

QUESTIONNAIRE
SOCIO-ECONOMIC AND ATTITUDE TO THE PROJECT

ENVIRONMENTAL SURVEY
FOR
THE DETAILED DESIGN
OF
THE SECOND MEKONG INTERNATIONAL BRIDGE
CONSTRUCTION PROJECT
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
AND
THE KINGDOM OF THAILAND

NAME ..... DATE .....

HOME NUMBER ..... VILLAGE ..... INTERVIEW BY : .....

SUB-DISTRICT .....

DISTRICT..... CHECK BY : .....

PROVINCE .....

1. *General Information*

1.1 Age ..... years

1.2 Gender

1. Male 2. Female

1.3 Education Attainment

01. Illiterate

02. Highest Education

2.1 Primary School

2.2 Junior High School

2.3 High School

2.4 Diploma

2.5 Bachelor Degree or Equal

2.6 Master Degree or Higher

1.4 What religious do you respect ?

1. Buddhism 2. Christ

3. Muslim 4. Others.....

1.5 What status are you in your family ?

1. Head 2. Wife

3. Son/Daughter/Son in law/ Daughter in law

4. Relative 5. Others.....

2. Information of household member

2.1 Number of household member

1. Male ..... persons
2. Female ..... persons

2.2 Age of household member

1. > 60 and unemployed ..... persons
2. < 6 ..... persons
3. 6-13 (Age to be a subject of education) ..... persons
4. 14-60 or upper (but still working) ..... persons

2.3 Occupation of household member

1. Base on economic
2. Non-based on economic

3. Socio-Economic Information of household

Use this code to answer the question 3.1-3.2

1.	Trader/Merchant	2.	Government Employee
3.	Private Company Employee	4.	Ownership
5.	Agriculture	6.	Student/College student
7.	Transportation	8.	Others.....
9.	Unemployed	10.	No answer

3.1 Major Occupation.....

3.2 Minor Occupation.....

3.3 Average Income of household/month (Approximately)

1.	< 5,000	Baht	2.	5,001 - 10,000	Baht
3.	10,000 - 15,000	Baht	4.	15,001 - 20,000	Baht
5.	20,001 - 25,000	Baht	6.	25,001 - 30,000	Baht
7.	30,001 - 40,000	Baht	8.	40,001 - 50,000	Baht
9.	50,001 - 60,000	Baht	10.	60,001 - 70,000	Baht
11.	70,001 - 80,000	Baht	12.	80,001 - 90,000	Baht

13. 90,001 - 100,000Baht 14. > 100,000Baht

15. Unemployed/No answer

3.4 Type of household earning

1. Stable Earning 2. Pretty Stable Earning

3. Unstable

3.5 Average Expenditure of household/month (Approximately)

1.	< 5,000	Baht	2.	5,001 - 10,000	Baht
3.	10,000 - 15,000	Baht	4.	15,001 - 20,000	Baht
5.	20,001 - 25,000	Baht	6.	25,001 - 30,000	Baht
7.	30,001 - 40,000	Baht	8.	40,001 - 50,000	Baht
9.	50,001 - 60,000	Baht	10.	60,001 - 70,000	Baht
11.	70,001 - 80,000	Baht	12.	80,001 - 90,000	Baht
13.	90,001 - 100,000	Baht	14.	> 100,000	Baht

15. Unemployed/No answer

3.6 Type of Building

01) Appearance of house

1.1 Single house 1.2 Townhouse

1.3 Commercial Building 1.4 Apartment

1.5 Others.....

02) Purpose of using this building

2.1 For living only

2.2 For commercial purpose only

2.3 For both

2.4 Others.....

03) Right of possessing in house/building

3.1 Owner 3.2 Parents' own

3.3 Leasing

04) Value of Land and Property

4.1 Value of House Structure _____

4.2 Value of House Ground _____

4.3 Value of Economic Trees _____

4. Environmental Location

4.1 Distance from home to workplace

1. At/Adjacent to home 2. < 500 m.
3. 0.5 - 1.0 km 4. 1.0 - 5 km
5. > 5 km

4.2 Convenience Travelling (from home to workplace)

1. Very Convenience 2. Pretty Convenience
3. Not so Convenience 4. Hard

4.3 Convenience Travelling (from home to market/District)

1. Very Convenience 2. Pretty Convenience
3. Not so Convenience 4. Hard

4.4 Fertilizer of infrastructure and public service in your community

4.4.1 Electricity : 1. Provide 2. Non-provide

4.4.2 Water Supply : 1. Provide 2. Non-provide

4.4.3 Garbage Pick up Service : 1. Provide 2. Non-provide

4.4.4 Public Telephone : 1. Provide 2. Non-provide

4.5 Environmental in living place

1. Good 2. Fair
3. Bad

4.6 Safety in life and property

1. Very Safety 2. Fair
3. Dangerous

4.7 Relationship in your community

1. None
2. Few
3. Moderate
4. Much

4.8 Desirable Satisfication in your community

1. Very Satisfy
2. Satisfy
3. Still
4. not so satisfy

4.9 What character of community do you prefer ?

1. Living Place Areas
2. Trading/Business Areas
3. Rural Areas/Agriculture Area

4.10 Opinion on moving out of your place

1. None

   Why ?

   1. Not acquaintance to new location
   2. Occupation/Income
   3. Education for Children
   4. Moving Expenses
   5. Loose neighbourhood
   6. Others

2. Willing

   Why ?

   1. Not so convenience in travelling
   2. Worse Environment

5. Land utilization and type of farm holding land

5.1 Farm size _____ Rai/household

5.2 Land Utilization (rai/house hold)

Paddy land _____
Under field crops _____
Under fruit tree _____
Under vegetable _____
Grass land _____

Other land _____

5.3 Right of possessing in land holding

1. Owner 2. Leasing
3. Using in others' own for free

5.4 Land Tennurial Status _____

5.5 Assess in land

1. Unknown
2. Known ; About _____ Baht/wah^2

Remark : the wah is a linear measure equivalent to two meters

5.6 Price of land sale

1. Unknown
2. Known ; About _____ Baht/wah^2

6. Information about Project

6.1 Do you get information about this project ?

1. No
2. Yes From
   - 2.1 Survey officer
   - 2.2 District officer
   - 2.3 neighbourhood

6.2 Opinion about project after you get information ?

1. Silent/Narmal
2. Anxiety about
   - 2.1 General
   - 2.2 Investment
   - 2.3 Expropriate lands.

6.3 Do you want add information about this project ?

1. No
2. Yes about
   - 2.1 Steady route.

2.2 Project characteristic

2.3 Project detail

2.4 Compensation

2.5 Impact from this project

7. Attitude about Project

7.1 Advantage and remainder from this project

7.1.1 Advantage

1. Good transportation and communication
2. Development community
3. Good economic
4. No opinion

7.1.2 Remainder

1. Lose residence and land
2. Traffic jam
3. Pollution
4. No opinion

7.2 Opinion about this project

1.	Approve because	01	Good transportation
		02	Good economic
2.	Not approve because	01	Lose residence and land
		02	Community don't get advantage
		03	Not necessary
3.	Hesitate because	01	Information about project is not clear.
		02	Information about impact is not clear.

8. Expectation about impact from this project

8.1 What do you expect about impact/damage from this project? (Answer more than 1)

1. Lose your home
2. Lose land for agriculture.
3. Lose residence
4. Lose building
5. Lose orchard

8.2 Do you think this project make you to migration?

1. Yes because 01 Lose whole of land
   02 Lose land for agriculture

   (If you answer Yes, to No.8.3-8.4)

2. No because 01 Your residence is not expropriate.
   02 Other.....

8.3 Migration

8.3.1 If you're migrated. Where do you want to stay ?

1. Nearby Village. Because .....
2. Other place. Distance from village ..... kms.

8.3.2 Can you find new living place. ?

1. Yes
2. No
3. Uncertain

8.3.3 What do you think about problem of migration. ?

1. No problem
2. Yes because 01 .....
   02 .....
   03 .....

8.4 What do you want to help from government for migration? (Answer more than 1)

1. Provide new residence
2. Provide land for agriculture and support occupation.
3. Pay for indemnity.
4. Provide Infrastructure in new place.
5. Education for childen.
6. Market for agriculture product.
7. No opinion.

9. Opinion on Environmental Impact from this Project During Construction and Operation

9.1 Environmental Impact During Construction

1. No Impact
2. Receive Impact (To No. 9.1.1)

9.1.1 Characteristics of Impact (Multiple Answers Possible)

01 Noise Pollution

02 Vibration

03 Dust

04 Obstruction on Path

05 Occupation

5.1 Advantages

1. Increase Income

2. Others (Please Specify).....

5.2 Disadvantages

1. Not so convenience in travelling

2. Lose land for agriculture

3. Change your occupation

4. Others (Please Specify).....

06 Safety in Life and Property

1. Supervisory on project

2. Others (Please Specify).....

9.1.2 Recommendation to Reduce Impact

01 Noise Pollution

1. Construction on Daytime

2. Solved by Constructor

3. Hasty Construction

4. No Opinion

5. Others (Please Specify).....

02 Vibration

1. Solved by Constructor

2. Hasty Construction

3. Construction on Daytime

4. No Opinion

5. Others (Please Specify).....

03 Dust

1. Solved by Constructor
2. Hasty Construction
3. Construction on Daytime
4. Inject by Water
5. No Opinion
6. Others (Please Specify).....

04 Obstruction on Path

1. Solved by Constructor
2. Hasty Construction
3. Construction on Daytime
4. Inject by Water
5. No Opinion
6. Others (Please Specify).....

05 Occupation

1. To Construct the temporary road.
2. Prefer the government provides alternative residence
3. No Opinion
4. Others (Please Specify).....

06 Safety in Life and Property

9.2 Environmental Impact During Operation

1. No Impact
2. Receive Impact (To No. 9.2.1)

9.2.1 Air Pollution

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High
2. Moderate
3. Low

03 Recommendations

1. To plant on road shoulder
2. Monitoring after the project is operated
3. Others (Please Specify).....

9.2.2 Noise Pollution

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High
2. Moderate
3. Low

03 Recommendations

1. Monitoring after the project is operated
2. Installed Noise Barrier
3. No Opinion
4. Others (Please Specify).....

9.2.3 Travelling from home to land for agriculture

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High
2. Moderate
3. Low

03 Recommendations

1. To construct the new road
2. To construct the cross way
3. No Opinion
4. Others (Please Specify).....

9.2.4 Travelling from home to market/district

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High
2. Moderate
3. Low

03 Recommendations

1. To construct the new road
2. To construct the cross way
3. No opinion
4. Others (Please Specify).....

9.2.5 Visual Aesthetics

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High
2. Moderate
3. Low

03 Recommendations

1. To plant
2. To construct the cross way
3. No opinion
4. Others (Please Specify).....

9.2.6 Occupation

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High
2. Moderate
3. Low

03 Recommendations

1. Prefer the government provides alternative residence
2. No opinion
3. Others (Please Specify).....

9.2.7 Economics/Trade of Locality

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High
2. Moderate
3. Low

03 Recommendations

1. Supervisory on Project
2. No opinion
3. Others (Please Specify).....

9.2.8 Land Value

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High
2. Moderate
3. Low

03 Recommendations

1. No opinion
2. Others (Please Specify).....

9.2.9 Relationship in Your Community

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High
2. Moderate
3. Low

03 Recommendations

1. No opinion
2. Others (Please Specify).....

9.2.10 Mentality

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High
2. Moderate
3. Low

03 Recommendations

1. Reduced Pollution
2. Monitoring after the project is operated.
3. No opinion
4. Others (Please Specify).....

9.2.11 Safety in Life and Property

01 Impact

1. Better
2. Worse
3. No Impact

02 Level of Impact

1. High

2. Moderate

3. Low

03 Recommendations

1. No opinion

2. Others (Please Specify).....

10. Opinion on expropriate and compensation

10.1 Opinion on expropriate

1. Pleasure (no conditions)
2. No Problem if the government fairly compensates
3. Uncertain
4. Do not want the expropriate

10.2 Opinion on compensation

1. Cash compensation
2. Prefer the government provides alternative residence
   - 2.1 Desired Area
     - 1.) Around
     - 2.) Convenience Travelling
   - 2.2 Type/Character of building
     - 1.) Commercial Building
     - 2.) Single house
3. Some cash and provide alternative residence

10.3 Period of compensation in the cash compensation case

1. whole compensate in one time
2. with in ..... months.

10.4 The appropriate assess land method

1. Consider follow the present assess of Department of land.
2. Consider with present sale price

10.5 The appropriate compensation method

1. Supported who have no own lands.
2. Fairly compensate for buying new land.
3. Compensates equal to the land that is expropriated
4. Deal with the officer whom may be concerned in direct.
5. No opinion

10.6 Other Need (except the compensation, land, property and moving expenses)

1. Monitoring after the project is operated
2. Provide infrastructures in the alternative residence
3. Compensate for the time to find new residence
4. Provide the residence with home
5. No opinion

Comment : .....

.....

.....

.....

.....

.....

.....

Appendix 3.10(1)-(16) The results the interview survey (Lao PDR)

Characteristics		Frequency	Percentage
Respondents	Head of Household	34	89.5
	Wife	4	10.5
Education	Illiterate	1	2.6
	Primary School	17	44.7
	Secondary School	8	21.1
	High School	9	23.7
	College	3	7.9
	University	-	-
Religion	Buddhist	38	100
Migrated to the Area	Less than10 years	16	42.1
	11-20 years	4	10.5
	21-30 years	12	31.6
	More than 30 years	6	15.8

Characteristics		Frequency	Percentage
Household Member	Male	23	60.5
	Female	15	39.5
Age of Household Members			
	Less than 6 years old	7	18.4
	6-13 (Age to be subjected to education)	11	28.9
	14-60 (But still working)	15	39.5
	> 60 & Unemployment	5	13.2
Occupation of Household Members			
	Based on Economic	16	42.1
	Non-Based on Economic	22	57.9
Average Size of Household		**Mean = 6.13**	**Sd. = 2.12**
Average Age		**Mean = 47.7**	**Sd. = 13.1**

Variable		Frequency	Percentage
Type of Building	Single House	11	28.9
	Partly Wood & Concrete	3	7.9
	Terrace House	4	10.5
	Hut	8	21.1
	Not Applicable	12	31.6
Purpose of Using	For Living Only	13	34.6
	For Commercial Purpose	5	13.2
	For Both	8	21.1
	Not Applicable	12	31.6
Right of Processing	Owner	30	78.9
	Parents' Own/Heritage	6	14.8
	Leasing	2	5.3

Variable		Frequency	Percentage	NA
Distance from Home to Workplace				
	Adjacent to Home	10	26.3	-
	< 500 m	2	5.3	-
	500-1000 m	1	2.6	-
	1000-5000 m	5	13.2	-
	More than 50000 m	20	52.6	-
Convenient Travelling (From Home to Workplace)				
	Very Convenient	20	52.6	-
	Convenient	12	31.6	-
	Not So Convenient	6	15.8	-
	Inconvenient	-	-	-
Convenient Travelling (From Home to Market/Town)				
	Very Convenient	22	57.9	-
	Convenient	9	23.7	-
	Not So Convenient	6	15.8	-
	Inconvenient	1	2.6	-
Public Services	Electricity	33	86.8	5 (13.2)
	Water Supply	10	26.3	28(73.7)
	Garbage Service	-	-	38(100)
	Telephone Service	4	10.5	34(89.5)

Notes: Figures inside parenthesis indicate percentage of the total number
NA=Not applicable

Variables		Frequency	Percentage
Environmental in Living Place	Good	34	89.5
	Bad	4	10.5
Safety in Life & Property	Very Safe	29	76.3
	Safe	6	15.8
	Not Safe	3	7.9
Community Relationship	Poor	3	7.9
	Fair	14	36.8
	Good	21	55.3
Desirable Satisfaction in the Community			
	Very Satisfy	20	52.6
	Satisfy	17	44.8
	No Comment	1	2.6
Community Preferred Characteristics			
	Living Area	12	31.6
	Trading/Business Area	16	42.1
	Rural Area/Agricultural Area	10	26.3

Reasons	Opinions		NA
	None	Willing	
Opinions on Moving	31 (81.6)	7 (18.4)	-
Loss of Neighborhood	25 (65.8)	-	13 (34.2)
Occupation/Income	30 (79.0)	-	8 (21.0)
Moving Expenses	21 (55.3)	-	17 (44.7)
Education for Children	27 (71.1)	-	11 (28.9)
Not Acquainted to New Location	20 (52.6)	-	18 (47.4)
Not so Convenient in Travelling	-	5 (13.5)	33 (86.5)
Worse Environment	-	10 (26.4)	30 (73.6)

Notes: Figures inside parenthesis indicate percentage of the total number
NA=Not applicable

Dimensions		Frequency	Percentage
Occupation	Retailer/Trader (Own Business)	4	10.5
	Government Official	5	13.2
	Company Employee	11	28.9
	Agriculturist	18	47.4
Income	Less than 100,000 Kip/Month	4	10.5
	110,000-150,000 Kip/Month	2	5.3
	151,000-200,000 Kip/Month	6	15.8
	210,000-250,000 Kip/Month	17	44.7
	251,000-300,000 Kip/Month	1	2.6
	More than 300,000 Kip/Month	8	21.1
Average Income		**Mean= 271,400 Kip/Month**	
Average Daily Expenditure		**Mean= 7500 Kip**	

Notes: - Figures inside parenthesis indicate percentage of the total number
- 1$=780 Kip

Components		Mean	Std.Dev
Average Land for Agriculture		7.1 rai	2.39
	Paddy Land	3.5	0.64
	Hill Crops	1	0.35
	Home Garden	1.3	0.42
	Grass Land	0.5	0.21
	Orchard Land	0.8	0.38
		Frequency	**Percentage**
Land Value Evaluation	Unknown	27	71.1
	Known	11	28.9
Right of Processing	Owner	32	84.2
	Leasing	6	15.8

Note: 6 rais = 1 hectare

Information		Frequency	Percentage	NA
Receiving an Information	No	2	5.3	-
	Yes	36	94.7	-
Sources of the Information				
	Surveyor	29	76.3	-
	District Officer	2	5.3	-
	Neighborhood	7	18.4	-
Opinions when Getting an Information				
	No Comment	11	28.9	-
	Anxiety	27	71.1	-
	Anxiety about the Investment	20	52.6	18(47.4)
	Anxiety about the Expropriation of Land	29	76.3	9 (23.7)
Additional Information		32	84.2	6(15.8)
	Steady Route	14	36.8	24(63.2)
	Project Characteristics	26	68.4	12(31.6)
	Project Details	27	71.1	11(28.9)
	Compensation	37	97.4	1 (2.6)
	Impacts from this Project	29	76.3	9 (23.7)

Notes: Figures inside parenthesis indicate percentage of the total number
NA=Not applicable

Impacts	Attitude	NA
Advantages		
Better Transportation & Communication	38 (100)	-
Community Development	14 (36.8)	24 (63.2)
Better Income	30 (78.9)	8 (21.1)
Increasing Number of Tourists	29 (76.3)	9 (23.7)
Disadvantages		
List of Residence and Land	33 (86.6)	5 (13.2)
Traffic Jam	26 (68.4)	12 (31.6)
Pollution	19 (50.0)	19 (50.0)
Increasing Accidents	27 (71.1)	11 (28.9)
Levels of Agreement		
Agreed	35 (92.1)	-
Disagreed	3 (7.9)	-

Notes: Figures inside parenthesis indicate percentage of the total number
NA=Not applicable

Impacts	Frequency	Percentage	NA
Loss of Residence	26	68.4	12 (31.6)
Loss of Agricultural Land	19	50.0	19 (50.0)
Loss of Orchards	9	23.7	29 (76.3)
Loss of Land for Building Construction	4	10.5	34 (89.5)

Notes: Figures inside parenthesis indicate percentage of the total number
NA=Not applicable

Opinions		Frequency	Percentage	NA
Relocation	Nearby Village	25	65.8	-
	Other Places	9	23.7	-
	No Idea	4	10.5	-
Finding a New Place	Yes	7	18.3	-
	No	23	60.6	-
	Uncertain	8	21.1	-
Migration Problems				
No Land for Building a New House		20	52.7	8 (47.3)
Lose Benefits		9	23.7	27 (71.1)
Difficult to Find the Skilled Workers		4	10.5	32 (84.2)
Not Enough Money to Build a New House		17	44.7	21 (55.3)
Not Enough Money to Move the House		5	13.2	33 (86.8)
Lose a Neighbor		14	36.8	24 (63.2)
Children's Education		36	94.7	2 (5.3)

Notes: Figures inside parenthesis indicate percentage of the total number
NA=Not applicable

Opinions		Frequency	Percentage
Expropriation	Accepted without Any Condition	3	7.9
	No Problem under the Condition Of Fair Compensation	34	89.5
	Against the Expropriation of Land	1	2.6
Type of Compensation Preferred			
	Money	25	65.8
	Alternative Residence	8	28.4
	Partly money and Land Provided	6	15.8
Condition of Paying Money Compensation			
	Pay the whole Amount in One Time (Within 3 months)	37	97.4
Land Value Evaluation			
	Follow the Government Price	-	-
	Follow the Market price	38	100

Characteristics		Frequency	Percentage
Respondents	Male	60	88.2
	Female	8	11.8
Education	Illiterate	2	2.9
	Primary School	20	29.4
	Secondary School	17	25.0
	High School	21	30.9
	College	5	7.4
	University	3	4.4
Religion	Buddhist	66	97.1
	Christian	2	2.9
Migrated to the Area	1-10 years	19	27.9
	11-20 years	34	50.0
	21-30 years	10	14.7
	More than 30 years	5	7.4
Occupations	Retailer/Own business	15	12.0
	Government Sector	10	14.7
	Private Sector	19	27.5
	Agricultural Sector	21	30.9
	Retiree/Housewife	3	4.4
Average Age		**44.18**	
Size of Household		**6.29**	
Average Income		**574,104**	**Kip/Month**
Average Daily Expenditure		**11,546**	**Kip/Day**

Information	Frequency	Percentage	NA
Receiving an Information			
No	3	4.4	-
Yes	65	95.6	
Sources of the Information			
Surveyor	51	75.0	-
District Officer	3	4.4	-
Neighborhood	14	20.6	-

Impacts	Frequency	Percentage	NA
Advantages			
Better Transportation & Communication	67	98.5	1 (1.56)
Community Development	64	94.1	4 (5.9)
Better Income	56	82.4	12 (17.6)
Increasing Numbers of Tourists	60	88.2	8 (11.8)
Disadvantages			
Traffic Jam	21	30.9	47 (69.1)
Pollution	62	91.2	6 (8.8)
Increasing Accidents	46	67.6	22 (32.4)
Levels of Agreement			
Agreed	48	100	-
Disagreed	-	-	-

Notes: Figures inside parenthesis indicate percentage of the total number
NA=Not applicable

Detail	Average	Count	Percent
NUMBER OF SAMPLES		120	100.0
Information of member			
1 Number of household member (persons)	4.6	555	100.0
- Male		257	46.3
- Female		298	53.7
Male : Female Ratio	86.2:100		
2 Age of household member			
- < 6 years old (Unemployed)		57	10.3
- 6-14 years old (Unemployed)		65	11.7
- 15-60 years old (Still working)		393	70.8
- > 60 years old (Unemployed)		40	7.2
Unemployed : Still working Ratio	*41.2:100*		
Economic conditions			
3 Occupation of household member			
- Base on economic		329	59.3
- Non-based on economic		226	40.7
4 Major Occupation			
- Trader/Merchant		4	3.3
- Government Employee		9	7.6
- Private Company Employee		1	0.8
- Ownership		2	1.7
- Agriculture		97	80.8
- Fishery/Other Labour		7	5.8
5 Minor Occupation			
- Trader/Merchant		20	23.8
- Ownership		6	7.2
- Agriculture		10	11.9
- Fishery/Other Labour		48	57.1
6 Average Income of household (Per month)			
- < 3,001 Baht		51	42.5
- 3,001-4,000 Baht		19	15.8
- 4,001-5,000 Baht		11	9.2
- 5,001-6,000 Baht		14	11.7
- 6,001-7,000 Baht		3	2.5
- 7,001-8,000 Baht		6	5.0
- 8,001-9,000 Baht		3	2.5
- 9,001-10,000 Baht		3	2.5
- 10,001-11,000 Baht		0	0.0
- 11,001-12,000 Baht		2	1.6
- > 12,000 Baht		8	6.7
7 Type of household earning			
- Stable Earning		29	24.2
- Pretty Stable Earning		20	16.7
- Unstable		71	59.2
8 Average Expenditure of household (Per month)			
- < 3,001 Baht		61	50.8
- 3,001-4,000 Baht		25	20.8
- 4,001-5,000 Baht		10	8.3
- 5,001-6,000 Baht		6	5.0
- 6,001-7,000 Baht		3	2.5
- 7,001-8,000 Baht		1	0.8
- 8,001-9,000 Baht		3	2.5
- 9,001-10,000 Baht		3	2.5
- 10,001-11,000 Baht		0	0.0
- 11,001-12,000 Baht		0	0.0
- > 12,000 Baht		8	6.8

9	Type of Building/House			
	01) Appearance of house			
	- Single house		120	100.0
	02) Purpose of using this building/house			
	- For living only		96	80.0
	- For commercial purpose only		2	1.7
	- For living and commercial purpose		22	18.3
	03) Right of possessing in house/building			
	- Owner		111	92.5
	- Parent's own		7	5.8
	- Leasing		2	1.7
	04) Value of Land and Property			
	1. Value of House Structure			
	- Unknown		36	30.0
	- <100,000 baht		9	7.5
	- 100,000-200,000 baht		50	41.6
	- 200,001-300,000 baht		11	9.2
	- 300,001-400,000 baht		7	5.8
	- 400,001-500,000 baht		5	4.2
	- 500,001-600,000 baht		0	0.0
	- 600,001-700,000 baht		2	1.7
	Average (baht/household)	201,905		
	2. Value of House Ground			
	- Unknown		53	44.2
	- <100,000 baht		3	2.5
	- 100,000-200,000 baht		49	40.8
	- 200,001-300,000 baht		7	5.8
	- 300,001-400,000 baht		4	3.3
	- 400,001-500,000 baht		2	1.7
	- 500,001-600,000 baht		0	0.0
	- 600,001-700,000 baht		0	0.0
	- 700,001-800,000 baht		0	0.0
	- 800,001-900,000 baht		0	0.0
	- 900,001-1,000,000 baht		2	1.7
	Average (baht/household)	200,299		
	3. Value of Economic Trees (baht/household)			
	- Unknown		119	99.2
	- 70,000 baht		1	0.8

Detail	Average	Count	Percent
NUMBER OF SAMPLES		120	100.0
Location of household			
1 Distance from home to workplace			
- At/Adjacent to home		13	10.8
- < 500 m.		34	28.3
- 0.5-1.0 km.		18	15.0
- 1.0-5.0 km.		41	34.2
- > 5 km.		14	11.7
2 Convenience Travelling (from home to workplace)			
- Very Convenience		95	79.2
- Pretty Convenience		9	7.5
- Not so Convenience		16	13.3
3 Convenience Travelling (from home to Maket/District)			
- Very Convenience		114	95.0
- Pretty Convenience		6	5.0
- Not so Convenience		0	0.0
Environmental Condition of household			
4 Fertilizer of infrastructure and public service in community			
- Electricity		120	100.0
- Water supply		117	97.5
- Garbage Pick up Service		0	0.0
- Public Telephone		68	56.7
5 Environmental in living place			
- Good		45	37.5
- Fair		72	60.0
- Bad		3	2.5
6 Safety in life and property.			
- Very safe		61	50.8
- Fairly safe		56	46.7
- Dangerous		3	2.5
Community relation			
7 Relationship in community			
- Few		1	0.8
- Moderate		34	28.4
- Much		85	70.8
8 Desirable satisfication in community			
- Very Satisfy		93	77.6
- Satisfy		25	20.8
- Still		1	0.8
- Not so satisfy		1	0.8
- Living place areas		52	43.3
- Trading/Business areas		15	12.5
- Rural living place areas/Agriculture areas		53	44.2
9 Opinion on moving out of your place			
- None		112	93.3
Because 1) Love this place			
2) Occupation			
- Willing		8	6.7
Because 1) Worse Environment			

Detail	Average	Count	Percent
NUMBER OF SAMPLES		120	100.0
Land utilization			
1 Farm size (rai*/household)	11.9		
2 Land Utilization (rai*)		1,423	100.0
- Paddy land		1,301	91.4
- Upland crops		47	3.3
- Fruit tree		14	1.0
- Under vegetable		13	0.9
- Forest Plantation		48	3.4
Type of land holding			
3 Type of possessing in land holding		-	
- Owner		115	95.8
- Unknown		5	4.2
4 Land Tennurial Status			
- The title deed		106	88.3
- Others		9	7.8
- Unknown		5	4.2
Value of Land			
5 Assess in land			
- Unknown		88	73.3
- < 100,000 baht		14	11.7
- 100,000-200,000 baht		9	7.5
- 200,001-300,000 baht		4	3.3
- 300,001-400,000 baht		2	1.7
- 400,001-500,000 baht		3	2.5
Average (baht/rai*)	160,313		
6 Price of land sale			
- Unknown		56	46.7
- < 100,000 baht		8	6.7
- 100,000-200,000 baht		24	20.0
- 200,001-300,000 baht		10	8.3
- 300,001-400,000 baht		9	7.5
- 400,001-500,000 baht		12	10.0
- 500,001-600,000 baht		1	0.8
Average (baht/rai*)	270,469		

* Remark : 625 rai = 1 km^2

Detail	Average	Count	Percent
NUMBER OF SAMPLES		120	100.0
Information about Project			
1 Do you get information about this project ?			
- No		0	0.0
- Yes From 1) Survey officer		33	27.5
2) District officer/Politician		56	46.7
3) Neighbourhood		13	10.8
4) Mass medias (TV., Newspaper, Radio)		18	15.0
2 Opinion about project after you get information?			
- Normal		110	91.7
- Anxiety about expropriate lands.		10	8.3
3 Do you want add information about this project ?			
- No		11	9.2
- Yes		109	90.8
about 1) Steady route		10	9.2
2) Construction period		14	12.8
3) Project detail		67	61.5
4) Compensation		5	4.6
5) Impact from this project		13	11.9
Attitude about project			
1 Advantage			
- Good transportation and communication		27	22.5
- Development community		28	23.3
- Good economic		65	54.2
2 Disadvantage			
- Lose residence and land		36	30.0
- Pollution		6	5.0
- No remainder		78	65.0
3 Opinion about this project			
- Approve		112	93.3
- Not approve		0	0.0
- Hesitate because information about project and impact is not clear.		8	6.7

Detail	Average	Count	Percent
NUMBER OF SAMPLES		120	100.0
Expectation about impact from this project			
1 What do you expect about impact/damage from this project ?			
- Not impact		97	80.8
- Lose home and residence		1	0.8
- Lose land for agriculture		22	18.4
2 Opinion about migration			
1) If you're migrated. Where do you want to stay ?			
- Near by Village		109	90.8
- Other Place		11	9.2
2) Can you find new living place ?			
- Yes		69	57.5
- Uncertain		38	31.7
- No		13	10.8
3) Problem of Migration			
- No Problem		96	80.0
- Adaptation to new community		24	20.0
Migration			
3 What do you want to help from government for migration ?			
1) Provide new residence		85	70.8
2) Provide land for agriculture and support occupation		75	62.5
3) Pay for indemnity		41	34.2
4) Provide infrastructure in new community		46	38.3
5) Education for children		17	14.2
6) Market for agriculture product		20	16.7

Detail	Average	Count	Percent
NUMBER OF SAMPLES		120	100.0
During construction			
1 Environ Environmental impact during construction			
- No Impact		70	58.3
- Receive Impact (To No. 9.1.2 and 9.1.3)		50	41.7
2 Characteristies of Impact			
- Noise Pollution		44	88.0
- Vibration		12	24.0
- Dust		25	50.0
- Obs Obstruction on path		14	28.0
3 Recommendation to reduce Impact			
- Construction on daytime		29	58.0
- Inject water in construction area		20	40.0
- Hasty construction		23	46.0
- Solved by constructor		23	46.0
During operation			
1 Environmental Impact during operation			
- No Impact		65	54.2
- Receive Impact (To No. 9.2.2 and 9.2.3)		55	45.8
2 Characteristies of Impact			
- Air Pallution		7	12.7
- Noise Pollution/Vibration		13	23.6
- Good transportation		35	63.6
- Good Economic		44	80.0
- Good to doing work		28	50.9
- Land value is Higher		43	78.2
3 Level of Impact			
- High		5	9.0
- Moderate		25	45.5
- Low		25	45.5

Detail	Average	Count	Percent
NUMBER OF SAMPLES		120	100.0
Opinion on expropriate and compensation			
1 Opinion on expropriate			
- Pleasure (no conditions)		22	18.3
- No Problem if the government fairly compensates.		88	73.4
- Uncertain		9	7.5
- No Pleasure		1	0.8
2 Opinion on compensation			
- Cash compensation		71	59.2
- Prefer the government prevides alternative residence (To No. 10.3)		45	37.5
- Some cash and provide alternative residence		4	3.3
3 Desired Area			
- Around project area		43	95.6
- Convenience travelling area		2	4.4
4 The appropriate assess land method			
- Consider follow the present assess of Department of land		8	8.9
- Consider with present sale price		112	91.1
5 The appropriate compensation method			
- Fairly compensate for buying new land.		66	55.0
- Compensates equal to the land that is expropriated		34	28.3
- Deal with the officer whom may be concerned in direct		20	16.7
6 Other need (except the compensation)			
- Monitoring after the project is operated.		49	40.8
- Provide infrastructures in the alternative residence		52	43.3
- Compensate for the time to find new residence		14	11.7
- Provide the residence with home		5	4.2

Appendix 3.11(1)-(8) The results of the interview survey (Thailand)

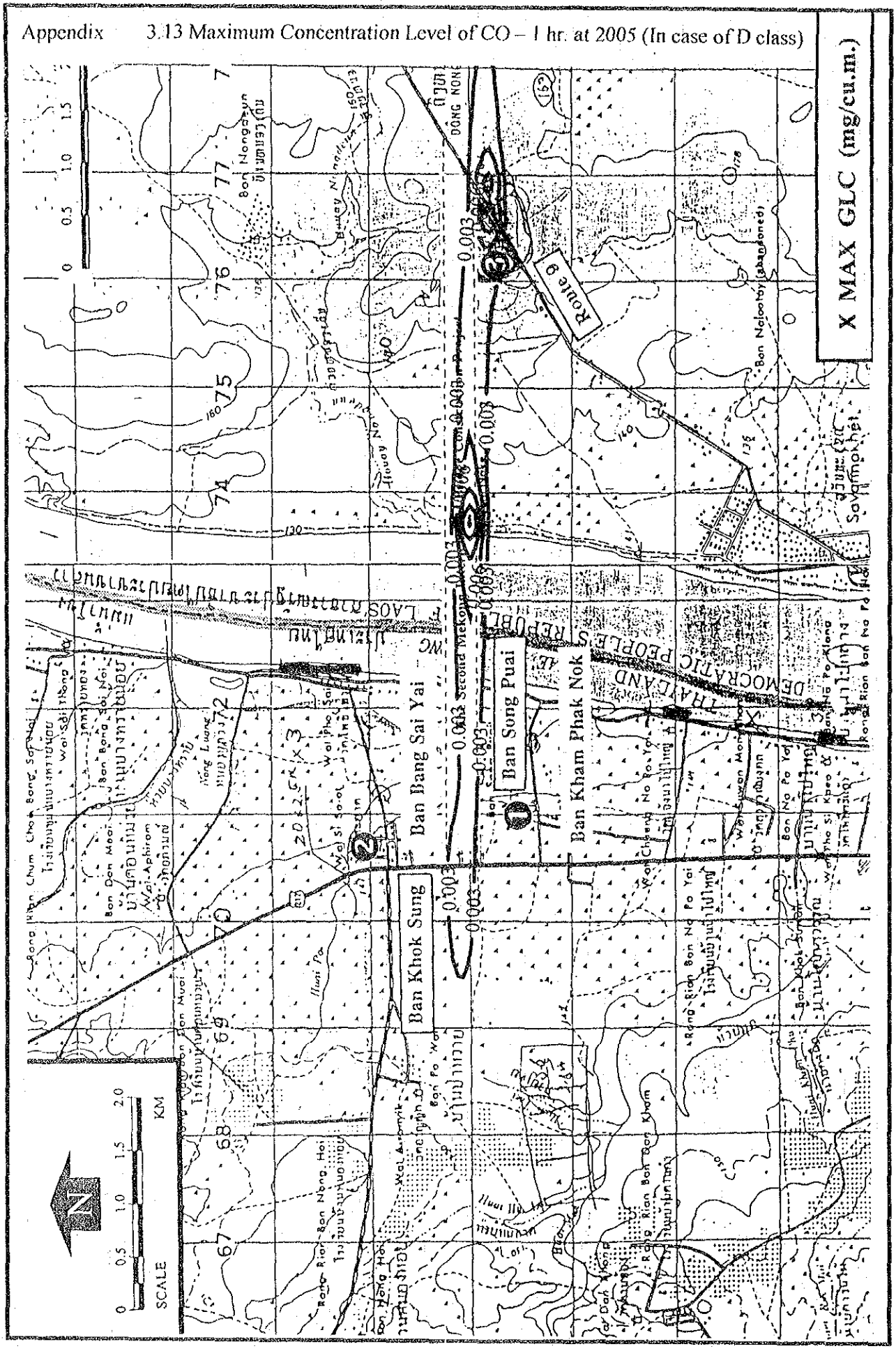
Detail	Average	Count	Percent
NUMBER OF SAMPLES		120	100.0
General Information of Samples			
1 Gender			
- Male		73	60.8
- Female		47	39.2
2 Age (Years)			
- < 31		18	15.0
- 31-40		32	26.7
- 41-50		40	33.3
- 51-60		18	15.0
- > 60		12	10.0
Average	44.3		
3 Education Attainment			
- Primary School		95	79.1
- Junior High School		5	4.2
- High School		7	5.8
- Diploma		2	1.7
- Bachelor Degree or Equal		11	9.2
4 Religious			
- Buddhism		118	98.3
- Christ		2	1.7
5 Status in your family			
- Head		81	67.5
- Wife		22	18.3
- Son/Daughter/Son in law/Daughter in law		17	14.2
		120	

Appendix 3.12 Representative rates of erosion from various land uses pattern

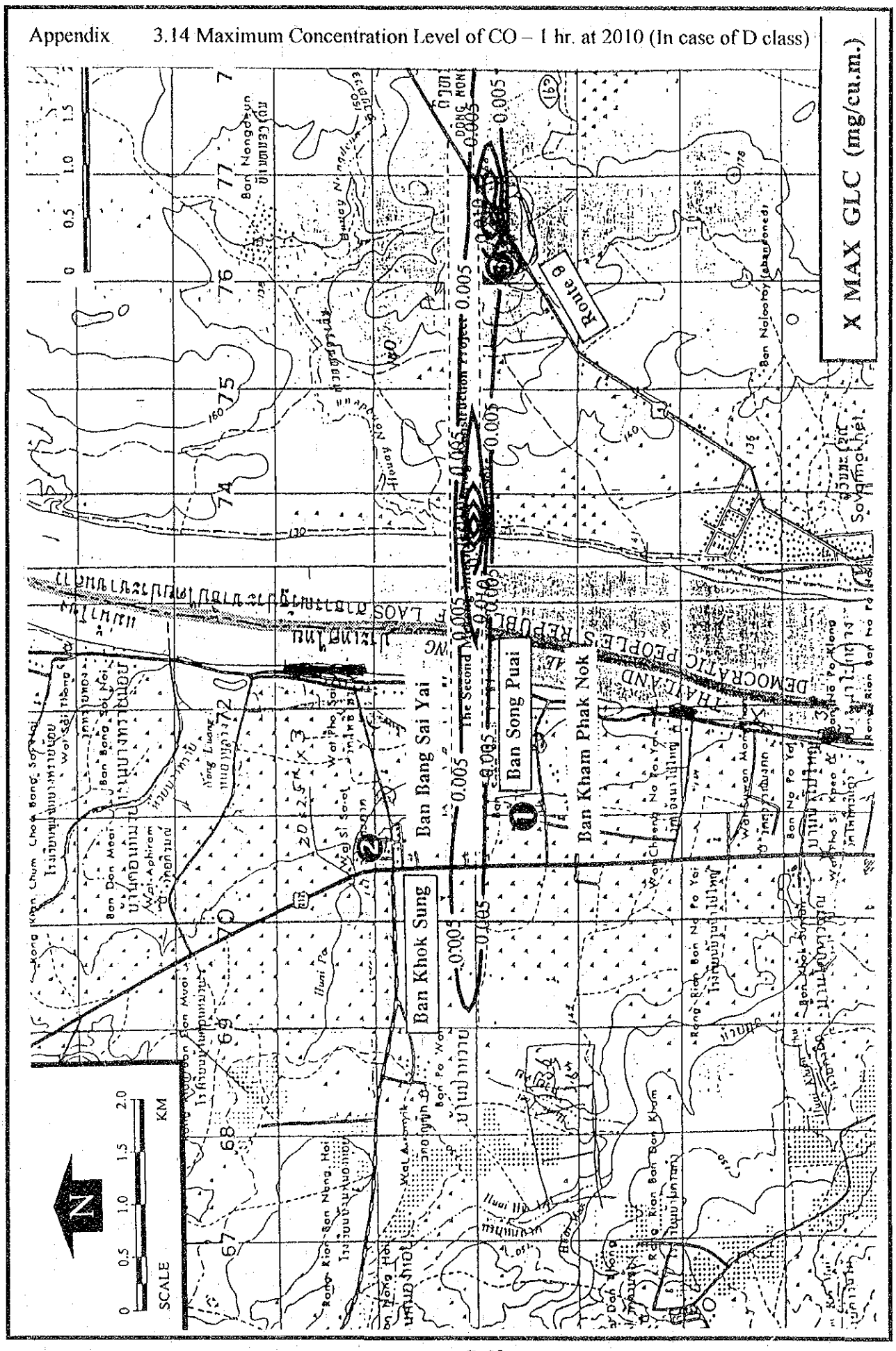
Land Use Pattern	Erosion Rate, MT/km^2-yr	Relative to Forest = 1
1. Forest	8.5	1
2. Grassland	85	10
3. Abandoned Surface Mines	850	100
4. Crop Land	1,700	200
5. Harvested Forest	4,250	500
6. Active Surface Mines	17,000	2,000
7. Construction	17,000	2,000

Source : Canter, 1977

Appendix 3.13 Maximum Concentration Level of CO – 1 hr. at 2005 (In case of D class)

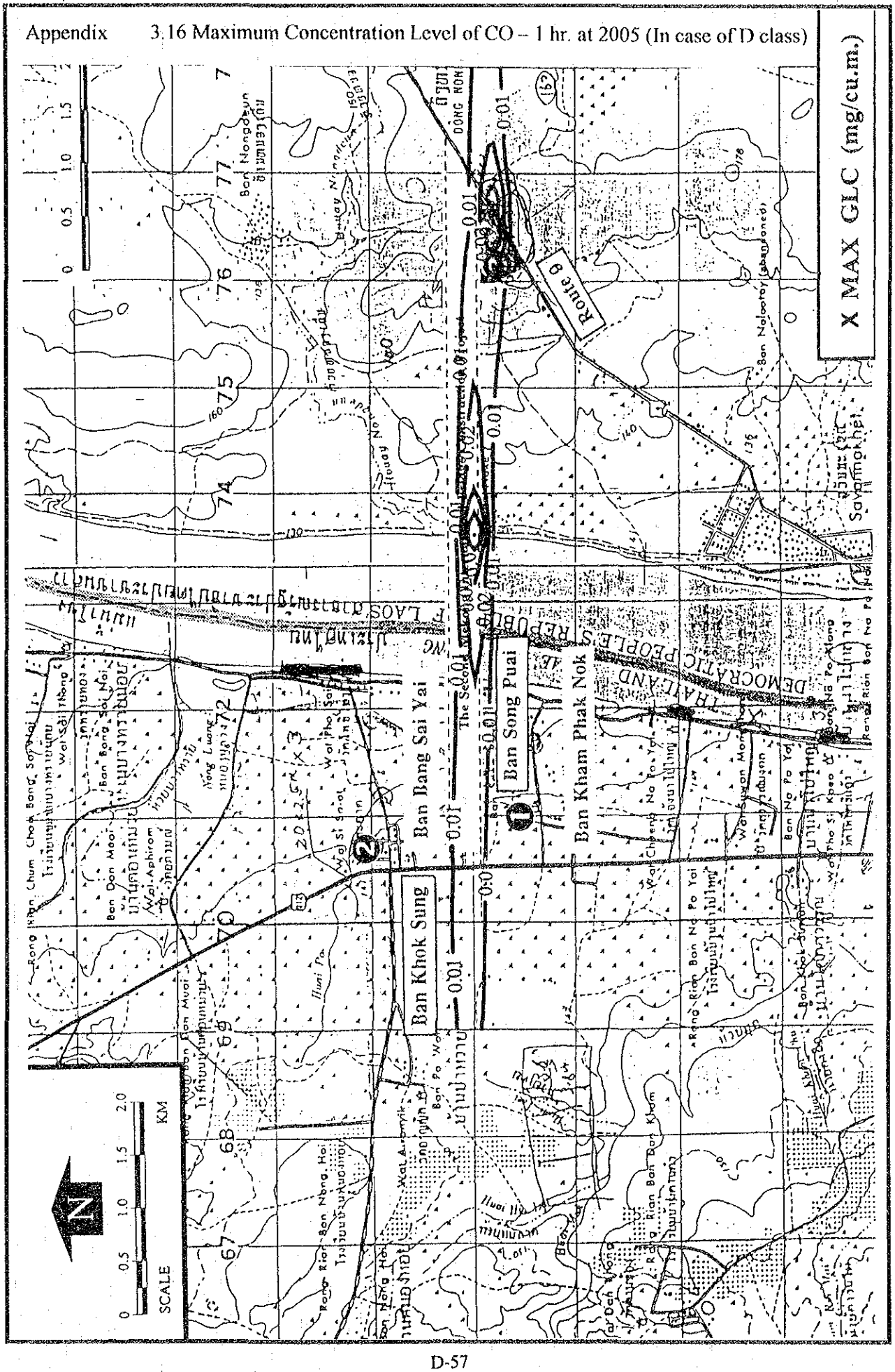


Appendix 3.14 Maximum Concentration Level of CO – 1 hr. at 2010 (In case of D class)



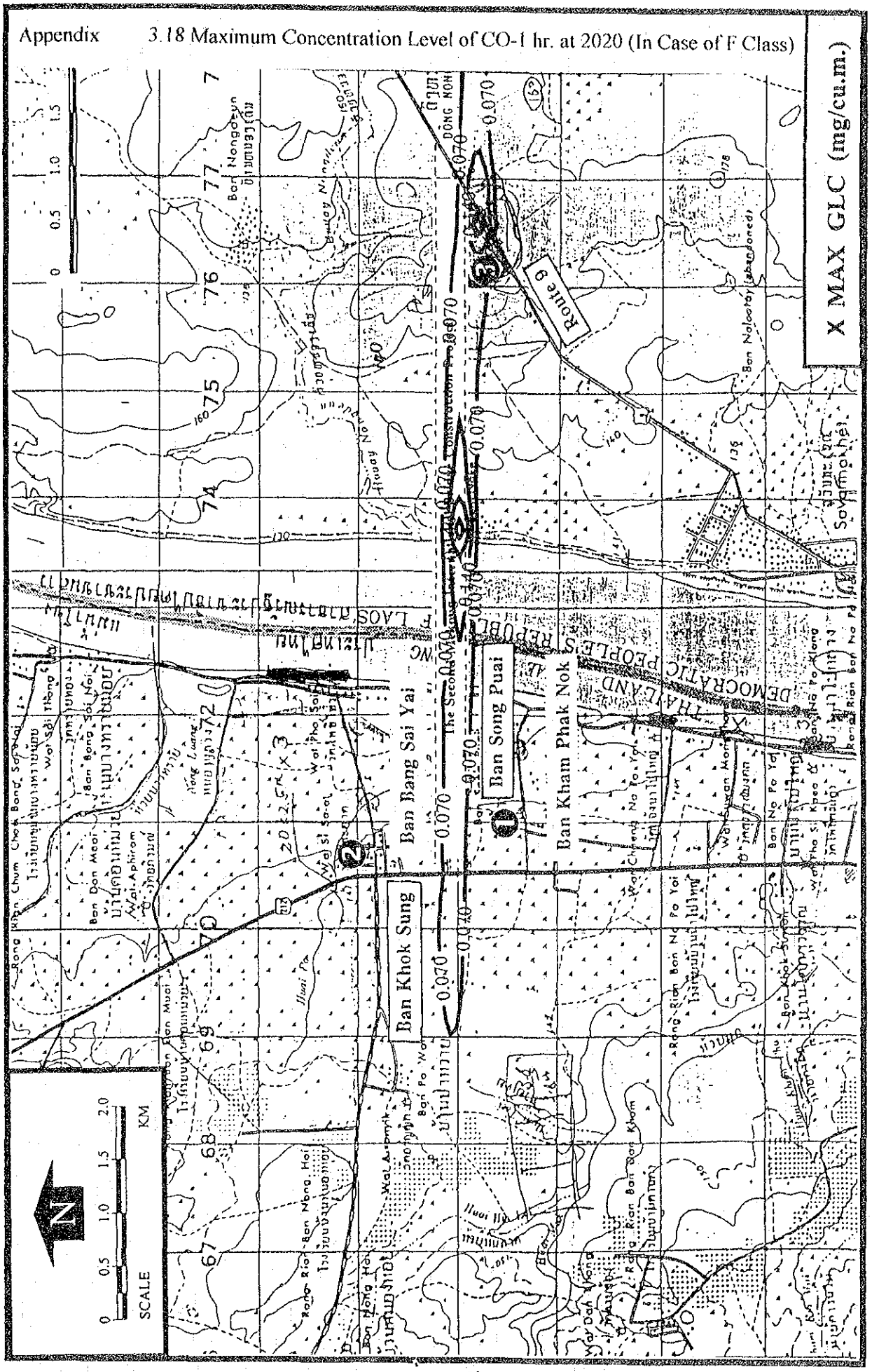
Appendix 3.15 Maximum Concentration Level of CO – 1 hr. at 2020 (In case of D class)

Appendix 3.16 Maximum Concentration Level of CO – 1 hr. at 2005 (In case of D class)

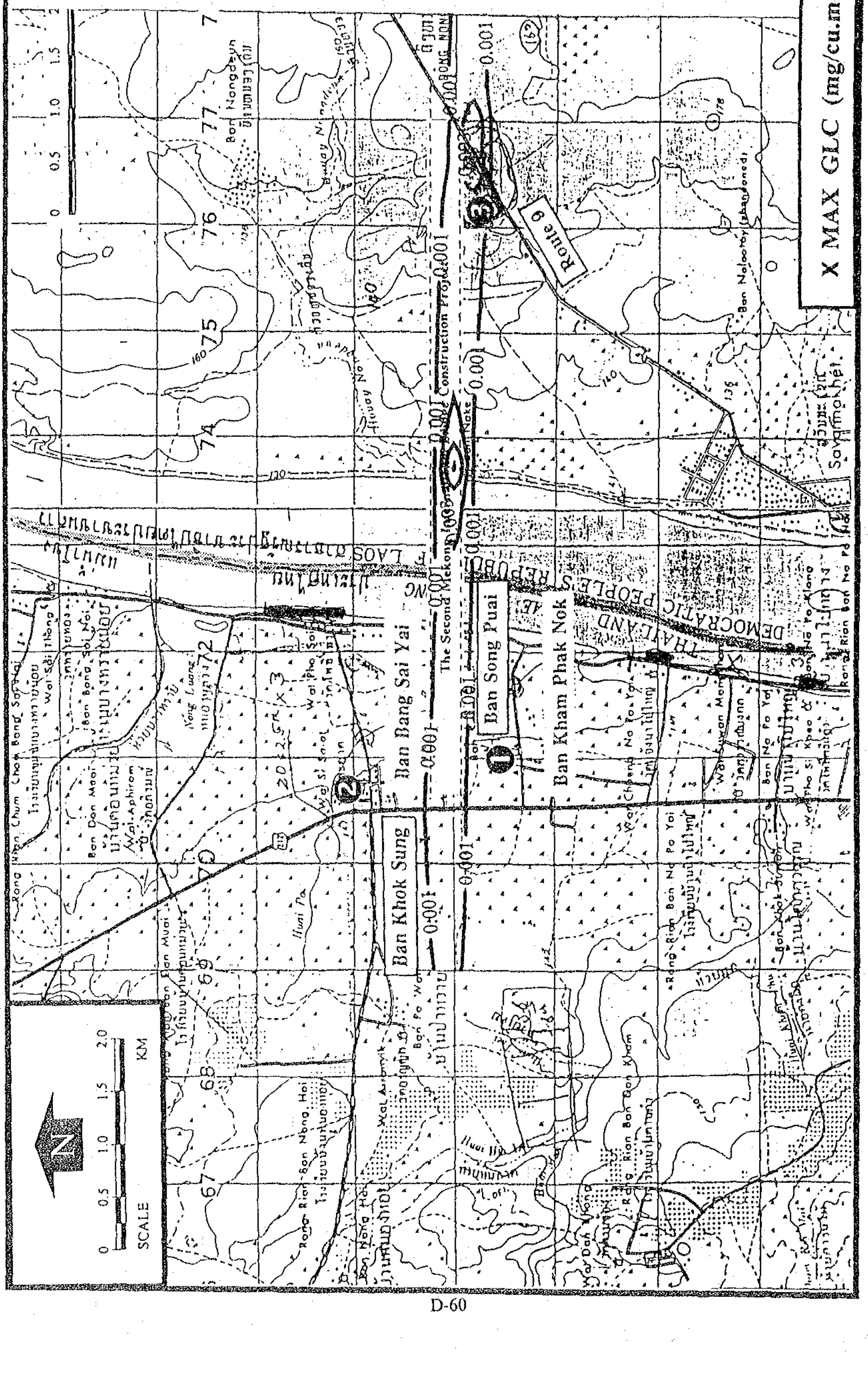


Appendix 3.17 Maximum Concentration Level of CO – 1 hr at 2010 (In case of D class)

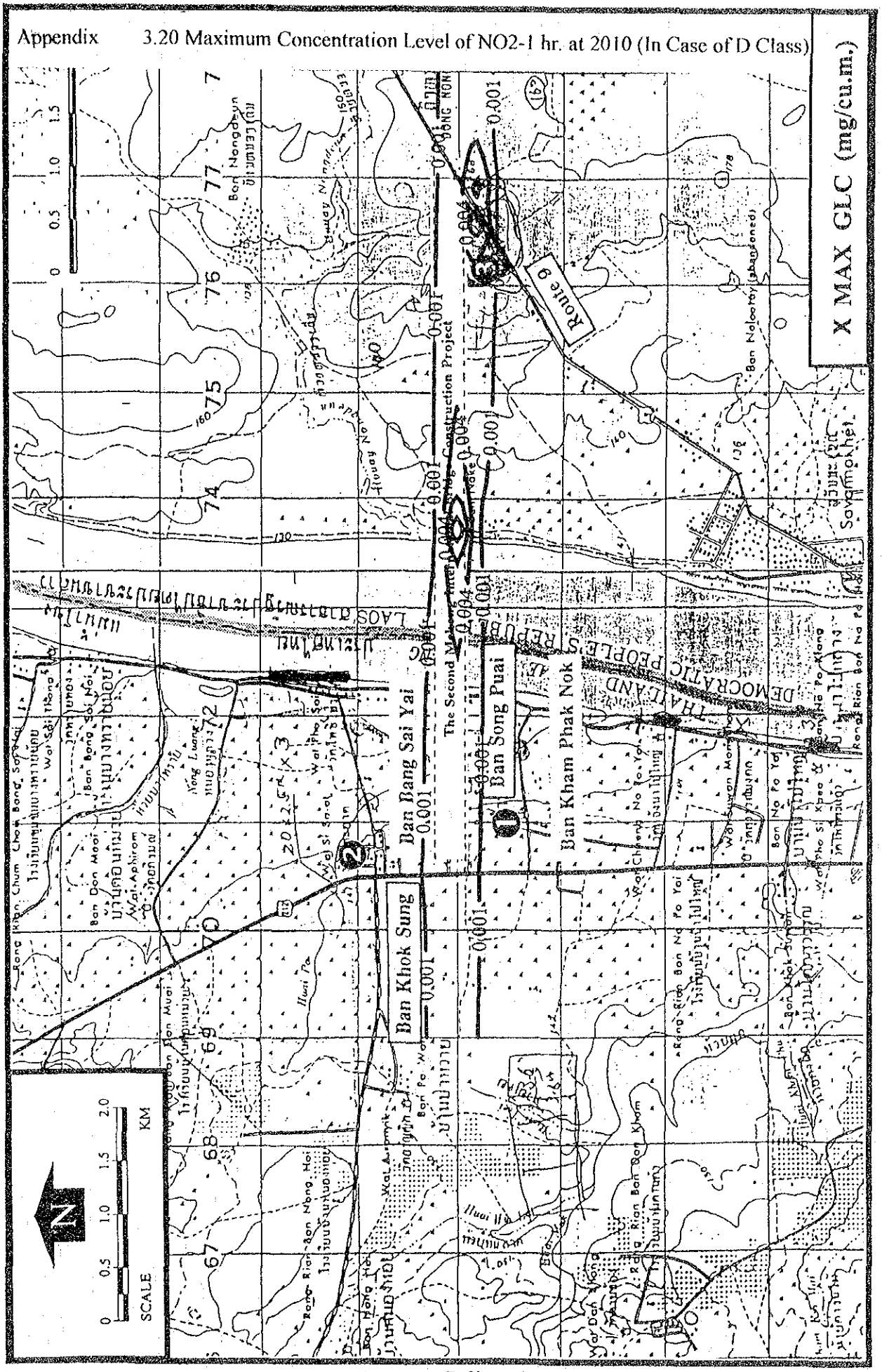
Appendix 3.18 Maximum Concentration Level of CO-1 hr. at 2020 (In Case of F Class)



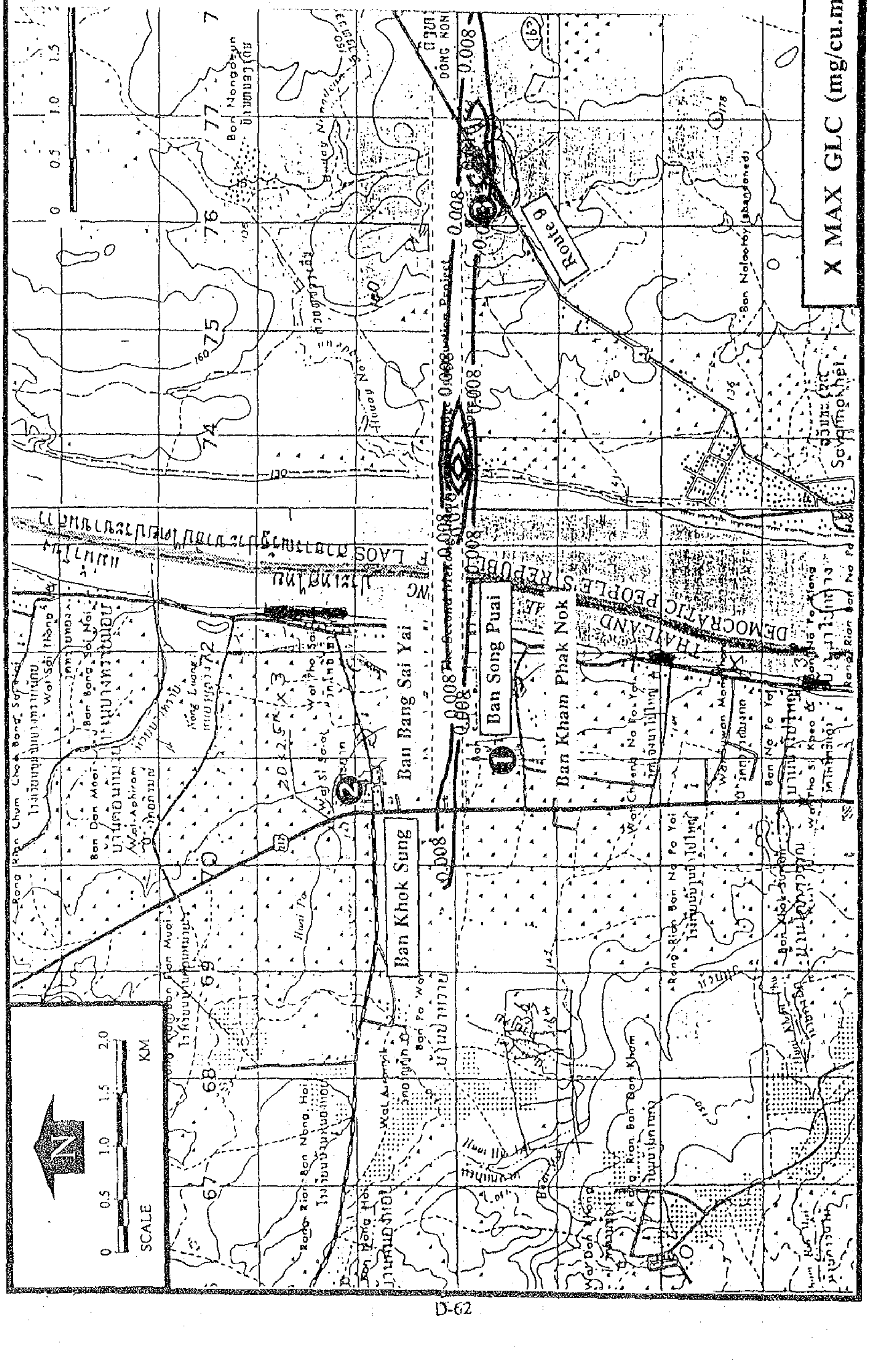
Appendix 3.19 Maximum Concentration Level of NO2-1 hr. at 2005 (In Case of D Class)



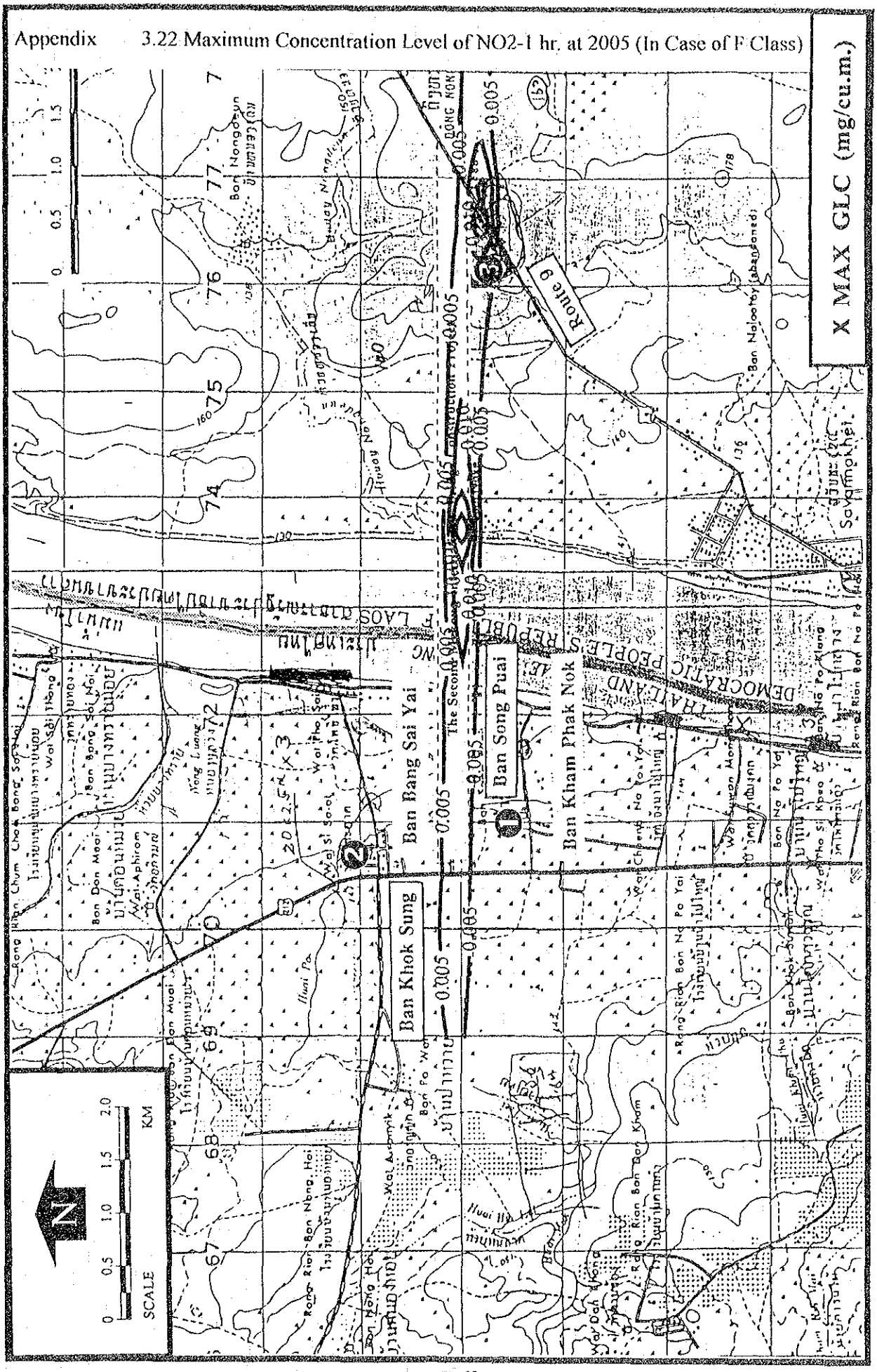
Appendix 3.20 Maximum Concentration Level of NO2-1 hr. at 2010 (In Case of D Class)



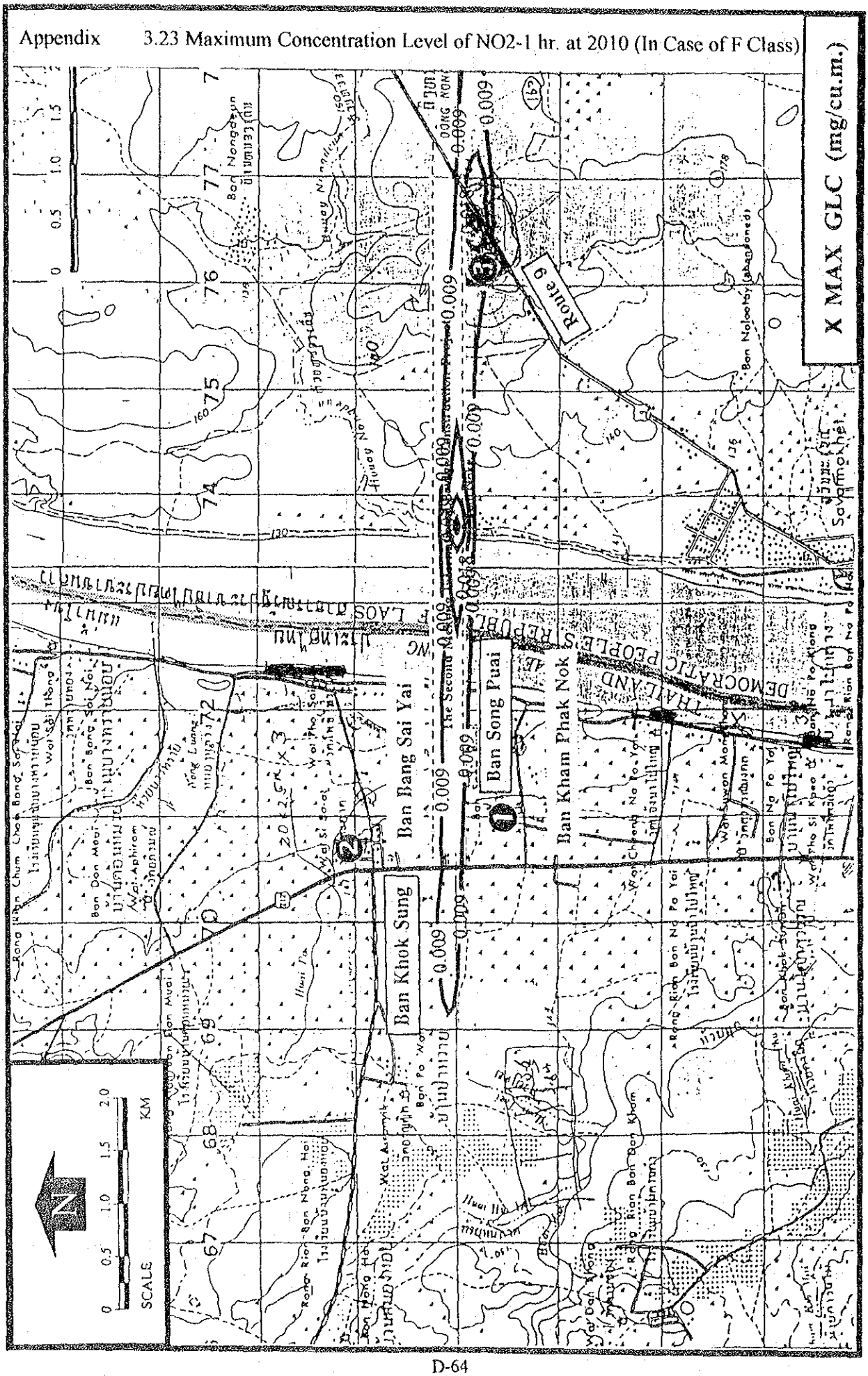
Appendix 3.21 Maximum Concentration Level of NO_2-1 hr. at 2020 (In Case of D Class)



Appendix 3.22 Maximum Concentration Level of NO2-1 hr. at 2005 (In Case of F Class)



Appendix 3.23 Maximum Concentration Level of NO2-1 hr. at 2010 (In Case of F Class)



Appendix 3.24 Maximum Concentration Level of NO2-1 hr. at 2020 (In Case of F Class)

Appendix 3.25 Noise level of Construction equipment

Construction Equipment	Noise Level Leq at 10 m, dB(A)
1. Earth Moving Activity	
– Wheeled Loader	80
– Tracked Loader	90
– Dozer	88
– Tracked Excavator	86
– Dump Truck	86
2. Piling Driving for Bridge and Viaducts	
– Diesel Hammer	100
– Drop Hammer	100
– Crane Mounted Auger	79
– Pneumatic Chipping Hammer	86
– Concrete Mixer	76
– Truck Mixer	84
– Lorry Mounted Concrete Pump	81
– Compressor	72
– Poker Vibrators	81
3. Column and Road Pavement	
– Concrete Mixer	76
– Truck Mixer	84
– Grout Mixer and Pump	80
– Lorry Mounted Concrete Pump	78
– Compressor	77
– Petro Driven Generator	83
– Pneumatic Breaker	91

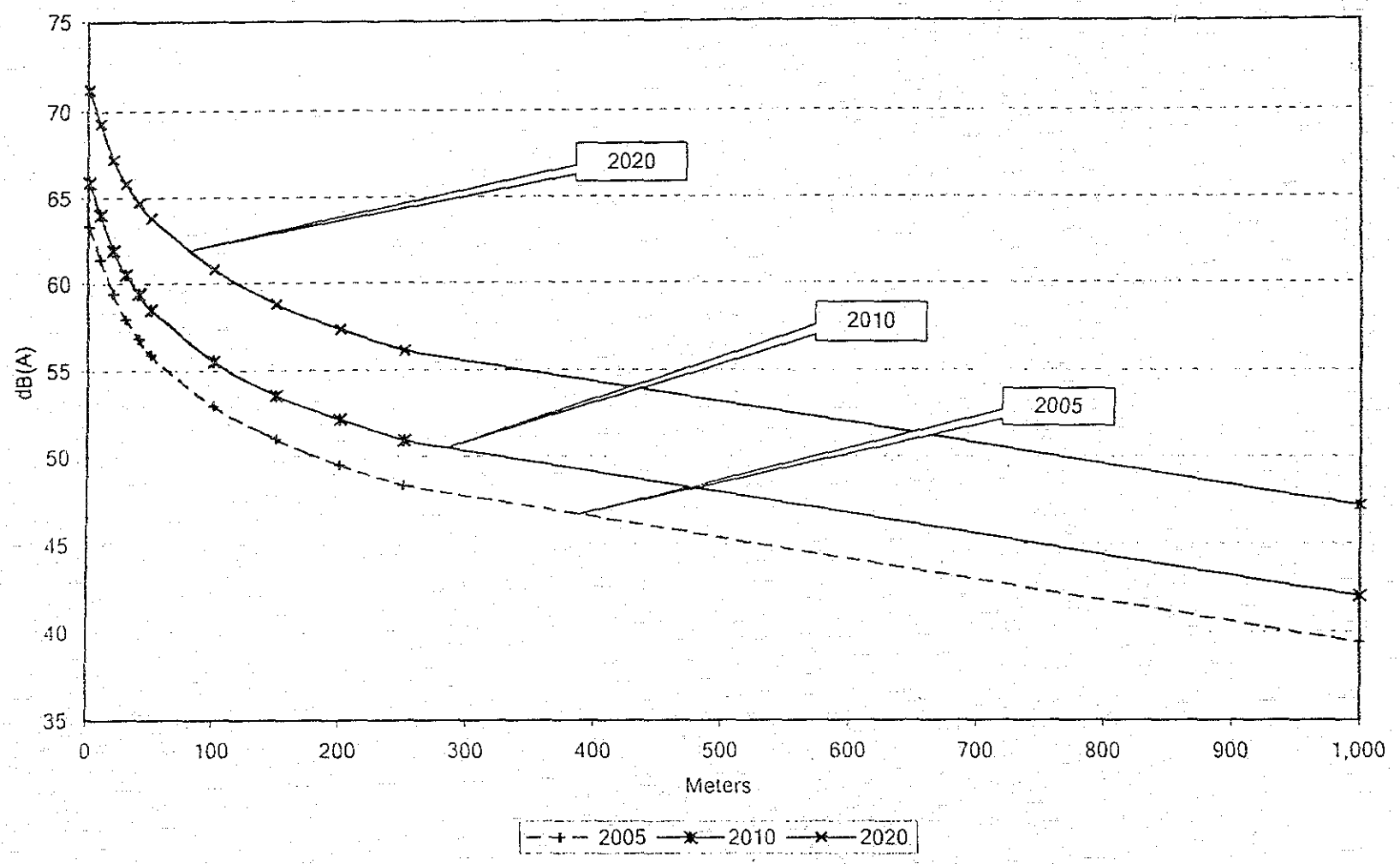
Note : Noise and Vibration Control on Construction and Open Sites (BS 5228 Part 1 : 1997)

Appendix 3.26 Prediction of noise level of construction equipment

Construction Equipments	Noise Level Leq at 10 m, dB(A)	Time Usage, %	Prediction of Noise Level: Leq (12 hr.), dB(A)						
			10 m.	15 m.	20 m.	30 m.	40 m.	50 m.	100 m
1. Earth Moving Activity									
– Wheeled Loader	80	80	79.0	76.5	74.0	70.5	68.0	66.0	60.0
– Tracked Loader	90	80	89.0	86.5	84.0	80.5	78.0	76.0	70.0
– Dozer	88	100	88.0	84.5	82.0	78.5	76.0	74.0	68.0
– Tracked Excavator	86	100	86.0	82.5	80.0	76.5	74.0	72.0	66.0
– Dump Truck	86	100	86.0	82.5	80.0	76.5	74.0	72.0	66.0
Total			93.6	90.5	88.0	84.5	82.0	80.0	74.0
2. Pile Driving for Bridge and Viaducts									
– Diesel Hammer	100	100	100.0	96.5	94.0	90.5	88.0	86.0	80.0
– Drop Hammer	100	60	97.8	96.5	94.0	90.5	88.0	86.0	80.0
– Crane Mounted Auger	79	30	73.8	75.5	73.0	69.5	67.0	65.0	59.0
– Pneumatic Chipping Hammer	86	30	80.8	82.5	80.0	76.5	74.0	72.0	66.0
– Concrete Mixer	76	50	73.0	72.5	70.0	66.5	64.0	62.0	56.0
– Truck Mixer	84	50	81.0	80.5	78.0	74.5	72.0	70.0	64.0
– Lorry Mounted Concrete Pump	81	50	78.0	77.5	75.0	71.5	69.0	67.0	61.0
– Compressor	72	100	72.0	68.5	66.0	62.5	60.0	58.0	52.0
– Poker Vibrators	81	50	78.0	77.5	75.0	71.5	69.0	67.0	61.0
Total			102.2	99.7	97.2	93.7	91.2	89.3	83.2
3. Column and Road Pavement									
– Concrete Mixer	76	50	73.0	72.5	70.0	66.5	64.0	62.0	56.0
– Truck Mixer	84	50	81.0	80.5	78.0	74.5	72.0	70.0	64.0
– Grout Mixer and Pump	80	50	77.0	76.5	74.0	70.5	68.0	66.0	60.0
– Lorry Mounted Concrete Pump	78	50	75.0	74.5	72.0	68.5	66.0	64.0	58.0
– Compressor	77	100	77.0	73.5	71.0	67.5	65.0	63.0	57.0
– Petro Driven Generator	83	100	83.0	79.5	77.0	73.5	71.0	69.0	63.0
– Pneumatic Breaker	91	50	88.0	87.5	85.0	81.5	79.0	77.0	71.0
Total			90.4	89.4	86.6	83.4	80.9	78.9	72.9

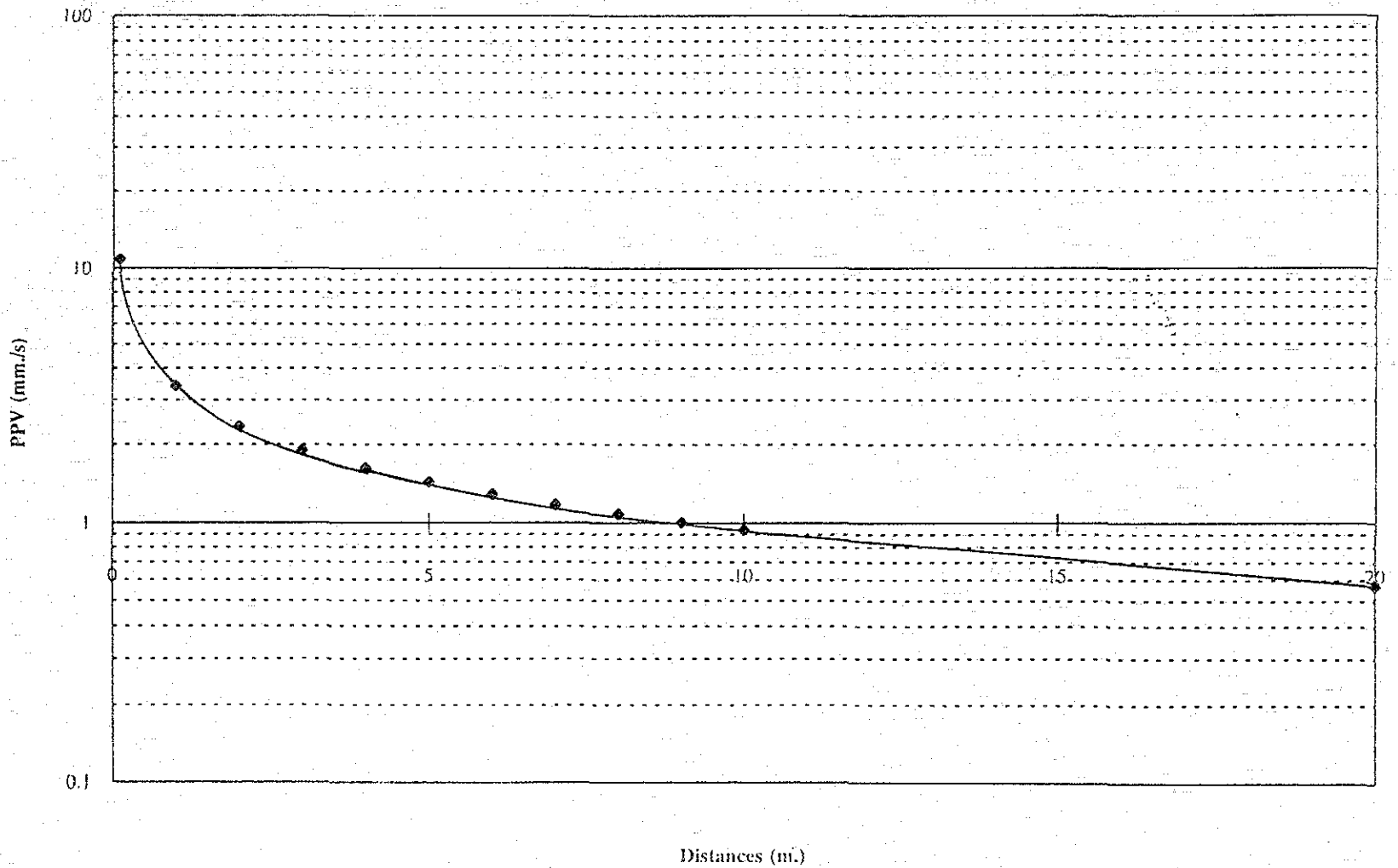
Note : Noise and Vibration Control on Construction and Open Sites (BS 5228 Part 1 : 1997)

Appendix 3.27 The Predicted Noise Level at Each Distance From Curb at Year 2008, 2010, 2020



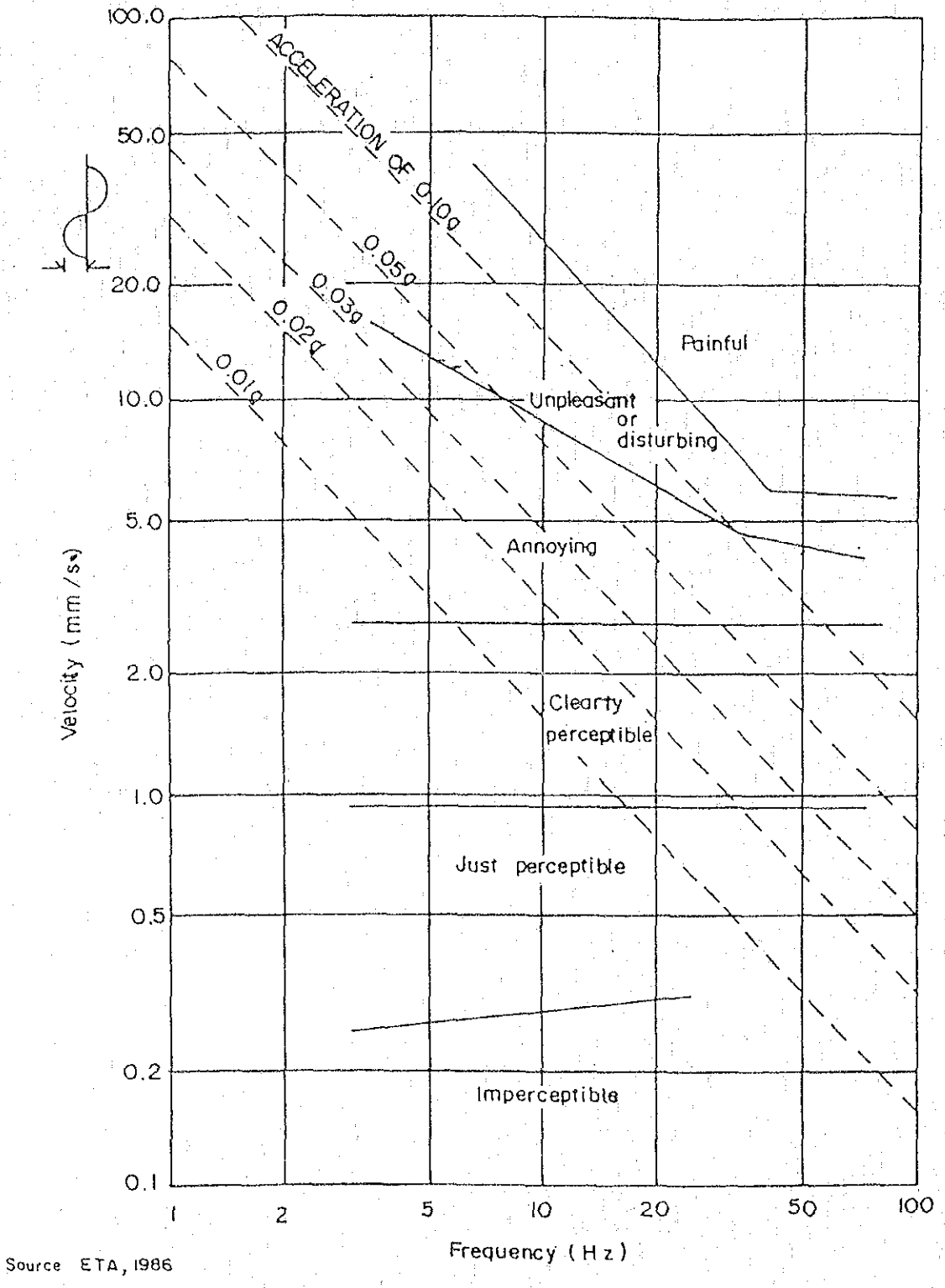
the Predicted Noise Level (Leq 24 hr.) at Each Distance from Curb at Year 2005, 2010 and 2020

Appendix 3.28 Predicted Vibration Level at Each Distance During Construction Period



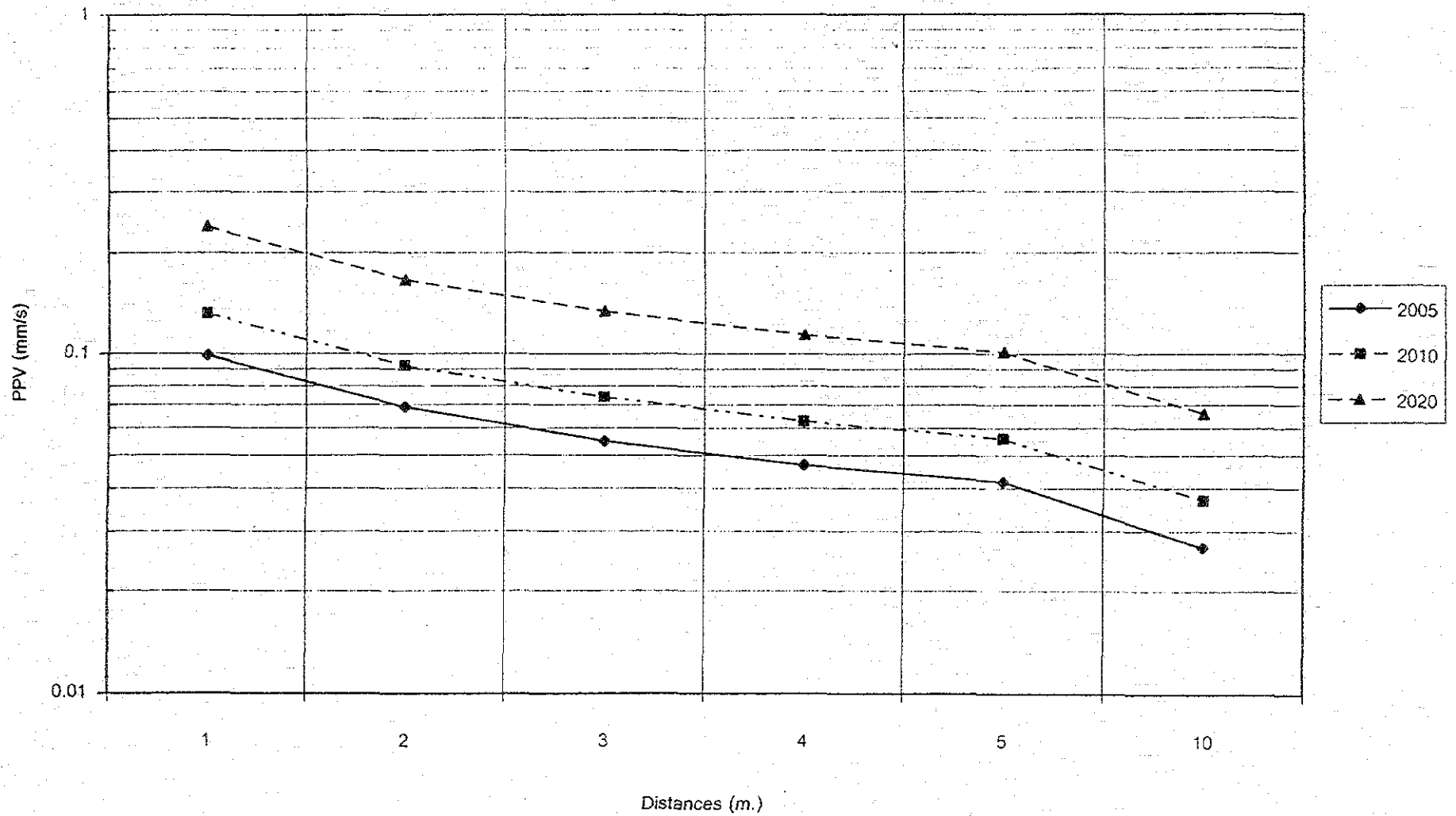
the Predicted Vibration Level (mm./s) at Each Distance during Construction Period

Appendix 3.29 Human Sensitivity to Vertical Vibration



Source ETA, 1986

Appendix 3.30 The Predicted Vibration Level at Each Distance From Curb at Year 2005, 2010, 2020



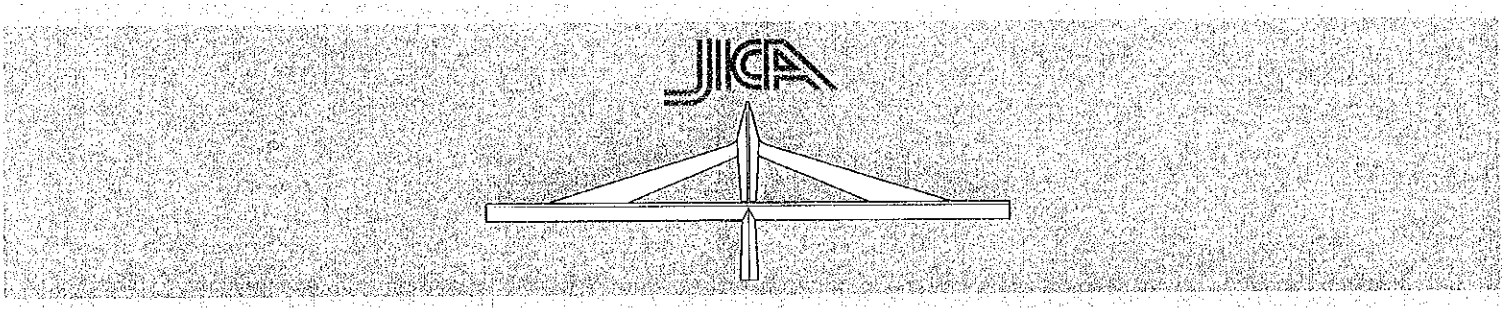
the Predicted Vibration Level (mm./s) at Each Distance from Curb at Year 2005, 2010 and 2020

Appendix 3.31 *Environmental Monitoring Programe*

Environmental Quality	Location/ Sampling Station	Monitoring Parameter	Period/Frequency	Estimated Expence	Responsible Agency
1. Water Quality	1. 1,000 m. upstream of the Bridge 2. 1,000 m. downstream of the Bridge	1. Temperature 2. pH 3. Turbidity 4. Conductivity 5. DO 6. COD 7. BOD_5 8. SS 9. Oil & Grease 10. Faecal Coli Form Bacteria	Construction Phase - 3 times/year in dry season (Feb. to May), winter season (Nov. to Jan.) and rainy season (Jun. to Oct.). Operation Phase - 3 times/year in dry season (Feb. to May), winter season (Nov. to Jan.) and rainy season (Jun. to Oct.) for the first 3 years of operation phase after that sampling frequency will be modified. Modification will be depend on the first 3 years results.	- 50,000 baht/station/time (300,000 baht/year)	- Construction phase by Contractor - Operation phase by DOH & MCTPC
2. Aquatic Ecology	1. 1,000 m. upstream of the Bridge 2. 1,000 m. downstream of the Bridge	1. Plankton 2. Benthic Organisms	Construction Phase - 3 times/year in dry season (Feb. to May), winter season (Nov. to Jan.) and rainy season (Jun. to Oct.). Operation Phase - 3 times/year in dry season (Feb. to May), winter season (Nov. to Jan.) and rainy season (Jun. to Oct.) for the first 3 years of operation phase after that sampling frequency will be modified. Modification will be depend on the first 3 years results.	- 40,000 baht/station/time (240,000 baht/year)	- Construction phase by Contractor - Operation phase by DOH & MCTPC

Environmental Quality	Location/ Sampling Station	Monitoring Parameter	Period/Frequency	Estimated Expence	Responsible Agency
3. Air Quality	1. Thai Side - Ban Song Puai - Ban Khok Sung 2. Lao Side - Interchange of Route No.9 & Kaysone Road.	1. Total Suspended Particles (TSP-24 hr.) 2. Particle Matter (PM-10 (24 hr.)) 3. Nitrogen Dioxide (NO_2) 4. Carbon Monoxide (CO)	Construction Phase - 2 times/year in dry season (Febuary-May) and winter season (November-January) - Each sampling period must be carried out for 3 consecutive day. Operation Phase - 2 times/year in dry season (Feb. to May) and winter season (Nov. to Jan.) for the first 3 years of operation phase after that sampling frequency will be modified. Modification will be depend on the first 3 years results. - Each sampling period must be carried out for 3 consecutive day.	- 150,000 baht/station/time (1,350,000 baht/year)	- Construction phase by Contractor - Operation phase by DOH & MCTPC
4. Noise Level	1. Thai side - Ban Song Puai - Ban Khok Sung 2. Lao side - Interchange of Route No.9	1. Leq-24 hr. 2. Ldn.	Construction Phase - 2 times/year in dry season (February-May) and winter Season (November-January) - Each Sampling period must be carried out for 3 consecutive day. Operation Phase - 2 times/year in dry season (Feb. to May) and winter season (Nov. to Jan.) for the first 3 years of operation phase after that sampling frequency will be modified. Modification will be depend on the first 3 years results. - Each sampling period must be carried out for 3 consecutive day.	- 120,000 bath/station/time (720,000 baht/year)	- Construction phase by Contractor - Operation phase by DOH & MCTPC

Environmental Quality	Location/ Sampling Station	Monitoring Parameter	Period/Frequency	Estimated Expence	Responsible Agency
5. Vibration	1. Thai side - Ban Song Puai - Ban Khok Sung 2. Lao side - Interchange of Route No.9	1. Peak Particle Velocity (PPV) 2. Frequency	Construction Phase - 2 times/year in dry season (February-May) and winter Season (November-January) - Each Sampling period must be carried out for 3 consecutive day. Operation Phase - 2 times/year in dry season (Feb. to May) and winter season (Nov. to Jan.) for the first 3 years of operation phase after that sampling frequency will be modified. Modification will be depend on the first 3 years results. - Each sampling period must be carried out for 3 consecutive day.	- 120,000 bath/station/time (720,000 baht/year)	- Construction phase by Contractor - Operation phase by DOH & MCTPC
6. Socio-economic	Households nearby the construction site (About 100 samples)	1. The project information perception 2. The impact during construction period 3. Opinion and attitude toward the project 4. Problems and needs and Suggestion Proposed for the project's consideration	Construction Phase - Every 6 months Operation Phase - Every 6 months for the first 3 years of operation phase after that sampling frequency will be modified. Modification will be depend on the first 3 year results.	- 50,000 baht/time (100,000 baht/year)	- Construction phase by Contractor - Operation phase by DOH & MCTPC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