

KINGDOM OF CAMBODIAN
NATION RELIGION KING

National Road No.5 Rehabilitation Project

REPORT ON ENVIRONMENTAL IMPACT ASSESSMENT (Final Report)



July 2012

Prepared by the Ministry of Public Works and Transport,
Royal Government of Cambodia
with Assistance of Katahira & Engineers International
and CES Co. Ltd.
Under Sponsorship of
Japan International Cooperation Agency

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ABBREVIATIONS

A

AC : Asphalt Concrete
ADB : Asian Development Bank

B

BTB : Battambang
BC : Benefit Cost Ratio
BMCH : Banteay Meanchey
BOD : Biological Oxygen Demand
Br : Bridge

C

CITES : Convention on International Trade of Endangered Species of Fauna and Flora
COD : Chemical Oxygen Demand
CRIP : Cambodia Road Improvement Project
CS : Construction Stage

D

DBST : Double Bituminous Surface Treatment
DO : Dissolved Oxygen
DPWT : Department of Public Work and Transportat

E

EC : Environmental Controller
EDC : Electric Du Cambodge
EFRP : Emergency Flood Rehabilitation Project
EIA : Environmental Impact Assessment
EIRR : Economic Internal Rate of Return
EMP : Environmental Management Plan

G

GDP : Gross Domestic Product
GIS : Geographic Information System
GOC : Government of Cambodia
GSSLC : the General Secretariat for SLC

I

IUCN : International Union for the Conservation of Nature

J

JICA : Japan International Cooperation Agency
JST : JICA Study Team

K

KP : Kilometer Post

M	MEF	: Ministry of Economy and Finance
	MLMUPC	: Ministry of Land Management, Urban Planning and Construction
	MOE	: Ministry of Environment
	MPWT	: Ministry of Public Works and Transport
N	No.	: Number
	N/A	: Not Available
	NGO	: Non-Governmental Organization
	NO ₂	: Nitrogen Dioxide
	NR	: National Road
	NPV	: Net Present Value
	NSLCC	: the National Social Land Concession Committee
O	OD	: Origin - Destination
P	PC	: Pre-stressed Concrete
	pH	: Power of Hydrogen
	PIU	: Project Implement Unit
	SPM	: Suspended Particular Matter
R	RAMP	: Road Assessment Management Project
	RAP	: Resettlement Action Plan
	RGK	: Royal Government of Cambodia
	RoW	: Right of Way
	RUPP	: Royal University of Phnom Penh
S	SLC	: Social Land Concession
	SO ₂	: Sulphur Dioxide
	SS	: Serei Saophoan
T	TOR	: Terms of Reference
	TSBR	: Tonle Sap Biosphere Reserve
	TSP	: Total Suspended Particulate
	TSS	: Total Suspended Solids
W	WB	: World Bank
	WHO	: World Health Organization

EXECUTIVE SUMMARY

1. Introduction

Trunk National Roads of Cambodia connect Phnom Penh to major cities and major border points. National Roads No.5(NR-5) is the trunk road reaching Bangkok through the border point of Poipet. The NR-5 Rehabilitation Project (the Project) is expected to receive financial assistance (ODA) of Japan International Cooperation Agency (JICA). Use of JICA's Guidelines for Environmental and Social Considerations (April 2010) is required for assessment of environmental impact of a JICA-assisted project, and this will be the case in the Rehabilitation of Battambang (BTB)- Serei Saophoan (SS) Section (North Section) of NR-5.

The objective of the EIA study is to ensure that the Project is environmentally sound and sustainable, and that any negative environmental consequences are recognized early in the project cycle and taken into account before project implementation.

2. Policy, Legal and Administrative Framework

The legislation of Cambodia related to EIA process includes the following:

- Law on Environmental Protection and Natural Resources (1996)
- Law on Land (2001)
- Law on Expropriation (2010)

Furthermore, the Royal Government of Cambodia has issued regulations related to EIA process as listed below:

- Sub-Decree on Environmental Impact Assessment Process (1999)
- Sub-Decree on Water Pollution Control (1999)
- Sub-Decree on Solid Waste Management (1999)
- Sub-Decree on Air Pollution and Noise Disturbance Control (2000)
- Sub-Decree on the Ozone Depleting Substances (2005)

These sub-decrees have been issued in accordance with the obligations stipulated in the Vienna Convention and the Montréal Protocol.

In addition to these, JICA has adopted guidelines related to EIA, including Guidelines for Environmental and Social Considerations (April 2010) which classifies projects into four categories (A, B, C and FI) depending on the magnitude/seriousness of environmental impact of the project. The Project is categorized as 'A Category' because it falls into the road sector and is likely to have significant adverse impact due to its characteristic (large-scale involuntary resettlement).

This EIA report is prepared to fulfil the environmental requirements of JICA. It is not intended to fulfil the requirements of the sub-decree on EIA of the Ministry of Environment of 1999 because the length of the Project Road is less than 100km and EIA is not required according to the sub-decree.

3. Project Description

(1) Widening of Existing National Road No.5

The Project is widening of the section of NR-5 between the cities of BTB, BTB Province and SS, Banteay Meanchey (BMCH) Province (the North Section) and construction of bypasses around BTB City and SS City.

Widening of the North Section is to widen the existing 2-lane road (approximately 11m wide including shoulders) into either 4-lane (approximately 20.5m wide including shoulders) or 2-lane plus motorcycle lane road (approximately 14m wide including shoulders). Both BTB

Bypass and SS Bypass are being planned as 2-lane plus motorcycle lane roads with widths of approximately 14m.

- Together with widening of the existing NR-5, the pavement is to be improved to asphalt concrete (AC) from the existing double-layer bituminous surface treatment (DBST). Bearing capacity of DBST is not sufficient to support heavy traffic load which is rapidly increasing due to rapid growth of socio-economic activities. Pavement of BTB Bypass and SS Bypass is also planned as AC.
- Widening of the existing NR-5 is executed by constructing additional embankment generally on the both sides of the existing road. Bypasses are to be constructed by filling low embankments with height of 1m to 2m traversing mainly agricultural land (rice paddy).
- The distance between BTB City and SS City along the existing NR-5 is approximately 68km. However, the section actually widened is the section between the intersection with the planned BTB Bypass in the north of BTB City and the intersection with planned SS Bypass in the south of Mongkol Borei Town, and the length of section is approximately 47km. The lengths of BTB Bypass and SS Bypass are approximately 23km and 13km, respectively. Thus, the total length of the Project Roads is approximately 83km.
- Widening of the North Section of existing NR-5 is expected to provide the traffic environment for safe and smooth travel of vehicles. Together with construction of the two bypasses, the Project is expected to promote socio-economic development of BTB-BTMC area.

(2) Construction of Bypasses

- In addition to the improvement of existing NR-5, two bypasses, one around the city of BTB, and another around the city of SS and town of Mongkol Borei, are to be constructed. These bypasses are to provide detour route for the traffics which are currently passing through the urbanized area of these cities and the town. Construction of bypasses is expected to contribute to reduce the traffic congestion and traffic accident in the urbanized areas. Thus, construction of bypasses is expected to make widening of the existing NR-5 in the urbanized areas unnecessary and to greatly reduce the need of relocation of houses and households.
- Cross sections of both BTB Bypass and SS Bypass are planned as opposed 2-lane with motorcycle lane on both sides (approximately 14m wide including shoulders).

4. Baseline Data

(1) Topography and geology

The Project Area is located in the lowland in the northwest of Tonle Sap Lake. The altitude of the area along the NR-5 is, in general, around 10 m above sea level or less, except at some section passing low hills. Thus, the terrain along NR-5 is generally flat.

The old and new mud formed the current lowland. Surface soil types in BTB and BMCH Provinces are classified into three categories according to their potentials for agriculture, forestry or both (i.e. tree crops and agro-forestry);

- (i) lacustrine alluvial soil found in the flood plain areas nearby Tonle Sap Lake,
 - (ii) alluvial lithosols found in the BMCH Province, and
 - (iii) brown hydromorphics found in BTB Province including the area along the proposed bypass and existing NR-5, and to less extent, in Mongkol Borei District, BMCH Province.
- These are fertile and very suitable for rice productions. Together with sufficient water in rainy season, the fertile soils make the area around the Project Road one of the main rice production areas in Cambodia.

(2) Climate

- The Project Area is one of the many areas in Cambodia influenced by warm-wet tropical monsoon. The climate consists of dry season and rainy season. The dry season lasts for six months, from November to April. The dry season is divided into summer and spring. Summer, which is hot during the day, is from February to April. Spring is from November to January. Monsoon wind blows from the north bringing cold air from Siberia. Rainy season lasts for six months from May to October. During rainy season, wind blows from southwest of country and brings moisture from Indian Ocean and drops rain which is vital to irrigation for agricultural crops and plants.

(3) Air quality

- Concentration level of NO₂, SO₂ and Suspended Particular Matter (SPM) measured at roadside and 200m away from roadside are as shown in the table below:

Location	Ambient Air Pollutants Concentration (milligram/m ³ N)			
	PM10	PM2.5	NO ₂	SO ₂
BTB KP 300, Road Site	0.065	0.031	0.007	0.005
BTB KP 300, 200m away from Road Site	0.038	0.026	0.005	0.003
BTB Bypass intersection with NR-57, Road Side	0.021	0.011	0.011	0.005
BTB Bypass intersection with NR-57, 200m away from Road Side	0.013	0.008	0.005	0.003
BMCH KP 356, Road Side	0.061	0.024	0.006	0.004
BMCH KP 356, 200m away from Road Side	0.027	0.014	0.004	0.003
Standard of Cambodia	-	-	0.1 (24-hr)	0.3 (24-hr)

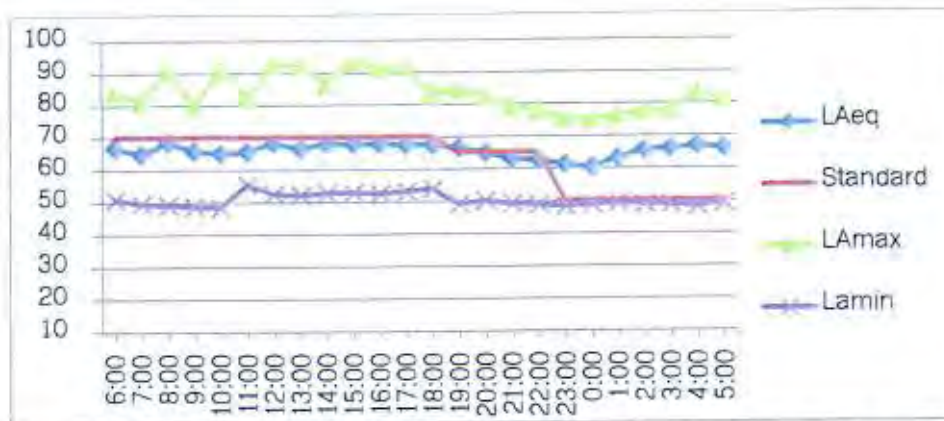
(4) Water quality

- Water quality was surveyed in three rivers crossed by the project roads. In each river, samples were taken at the bridge of existing NR-5 or that of planned bypass and 2km downstream.
- Water Quality in Three Rivers

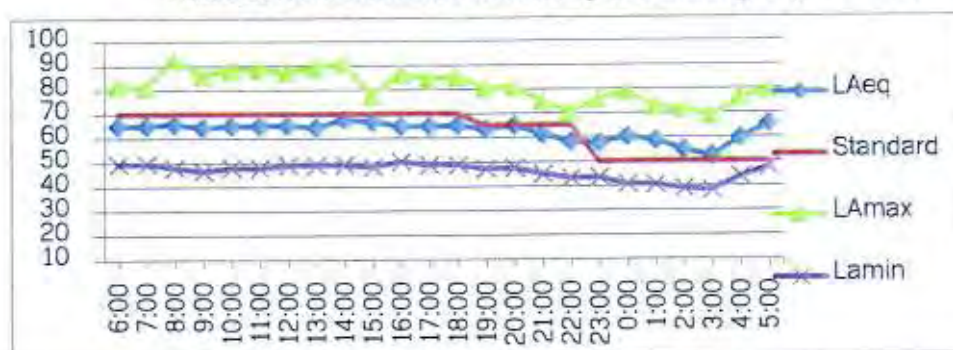
Location	pH (-)	TSS/SS (mg/l)	BOD (mg/l)	COD (mg/l)
O Ta Ke Stream in BTB (Bridge of NR-5: KP 305)	7.59	94	0.85	2.48
O Ta Ke Stream 2km downstream from NR-5	7.32	86	1.00	3.19
Stung Sangke, crossing point of BTB Bypass	7.97	120	0.40	1.87
Stung Sangke, 2km downstream from BTB Bypass	7.91	96	0.60	2.04
Serey Saophoan River, BMCH (Bridge of NR-5: KP 358)	7.96	46	2.05	4.62
Serey Saophoan River 2km downstream from NR-5	7.53	42	1.73	3.97
Standard of Cambodia (Water quality standard along public water for aquatic biodiversity conservation)	6.5-8.5	25-100	1.00-10.0	-

(5) Noise and vibration

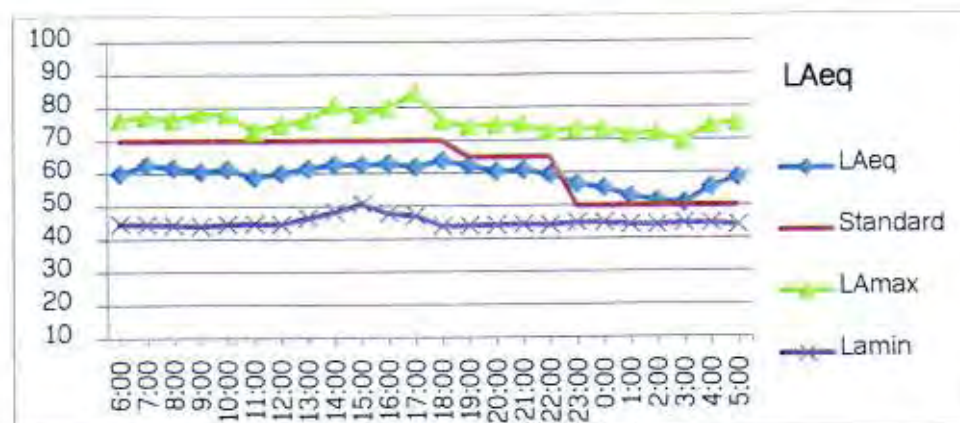
- Noise and vibration were measured at three locations; northwest suburbs of BTB City (KP 300), southeast suburbs of SS City (KP 356) and planned intersection of BTB Bypass and NR-57 which is located on southwest suburbs of BTB City.



Noise Level at Northwest Suburbs of Battambang City (KP 300)



Noise Level at Southern Suburbs of Serei Saophoan City (KP 356)



Noise Level at Southeast Suburbs of BTB City

(Planned Intersection of Bypass and NR-57)

- Noise level is below the standard during day and evening but exceeds the standard during midnight at all of the three locations.
- Measured level of vibration is 40 dB or below and well below the standard at all of three locations.

(6) Solid waste

- Approximate amounts of rubbish are as follows:

- BTB Province

BTB City:80 t/day

Thma Koul District:50 t/day

Other small towns: 1 t/day

- * BMCH Province

SS City : 43 t/day

Mongkol Borei Town: 6 tons per 5 days

- * There are private firms who collect and recycle waste boths in BTB Province and BMCH Province.

(7) Malodor

- There are bad smells from landfills and market that local people disposed the garbage and discharge the sewage. In addition, bad smell comes from some streams where the local people dispose garbage.

(8) Natural environment

(a) Protected Area

In general, Right of Way (ROW) and its surrounding area of NR-5 has been already cultivated and developed for human activities with variety of land use form, such as agricultural land, residential area, commercial spots, and so on. Therefore, there is not specified environmental protected area within NR-5 project site. However, there are wetlands as natural habitat of agro-ecosystem, and eastern side of NR-5 has indirect connection to Tonle Sap Lake Biosphere. The figure and table below show each location and information of protected area comparatively near to NR-5 Project section.



- * Location Map of Protected Area

Basic Information on Protected Area near to NR-5

Name	Management Type	Size (ha)	IUCN* Category	Distance from NR-5
Roniem Daun Sam	Wildlife	178,750	III	Far

	Sanctuary			
Samlaut	Multiple Use Area	60,000	III	Far
Phnom Somkos	Wildlife Sanctuary	333,750	IV	Far
Cardamom Mountains	Protected Forest	402,000	-	Far
Phnom Aural	Wildlife Sanctuary	253,750	III	Partially near
Tonle Sap	Multiple Use Area	316,250	IV	Partially near

(b) Flora

- Forest area in Cambodia is classified into (1) Concession Forests and (2) Protected Forests, however, there are no remarkable forest zone along NR-5 Project section because of high level land use by human activities.
- Vegetation along the NR-5 is mainly agricultural crops such as; rice, fruit trees including palms, vegetables and some areas are covered with shrubs, grasses and sparse trees. On the other hand, the area where annual flood comes periodically and wetland area are observed along NR-5 with typical fresh water vegetation same as the Mekong Delta region. Northern-Western side of NR-5 is the border of Transition Areas of Tonle Sap Biosphere Reserve where development activities are flexibly admitted.

(c) Fauna

There are not so many kinds of animal species in the project site because the area is generally very narrow right of way (ROW) along the existing national road. However, there is possibility to find wild animals that depends on habitats nearby NR-5, especially in the section of new alignment for the bypass. There has not been conducted comprehensive study to confirm fauna along NR-5.

Amphibian and Reptile

According to interview with local people along NR-5, there are some amphibian species. There is no strictness on the result of interview, however, there might be some sort of Amphibian and Reptile species including frog, snake, tortoise which depends on wetland in the vicinity of NR-5.

Birds

- In the flooded forests of Tonle Sap Lake next to the project site, there are around 100 species of birds, of which at least 16 belong to species of globally threatened according to IUCN ranking. Pelicans, storks, ibis, darters and cormorants nest in the flooding forests.
- According to the interview to the local people, some birds, such as partridge, duck, parrot and dove are found in the Project area but no endangered or precious species were mentioned.

Fishes and Crustaceans

- Wetlands along NR-5 including ponds and small rivers running into Tonle Sap Lake have direct or indirect connection to Tonle Sap aquatic ecosystem. Tonle Sap is well known as traditional fishing which is one of the most important income sources of the region. Over 200 species of fish occupy the Tonle Sap.
- Through interview to the local residents, it was found that fish species seen in Setung Sangkae, O Ta Ke Stream and Setung SS include such fish as Siamese mud carp, Asian red-tail catfish and one-gilled eel.

5. Environmental Impacts Evaluation

- Evaluation of anticipated adverse impacts of the Project and their possible mitigations measures are as summarized in the tables below. (Please note that the following tables focus only on adverse or negative impact and its mitigation measures. There are many positive impacts accruing from the Project. Positive impacts are presented in the main text of Chapter 4.)

(1) Widening of North Section of National Road No.5

- Evaluation of, and mitigation measures for, adverse impacts due to widening of NR-5 are as summarized in the table below:

Evaluation of Adverse Impacts of Widening of NR-5 and Their Mitigations Measures

Item	Evaluation of Impact	Reason of Assessment	Mitigation Measures
I: Pre-construction and Construction Stages			
A: Pollution			
Air pollution and global warming	B-	Air pollutants including CO ₂ are exhausted by construction equipment. Dust is caused by construction activities. Traffic congestion is caused by narrowing the carriageway resulting in increase of exhaust gas of vehicles.	Routine equipment and machinery check-ups and proper maintenance shall be practiced. Monitor air pollution at construction site. Water shall be sprayed to minimize dust throughout the construction zone. Prepare adequate traffic management plan to minimize traffic congestion.
Water	C	Water quality may be worsened due to the road construction.	Concrete casting and road surfacing shall be closely supervised to prevent spillage. Temporary sanitation facilities such as portable toilet and garbage bins shall be installed.. Conduct daily routine equipment and machinery check-ups. Prohibit from washing the construction tools along the water sources to prevent further pollution. Monitor water quality.
Waste	B-	Waste, including waste soil and waste oil, are anticipated during construction stage.	Prepare proper recycle and disposal plan of the construction waste. Bitumen, diesel oil and waste oil shall be handled and stored carefully. Waste oil shall be stored in drum cans or other container, raised off the ground, covered to keep rain out. Monitor the waste disposal.

Item	Evaluation of Impact	Reason of Assessment	Mitigation Measures
Noise/Vibration	B-	Noise and/or vibration are emitted by construction equipment.	Practice proper routine maintenance of construction equipment, especially on muffler and other noise-suppression device. Monitor noise/vibration level periodically. Limit works with high noise level during daytime. Temporary noise barrier shall be installed if necessary.
Subsidence	C	Subsidence near the road is anticipated due to the soil weight which is added.	Monitor the ground subsidence. If the ground subsidence occurs, the consultant and contractors should reconsider the construction technique.
Malodor	B-	Malodor may be emitted by construction equipment, especially asphalt mixing plant.	Construct asphalt mixing plant at a place where there is no house in the vicinity. Practice routine check-ups and maintenance of construction equipment.
B: Natural Environment			
Sedimentation	B-	Filled soil can be eroded by rain water and flow into rivers and streams, and will be accumulated at the bottom of rivers and streams. Such soil can finally flow into Tonle Sap Lake.	Embankment works shall be minimized during rainy season. Plant vegetation on embankment slope as soon as possible after embankment works.
Hydrology	C	Water flow in the river or stream may be altered during construction. But it is temporary and area is limited. Details of drainage is to be designed in the detailed design stage.	Project will not change existing discharge condition. Drainage shall be planned so as not to alter overall flow of surface water.
C: Social Environment			
Involuntary Resettlement	A-	Many houses/buildings and households relocation are required due to widening of NR-5.	Design the road width to be minimum to secure smooth and safe traffic environment. Conduct census survey and local stakeholder meeting. Prepare RAP (Resettlement Action Plan) and implement resettlement in accordance with it. Monitor the resettled families and assist them if their levels of lives are downgraded.
Uneven distribution of harm and benefit	A-	Under present condition, (1) secure the payment to illegal settlers, (2) estimation for the compensation of resettlement, (3) assistance to the recovery of living are insufficient. Eventually unfairness may arise.	Conduct census survey and local stakeholder meeting. Conduct detailed survey on resettled houses and families with diligent care and close consultation with Ahs. Preparation of diligent RAP, its implementation and monitoring.
Community organization including organization	B-	Impact on community meeting and other community activities is anticipated because of alteration of physical structure of the community	Hold sufficient local stakeholder meetings in every stage and establish mutual understanding.

Item	Evaluation of Impact	Reason of Assessment	Mitigation Measures
for local governance		caused by land acquisition.	
Existing Infrastructure	B-	There will be negative impact on the existing infrastructures which needs to be relocated.	Social service utilities such as electric power line and telecommunication line will be diverted before starting the construction activity. Confirm the necessity of alternative sites in census survey and in case of need, secure the site.
Poor, indigenous, minority people	B-	There is a possibility that poor people may face disadvantage in the compensation for resettlement. There are no indigenous or minority people known to be living near the Project road.	Conduct detailed survey on resettled houses and families with diligent care and close consultation with AHs. Preparation of diligent RAP, its implementation and monitoring.
Confrontation of stakeholders	B-	There is a possibility that conflicts arise in the roadside communities as the benefit and harm derived from the road improvement may vary among the stakeholders.	Prevent or solve the conflicts through free and prior consultations between affected people and competence authorities. Encourage the cadastral registration program.
Gender	B-	Opinions of women often tends to be given less attention.	Feminine gender shall be positively invited and join in stakeholder meeting and other opportunities.
Children's right	B-	Some children may face some difficulty going to school due to relocation of their houses.	Secure the accessibility to go to school when select resettlement places.
Risks for infectious disease such as AIDS/HIV	B-	Infectious disease may be brought by migrant construction workers during construction stage.	Educate to migrant construction worker about HIV/AIDs and other infectious disease. Implement campaign on HIV/AIDs and other infectious disease to general public.
Working environment	B-	Safety and sanitation, as well as third party accidents, during construction stage needs to be addressed.	Construction personnel will be provided with the necessary safety gears such as protective hard hat, etc. Contractor provides the safety camps, sanitation water and food, and toilets. Contractors shall communicate with the provincial hospital in case of emergency.
Accident	B-	Construction worker or third party may be involved in the accident during construction stage.	Construction personnel will be provided with the necessary safety gears such as protective hard hat, etc. Safety management plan shall be prepared and works shall be executed in accordance with the safety management plan. The safety management plan and execution plan shall include traffic management plan which intends to secure traffic safety.
2: Service Stage			
A: Pollution			
Water	C	Water quality may be worsened due	Provincial authorities are expected to establish

Item	Evaluation of Impact	Reason of Assessment	Mitigation Measures
		to the development of surrounding area where commercial buildings and factories are constructed.	effective rules on quality of water discharged from factories and shops. Relevant authorities are expected to improve sewerage system.
Waste	B-	Solid waste thrown from vehicles may increase due to increase in traffic volume Increase of waste due to growth of economic and industrial activities is anticipated.	The government should establish a system where garbage on and along road be periodically collected and treated. Waste produced in the newly developed areas along the bypass should be collect and disposed or recycled in compliance with rules in BTB and BMCH provinces.
Noise/Vibration	B-	Noise may increase due to increase of traffic volume.	Install noise barrier fence if necessary. Speed regulation in urbanized areas. Strict enforcement on poor maintenance vehicles.
Subsidence	C	Excess pumping out of ground water may occur due to growth of industrial activities in the region resulting in land subsidence.	Provincial governments should monitor land subsidence and pumping of ground water, and regulate ground water pumping if necessary.
C: Social Environment			
Community organization including organization for local government	B-	Separation of community may occur due to the widened carriageway and increase of traffic volume and travelling speed which make crossing the road from one side to the other makes difficult and hamper communication of the people.	Install signals, traffic signs, road markings and devices to help pedestrian crossing such as traffic signal, pedestrian crossing marking and humps as necessary. Speed shall be regulated in towns.
Confrontation of stakeholders	B-	There is a possibility that conflicts increase due to increment of commercial establishment and economical activities between local people and new comers.	Prevent or solve the conflicts through free and prior consultations between affected people and competence authorities.
Children's right	B-	Children are the vulnerable to risk of traffic accident which is caused by the increase of traffic volume and vehicle speed.	Regulate vehicle speed in town and/or near school. Install traffic signs along the section near school.
Risks for infectious disease such as AIDS/HIV	B-	Long-distance truck drivers and other transport business people may bring infectious disease.	Implement campaign on infectious diseases including HIV/AIDs.
Accident	B-	Possibility of accidents may increase due to increased travel speed of vehicles.	Regulate vehicle speed where necessary. Enforce speed regulation. Install traffic signal, traffic sign and other traffic control devices where necessary.

(2) Construction of Battambang Bypass

- Evaluation of, and mitigation measures for, adverse impacts due to construction of BTB Bypass are as summarized in the table below :
- Evaluation of Adverse Impacts of Construction of BTB Bypass

• and Their Mitigations Measures

Item	Evaluation of Impact	Reason of Assessment	Mitigation Measures
I: Pre-construction and Construction Stages			
A: Pollution			
Air and global warming	B-	Air pollutants including CO ₂ are exhausted by construction equipments. Dust is caused by construction activities.	Routine equipment and machinery check-up and proper maintenance shall be practiced. Monitor air pollution at construction site. Water shall be sprayed to minimize dust throughout the construction zone.
Water	C	Water quality may be worsened due to the road construction.	Concrete casting and road surfacing shall be closely supervised to prevent spillage. All formworks will be secured prior to pouring to ensure failure will not occur. Temporary sanitation facilities such as portable toilets and garbage bins shall be installed. Conduct daily routine equipment and machinery check-ups. Prohibited from washing the construction tools along the river water to prevent further pollution. Monitor water quality.
Waste	B-	Solid waste from construction activities and vehicle.	Prepare and implement proper recycle and disposal plan of the construction waste. Bitumen, diesel and waste oil will be handled and stored carefully to prevent leakage or spill. Waste oil shall be stored in drum cans or other proper container, raised off the ground and covered to keep rain out. Monitor the waste disposal.
Subsidence	C	There are soft ground areas along the proposed bypass. Subsidence near the road is anticipated due to the soil weight which is filled on the rice field generally. Further investigation for subsidence is required in detailed design stage.	Monitor the ground subsidence. If subsidence is found, subsided ground is filled and re-shaped to the original condition. Tilting of houses/buildings shall be monitored. If tilting of houses/building occurs, tilting shall be rectified by various methods.
Malodor	B-	Malodor may emitted by construction equipment, especially asphalt mixing plant.	Construct asphalt mixing plant at a place where there is no house in the vicinity. Practice routine check-ups and maintenance of construction equipment.
B: Natural Environment			
Topography	B-	Topography may be changed that embankment is constructed in the flat plain.	Embankment height shall be designed to be sufficient to avoid inundation but as low as possible. Trees and grasses planted along the bypass are expected to mitigate disturbance to the landscape. Drainage system, such as culverts, shall be designed to minimize alteration of flow of surface water.
Sedimentation	B-	Filled soil can be eroded by rain and	Embankment works shall be minimized during

Item	Evaluation of Impact	Reason of Assessment	Mitigation Measures
		flow into rivers and streams, and will be accumulated at the bottom of rivers and streams. Such soil can finally flow into Tonle Sap Lake.	rainy season. Plant vegetation on embankment slope as soon as possible after embankment works.
Eco system	B-	There is a possibility that bypass may separate the wild animal activity area.	Provision of culverts as passage of animals at locations animal path is found.
Hydrology	C	Impact on the surface water flow may be anticipated because a new embankment is constructed in the flat agricultural land.	Hydrological survey shall be conducted in the detailed design stage and proper drainage system and structure, which basically does not alter overall flow of surface water, shall be designed.
C: Social Environment			
Land use and local resources	A-	Bypass is to traverse agricultural land to avoid resettlement and considerable area of agricultural land will be lost.	Convert unused land into agricultural land by improving irrigation etc.
Uneven distribution of harm and benefit		Under present Cambodian Law, provisions for (1) secure the payment to illegal settlers, (2) estimation for the compensation of resettlement, (3) assistance to the recovery of living are insufficient. Eventually unfairness may arise. Due to the change of traffic flow, the income of the shops which are operating along the existing National Road No.5 (within the urbanized area) may be reduced while newly set up shops along newly constructed bypass will start business and make profit from that.	Conduct census survey and local stakeholder meeting. Conduct detailed survey on resettled houses and families with diligent care and close consultation with Ahs. Preparation of diligent RAP, its implementation and monitoring.
Involuntary Resettlement		Approximately are estimated to be relocated	Conduct census survey and local stakeholder meeting. Prepare RAP (Resettlement Action Plan) and implement resettlement in accordance with it. Monitor the resettled families and assist them if their levels of lives are downgraded.
Community organization including organization for local governance	B-	There will be negative impact that community structure may change due to the separation by the newly constructed bypass.	Hold sufficient local stakeholder meetings in every stage and establish mutual understanding. Implement measures to make movement of people across the bypass, such as traffic signals and pedestrian crossing, speed regulation and traffic signs.
Poor, indigenous, minority people	B-	There is a possibility that poor people may face disadvantage for the compensation of resettlement. Minority people are not living in the proposed area.	Conduct detailed survey on resettled houses and families with diligent care and close consultation with Ahs. Preparation of diligent RAP, its implementation and monitoring.
Gender	B-	Female household tends to be more	At the planning stage, opinion of the female

Item	Evaluation of Impact	Reason of Assessment	Mitigation Measures
		susceptible to degradation of life level due to relocation, compared to male household, because of less adaptability to new environment because of less physical strength, less chance of new job etc than male.	shall be reflected on the road design. Feminine gender shall be invited and join local stakeholder as well as male gender. Interview to feminine gender while in census survey will be considered.
Working environment	B-	Safety and sanitation, as well as third party accidents, during construction stage needs to be addressed.	Construction personnel will be provided with the necessary safety gears such as protective hard hat and safety. Contractor provides the safety camps, sanitation water and food and toilets are enough. Contractors shall communicate with the provincial hospital in case of emergency.
Risks for infectious disease such as AIDS/HIV	B-	Infectious disease may brought by migrant construction workers during construction stage.	Educate to migrant construction worker about HIV/AIDs and other. Implement campaign on infectious disease including HIV/AID.
Accident	B-	Construction worker or third party may be involved in the accident during construction stage.	Construction personnel will be provided with the necessary safety gears such as protective hard hat, etc. Safety management plan shall be prepared and works shall be executed in accordance with the safety management plan. The safety management plan and execution plan shall include traffic management plan which intends to secure traffic safety.
2: Service Stages			
A: Pollution			
Air and global warming	B-(In the area along the bypass)	Air pollutants including CO ₂ are exhausted from traffic in the newly constructed bypass.	Pollutants emitted from the traffic passing the urbanized area is decreased due to decrease of traffic volume. As the total, there will be very little difference in the amount of emission of pollutants from the traffic. Bypass is expected to reduce traffic congestion and reduction of pollutants as a whole compared to the case where the bypass is not constructed.
Water	C	Water quality may be worsened during servicing stage due to the development of the area where new commercial buildings or factories will be constructed.	Provincial authorities are expected to establish effective rules on quality of water discharged from factories and shops. Relevant authorities are expected to improve sewerage system.
Waste	B-	Garbage is thrown from the traffic on the newly constructed bypass. Solid waste will be produced by the population who will live or do business along the bypass.	The government should establish a system where garbage on and along road be periodically collected and treated. Waste produced in the newly developed areas along the bypass should be collect and disposed or recycled in compliance with rules in BTB and BMCH provinces.
Noise/vibration	B-	Noise will be emitted by the traffic on	Bypass generally traverses area away from

Item	Evaluation of Impact	Reason of Assessment	Mitigation Measures
n		the bypass.	houses. Thus, influence to houses is minimal. If necessary, noise barrier fence shall be installed.
Subsidence	C	Excess pumping out of ground water may occur due to growth of industrial activities in the region resulting in land subsidence.	Province government should monitor land subsidence and pumping of ground water, and regulate ground water pumping if necessary.
B: Natural Environment			
Eco system	B-	There is a possibility that bypass may separate the wild animal activity area. There is a high possibility that wild animals are hit by vehicles while crossing the bypass.	Provision of culverts as passage of animals at locations animal path is found. Install fences to stop animals from entering the bypass.
Hydrology	C	Impact on the surface water flow, if occurs caused by construction of embankment for the bypass, will continue also in the service stage.	Hydrological survey shall be conducted in the detailed design stage and proper drainage system and structure, which basically does not alter overall flow of surface water, shall be designed.
C: Social Environment			
Community organization including organization for local governance	B-	There will be negative impact that community structure may change due to the separation by the newly constructed bypass.	Hold sufficient local stakeholder meetings and establish mutual understanding. Implement measures to make movement of people across the bypass, such as traffic signals and pedestrian crossing, speed regulation and traffic signs.
Uneven distribution of harm and benefit	B-	Due to the change of traffic flow, the income of the shops which are operating along the existing NR-5 may be reduced while newly set up shops along newly constructed bypass will start business and make profit from that.	Local authorities including provincial government should prepare business plan for local people to cope with new transportation/traffic environment.
Confrontation of stakeholders	B-	There is a possibility that conflicts arise in the roadside communities as the benefit and harm derived from the road improvement may vary among the stakeholders.	Local authorities including provincial government should prepare business plan for local people to cope with new transportation/traffic environment.
Children's right	B-	Children are the vulnerable to risk of traffic accident which is caused by the traffic on the bypass.	Regulate vehicle speed in town and/or school. Install traffic sign along the section near school.
Risks for infectious disease such as AIDS/HIV	B-	Long-distance truck drivers and other transport business people may bring infectious disease.	Implement campaign on infectious disease including HIV/AIDs.
Accident	B-	There will be new cases of traffic accidents on the bypass while numbers of traffic accidents in the urban area is expected to decrease.	Regulate vehicle speed where necessary. Enforce speed regulation. Install traffic signal, traffic sign and other traffic control devices where necessary.

(3) Construction of Serei Saophoan Bypass

Physical features, manner of construction and other aspects of SS Bypass, except the location and length, are same to those of BTB Bypass. Thus, evaluation of adverse impacts and mitigation measures for BTB Bypass, as presented above, can be applied to the case of construction of SS Bypass. Readers are referred to the above table for evaluation of adverse impacts and mitigation measures of SS Bypass.

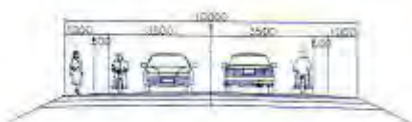
6. Analysis of Alternatives

In order to examine the justification of the Project, alternatives or options were established and their advantages and disadvantages were compared. Alternatives were prepared for widening of existing NR-5 and construction of bypasses separately.

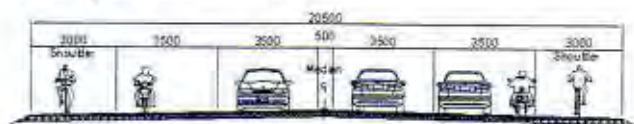
(1) Improvement of North Section of National Road No.5

Three options, besides the 'Zero Option' or Option-0 were established for Improvement of the North Section of existing NR-5.

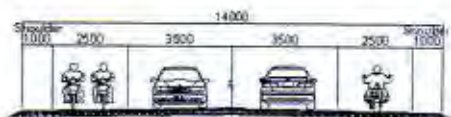
- (i) Option-0: No improvement
- (ii) Option-1: Pavement Improvement only
- (iii) Option-2: Widening to 4-lane road
- (iv) Option-3: Widening to 2-lane with motorcycle lanes on both side.



Cross Section of Option-0 & Option-1



Cross Section of Option-2



Cross Section of Option-3

- Option-0 and Option-1 do not need acquisition of additional right of way (ROW) and thus, do not require resettlement. However, these two options cannot solve improve traffic congestion and traffic safety which is anticipated to become worse in the near future as traffic volume increase.
- On the other hand, Option-2 and Option-3 are expected to substantially improve the traffic congestion and traffic safety but require land acquisition and resettlement of large number of houses and families.

(2) Construction of Battambang Bypass

- Besides the Option-0, two options were established for construction of BTB Bypass :
 - (i) Option-0 : No improvement
 - (ii) Option-1 : Widen the existing NR-5 passing thorough the urbanized area of BTB City
 - (iii) Option-2 : Construct a bypass detouring the urbanized area of BTB City
- Traffic congestion and traffic accident is anticipated due to increase in traffic volume passing through the urbanized area of BTB City, if Option-0 is adopted. As a result, adverse impacts, including air pollution and increase of noise are also anticipated.

- In case of Option-1, large number of houses and families existing in the urbanized section of Battambang City need to be relocated to secure ROW needed for widening of the existing NR-5.
- In case of Option-2, substantial area of agricultural land need to be used as ROW. However, Option-3 can solve the problem of traffic congestion in the urbanized area without large-scale
- Six alternative routes of BTB Bypass, three by DPWT of BTB Province and three by the JICA Team, were proposed, as shown in the figure below. The alternatives routes proposed by DPWT of BTB were basically to utilize the existing streets or roads while the alternatives routes proposed by the JICA Team basically detour the urbanized area and construct new roads in the agricultural area in the outskirts of BTB City.
- All of three routes proposed by DPWT of BTB Province need relocation of houses and families along the route, since they are basically widening of the existing roads.
- Possibility of adverse impacts to the ecology of Tonle Sap Lake and its surroundings cannot be denied if JICA-3 route is to be adopted.
- While both JICA-1 and JICA-2 route are expected to have sufficient traffic functions as a bypass and are expected to reduce traffic congestion and traffic accidents in the urbanized area of BTB City. It is anticipated that the traffic functions of JICA-2 route be lost in the future as the urbanized area of BTB City will expand. Thus, JICA-1 route was recommended as the best alternative.



Alternative Routes of Battambang Bypass

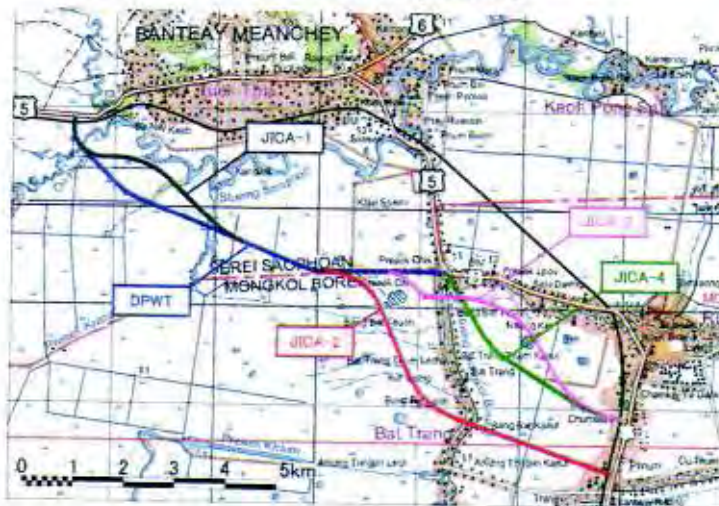
- JICA-1 route was further modified after consultation among MPWT, DPWT, BTB and JICA Survey Team, as well as the site survey, as shown in the figure below.



Adjusted Route of BTB Bypass

(3) Construction of Serei Sophoan Bypass

- Similarly to the case of BTB Bypass, Option-0 and two options were comparatively evaluated.
 - (i) Option-0 : No improvement
 - (ii) Option-1 : Widen the existing NR-5 passing through the urbanized area of BTB City
 - (iii) Option-2 : Construct a bypass detouring the urbanized area of BTB City
- Option-0 was evaluated not solve the problems of traffic congestion and traffic accidents. Option-1 was evaluated to need large-scale resettlement. Option-2 was evaluated to be able to solve the traffic problem without substantial relocation in the urbanized area of SS City but need acquisition of agricultural land.
- One alternative route and three alternative routes were proposed by DPWT of BMCH Province and JICA Team, respectively.



- In case of the alternative proposed by DPWT of BMCH Province, it was anticipated that widening of the existing NR-5 in the urbanized area of Mongkol Borei Town becomes necessary, resulting in substantial scale of relocation of houses and families.
- Considering connection to the existing NR-5 and crossing of streams and ponds, JICA-3 route was recommended as the most preferable route.

7. Environmental Management Plan

Environmental management plan (EMP) is applied throughout the project pre-construction, construction and service stages.

The main objectives of environmental monitoring are:

- (i) To assess the changes in environmental conditions,
- (ii) To monitor the effective implementation of mitigation measures,
- (iii) To warn significant deteriorations in environmental quality for further prevention action.

In order to meet the above objectives for the NR-5 BTB-Seri Saophoan project, the following parameters need to be monitored on air quality, noise and vibration, surface water quality, subsidence, general waste management and hydrology

Table Environmental Monitoring and Management System for Widening and Bypass

Table Environmental Monitoring and Management System for Widening and Bypass					
Parameters	Location	Means of Monitoring	Frequency	Responsible Agency Implemented by Supervised by	
A: Pre-Construction Stage					
Air quality	Intersection of BTB Bypass & NR-5 (KP 302.3)	Measure PM10, PM2.5, SO ₂ , NO ₂ .	1 time in dry season and 1 time in rainy season	MPWT (Consultant employed for Detailed Design)	by MPWT(MOE) for
	Intersection of SS Bypass and NR-5 (KP349.3)	Measure roadside & 200m from roadside.	at before construction works start.	MPWT (Consultant employed for Detailed Design)	
Noise	Same as above	Record noise level, L(A), for 24 hrs.	1 time before construction works at start.	MPWT (Consultant employed for Detailed Design)	by MPWT(MOE) for
		Calculate L(A) _{eq} Measure roadside & 200m from roadside			
Water quality	Crossing point of Serei Saopha Bypass with Ou Pdau (Steung SS) River	Measure pH, TSS, BOD and COD	1 time dry season and 1 time in flood season	MPWT (Consultant employed for Detailed Design)	by MPWT(MOE) for
	Crossing point of BTB Bypass with Steung Sangkae River	Measure crossing point of bypass and river & 2km downstream	at season before construction works start.	MPWT (Consultant employed for Detailed Design)	
Hydrology	All the rivers, streams, water channels, ponds and reservoirs crossed by NR-5 or bypasses	Length and depth of water crossed by NR-5 and bypasses in dry season	1 time in dry season and 1 time in flood season	MPWT (Consultant employed for Detailed Design)	by MPWT(MOE) for
		Situation of flow of surface water across NR-5 in flood season			
B: Construction Stage					
Air quality	Intersection of BTB Bypass & NR-5 (KP 302.3)	Measure PM10, PM2.5, SO ₂ , NO ₂ .	2 times in dry season and 2 times in rainy season	Contractor	MPWT(MOE)
	Intersection of	Measure at			

Parameters	Location	Means of Monitoring	Frequency	Responsible Agency Implemented by Supervised by	
Noise/Vibration	SSBypass and roadside and 200m away from road side.	Measure level which and/or large level is boundary ROW.	When noise/vibration exceeding Cambodian standard is anticipated When there is complaint from residents living near construction site	Contractor	MPWT(MOE)
Water quality	Crossing point of Serei Saophaan Bypass with Ou Pdaou (Steung SS) River Crossing point of BTB Bypass with Steung Sangkae River	Measure pH, TSS, BOD and COD Measure in Steung Sangkae River and at crossing point of bypass and river & 2km downstream	2 times in dry season and 2 times in rainy season	Contractor	MPWT
Subsidence	Soft ground area along NR-5 and bypass	Hearing to roadside residents Observation of ground surface level Observation of uniformity of embankment works in soft water depth in rice ground area paddy Deformation of houses and other structures - Control river or stream bank erosion. - Flow change and obstruction of	During	Contractor	MPWT
Hydrology	Stung Sangkae river (proposed bridge), O Ta Ke Ta Ke and Stung Serey Saophoan	Stung Sangkae, O Ta Ke and Stung Serey Saophoan caused from bridge construction -Implementation of water conservation practices.	2 times in dry season and 2 times in rainy season	Contractor	MPWT

C: SERVICE STAGE

Parameters	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented by	Supervised by
Air quality	Intersection of BTB Bypass & NR-5 (KP 302.3)	Measure PM10, PM2.5, SO ₂ and NO ₂ .	2 times in dry season and 2 times in rainy season	Provincial authority	MPWT and MOE
	Intersection of SS Bypass and NR-5 (KP349.3)	Measure noise level (LAeq) and/or vibration at the roadside & 200m from roadside.			
Noise/Vibration	Intersection of BTB Bypass & NR-5 (KP 302.3)	Measure noise level (LAeq) and/or vibration at the roadside & 200m from roadside.	2 times per year	Provincial authority	MPWT and MOE
	Intersection of SS Bypass and NR-5 (KP349.3)	Measure noise level (LAeq) and/or vibration at the roadside & 200m from roadside.			
General waste	Area along road including bus stop and taxi station	Volumes of waste collected from roadside area and within ROW, including bus stop and taxi station	1 time per year for roadside area and 1 time per one month for bus stop and taxi station	Provincial authority	MPWT and MOE
Subsidence	Area along NR-5 and bypasses	Observation of ground water level in wells	1 time per year for ground water level	Provincial authority	MOE
		Periodical Observation of rising up of structures supported by deep foundation	2 times per year if substantial lower in g of ground water level is found.		

8. CONCLUSION

Environmental impacts of the Project of widening of BTB– BMCH Section and construction of BTB Bypass and SS Bypass was studied.

Adverse impacts on air, water, noise/vibration, waste, subsidence, sedimentation, hydrology, ecosystem and natural environment were examined.

Certain degree of air pollution, noise/vibration, water pollution, waste, malodor and sedimentation are anticipated. But these impacts can be mitigated to the extent that does not practically harm the lives of citizens or industrial/agricultural/economical activities. There is a possibility that subsidence may occur depending condition of ground and ground water pumping. However such subsidence can be controlled or remedied if proper monitoring and measures are taken.

Impacts to ecosystem including those Tonle Sap Lake and its surrounding natural reserves are considered to be limited.

Significant positive impacts of the Project are mitigation of traffic congestion and improvement of traffic safety. Indirect positive impacts such as development of social and economic activities due to improvement of mobility/transportation is also expected.

1. INTRODUCTION

1.1 Background of the Study

Cambodia that counts for 13.4 million inhabitants in 2008 is one of the least developed countries in the world with only USD 490 per capita. Agriculture sector represents 30% of GDP. The service sector in which tourism plays key role is a growing economic importance with 44% of GDP. Over half of Cambodia is forested¹, but illegal logging is robbing the country of millions of dollars of badly needed revenue.

After 30 years of the civil war, Cambodia has started a reconstruction program, financed largely by foreign aids. Political stability has brought national efforts to concentrate on environmental issues in particular natural resource conservation and water pollution control. Economic development in recent years has brought more industrial firms to establish in Cambodia. Nowadays the industry sector represent up to 26% of GDP compared to only 22% in 2000 (WDI, 2008).

The principal mode for the movement of goods and people in Cambodia is by road. The road transport accounts for around 65% of the passenger transport, for 70% of the freight transport, and play the most important role in the domestic transport. However the most of the roads were severely deteriorated during the civil war in the 70's to 80's. Since the early 90's the Royal Government of Cambodia (RGC) has been exerting strenuous effort on rehabilitation of the road network with the assistance of Japan, the United States, Australia, Asian Development Bank (ADB) and Word Bank.

Trunk National Roads of Cambodia connect Phnom Penh to major cities and major border points. National Roads No.5(NR-5) is the trunk road reaching Bangkok through the border between Cambodia and Thailand. It is also designated as Asian Highway A-1 or Southern Economic Corridor of GMS. The Survey Roads was damaged by the flood in 2000, and have been temporarily repaired. The outline of repair work is as follows:

Table 1-1 The outline of Repair Work

Resource	Section	Distance (km)	Inauguration Year
Army	Phnom Penh to Kampong Chhnang	91	2003
ADB	Kampong Chhnang to Thlea Ma'Am	80	2004
	Thlea Ma'Am to Battambang	130	2003
	BTB to Serei Saophoan	68	2004
	SS to Poipet	49	2008

Source: Inception Report, JICA Study Team, March 2011

The repairs mentioned above mostly adopted DBST and the surface condition is being deteriorated, and the traffic flow has been hampered. Improvement of Southern Economic Corridor is in urgent need as known from the fact that it was designated as one of the prior projects in the "Study on the Road Network Development in the Kingdom of Cambodia" (Master Plan Study), implemented by JICA in 2006. Considering these, RGC requested ODA (loan) to Japanese Government for improvement of Battambang(BTB)– Serei Saophoan(SS) Section of NR-5.

Under such condition, JICA dispatched a survey team to Cambodia in November 2010, held a series of discussions and reached agreement about a scope of the Preparatory Survey.

¹World Development Indicators, World Bank, 2008

This Preparatory Survey (the Survey) is implemented, in view of the background as sited above, to obtain data and information required for appraisal of loan project of Japanese ODA, such as preliminary design, project cost, implementation plan, and natural and social impacts.



Figure 1-1 Road Network in Cambodia

1.2 Objective of the Environmental Impact Assessment Study

The objective of the EIA study is to ensure that the project is environmentally sound and sustainable, and that any negative environmental consequences are recognized early in the project cycle and taken into account before project implementation.

This is done through:

- Description of the proposed project and associated works together with the requirements for carrying out proposed development
- Identification and description of the elements of the environment likely to be affected by the proposed development;
- Establishment of the baseline environment of the project area that would be impacted by the NR-5 rehabilitation (BTB-SS) and BTB Bypass;
- Identification and assessment of the beneficial (positive) and adverse (negative) environmental impacts of the project;
- Proposal of mitigation measures to the negative impacts of the project ;
- Prepare an Environmental Management Plan (EMP) of impact prevention and mitigation actions to be taken and a monitoring program to ensure compliance with the plan ;
- Public participation/consultation.

The EIA is prepared to satisfy the environmental requirements of Japan International Cooperation Agency (JICA). It is not intended to satisfy the EIA Sub-decree requirements of the Ministry of Environment of 1999 since the total length of the Project roads is less than 100km.

1.3 Scope of the Study

The Study Area is the section of NR-5 from BTB to SS (length is approximately 68km) with proposed bypass around BTB City (length is approximately 23km) and SS City (length is approximately 13km), and its roadside areas.

The EIA assesses the impacts resulting from the pre-construction, construction and service phases of the road improvement and bypass on the pollution, natural environments and social environments.

The assessment covers the proposed on-site activities as well as the transportation of the generated waste to the waste disposal sites. The impacts of the project components on the environment have been also assessed.

1.4 Methodology

The table of content of EIA report was prepared in accordance with JICA Guidelines for Environmental and Social Considerations (April 2010). EIA evaluates the impacts of project and components of projects on natural and social environment. Both negative and positive impacts are considered. The identified negative impacts are proposed to be minimized through the project design and operation.

The general methodology is as described below:

1.4.1 Data collection

- The data/information on environment in BTB and Banteay Meanchey (BMCH) Provinces including laws, policies, guidelines and other data concerning the project site.
- Review the technical report including Inception Report and Progress Report of Preparatory Survey for NR-5 Rehabilitation Project.

1.4.2 Consultation meeting

- Meet and consult with department of environment, department of water resource and meteorology and department of public work and transport of BTB and BMCH Provinces.
- Interview with local people along the widening road and bypass for get additional information on natural environment and pollution.

1.4.3 Field survey

- Fauna and flora survey along the existing NR-5 and proposed bypasses;
- Survey and analysis of water quality, air and noise/vibration ;
- Hydrology survey.

1.4.4 Analysis and assessment of potential environmental impacts

- Environmental scoping to identify the probable impacts of the project and its components.
- Analysis and compilation of the collected data/information, including those obtained through the field surveys on pollution and natural environment, to prepare the baseline data/information.
- Review the potential of both negative and positive environmental impacts during pre-construction, construction and service stages.

1.4.5 Preparation/compilation of EIA report

- Report form must follow the JICA's Guidelines for Environmental and Social Considerations (April 2010);
- Propose mitigation measures to reduce the negative environmental impacts during pre-construction, construction and service stages;

- Propose Environmental Management Plan during construction and service stages;
- Estimate the compensation plan for social impact²;
- Estimate cost for mitigation measure and the project monitoring³.

1.5 Structure of the Report

The report consists of the following chapters:

- Executive summary
- Chapter 1 (this chapter) comprises the introduction, objective, scope, methodology and sets out the context of the report.
- Chapter 2 provides a summary of the legislations and guidelines in Cambodia, as well as that of JICA, which are pertinent to the proposed development.
- Chapter 3 presents the project description.
- Chapter 4 describes the methodology used in baseline data collection as well as a description of general impacts from the project on environment and vice versa.
- Chapter 5 presents the assessment of potential impacts from the construction and operation activities and proposal of mitigation measures.
- Chapter 6 describes a comparison of project alternatives.
- Chapter 7 sets the principles of the environmental management and monitoring plan.
- Chapter 8 summarizes the results of EIA study.

2. POLICY, LEGAL AND ADMINISTRATION FRAMEWORKS

2.1 National Legal Frameworks related to Environmental Impact Assessment

2.1.1 Law on Environmental Protection and Natural Resource Management

This law was prepared by the Ministry of Environment (MOE) and promulgated by the King on December 24, 1996. This law is the main legal instrument in governing the environmental protection and natural resource management in Cambodia.

The purposes of this law are:

- To protect and promote environmental quality and public health through the prevention, reduction, and control of pollution,
- To assess the environmental impacts of all proposed projects prior to the issuance of a decision by the Royal Government,
- To ensure the rational and sustainable conservation, development, management, and use of the natural resources of the Kingdom of Cambodia,
- To encourage and enable the public to participate in environmental protection and natural resource management,
- To suppress any acts that cause harm to the environment.

Article 6 *“An environmental impact assessment (EIA) shall be conducted on every project and activity of the private or public, and shall be approved by the Ministry of Environment before being submitted to the Royal Government for decision.*

²This subject is described in the separate report on Resettlement Action Plan and not presented in this report.

³Same as above.

This assessment shall also be conducted for existing activities that have not yet been assessed for environmental impacts.

The procedures of the process for environmental impact assessment shall be defined by sub-decree following a proposal of the Ministry of Environment.

The nature and size of the proposed projects and/or activities (proposed and existing) both private and public, that shall be subject an environmental impact assessment which shall be defined by sub-decree following a proposal of the Ministry of Environment"

Article 7 "All investment Project Applications and all proposed State projects shall be subject to an initial Environmental Impact Assessment and/or Environmental Impact Assessment as specified in **article 6** of this law. The Ministry of environment shall review and provide recommendations on the initial Environmental Impact Assessment and/or environmental impact assessment to the competent bodies within period determined by the Law on Investment of the Kingdom of Cambodia."

2.1.2 Land Law

The current legislation governing land ownership is the *Land Law* in the Kingdom of Cambodia dated 30 August 2001. This new Land Law replaced the former Land Law enacted in October 1992. This Act contains some provision that is relevant in relation to a national resettlement policy that is presently under process of formulation.

Article 5: "No person shall be deprived of their ownership unless this action is for the public interest consistent with formalities and procedures which provided by laws and regulations, and after just and fair compensation is provided."

Article 6: "All transfers or changes of rights of ownership shall be made under the rules of general procedures of sale, succession, exchange, or donation, or by the court decision."

Accordingly, a number of legal documents supporting the implementation of the *Land Law* and Policy have been prepared and issued, most notably those of Sub-decree 19 on Social Land Concessions(dated 19 March 2003), Sub-decree 118 on State Land Management(dated 07 October 2005) and Prakas on Guidelines to Implement Sub-decree on Social Land Concession(dated 19 November 2003).

2.1.3 Law on Expropriation

The law was prepared by the Ministry of Economy and Finance (MEF) and promulgated by the King on February 26, 2010.

The purposes of this law are: "Aims to deprive the private ownerships and the obvious rights of immovable property of natural persons, legal entities and public legal entities including the land, various constructions and crops for the rehabilitation, reconstruction and expansion of public natural infrastructure which serve public or national interests with the payment of fair and just compensation in advance."

The key stipulations of Chapter 2 of this law are as summarized below:

- Only State has the right to implement the expropriation.
- The expropriation shall be made on whole or a part of immovable property and/or the right of immovable property.
- The State deserves an exclusive rights of conducting expropriation in special case and for urgent national demand without public consultation. In these cases, the expropriation is made in temporary period.
- Government has to reserve the budget to make expropriation.

2.1.4 Royal Decree on the Creation and Designation of Protected Areas (1993)

This decree established 23 protected areas administrated by the MOE. Those areas cover 3,273,200 ha accounting for about 18% of country's surface area. Those areas are under direct legal framework of the new *Protected Areas Law* promulgated in January 2008.

2.1.5 Sub-Decree on environmental impact assessment process

This sub-decree was prepared by the MOE and promulgated by the RGC on August 11, 1999. The main objectives of this sub-decree are:

To determine an Environmental Impact Assessment (EIA) process for every private and public project or activity. The assessment shall be reviewed by the Ministry of Environment prior to submission to the Royal Government for a decision.

To determine the type and size of the proposed private and public projects and activities, including existing and ongoing activities subject to the process of EIA.

To encourage public participation in the implementation of the EIA process and take into account their input and suggestions in the process of project approval.

Article 2 *"This sub-decree hereby applies to every proposed and ongoing project(s) and activities, either by private, joint-venture or state government, ministry institutions of which are described in the annex of this sub-decree, except a special case, where a project will be approved by the Royal Government."*

Article 6 *"A Project Owner must conduct Initial Environmental Impact Assessment (IEIA) in order to comply with the EIA requirement as stated in the annex of this sub-decree."*

Article 8 *"A Project Owner must apply to the MoE for reviewing their full report of EIA report and Feasibility Study, in case a project tends to cause a serious impact to the natural resources, ecosystem, health and public welfare."*

Article 11 *"A Project Owner must cover all the fee's services for reviewing and monitoring upon their project. These service fees shall be approved by the Ministry of Economy and Finance following the proposal of the MoE. The said fee shall be incorporated into the national budget."*

Following the sub-decree on *Environmental Impact Assessment Process, 1999*, the preparation of the EIA report is required in accordance with Item No.8: Improvement of national road (length over 100km). Therefore, this project is not under the annex of the *EIA sub-decree*.

2.1.6 Sub-Decree on Water Pollution Control

This sub-decree was prepared by the MOE and promulgated by the RGC on April 6, 1999. The purpose of this sub-decree is to control water pollution in order to prevent and reduce the pollution of public water areas so that the protection of human health and the conservation of bio-diversity may be ensured. This sub-decree applies to all sources of pollution and all activities that cause pollution of public water areas. It also set up the water quality standards for public water area and the standard for effluent discharge into water body.

2.1.7 Sub-Decree on Solid Waste Management

This sub-decree was prepared by the MOE and promulgated by the RGC on April 27, 1999. The purpose of this sub-decree is to regulate solid waste management in a proper technical manner and to provide safety precautions in order to ensure the protection of human health and the conservation of biodiversity. This sub-decree covers all activities related to disposal.

storage, collection, transport, recycling, dumping of garbage, and hazardous waste. It provides the classification of waste into household waste and hazardous waste (32 categories).

2.1.8 Sub-Decree on Air Pollution and Noise Disturbance Control

The Sub-decree was prepared by the MOE and promulgated by the RGC on July 10, 2000. The purpose of this sub-decree is to protect the quality of the environment and public health from pollutants and noise disturbance through monitoring, curbing and mitigating activities. This sub-decree applies to all movable sources and immovable sources of air pollution and noise disturbance. It provides a standard of ambient air quality and a standard for toxic substances emission from different sources.

2.1.9 Sub-Decree on the Ozone Depleting Substances

The Sub-decree was promulgated by the RGC on March 17, 2005 in response to the obligations under the *Vienna Convention* and the *Montréal Protocol*. Its objective is to stop the use of ozone depleting substances and manage all business activities and consumption identified by the Convention and the Protocol. This sub-decree applies to import, export, handling, production and the use of the ozone depleting substances.

2.1.10 Land Management Policies of Government

The policy governing the *Social Land Concessions* originates what was outlined in the RGC's *Interim Paper for Strategy of Land Policy Framework* (06 September 2002). This document was written to provide guidance on how to interpret, implement and use the *Land Law of the Kingdom of Cambodia* (dated 30 August 2001). As noted in the section on land distribution, "many poor people have no land or too little land to earn a living...some people cannot afford to buy or rent land...This means that other mechanisms of land allocation such as social concessions or leasing of public land are needed for some groups to fill needs for shelter and livelihood." Accordingly, a number of legal documents supporting the implementation of the *Land Law* and Policy have been prepared and issued, most notably those of *Sub-decree 19 on Social Land Concessions* (dated 19 March 2003), *Sub-decree 118 on State Land Management* (dated 07 October 2005) and *Prakas 200 on Guidelines to Implement Sub-decree on Social Land Concession* (dated 19 November 2003).

At national level, the National Social Land Concession Committee (NSLCC) is the institution to make national policy with respect to land concessions as well as review, adjust, manage and monitor all Social Land Concession (SLC) activities at provincial level. The NSLCC is subject to the supervision of the Council for Land Policy who also has a role in the approval process for registration of SLC as State Private Land. The NSLCC operates primarily through the General Secretariat for SLC (GSSLC). A role is played within this process by the Ministry of Economy and Finance (MEF) who are also involved in SLC, financial management and procurement. The Ministry of Land Management, Urban Planning and Construction (MLMUPC) provide general technical and administrative support and overall supervision.

Basic policy in Cambodia is that a proponent has to prepare budget for compensation of resettlement of local people even if they have been illegally living in the project site.

Since "Law on Expropriation" became effective on December 28, 2009, smooth land acquisition is expected to be conducted for public works, while resettlement procedure for illegal inhabitants is not prescribed in the law. On the other hand, "Circular on Settlement of the Illegal Construction on the State Land in Cities and Urban Areas" was put into force on May 31st, 2010 for the issues of illegal settlers in urban area. However, land acquisition

and resettlement for illegal habitants will be conducted on the basis of traditional policy for time being.

2.2 JICA Guidelines for Environmental and Social Consideration

The Japan International Cooperation Agency Requirements: JICA Guidelines for Environmental and Social Considerations (April 2010, JICA Guidelines) provides four categories of projects as per its environmental classification system.

JICA has classified Projects in the following four categories:

- (1) Category A: Proposed projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society. Projects with complicated or unprecedented impacts that are difficult to assess, or projects with a wide range of impacts or irreversible impacts, are also classified as Category A. These impacts may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors, projects that have characteristics that are liable to cause adverse environmental impacts, and projects located in or near sensitive areas. An illustrative list of sensitive sectors, characteristics, and areas is provided in Appendix 3.
- (2) Category B: Proposed projects are classified as Category B if their potential adverse impacts on the environment and society are less adverse than those of Category A projects. Generally, they are site-specific; few if any are irreversible; and in most cases, normal mitigation measures can be designed more readily.
- (3) Category C: Proposed projects are classified as Category C if they are likely to have minimal or little adverse impact on the environment and society.
- (4) Category FI: Proposed projects are classified as Category FI if they satisfy all of the following requirements: JICA's funding of projects is provided to a financial intermediary or executing agency; the selection and appraisal of the sub-projects is substantially undertaken by such an institution only after JICA's approval of the funding, so that the sub-projects cannot be specified prior to JICA's approval of funding (or project appraisal); and those sub-projects are expected to have a potential impact on the environment.

When necessary, JICA can change a category even after screening. This might occur such as when a new significant impact has come to light as a result of the cooperation project process, or in other specific situations.

So, the Project of NR-5 rehabilitation and construction of bypasses (around BTB and SS) is likely to be classified as "Category A", according to JICA Guidelines (2010), which falls into the road sector and is likely to have significant adverse impact due to large-scale involuntary resettlement. Thus, preparation of EIA report including RAP, as well as the technical advice by the Advisory Committee in Japan, is required.

3. PROJECT DESCRIPTION

3.1 Introduction

NR-5 is an arterial international road connecting Phnom Penh and the border point with Thailand. It traverses provinces of BMCH and BTB whose population are 3rd and 4th largest in the country. Thus, NR-5 accommodates the traffic needed for the day-to-day activities of the citizens, including access to the public services such as hospital and school, along the highway.

NR-5 also accommodates the traffic transporting goods and passengers between the major cities along the highway, such as SS, BTB, Pursat, Kampong Chhnang and Phnom Penh.

Further it is connected, via Phnom Penh to National Road No.1(NR-1) which reaches to Ho Chi Min City in Vietnam and National Road No.3 (NR-3) and National Road No.4 (NR-4) which reach to Sihanoukville, the largest international seaport of Cambodia.



Figure 3-1 Location Map

NR-5 is an important highway not only for domestic transport in Cambodia but also for International transport in ASEAN and the Greater Mekong Subregion (GMS). NR-5, together with NR-1, forms a route connecting Bangkok, Phnom Penh and Ho Chi Minh City.

3.2 Present Condition of North Section of National Road No.5

3.2.1 Present condition of North Section

The present condition of the North Section of NR-5 can be summarized as follows:

Road width: The average width of pavement is 7.8m. This width is minimal as an opposed 2-lane road. High-speed vehicles, such as passenger cars, and slow vehicles, such as bicycles and agricultural tractors are travelling same lane, resulting in hazardous traffic condition.

Horizontal and vertical alignment: The horizontal alignment of NR-5 is generally generous but there are some curve sections with small radii and need improvement. The vertical alignment is also generally flat.

Pavement: The existing pavement is double-layer bituminous surface treatment (DBST). This type of pavement does not have sufficient bearing capacity to support heavy traffic.

Bridges: There are bridges along the North Section. Some of them need rehabilitation and some others need widening.

Roadside land use: The cities, towns and villages are developed along the road. Many factories, shops, stalls, vendors, benches and houses are observed just beside the road. The basic form of land use outside of urbanized area is agriculture, especially rice paddy. There are many rice mill factories and warehouses along the road functioning as the base station of transportation for rice.

3.2.2 Problems of Present North Section

The problems of present North Section can be summarized as follows:

Traffic safety: Because of narrow road width, high-speed vehicles, such as passenger cars, and slow vehicles, such as bicycles and agricultural tractors are travelling same lane, resulting hazardous traffic condition.

Narrow road width: The width of the North Section is minimal as a 2-lane road. Traffic congestions are anticipated in the future as the traffic volume increase.

Weak pavement: Current pavement is DBST which does not have sufficient bearing for heavy vehicles. As regional integration will develop in the future, volume of heavy traffic is anticipated to grow. Already, fragile pavement is imposing large amount of maintenance cost to the Government.

Necessity of bypass: The existing North Section of NR-5 is passing through cities and towns, such as City of BTB, City of SS and Town of Mongkol Borei, causing traffic congestion and traffic accidents. Basic solution to these problems is construction of bypasses.

3.3 Outline of the Project

The project consists of three components:

- (i) widening of the section of NR-5 between the cities of BTB and SS,
- (ii) construction of a bypass around the City of BTB and,
- (iii) construction of bypass around the city of SS and Town of Mongkol Borei.

Figure 3-1 schematically shows the relative positions of these three components.



Figure 3-2 Relative Position of Components of Project

3.3.1 Widening of North Section of National Road No.5

Widening of the North Section is to widen the existing 2-lane road (approximately 11m wide including shoulders) into either 4-lane (approximately 20.5m wide including shoulders) or 2-lane plus motorcycle lane road (approximately 14m wide including shoulders) (see Figure 3-3).

Together with widening of the existing NR-5, the pavement is to be improved to asphalt concrete (AC) from the existing DBST.

Widening of the existing NR-5 is executed by construction additional embankment generally on the both sides of the existing road.

3.3.2 Construction of Battambang Bypass

A new road with cross section of 2-lane plus motorcycle lane is to be constructed traversing mainly agricultural land (rice paddy) in the southwest suburbs of BTB City. Pavement of the bypass is planned as AC. Bypass is to be constructed by filling low embankment with height of 1m to 2m.

3.3.3 Construction of Serei Saophoan Bypass

Also a new road with cross section of 2-lane plus motorcycle lane is to be constructed traversing mainly agricultural land (rice paddy) in the southwest suburbs of SS City and Mongkol Borei town. Pavement of the bypass is also planned as AC. SSBypass is to be constructed also as low embankment road with height of 1m to 2m.

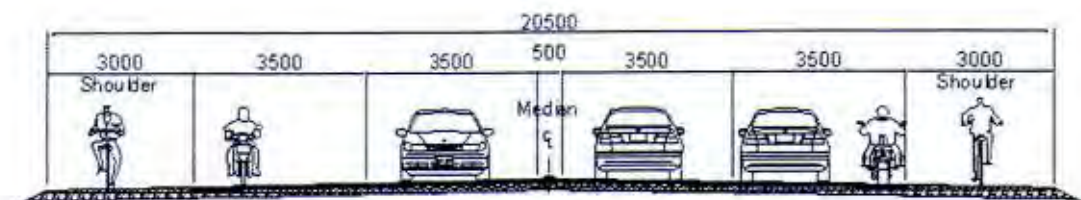
3.3.4 Summary

Table 3-1 summarizes the outline of these components. Figure 3-3 shows cross sections of widening and bypasses.

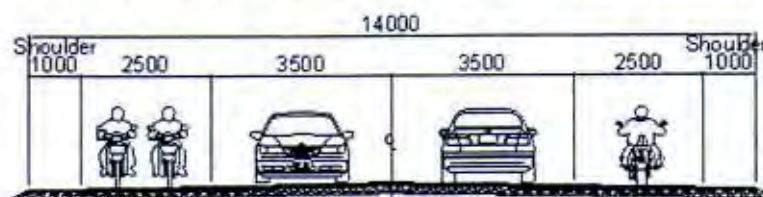
Table 3-1 Outline of Project

Section	Start Point – End Point	Length (km)	Outline of Improvement/Construction
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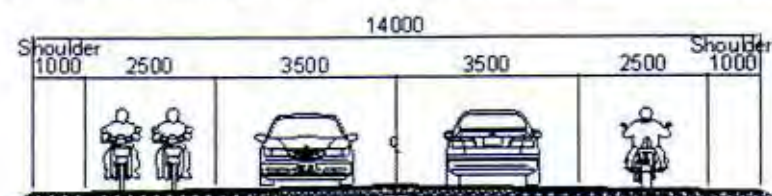
Section I: North Section	Intersection with BTB Bypass in north of BTB City (KP 302.3)– Intersection with SS Bypass in south of Mongkol Borei Town (KP 349.3)	47.0	- Widening of existing NR-5 into 4 lanes or 2 lanes plus motorcycle lanes on both sides(See cross sections shown in Figure 3-3); To be decided after consultation between RGC and JICA - Pavement: Asphalt concrete (AC) - Bypass is newly constructed
Section II: BTB Bypass	KP 282.2 of NR-5south of BTB City)– KP 302.3 of NR-5(north of BTB City)	23.1	- Road width: 2 lanes plus motorcycle lanes on both sides(See cross sections shown in Figure 3-3) - Pavement: AC - Bypass is newly constructed
Section III: SS Bypass	KP 349.3 of NR-5(south of Mongkol Borei Town)– KP 366.2 of NR-5(west of SS City)	13.4	- Road width: 2 lanes plus motorcycle lanes on both sides(See cross sections shown in Figure 3-3) - Pavement: AC



Cross Section for Widening of National Road No.5(4-Lane)



Cross Section for Widening of National Road No.5(2-Lane + Motorcycle Lanes)



Cross Section of Battambang Bypass and Serei Saophoan Bypass

Figure 3-3 Cross Section of Widening of National Road No.5 and Bypasses

3.4 Objective of the Project

Objective of the project is to solve or mitigate the problems of exiting North Section of NR-5 as described in Subsection 3.2.2:

- Improvement of traffic safety by providing separate lanes for high-speed traffic and slow traffic ;
- Provide sufficient traffic capacity by widening and mitigate traffic congestion which is anticipated in the near future ;
- Improving pavement into AC to support heavy traffic ;

- Construct bypasses to let the through traffic detour BTB City, SS City and Mongkol Borei Town and avoid widening of the existing NR-5 which necessitates resettlement of large number of houses and families.

4. BASELINE DATA

4.1 Physical Environment

4.1.1 Geography

Cambodia is located in the southwest region of Indo-China Peninsula. Its land extends between latitudes of 10° north and 15° north, and longitudes of 102° east and 108° east. It has a width of 580km in east-west direction and a length of 450km in south-north direction. It is bordered with Thailand, Laos and Viet Nam on northwest, north and east, respectively. It has 2,438km of border line, 162km of costal line and land area of 181,035km².

NR-5 starts from Phnom Penh and traverses the southwest side of Tonle Sap Lake up to BTB. Between BTB and SS, it passes through the upstream land of Tonle Sap Lake and finally reaches Poipet, the border point with Thailand. The distance between the city of SS (the north end of the Survey Section) and Poipet is approximately 50km and distance between Poipet and Bangkok in Thailand is approximately 250 km. Thus, NR-5 is the main transport route between Phnom Penh and Bangkok.

4.1.2 Topography

NR-5 traverses lowland area in southwest to northwest of Tonle Sap Lake. The ground height along the NR-5 is, in general, around 10m above sea level or less except at some section passing low hills. Thus, the terrain along NR-5 is generally flat.

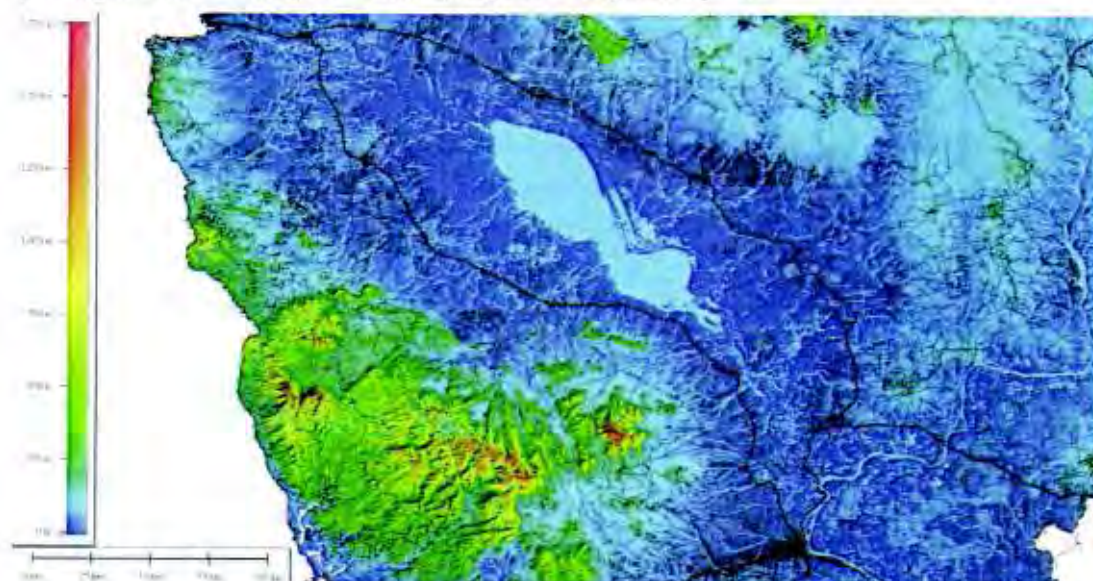


Figure 4-1 Topography of Project Area

4.1.3 Geology and Surface Soil

In the Precambrian Era, Cambodia was the sea bottom and covered by rock debris of old continents and plentiful iron. After Precambrian Era, there were various activities in Kravanh Mountains which formed the old rocks, such as granite, sandstone, coal, petroleum and other types of minerals. In Paleozoic Era, Cambodia disappeared into sea again, the rock debris mixed with plants and animal fossils deposited. These deposits formed mountains today, especially Kravanh and Dangrek Mountains as well as the Northeastern Plateau. In

Mesozoic Era, there were many young volcanoes which produced flow of basalt, which became red soil in the eastern plateau today. In Cenozoic Era, there were waterways, especially Mekong River, which brought mud to fill gulf while push-up movement of earth and recession of seawater made the old mud in Kravanh and Dangrek Mountains, as well as the new mud at Tonle Sap Lake (surrounding the lake such BTB and BMCH Provinces) appear. The old and new mud formed the current central lowland.

According to the Croaker's Soil Map⁴, soils within the BTB and BMHC Provinces are classified into three categories according to their potential for agriculture, forestry or both (i.e. tree crops and agro-forestry) including (i) lacustrine alluvial soil found in the flood plain areas nearby Tonle Sap Lake, (ii) alluvial lithosols found in the BMCH province and (iii) brown hydromorphics widely found along NR-5 between BTB and BMCH which are fertile and very suitable for rice productions.

Owing to this fertile soil, wide flat land and water resource provided by many rivers and streams including Steung Sangake, O Ta Ke and Steung SS, this area is very suitable for agriculture, especially for rice production. Huge areas of rice paddy are found along NR-5, especially in the rainy/flood season.

⁴Croaker, D., "Explanatory Survey of the Soils of Cambodia", Royal Government of Cambodia & USAID, 1963

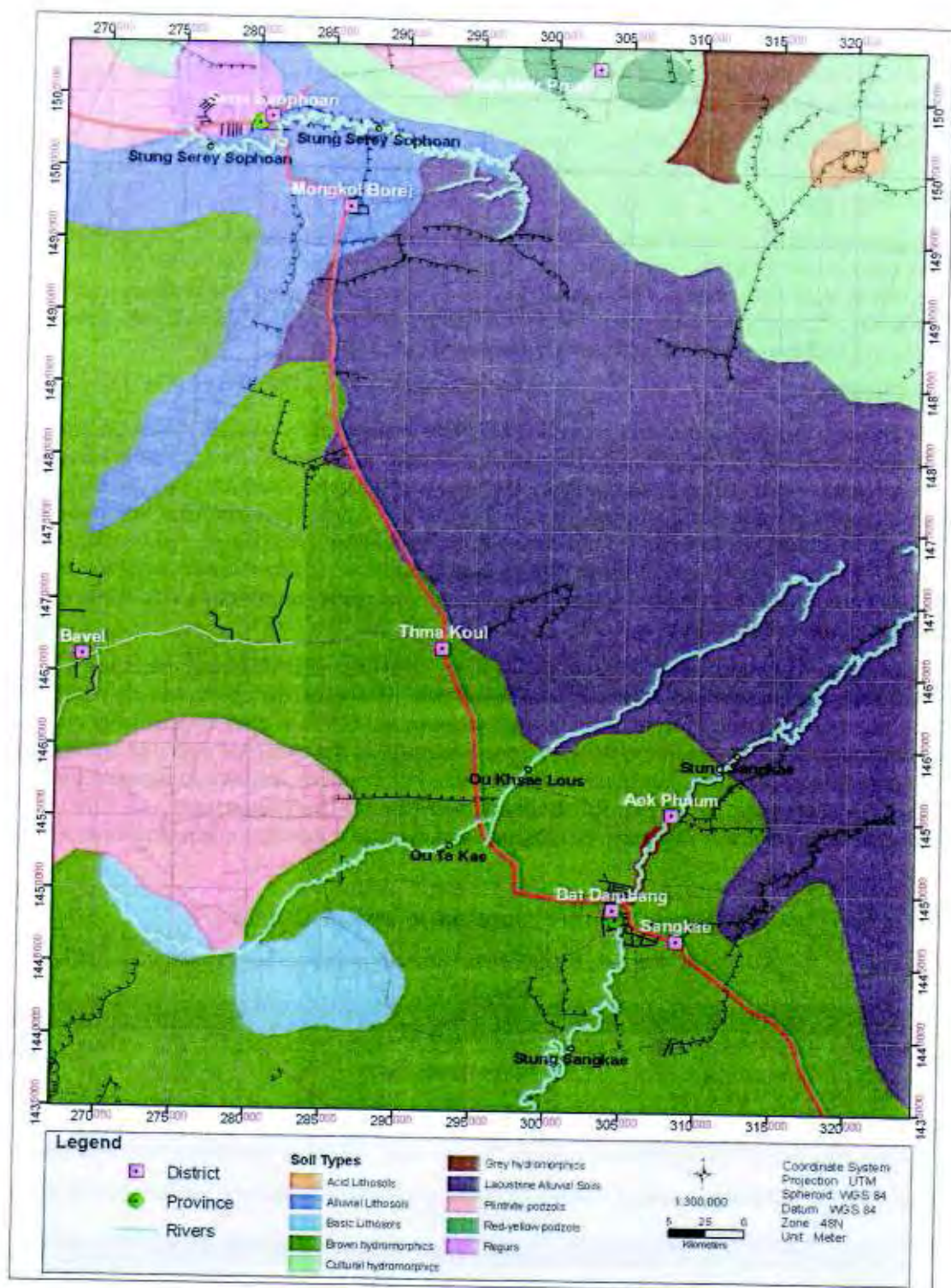


Figure 4-2 Soil Classification

4.1.4 Soil Erosion and Sediment

Erosion has been noticed on the banks of Steung Sangkai River, O Ta Ke Stream and Steung SSRiver. Forty(40) year ago, these rivers and stream were deep and narrow but now

thewidths have been increased and the depths have become shallow. The erosion of river banksresulted in the sedimentationsdownstream, including Tonle Sap Lake and its surrounding areas. However, the main sources of sedimentation in Tole Sap Lake and its surrounding area are considered to be Mekong River.

A paper presented by Sarkkula et al⁵ states *"The Tonle Sap Lake and flood plain ecosystem is retaining more than 80% of the amount of the sediments it receives from the Mekong River and the tributaries"*

This sedimentation is considered to be supplying nutrients and oxygen to Tonle Sap system. The same paper by Sarkkula et al states *"The Mekong Upstream developments, like construction of dams and reservoirs may lead to significant trapping of sediments and nutrients significant changes in the flood regime and the suspended solids concentration may have influence in the productivity of the lake Tonle Sap"*.

4.1.5 Climate

The Project Area is one of many areas in Cambodia influenced by tropical monsoon. The climate consists of dry season and rainy season. The dry season lasts for six months from November to April. The dry season is divided into two seasons of summer and spring. Summer, which is hot during the day, is from February to April. Spring is from November to January. Monsoon wind blows from the north bringing cold air from Siberia. Rainy season lasts for six months from May to October. During rainy season, wind blows from southwest of country bringing moisture from Indian Ocean and drops rainwater which is vital for irrigation of agricultural crops and plants.

Departments of Water Resources and Meteorology of BTB and BMCH Provinces are measuring temperature and other meteorological data. However, the observed data of BMCH Province were lost due to breakdown of the computer in 2009, and data are available only since January 2010. In addition, there is some limitation in the observed data due to the types of equipment and methods used in the observation. For example, the thermometer records only highest temperature and lowest temperature. Thus, only maximum and minimum temperatures of the day are recorded and average temperature is not calculated.

(a) Temperature

The temperature in BTB and BMCH Provinces are as indicated below:

Table 4-1 Maximum and Minimum Temperature in Battambang Province in 2010 and 2011(°C)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	2010	33.2	35.3	36.1	37.1	36.6	34.6	33.4	32.3	32.1	30.5	30.6	31.1
	2011	30.8	33.6	32.5	33.8	34.0	33.4	33.5					
Min	2010	22.4	24.9	25.2	26.0	27.2	26.3	25.6	25.4	25.5	24.5	23.7	21.7
	2011	20.1	23.2	23.3	25.3	25.8	26.0	25.6					

Source: Department of Water Resources and Meteorology, BB Province Station: Veal Bek Chan

Table 4-2 Maximum and Minimum Temperature in Banteay Meanchey Province in 2010 and 2011(°C)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	2010	35.2	37.3	39.3	40.1	40.3	38.3	36.3	34.8	36.3	33.5	32.0	31.0

⁵Sarkkula, J., Kirikki, M., Koponen, J. and Kumm, M; Ecosystem Process of the Tonle Sap Lake, Full Paper for 1st Workshop of Ecotone Phase II, 2003 in Phnom Penh and Siem Reap in Cambodia

	2011	31.5	34.0	34.5	35.1	33.0	33.0	33.0					
Min	2010	18.7	23.0	20.2	24.0	24.4	24.2	24.0	23.3	22.5	22.1	20.0	16.0
	2011	15.0	16.3	17.0	20.0	23.0	22.0	22.0					

Source: Department of Water Resources and Meteorology, BMCH Province Station: SS

(b) Rainfall

Table 4-3 and Table 4-4 show the data of monthly rainfall in BTB and BMCH for 2010 and 2011.

Table 4-3 Monthly Rainfall in Battambang (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2010	8.3	12.0	25.2	69.9	77.3	121	242	217	193	325	40.5	8.3	1,340
2011	0.0	50.8	35.1	153	152	108	187	253					938.1

Source: Department of Water Resources and Metrology, BB Province

Table 4-4 Monthly Rainfall in Banteay Meanchey (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2010	9.7	13.5	25.7	62.3	71.3	123	96.8	204	229	256	9.0	0.0	1,100
2011	0.0	13.0	20.2	282	89.6	57.3	214	299					974.7

Source: Department of Water Resources and Metrology, BMCH province

(c) Wind

Wind Speed and Direction in BB

Data of average wind speed and direction of 2007 are available for BTB Province. But the data for June to August were not available because the equipment was defective, according to the official of Department of Water Resources and Metrology. Data of average and minimum wind speed in 2010 and 2011 are not available because the equipment for wind speed measurement has been broken since 2008 until now. Thus, only monthly maximum of wind velocity in 2010 and 2011 are available.

Table 4-5 Monthly Maximum, Minimum and Average of Wind Speed in Battambang, 2007(m/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	5.13	5.34	4.98	6.33	4.77	-	-	-	3.92	4.64	4.54	5.22
Average	1.98	1.83	1.77	1.87	1.05	-	-	-	0.47	1.32	1.51	1
Min	0	0	0.01	0	0	-	-	-	0	0	0	0

Source: Department of Water Resources and Metrology, BTB Province

Table 4-6 Monthly Maximum Wind Speed (m/sec) and Direction in Battambang

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	Direction	NE	SW	S	S	NW	SW	SW	E	SW	NE	N	NE
	Speed	5	5	4	5	14	7	10	8	6	5	5	5
2011	Direction	NW	NW	N	SE	S	W	W	SW				
	Speed	6	5	5	7	12	8	10	12				

Source: Department of Water Resources and Metrology, BTB province

Wind Speed and Direction in BMCH

The monthly maximum of wind speed and direction in BMCH are as show in the Table 4-9.(Data of average wind speed are not available for BMCH Province.)

Table 4-7 Monthly Maximum of Wind Speed (m/sec) and Direction in Banteay Meanchey

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
--	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

2010	Direction	N	NE	NE	W	SE	SW	SW	W	SW	NE	NW	NE
	Speed	6	6	7	14	12	16	12	13	12	12	10	8
2011	Direction	N	N	W	W	W	SW	W	W				
	Speed	8	10	12	13	13	10	14	12				

Source: Department of Water Resources and Metrology, BMCH Province

(d) Humidity

The monthly data of humidity are available for year 2011 both in BTB and BMCH Provinces.

Humidity in Battambang

Monthly maximum, minimum and average of humidity are shown in Table 4-8 and Figure 4-3.

Table 4-8 Monthly Maximum, Minimum and Average of Humidity in Battambang

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	57	51	49	55	61	63	63	1	77	71	66	61
Ave	68	70	66	74	75	78	79	70	85	85	753	71
Max	80	95	83	92	88	95	89	95	93	99	84	83

Source: Department of Water Resources and Meteorology, BB Province

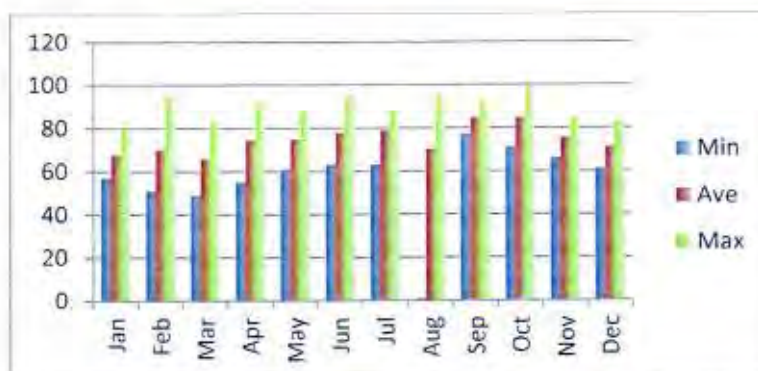


Figure 4-3 Monthly Maximum, Minimum and Average of Humidity in Battambang

Humidity in Banteay Meanchey

Monthly maximum, minimum and average of humidity are shown in Table 4-9 and Figure 4-4.

Table 4-9 Monthly Maximum, Minimum and Average of Humidity in Banteay Meanchey

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min	54	54	53	53	54	62	61	64	74	75	65	65
Ave	68	67	68	71	73	74	76	76	84	83	78	79
Max	89	79	91	92	88	88	91	88	95	93	93	93

Source: Department of Water Resources and Meteorology, BMCH Province

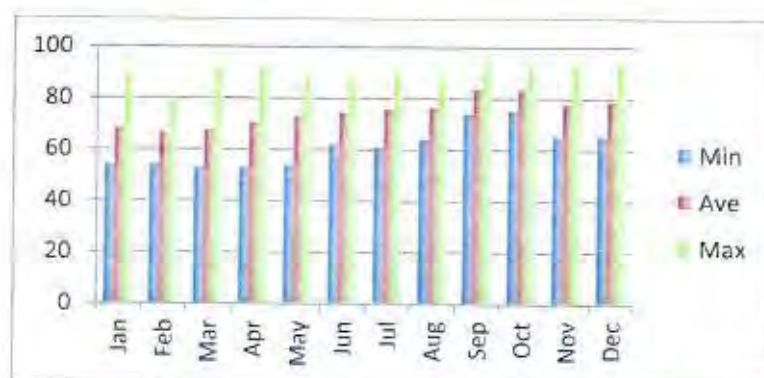


Figure 4-4 Monthly Maximum, Minimum and Average of Humidity in Banteay Meanchey

Humidity at six locations along the Project roads were measured at the time of air quality survey locations as shown in Table 4-10.

Table 4-10 Humidity Measured at the Location of Air Quality Survey

Location	Humidity (%)	Remarks
BTB KP 300, road side	61.5	During the survey, rained in the night.
BTB KP 300, 200m away from road side	58.8	
Intersection of NR-57 with BTB Bypass, Road Side	61.6	Rained from evening until night during the survey.
Intersection of NR-57 with BTB Bypass, 200m away from Road Side	59.7	
BMCH KP 356, Road Side	58.7	During the survey, rained in the night.
BMCH KP 356, 200m away from Road Side	56.0	

4.1.6 Air quality

(a) Standard of Cambodia

Sub-decree on air pollution control and noise disturbance, 2000 stipulates the standards of air quality as summarized in Table 4-11.

Table 4-11 Ambient Air Quality Standard

No.	Parameter	1 Hour Average (mg/m ³)	8 Hour Average (mg/m ³)	24 Hour Average (mg/m ³)	1 Year Average (mg/m ³)
1	Carbon monoxide (CO)	40	20	-	-
2	Nitrogen dioxide (NO ₂)	0.3	-	0.1	-
3	Sulfur dioxide (SO ₂)	0.5	-	0.3	0.1
4	Ozone (O ₃)	0.2	-	-	-
5	Lead (Pb)	-	-	0.005	-
6	Total Suspended Particulate (TSP)	-	-	0.33	0.1

The same Sub-decree stipulates standards for gas emitted by motor vehicles as summarized in Table 4-12.

Table 4-12 Gas Emission Standard for Motorized Vehicle

No.	Type of Vehicle	Type of Fuel	Level of emission				
			CO (%)		HC (ppm)		Dark Fume (%)
			A	B	A	B	
1	Motorcycle with 2 Strokeengine	Gasoline	4,5	4	10000	3000	-
2	Motorcycle with 4 Strokeengine	Gasoline	4,5	4	10000	2400	-

No.	Type of Vehicle	Type of Fuel	Level of emission				
			CO (%)		HC (ppm)		Dark Fume (%)
			A	B	A	B	
3	Motorized vehicles other than motorcycle	Gasoline	4.5	4	10000	800	-
4	Motorized vehicles other than motorcycle	Diesel	-	-	-	-	50

A: Vehicles used for more than 5 years from year of production.

B: Vehicles which are newly imported within 5 years from year of production.

(b) Field survey

Location of field survey

Air quality of three locations was surveyed to know the current situation of air quality in the Project Area. These three locations were selected for the reasons as explained in Table 4-13.

Table 4-13 Explanation of Three Locations Where Air Quality was Surveyed

No.	Location	Reason for Selecting the Location	Remarks
1	KP 300 of NR-5	Beginning point of North Section: Represents outskirts of BTB City	Air quality was surveyed at road side and 200m away from road side: Data measured at 200m away from road side was to know the background concentration.
2	KP 356 of NR-5	Middle point between SS City and Mongkol Borei Town: Represents suburban residential area of SS City	
3	Planned intersection of NR-57 and BTB Bypass	To obtain the baseline data of air quality in the suburban area of BTB City along NR-57: Also represents location where air quality will become worse compared to other places along BTB Bypass because this is the crossing point of the bypass and NR-57.	



Figure 4-5 Location of Air Quality Survey

Also detailed data of these three locations are described in Table 4-14. Detailed maps of locations of air quality survey are shown in Figure 4-6, Figure 4-7 and Figure 4-8.

Table 4-14 The location of Air Survey

Location	UTM (WGS 84) Coordinate		Name of Administrative Unit			
	X	Y	Village	Commune	District	Province
BMCH KP 356, road side	281951	1499380	Kbal Spean	Preah Ponlea	SS	BMCH
BMCH KP 356, 200m away from road side	281898	1499371	Kbal Spean	Preah Ponlea	SS	BMCH
BTB KP 300, road side	298017	1451085	Svay Chrum	Chhrey	Thma Koul	BTB
BTB KP 300, 200m away from road side	298101	1451087	Svay Chrum	Chhrey	Thma Koul	BTB
Intersection with NR-57	298717	1443910	Boeug Reang	O Mal	BTB	BTB
Intersection with NR-57, 200m away from road side	298651	1443948	Boeug Reang	O Mal	BTB	BTB

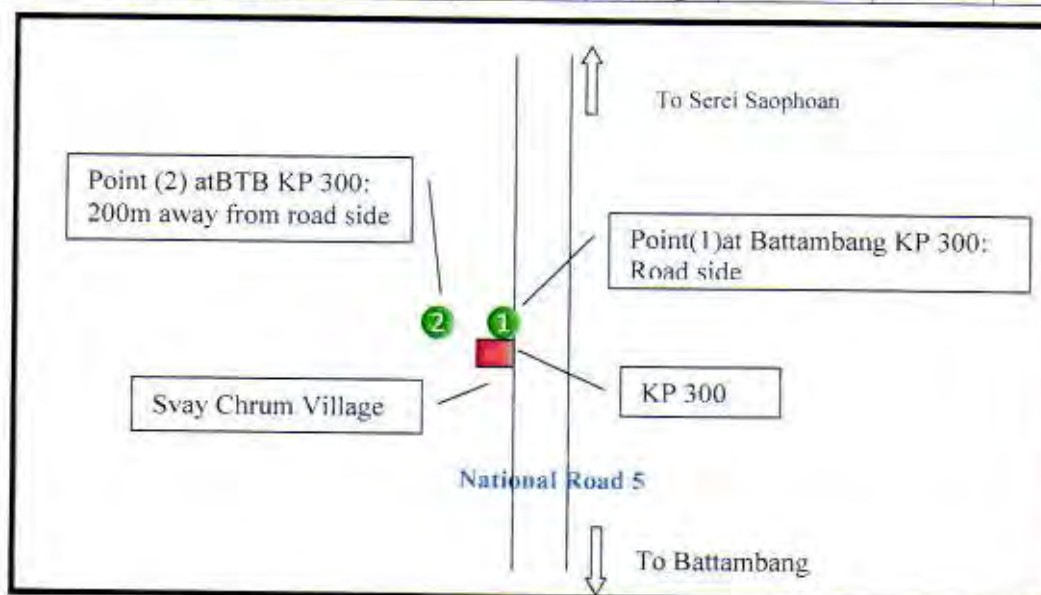


Figure 4-6 Location of Air Quality Survey at KP 300 National Road No.5

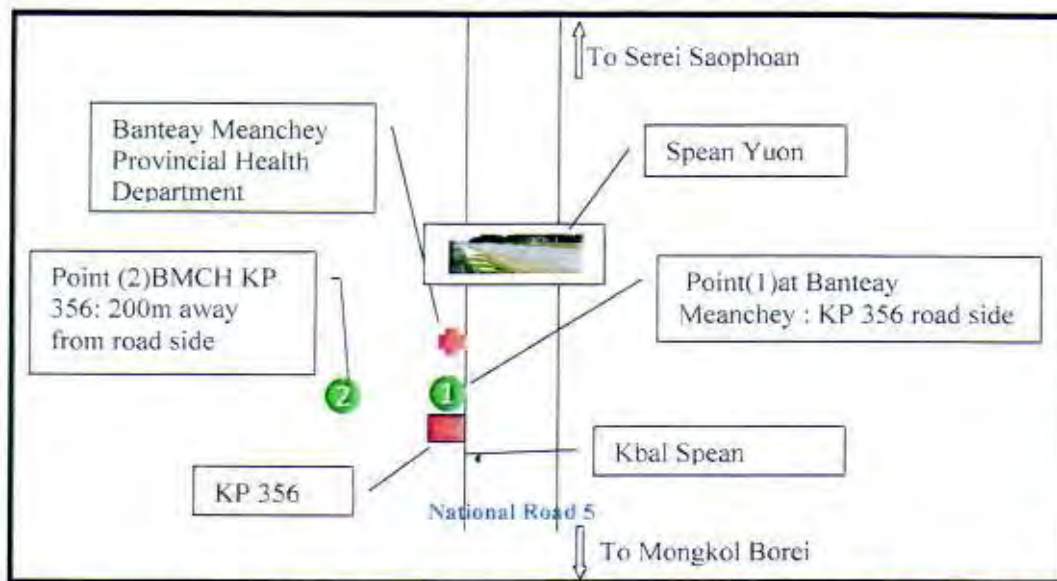


Figure 4-7 Location of Air Quality Survey at KP 356 National Road No.5

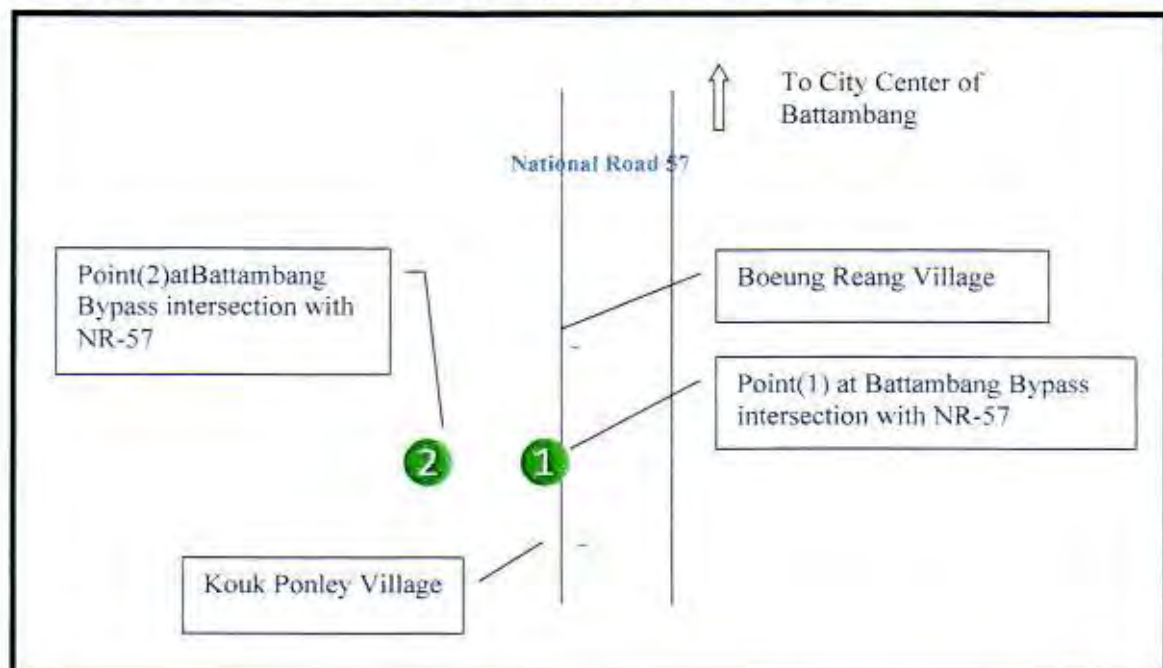


Figure 4-8 Location of Air Quality Survey at Intersection of National Road No.57 with Battambang Bypass

Results of air quality survey

Figure 4-15 shows the results of air quality survey.

The followings are noted:

- The values of PM10 and PM2.5 measured at road side of NR-5 exceed the standards of WHO, both in the suburbs of BTB City and SS City.

- The measured values of NO₂ and SO₂ are lower than the values of Cambodian standard, except that measured at the planned intersection of NR-57 with BTB Bypass.

Table 4-15 Result of Air Quality Survey in the Project Area

No.	Location & Date	Ambient Air Pollutants Concentration (milligram/m ³ N)			
		PM10	PM2.5	NO ₂	SO ₂
1	BTB KP 300, Road Side (August 07, 2011)	0.065	0.031	0.007	0.005
2	BTB KP 300, 200m away from Road Side (August 12, 2011)	0.038	0.026	0.005	0.003
3	BTB Bypass intersection with NR-57, Road Side (June 02, 2012)	0.021	0.011	0.011	0.005
4	BTB Bypass intersection with NR-57, 200m away from Road Side (June 04, 2012)	0.013	0.008	0.005	0.003
5	BMCH KP 356, Road Side (August 06, 2011)	0.061	0.024	0.006	0.004
6	BMCH KP 356, 200m away from Road Side (August 13, 2011)	0.027	0.014	0.004	0.003
	Duration (Hour)	24	24	24	24
	Method/Equipment	High Volume Sampler	Low Volume Sampler	Saltzman Method	Para-rosaniline Method
	Standard of Ministry of Environment*	0.05 (24-hr) (WHO**)	0.02 (24-hr) (WHO**)	0.1 (24-hr)	0.3 (24-hr)

* Cambodian standard stipulates SPM and there are no Cambodian standards for PM10 and PM2.5. Thus, WHO's standards are shown as reference.

** WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide

4.1.7 Noise and Vibration

(a) Standard of Cambodia

Sub-decree on air pollution and noise disturbance, 2000 stipulates the maximum permitted noise level as shown in Table 4-16. According to MOE, these standards are applied to the noise level at the areas written in Table 4-16 and are not interpreted to be applicable to the areas facing public roads.

Table 4-16 Maximum permitted noise level in public and residential area (dB(A))

No.	Area	Period of time		
		6:00 - 18:00	18:00- 22:00	22:00- 6:00
1	Quiet Area: - Hospitals - Libraries - School - Kindergarten	45	40	35
2	Residential Area: - Hotels - Administration offices - House	60	50	45
3	Commercial and service areas and mix	70	65	50
4	Small industrial factories intermingling in residential areas	75	70	50

Source: Sub-decree on air pollution control and noise disturbance, 2000

The same sub-decree also stipulates the maximum permitted noise level emitted by motorized vehicles as shown in Table 4-17. These standards are applied to control of noise emission of all kinds of vehicles when operating on public roads.

Table 4-17 Vehicle of noise in public and residential area maximum permitted noise level

No.	Category of Vehicle	Maximum noise level (dB(A))
1	Motorcycles, cylinder capacity (CC) of the engine does not exceed 125cm ³	85
2	Motorcycles, CC of the engine exceeds 125cm ³	90
3	Motorized tricycles	90
4	Cars, taxi, passenger vehicle for the carriage of not more than 12 passengers	80
5	Passenger vehicle constructed with capacity not exceeding 12 passengers	85
6	Truck with cargo capacity not exceeding 3.5 tones	85
7	Truck with cargo capacity exceeding 3.5 tones	88
8	Truck with engine power more than 150 KW	89
9	Tractor or any other truck not described in the above categories	91

Source: Sub decree on air pollution control and noise disturbance, 2000

(b) Field Survey

Location of field survey

Current levels of noise and vibration were measured at three locations which are same to those for air quality survey. Noise and vibrations were surveyed, however, only at road side points (7.5m from edge of pavement).

The road side land use along the roads at these locations can be regarded as "Commercial and service areas and mix".

Results of survey

Figure 4-9, Figure 4-10 and Figure 4-11 show the surveyed noise levels, and Figure 4-12, Figure 4-13 and Figure 4-14 show the surveyed vibration levels. The standard of Cambodia for noise in "Commercial and service areas and mix" is shown in the figures of surveyed noise as reference although it is not applicable to road side area.

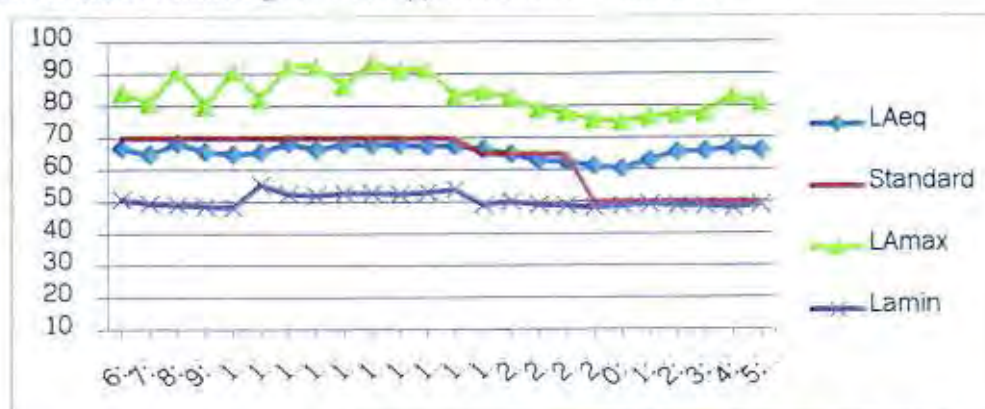


Figure 4-9 Noise Level in the Suburbs of Battambang City (National Road No. 5, KP 300; road side)

(Survey Date: 07 Aug 2011)

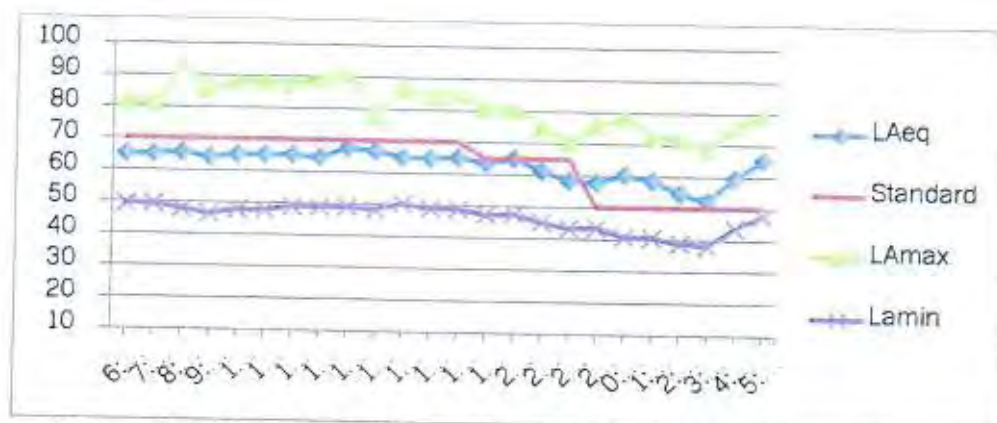


Figure 4-10 Noise Level in the Suburbs of Serei Saophoan City (National Road No.5, KP 356)

(Survey Date: 06 Aug 2011)

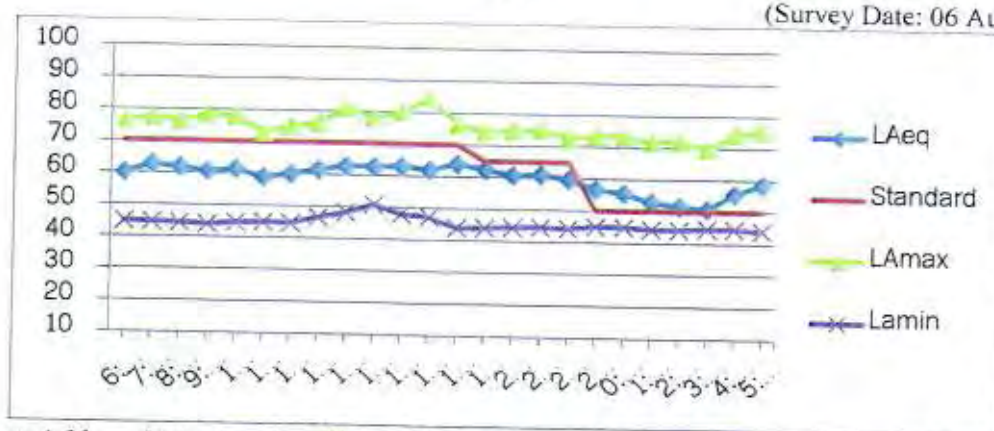


Figure 4-11 Noise Level at Planned Intersection of National Road No.57 with Battambang Bypass

(Survey Date: 08 Aug 2011)

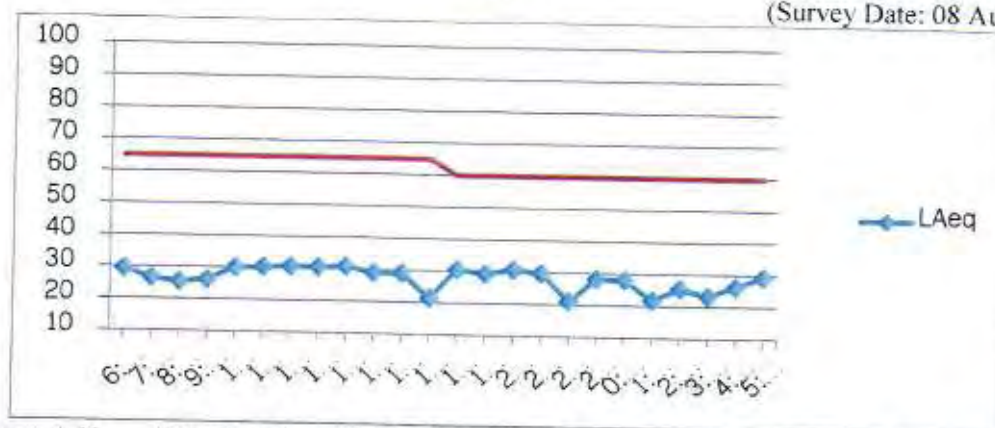


Figure 4-12 Vibration Level in the Suburbs of Battambang City (National Road No.5, KP 300)

(Survey Date: 07 Aug 2011)

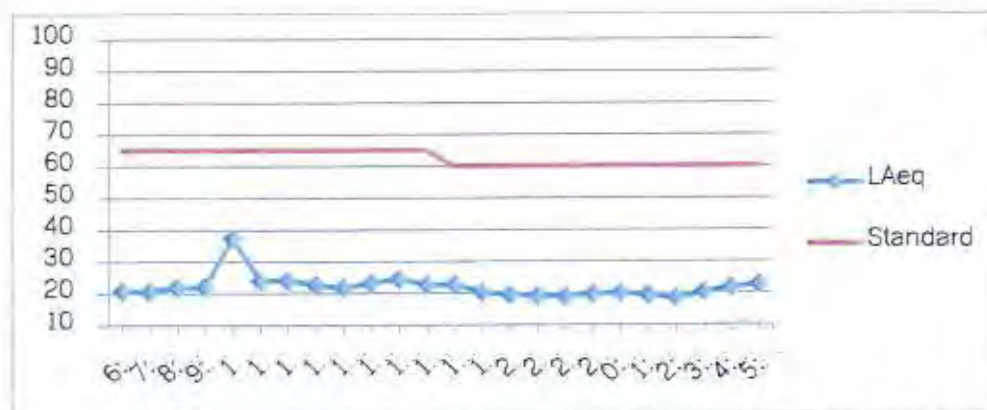


Figure 4-13 Vibration Level in the Suburbs of Serei Saophoan City (National Road No.5, KP 356)

(Survey Date: 06 Aug 2011)

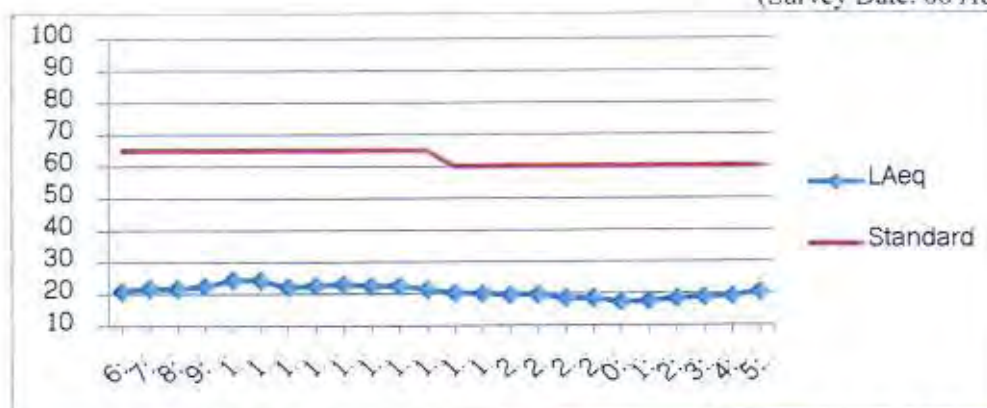


Figure 4-14 Vibration Level at Planned Intersection of National Road No.57 with Battambang Bypass

(Survey Date: 08 Aug 2011)

Followings are noted on the surveyed noise level and vibration level:

- Vibration level is well below Cambodian environmental standard at all of three locations.
- On the other hand, noise level during night time exceeds standard for "Commercial and service areas and mix".

The high noise level during night times may be attributed to the following facts:

- There was noise from a generator of Health Department of BMCH Province near KP 356.
- There was noise from Karaoke, voice of people and noise from heavy trucks at KP 300.
- At intersection of NR-57 with BTB Bypass, heavy trucks which park on the road for two to three minutes to pay money for the road maintenance of NR-57.

These facts mean that background noise levels along the project roads are considerably high because

4.1.8 Water Quality

(a) Standard of Cambodia

Sub-Decree on Water Pollution Control, 1999 stipulates the standards for water quality for rivers and lakes/reservoirs.

Table 4-18 Standard for Water Quality

1: River

No.	Parameter	Unit	Standard Value
1	pH	mg/l	6.5 – 8.5
2	BOD ₅	mg/l	1 – 10
3	Suspended Solid	mg/l	25 – 100
4	Dissolved Oxygen	mg/l	2.0 - 7.5
5	Coliform	MPN/100ml	< 5000

2: Lakes and Reservoirs

No.	Parameter	Unit	Standard Value
1	pH	mg/l	6.5 – 8.5
2	COD	mg/l	1 – 8
3	Suspended Solid	mg/l	1 – 15
4	Dissolved Oxygen	mg/l	2.0 - 7.5
5	Coliform	MPN/100ml	< 1000
6	Total Nitrogen	mg/l	1.0 – 0.6
7	Total Phosphorus	mg/l	0.005 – 0.05

Source: Sub-Decree on Water Pollution Control, 1999

(b) Field Survey

Location of sampling and items of analysis

Samples of water were taken from two rivers and one stream; Steung Sangkae River flowing in and around the City of BTB, O Ta Ke Stream, flowing through the Town of Thma Koul about and SteungSS. These rivers/stream were chosen because they are major rivers in the Project Area flowing into Tonle Sap Lake which cross NR-5 (and planned bypasses).

In each river/stream, samples were taken at two points; crossing point of NR-5 or the bypass with the river/stream. Figure 4-15 shows location of these rivers and a stream and point of sampling. Table 4-19 shows detailed data of locations of sampling for water quality.

Items which were analyzed are acidity/alkalinity (pH), Total Suspended Solid (TSS), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand.



Figure 4-15 Location of Rivers/Stream of Water Quality Survey and Location of Sampling

Table 4-19 Detailed Data of Location of Water Sampling

Table 4-19 Detailed Data of Location of Water Sampling

No.	Name of River/Stream	Road & Location	UTM		Administrative Unit			
			Above: X	Below: Y	Village	Commune	District	Province
1	Steung Sangkae	Proposed BTB Bypass	0304487	1443038	Kampong Ampil	Voat Ta Moeum	Sangke	BTB
2	Steung Sangkae	Proposed BTB Bypass; 2km downstream	0305053	1444942	Voat Kor	Voat Kor	Sangke	BTB
3	O Ta Ke	Thma Koul: NR-5, KP305	0295600	1454924	Popeal Khe	O Ta Ke	Thma Koul	BTB
4	O Ta Ke (Confluence point with O Khse Ralous)	Thma Koul: NR-5, KP305, 2km downstream	0297008	1456004	Tras Or Khse Lous	O Ta Ke	Thma Koul	BTB
5	Steung Serey Saophoan	SS: NR-5, KP358;	0281642	1501542	Prey Reusse	Preah Ponlea	SS	BMCH
6	Steung Serey Saophoan	SS: NR-5, KP358; 2km downstream	0282272	1503431	Ta Tong	Preah Ponlea	SS	BMCH

Results of Survey

Table 4-20 shows the results of survey. Almost all the data, except TSS/SS in Steung Sangkae River at the site of proposed bridge of BTB Bypass, are within the Cambodian standard.

Table 4-20 Result of Water Quality Analysis in the Project Site

No.	Location	Date	pH	TSS/SS (mg/l)	BOD (mg/l)	COD (mg/l)
1	Steung Sangkae River, at proposed bridge of BTB Bypass	09 Aug 2011	8.0	120	0.4	1.9
2	Steung Sangkae River, 2km downstream from the proposed bridge	09 Aug 2011	8.0	96	0.6	2.0
3	O Ta Ke Stream at e bridge of KP 305, NR-5 in Thma Koul	08 Aug 2011	7.6	94	0.9	2.5
4	O Ta Ke River, 2km downstream from the bridge in Thma Koul	08 Aug 2011	7.3	86	1.0	3.2
5	Steung SS River, KP 358, NR-5(at bridge)	08 Aug 2011	8.0	46	2.1	4.6
6	Steung SS River, KP 358, 2km downstream from the bridge	08 Aug 2011	7.5	42	1.7	4.0
	Method/Equipment	EC & TDS meter				
	Standard of Cambodia*	6.5-8.5		Method 2540 D	Method 5210 B	JIS K
		-		25-100	1-10	-

*Water Quality Standard in Public Water for Aquatics Biodiversity Conservation, Sub-Decree on Water Pollution Control, 1999

Cross section of river/stream and velocity of flow

As reference, cross sections and flow velocities of the rivers/stream were measured at the points where water samples were taken. These data are shown in Appendix 4-1.

4.1.9 Waste

(a) Battambang Province

According to the Environmental Department of BTB, the approximate amounts of rubbish are as summarized below:

- BTB City : 80t/day (8-10t/day from road side of NR-5)
- Thma Koul District : 50t/day (3t/day along NR-5)
- Other area along NR-5 : 1t/day

This rubbish is collected 3 times every day by CINTRI (Cambodia) Ltd, Cambodia.

(b) Banteay Meanchey Province

According to the Environmental Department of BMCH, approximate amounts of rubbish are as summarized below:

- SS City : 43t/day
- Mongkol Borei Town : 1.2t/day (6t/5days)

This rubbish is disposed to dump sites in Phnom Thom, Chamkar Lol Village, about 10km away from Mongkol Borei Town. The rubbish was transported by the Haga E Ya (Private Company).

In addition, local people dispose rice husk at the rice field and free land along NR-5 from Banteay Neang Market near the BTB border. Rice husk is also burnt by the local farmers.

Furthermore, there is humid waste and other waste of 1.5-2 tons along NR-5 that are not collected or burnt and remain there for considerable period of time.

4.1.10 Malodor

Currently, offensive odor is coming from landfills and market where local people dispose garbage and discharge the sewage. In addition, some rivers and streams emit bad smell because local people dispose garbage into the water.

4.1.11 Subsidence

There has been no report on land subsidence in BTB Province and BMCH Province.

4.2 Natural Environment

The project area is located at the Southern-Western border of Tonle Sap Lake which is well-known as the largest freshwater inland lake in South-East Asia. In the flood season, especially from September to November, expanded lake area due to flood water coming from Mekong to Tonle Sap approaches to vicinity of NR-5. Therefore, it could be said that the project area has gentle and transitional relation to natural environment of Tonle Sap ecosystem.

On the other hand, there is no integrated study on natural environment in the project site; therefore, this EIA study is based on limited interview survey in the project site and information from International Union for Conservation of Nature (IUCN) Cambodia, the Royal University of Phnom Penh (RUPP), and the WWF in Cambodia. Even in above institutions, there are no record of study and related data on natural environment in/nearby the project area.

In above conditions, RUPP provided some information and data to complement the result of interview survey as marked in the table of species in following paragraph. The IUCN Cambodia also provided IUCN Red List of threatened species for reference.

4.2.1 Protected Areas

In Cambodia, protected conservation areas cover around 5.4million ha. There are 7 national parks, 9 wildlife sanctuaries, 3 protected landscape areas, and 3 protected areas. The national parks are located in the coastal zone, the mountainous areas, and cover 742,300 million ha in total. Wildlife sanctuaries in these regions cover 4.138 million ha. The protected landscapes area covers 97,000 ha. Archaeological and cultural sites and protected areas cover 403,900 ha.

In general, Right of Way (ROW) and its surrounding area of NR-5 has been already cultivated and developed for human activities with variety of land use form, such as agricultural land, residential area, commercial spots, and so on. Therefore, there is not specified environmental protected area within NR-5 project site. However, there are wetlands as natural habitat of agro-ecosystem, and eastern side of NR-5 has indirect connection to Tonle Sap Lake Biosphere.

Table 4-16 and Table 4-21 show each location and information of protected area comparatively near to NR-5 Project section which regulated by *Law on Protected Area* (2008).

The Law defined protected areas as below:

- (i) National parks
- (ii) Wildlife sanctuaries
- (iii) Protected landscapes
- (iv) Multiple use areas
- (v) Ramsar sites
- (vi) Biosphere reserves
- (vii) Natural heritage sites and
- (viii) Marine parks



Source: National Report on Protected Areas and Development⁶

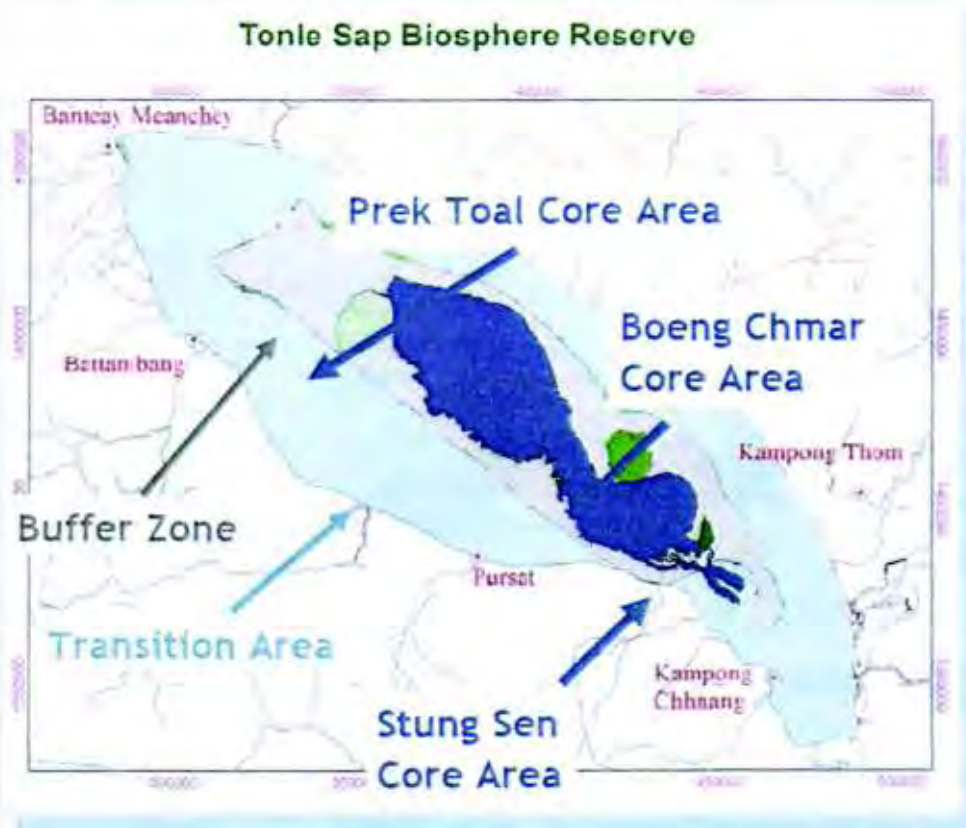
Figure 4-16 Location Map of Protected Area

⁶The PAD Partnership, "Review of Protected Areas and Development in the Four Countries of the Lower Mekong River Region: Cambodia National Report on Protected Areas and Development", 2003

Table 4-21 Basic Information on Protected Area near to National Road No.5

Name	Management Type	Size (ha)	IUCN Category	Distance from NR-5
Roniem Daun Sam	Wildlife Sanctuary	178,750	III	Far
Samlaut	Multiple Use Area	60,000	III	Far
Phnom Somkos	Wildlife Sanctuary	333,750	IV	Far
Cardamom Mountains	Protected Forest	402,000	-	Far
Phnom Aural	Wildlife Sanctuary	253,750	III	Partially near
Tonle Sap	Multiple Use Area	316,250	IV	Partially near

The Tonle Sap Lake (Great Lake) is the largest freshwater lake in Indochina Region, with the area of 2,500-3,000 km² in the dry season, and 10,000 - 15,000 km² in the flooding season. The area surrounding the lake was set as Tonle Sap Biosphere Reserve (TSBR) in 1997 under UNESCO's initiative. TSBR spans almost 1.4 million ha (8% of Cambodia's total area) and includes the lake and most of the surrounding area bordered by the NR-5 and NR-6. The area has (1) Core areas, (2) Buffer areas, and (3) Transition areas as shown in the Figure 4-17 and Table 4-22. In general the project site (NR-5) has some distance from core zone of TSBR including flooding forest where the vulnerable species are living.



Source: Government Boucher TSBR funded by ADB, TSBR Secretariat⁷
Figure 4-17 Location Map of Tonle Sap Biosphere Reserve

⁷ Dr. Neou Bonheur, Tonle Sap Biosphere Reserve Secretariat (TSBRS), "The Tonle Sap Biosphere Reserve" (Brochure), funded by ADB TA: Tonle Sap Environmental Management Project (TSEMP)

Table 4-22 Tonle Sap Biosphere Reserve

Category	Size (ha)	Environmental Characteristics	Province & District
Core Areas	43,000	Strictly protected; - Flood forest - Water bird - Freshwater Fish - Reptiles	- Koh Chiveang Commune, Ek Phnom District, BTB Province - Peam Bang Commune, Stong District, Kampong Thom Province - Phat Sanday Commune, Kampong Svay District, Kampong Thom Province
Buffer Areas	541,482	Used for Environmental education, tourism, and etc.	Outside of flood forest
Transition Areas	899,600	Flexible for development for economic activities	Southern edge with NR-5

Source: Royal Decree on the Establishment and Management of Tonle Sap Biosphere Reserve (2001)

Transition Areas where NR-5 makes border edge is defined as below;

"Transition area may contain a variety of agricultural activities and human settlements. Here all stakeholders have to cooperate to achieve sustainable development."

4.2.2 Flora

(a) Forest

Forest area in Cambodia is classified into (1) Concession Forests and (2) Protected Forests, however, there are no remarkable forest zone along NR-5 Project section because of high level land use by human activities. The two main forest area located nearby to NR-5 are below;

Cardamom Mountains:

Where wild life is widely confirmed in the area of Southern-Eastern side of NR-5, however, it may not be affected directly by the project because of the distance and connectivity. Illegal logging from these protected is one of the urgent social issues to be solved.

Tonle Sap Lake:

Well known as rich flooding forest where about 200 species of plants have officially been recorded, and much species still left to be discovered.

(b) Vegetation

Vegetation along the NR-5 is mainly agricultural crops such as; rice, fruit trees including palms, vegetables and some areas are covered with shrubs, grasses and sparse trees.



Photo: National Road No.5 North Section (a sample of road side vegetation)

On the other hand, the area where annual flood comes periodically and wetland area are observed along NR-5 with typical fresh water vegetation same as the Mekong Delta region. Northern-Western side of NR-5 is the border of Transition Areas of Tonle Sap Biosphere Reserve where development activities are flexibly admitted.

4.2.3 Fauna

There are not so many kinds of animal species in the project site because the area is generally very narrow right of way (ROW) along the existing national road. However, there is possibility to find wild animals that depends on habitats nearby NR-5, especially in the section of new alignment for the bypass. There has not been conducted comprehensive study to confirm fauna along NR-5, therefore, the Survey implemented interview survey to local residents. Because the answer (name of species) from local people is sometime not so sophisticated, some local name could not be written in English and/or Scientific name. In this background, the list of species below does NOT mean such species have officially or scientifically confirmed or found in the just area of the project site. It could be said that there are some degree of possibility to find such kind of fauna and species in or near the project site.

(a) Amphibian and Reptile

According to interview with local people along NR-5, there are some amphibian species as describe in the Table 4-23. There is no strictness on the result of interview, however, there might be some sort of Amphibian and Reptile species including frog, snake, tortoise which depends on wetland in the vicinity of NR-5.

Table 4-23 Amphibian and Reptile Species Which Exist in the Project Area

No.	Khmer Name	English Name	Scientific Name	IUCN Category
1	Kangkobbob ¹	Rugulose bullfrog ²	Hoplobatrachus rugulosus ²	LC
2	Kingkook	Common Asian toad ¹	Bufo melanostictus ¹	LC
3	Kanchanchek	Tree frog ¹	N/A	*
4	Thlain	Skink ¹	N/A	*
5	Banguoy Slab	Gliding lizard ¹	N/A	*
6	Bankuoy Thamada	Fence lizard ¹	N/A	*
7	Bankuoy Snaeng	Horned lizard ¹	N/A	*
8	Puos Prey	Chinese Ratsnake ³	Ptyas korro ¹	N/A
9	Puos Khiev	Bleu snake ⁴	N/A	*
10	Kantheay	Asian softshell turtle ¹	Amyda cartilaginea ⁵	Vulnerable
11	Andaeuk Toek	Turtle ⁴	N/A	*

Source: interview with local people, August, 2011 (Khmer)

1 Royal University of Phnom Penh, Cambodia, Center for Biodiversity Conservation.

2 Neang, T. & Holden, J. (2008). *A Field Guide To The Amphibians of Cambodia*, p. 87, Fauna Flora International, Phnom Penh, Cambodia.

3 http://en.wikipedia.org/wiki/Ptyas_korros

4 Translated word by word from Khmer

5 Bryan L. S., Peter P. v. D., Douglas B. H. (2001). *Photographic Guide to the turtles of Thailand, Laos, Vietnam and Cambodia*, p.32, Wildlife Conservation Society, ISBN 0-9632064-6-X 5.00

6LC: Least Concern (Not yet threatened or endangered)

* Unable to check due to insufficient information of scientific name of the species.

(b) Birds

According to interview with local people along NR-5, there are some wild birds as described in the Table 4-24. There might be some sort birds which migrates across the NR-5 between Tonle Sap Lake and western mountainous area. In the flooded forests of Tonle Sap Lake next to the project site, there are around 100 species of birds, of which at least 16 belong to species of globally threatened according to IUCN ranking. Pelicans, storks, ibis, darters and cormorants nest in the flooding forests.

Table 4-24 Bird Species Which Exist in the Project Area

No.	Khmer Name	English Name	Scientific Name	IUCN Category
1	Pro Voeuk	Lesser Whistling-duck	<i>Dendrocygna javanica</i>	LC
2	Lolok Bay	Spotted Dove	<i>Streptopelia chinensis</i>	LC
3	Lolok Slab Beytang	Emerald Dove	<i>Chalcophaps indica</i>	LC
4	Sarikakeo Vong	Common Hill Myna	<i>Gracula religiosa</i>	LC
5	Popech Trocheakchnoth	Streak-eared Bulbul	<i>Pycnonotus blanfordi</i>	LC
6	Chab Tet	Common Tailorbird	<i>Orthotomus sutorius</i>	LC
7	Kruoch	Partridge	N/A	-
8	Krouch ourt	Barred Buttonquail	<i>Turnix suscitator</i>	LC
9	Sek Krech	Vernal Hanging Parrot	<i>Loriculus vernalis</i>	LC
10	Kroling Kroloung	Black-collared Starling	<i>Sturnus nigricollis</i>	LC
11	Chab Kanlong	Olive-backed Sunbird	<i>Nectarinia jugularis</i>	LC
12	Chab Dangkov	Prinia	<i>Prinia sp.</i>	LC
13	Chab Dangko Loeung	Yellow-bellied Prinia	<i>Prinia flaviventris</i>	LC
14	Chab Kanlong Phloeung	Fire-breasted Flowerpecker	<i>Dicaeum ignipectus</i>	LC
15	Chab Kanlong Khiev	Purple Sunbird	<i>Nectarinia asiatica</i>	LC
16	Chek Tum	Black-naped Oriole	<i>Oriolus chinensis</i>	LC
17	Tradav Toch	Green Bee-eater	<i>Merops orientalis</i>	LC
18	Sek Sork	Red-breasted Parakeet	<i>Psittacula alexandri</i>	LC
19	Sek Soam	Alexandrine Parakeet	<i>Psittacula alexandri</i>	LC
20	Antep Khmao	Black Drongo	<i>Dicrurus macrocerus</i>	LC
21	Papol Kbal Beytang	Orange-breasted Green Pigeon	<i>Treron bicincta</i>	LC
22	Tea Toeuk	Water duck**	N/A	-
23	Mean Toeuk Khmao	Common Moorhen	<i>Gallinula chloropus</i>	LC
24	Ka Ek	Large-billed Crow	<i>Corvus macrorhynchos</i>	LC
25	Ta Vao	Asian koel	<i>Eudynamis scolopacea</i>	LC
26	Khleng Srak	Common Barn Owl	<i>Tyto alba</i>	LC
27	Chab Srok	Plain-backed Sparrow	<i>Passer flaveolus</i>	LC
28	Chab Phtas	Eurasian Tree Sparrow	<i>Passer montanus</i>	LC
29	Chab Krok	Striated Grassbird	<i>Megalurus palustris</i>	LC
30	Porpich	Bulbul	<i>Pycnonotus sp.</i>	LC
31	Kha Ek Teouk	Cormorant	<i>Plalacrocorax sp.</i>	-

LC: Least Concern (Not yet threatened or endangered)

Source: Interview with local people, August 2011.



Figure 4-18 Important Birds Area

Wetlands along NR-5 including ponds and small rivers running into Tonle Sap Lake have direct or indirect connection to Tonle Sap aquatic ecosystem. Especially in the flooding season, water from the Tonle Sap Lake gives indirect influences to the area of eastern side of NR-5 which nominated as the transitional zone of Tonle Sap Biosphere Reserve. Over 200 species of fish occupy the Tonle Sap.

Tonle Sap is also well known as traditional fishing which is one of the most important income sources of the region. In the flooding season, the fishing area (community fishing lots) are located by NR-5 closely (Figure 4-15).

⁸Hout, S. K., Bunnat, P., Poole, C. M., Torodoff, A. W., Davidson, P. & Delattre, E., Directory of Important Bird Areas in Cambodia – Key Sites for Conservation, 2003

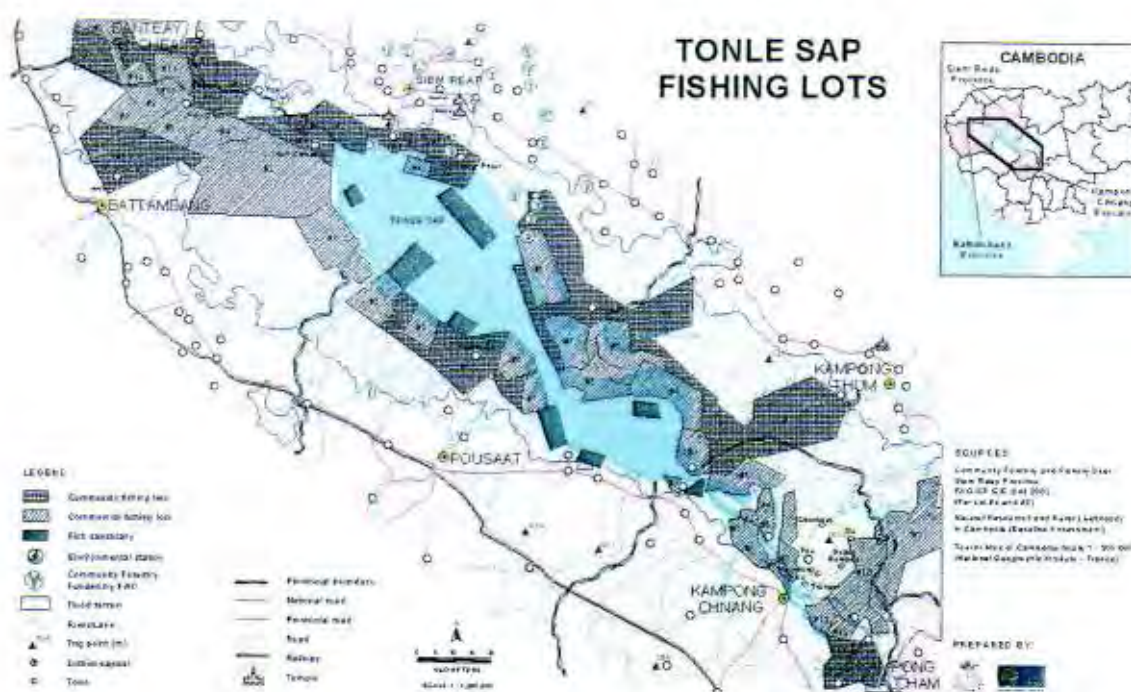


Figure 4-19 Tonle Sap Fishing Lots and Location of National Road No. 59

According to the field observations and interview with local people in the Project Area, there are some fish species in the Steung Sangkae River, O Ta Ke Stream and Steung Serey Saophoan River such as Trey Angdeng, Trey Chhlonh, Trey Sa, Trey Chhpin, Trey Kanhchos, etc. Common fish that can be found are given in the Table 4-25 below.

Table 4-25 Fish Species Which Exist in the Project Areas

No.	Kbmer Name	English Name	Scientific Name	IUCN Category
1	Trey Kampleanh Sre	Three spot gourami	Trichogaster trichopterus	N/A
2	Trey Changva	Barilius nanensis	Opsarius koratensis	N/A
3	Kampeus	Oriental river Prawn**	Macrobrachium nipponese	N/A
4	Trey Changvamol	Kottelat rasbora	Rasbora hobelmani	N/A
5	Trey Chhlat	Bronze featherback	Notopterus	N/A
6	Trey Realtob	Siamese mud carp	Cirrhinus siamensis	N/A
7	Trey Chhpin	Java barb (Silver barb)	Barbonymus gonionotus	N/A
8	Trey Sa	N/A	N/A	*
9	Trey Kanhchos Thmar	Asian bumblebee catfish	Pseudomystus siamensis	N/A
10	Trey Chhlaing	Asian redbtail catfish	Hemibagrus sp.	N/A
11	Trey Andeng Tun	Broadhead catfish	Clarias macrocephalus	Near Threatened

*FAO and ASIA Forest Network, Patrick T. Evans, Melissa Marschke, Kiran Paudyal, "Flood Forests, Fish and Fishing Villages Tonle Sap, Cambodia", 2004

No.	Khmer Name	English Name	Scientific Name	IUCN Category
12	Trey Andeng Roeung	Walking catfish	Clarias batrachus	LC
13	Trey Kesh	Reddish sheatfish	Kryptopterus bleekeri	N/A
14	Trey Kranh	Climbingperch	Anabas testudineus	Data Deficient
15	Trey Changva Neang	N/A	Garra fasciacauda	N/A
16	Antung	Onegilled eel	Ophisternon bengalense	LC
17	Trey Khachhoeung	Frecklefin eel	Macrogathus maculatus	N/A
18	Trey Chhlonh	Peacock eel	Macrogathus siamensis	N/A
19	Trey Kantrab	Catopra	Pristolepis fasciata	LC
20	Trey Krola Bey	N/A	N/A	*
21	Trey Chhdov	Giant snakehead	Channa micropeltes	N/A
22	Trey Tra Auon	Borneo glass catfish	Ompok engeneiatus	N/A
23	Trey Phork	Snakehead murrel	Channa striata	LC
24	Kdam	Crab	N/A	*
25	Trey Kroem Kdam	Croaking gourami	Trichogaster vittata	N/A

Source: Interview with local people, August, 2011

English and Scientific name source: Fisheries diary 2012, Regional Fisheries Livelihoods Programme for South and Southeast Asia (RFLP)

* Unable to check due to insufficient information of scientific name of the species.

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4.2.4 Hydrology

There are many rivers and streams in the Project area, as shown in Figure 4-20. Depths and flow velocities of three of these rivers and streams are shown in Appendix 4-1, as reference.

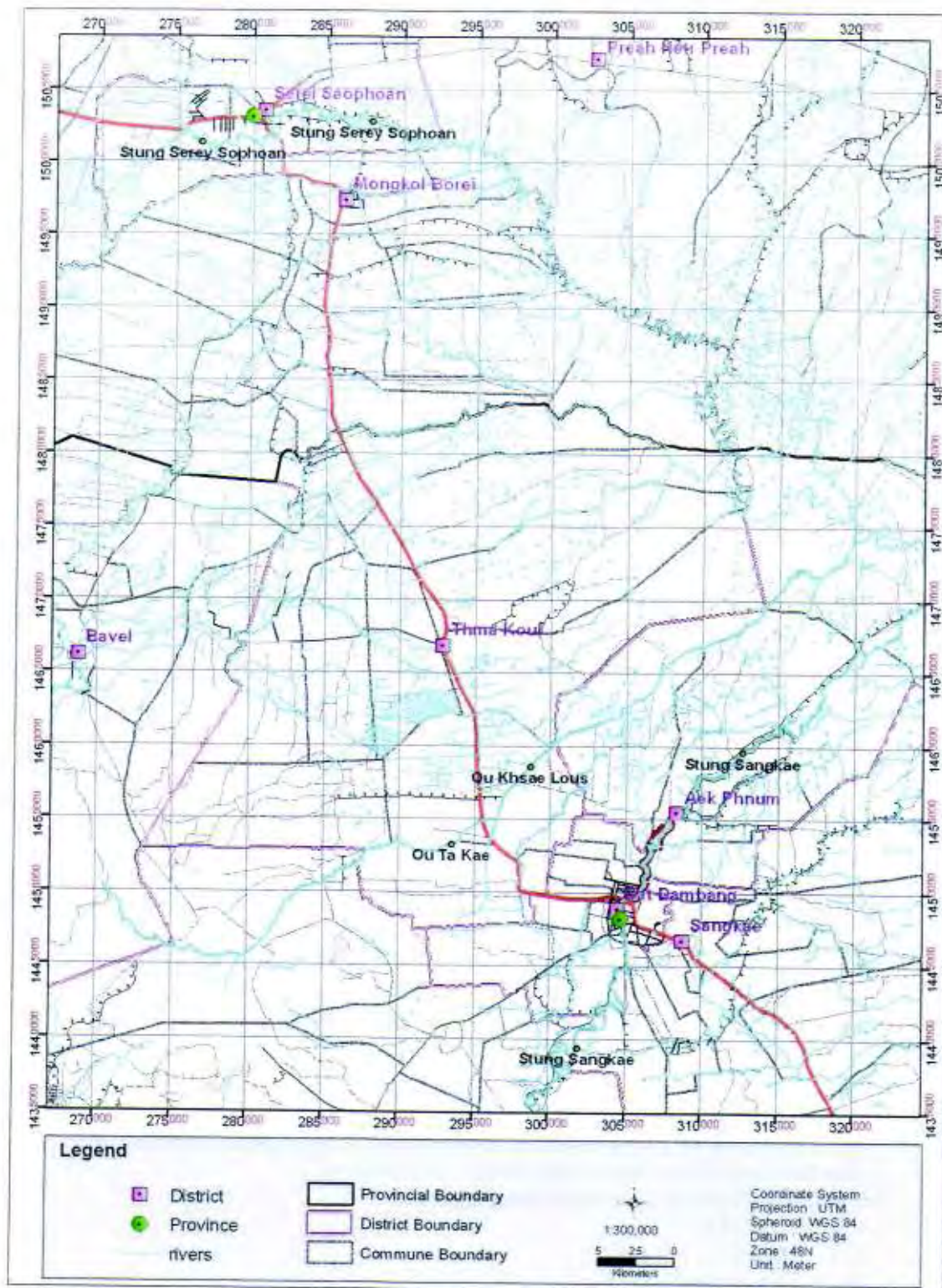


Figure 4-20 Rivers and Streams in Project Area

5. ENVIRONMENTAL IMPACTS EVALUATION

5.1 Introduction

The Project of widening of BTB – SS Section of NR-5 and construction of bypasses around BTB and SS was described in Chapter 3. Taking into account the natural environment and social condition along the road, the environmental impacts are identified, evaluated and expressed in the context of pollution, natural environment, social environment and other points of view.

5.2 Potential of Environmental Impacts and Scoping Matrix

5.2.1 Methodology

Environmental assessment of the project is carried out in three main steps. These are:

- (i) Identification of potential impacts
- (ii) Evaluation and assessment of the impacts in terms of their significance
- (iii) Identification/proposition of mitigation measures for minimizing the effects of significant impacts.

5.2.2 Identification of Potential Environmental Impacts

Impact identification is made based on the analysis of project specifications and baseline information collected in the field, literature reviews, scoping meetings and internet searches of similar projects, as well as information regarding project components.

Potential impacts identified in the scoping stage are concerned with the pre-construction, construction and service stages, including:

- Air and noise emissions;
- Vibration impacts;
- Waste;
- Water quality;
- Impacts on traffic;
- Health impacts;
- Visual impacts;
- Land acquisition and resettlement;
- Socio-economic impacts;
- Utility relocation;

The Scoping Matrices (Tables 5-1 to 5-3) are designed so that the key potential impacts associated with the project become apparent. The layout of the matrix is as follows:

- The “x” axis of the matrix consists of a list of activities associated with pre-construction, construction and service stages.
- The “y” axis consists of the resources and receptors susceptible to impacts categorized as pollution, natural environment and social environment aspects. Identified resources and/or receptors are:
 - Air quality;
 - Water;
 - Soil Contamination;
 - Waste;
 - Noise and Vibrations;
 - Subsidence;
 - Malodor;

- Global warming;
- Topography;
- Sedimentation;
- Ecosystem;
- Hydrology;
- Natural reserve.

The identified potential impacts are classified into the following categories according to their magnitude and positivity or negativity.

“A-”: Big negative impact, “A+”: Big positive impact

“B-”: Substantial negative impact, “B+”: Substantial positive impact

“C”: Impacts which are not clear and need more investigation, and

“D”: No impact or impacts are negligible and no further study is required.

However, this is a general classification since the impacts are not applicable to all areas of project implementation but rather to specific locations containing sensitive receptors.

5.2.3 Evaluation and Assessment of Impacts

Potential impacts are subject to a process of impact evaluation, based on the analysis of the proposed project components and activities, in order to determine the significance of the different impacts. Impact evaluation is made based on pre-set criteria including:

- Magnitude of the impact (high, medium, low)
- Impact duration (short term, medium, long term)
- Reversibility of the effect on receptor.
- Spatial extent (local, regional or national)
- Sensitivity or importance of the receptor.

The impact evaluation also takes into consideration the mitigation measures included in the planning and design to which the project proponent is committed. This is in addition to measures of good international practice.

Significant effects occur where resources are valuable or sensitive resources, or where numerous receptors are subject to effects of considerable magnitude. Contrarily, effects are unlikely to be significant where resources are of low-value or non-sensitive resources, or small numbers of receptors are subject to only minor effects.

5.2.4 Environmental Scoping Matrix

Tables 5-1, 5-2 and 5-3 are the environmental scoping matrices for widening of NR-5 (BTB – SS Section), construction of BTB Bypass and construction of SS Bypass, respectively.

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	Item	Negative Impact										Positive Impact					
		PS			CS				SS			CS			SS		
	Resettlement																
2	Local Economy as Employment and livelihood		D										A ⁺		A ⁺	A ⁺	
3	Land use and local resources		D												B ⁺	B ⁺	
4	Community organization including organization for local governance		B ⁻								B ⁻				D	D	
5	Existing Infrastructure		D								B ⁻				A ⁺		
6	Poor, indigenous, minority people		B ⁻								D				D	D	
7	Uneven distribution of harm and benefit		A ⁻														
8	Confrontation of																
	Overall Rating		A ⁺														

	Positive Impact																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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Item	9	Gender	Children's right	Cultural heritage	Risks for infectious disease such as AIDS/HIV	Landscape	Working environment	I	Accident	Other	Enhancement of economic activities along the road and local economy (including the access to the market for transport agro-products)	B+																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								</

Rating: A-: Big Negative Impact A+: Big Positive Impact C: Impacts are not clear, need more investigation.

B-; Certain Negative Impact

B+: Nature of positive and negative impacts are different, or those who are subject to impacts are different.

Table 5-2 Scoping Matrix: Battambang Bypass

	Item	Negative Impact										Positive Impact						
		PS		CS						SS			CS			SS		
		Deterioration of Life due to Resettlement	Land Acquisition, vanishing of Buildings	Inflow of construction worker, setting up camp for work	Construction of Bypass	Movement of Construction Vehicles/Machine	Setting up temporary facilities	Traffic movement on the Bypass	Increment of population along the road	Increment of commercial establishment and economical activities	Increment of traffic accident	Inflow of construction worker, setting up camp for work	Construction of Bypass	Movement of Construction Vehicles/Machine	Decrease number of through traffic into the city and intercity traffic	Decrease the traffic congestion and accidents in the city	Shortening of travel time	Enhancement of economic activities along the road and local economy (including the access to the market for transport agro-products)
1	Air			B-	B-	B-		B-	B-	B-				B+	B+			
2	Water			C	C	C	C		C									
3	Soil Contamination			D	D	D	D	D	D	D								
4	Waste			B-	B-	D	B-	B-	B-	B-								
5	Noise/Vibration			D	D	D	D	D	D	D				B+				
6	Subsidence			C	C				B-	B-				B+	B+			
7	Malodor			B-	B-	B-	B-	B-	B-	D					B+	B+		
8	Global warming			B-	B-	B-		B-	B-	B-								
1	Topography			B-	B-													
2	Sedimentation			B-	B-		B-											
3	Ecosystem			B-	B-		D	B-	B-									
4	Hydrology			C	C													
5	Natural preserve			D	D		D											
1	Involuntary Resettlement	B-	B-	B-														

Item	Positive Impact									
	CS			SS						
2	Local Economy as employment and livelihood	A+								
3	Land use and local resources	A+								
4	Community organization including organization for local governance	A+								
5	Existing Infrastructure	A+								
6	Poor, indigenous, minority people	B+								
7	Uneven distribution of harm and benefit	A-								
8	Confrontation of stakeholders	B-								
9	Gender	B+								
10	Children's right	B-								

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Item	Negative Impact				Positive Impact			
	PS		CS		CS		SS	
	Deterioration of Life due to Resettlement	Land Acquisition, vanishing of Buildings	Inflow of construction worker, setting up camp for work	Construction of Bypass	Movement of Construction Vehicles/Machine	Decrease the traffic congestion and accidents in the city	Shortening of travel time	Enhancement of economic activities along the road and local economy (including the access to the market for transport agro-products)
11 Cultural heritage			D				D	
12 Risks for infectious disease such as AIDS/HIV			B-				B+	
13 Landscape								
14 Working environment			B-				A+	A+
1 Accident	D			B-			A+	
Other								
Overall Rating								
D								
B-								
D								
B+								
B-								

• **Rating:** A-: Big Negative Impact A+: Big Positive Impact C: Impacts are not clear, need more investigation

B-: Substantial Negative Impact

B+: Substantial Positive Impact

D: No impact, or Impacts are negligible, no further study required.

5.3 Positive Impacts

Based on project components and the existing environmental conditions, it is anticipated that the project would provide a set of long-term positive impacts on a number of key environmental and socio-economic factors. Positive impacts include: *Environmental factors such as improved air quality, reduced noise/vibration disturbance* due to reduction of traffic and resultant reduction of traffic congestion in BTB City and SS City as the project is providing an alternative route (bypasses). Also widening of NR-5 is expected to reduce traffic jams on NR-5 and reduce air pollution.

Further, smooth traffic produced by widening of NR-5 and construction of bypasses is expected to *promote growth of national and regional economy*.

5.4 Reason of Assessment of Impacts and Mitigation Measures

5.4.1 Narrative Explanation of Assessment of Negative Impacts

Impacts of the Project and their magnitudes are identified as shown in Tables 5-1 to 5-3. The reasons for such assessment are summarized in Tables 5-4 and 5-5.

5.4.2 Mitigation Measures

The negative impacts can be avoided or mitigated, for example, by adopting good engineering practices. These measures shall be incorporated in the plan/design of the activities in the pre-construction, construction and service stages. Mitigation measures for the negative impacts are described in the right-most column of Tables 5-4 and 5-5. Naturally, mitigation measures are proposed only for negative impacts.

5.4.3 Widening of North Section of National Road No.5

Reason of assessment of impacts and their mitigation measures are as described in Table 5-4:

Table 5-4 Reason of Assessment and Mitigation Measures for Widening of North Section of National Road No.5

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
1-Pre-construction and Construction Stages			
A- Physical Environment (Pollution)			
Air pollution	B-	Emission from construction equipments, dust arisen by construction activities, and air pollutant due to traffic congestion during construction stage are anticipated.	Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that these are in adequate working conditions. Regular maintenance service of construction equipment and machineries shall be practiced and machineries shall strictly comply with the national standard. Proper work schedules should be prepared considering not to concentrate the construction equipment at a certain point for long time. Water shall be sprayed during construction, particularly in town and villages, to ensure that dust is minimized throughout the construction zone.
Waste	B-	Solid waste and polluted water are anticipated to be produced by construction activities.	Contractor shall be required to facilitate proper re-use and disposal plan, and manage the construction waste. Because the surplus soil containing bentonite may cause negative impact on drainage condition in agricultural land; the proper disposal site should be selected at the next stage. Bitumen, diesel and waste oil shall be handled and stored carefully to prevent leakage or spill. Waste oil shall be collected, stored in drums and disposed at a site approved by the Engineer (according to provincial authority's advice). Waste oil storage shall be in drums, raised off the ground, covered to keep rain out and surrounded by a bund to contain any spills and simplify clean up. The Contractor shall prepare Spill Contingency Plan (including measures to be taken and equipment to be used) to ensure adequate clean-up of any spills. The supervision consultant shall monitor the waste disposal. Provincial authorities should maintain close consultation with

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Noise/Vibration	B-	Noise and Vibration arising from construction equipment/vehicle during construction stage is anticipated.	the contractor on the collection of garbage. A proper work schedules should be prepared not to concentrate the construction equipment at a certain point for long time. Noise suppressors such as mufflers shall be installed whenever deemed necessary to maintain the noise generated by the various heavy equipments and other construction machinery within permissible limits. Temporary noise barriers such as corrugated metal sheets shall be installed around the construction sites to maintain noise level within permissible level if necessary. High noise generating construction activities shall be scheduled during daytime only (06:00am – 06:00pm) to avoid noise disturbance to adjacent residential and commercial areas, and other noise-sensitive areas. Contractors will be required to use low-vibration equipped machinery whenever it is necessary. The explanation and consultation to the affected persons prior to the construction should be conducted to obtain the understanding about the potential impacts including information of the positive impacts such as promotion of the local socio-economic activity. If the local people complain about noise and vibration, the consultant of the supervision and the contractors should reconsider the construction technique. The proper countermeasures to reduce noise and vibration such as slow speed in curve sections, installation of sound barrier and adoption of expansion and contraction joint should be included in the plan and design. In residential area, the noise around the works site should be periodically monitored. If the noise level reaches a significant level such as exceeding the environmental

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Malodor	B-	There is a possibility that malodor arises from the construction equipment, particularly asphalt mixing plant, during construction.	standards, the mitigation measures on noise control should be conducted. Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that these are in the optimum working conditions. Regular preventive maintenance service of construction equipment and machinery will strictly comply with national standard of Ministry of Environment. Asphalt mixing plant shall be constructed at a location remote from residential areas.
Global Warming	B-	CO ₂ emission from construction equipment during construction stage is anticipated.	Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that they are in the adequate working conditions Regular preventive maintenance service of construction equipment will be practiced and machineries will strictly comply with the national standard. The regulation on fuel quality, importing old cars and emission gas control is to be prepared by MoE in the future. This regulation will improve the air quality, if the air pollution levels exceed significantly the standard.
Water pollution	C	Influence of bridge works on water quality of nearby rivers will be studied in the future.	Concrete casting and road surfacing shall be closely supervised to prevent spillage. All formworks shall be secured prior to casting to ensure failure will not occur. Temporary sanitation facilities such as portable toilets and garbage bins shall be provided by the contractors to ensure that the domestic wastes to be generated by the construction personals are properly handled and not thrown into the rivers or streams to prevent further pollution. Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that they are in the adequate working conditions.

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
			Regular maintenance service of construction equipment and machineries shall be implemented. Contractors will be prohibited from washing the construction tools along the rivers, streams, reservoirs and other public water to prevent further pollution. In construction works near water bodies such as O Ta Ke stream and Steung SS River, the supervision consultant and contractor should monitor and control the turbid water as necessary.
Land subsidence	C	There are soft ground areas along the proposed road. Subsidence is anticipated near the road caused by the weight of additional embankment which is added to the existing road for widening. Further study will be conducted in detailed design stage.	The consultant of supervision and contractor should monitor the ground subsidence. If the ground subsidence occurs, the consultant and contractors should reconsider the construction technique.
Soil Contamination	D	There is a possibility that newly filled soil on the proposed widening of road may be eroded and flow into the nearby agricultural land. However, the area of impact is limited and recovery to original condition is possible by removing the eroded soil.	
B-Natural Environment			
Topography/Geography	B-	Existing National Road No.5 is of embankment structure in general. There will be some alteration of topography as additional embankment will be constructed on the both sides, or one side, of existing road for widening of the road. There may be temporary changes in topography during construction stage as temporary construction facilities may be set up on a temporary embankment.	New slopes of additional embankment shall be covered by vegetation as soon as possible to recover similar view. Temporary embankment for construction facilities shall be removed and original topography is recovered as soon as the facility becomes unnecessary.
Sedimentation	B-	There is a possibility that filled soil will flow into the river due to heavy rain during construction stage and eventually sediment at the bottom of Tonle Sap Lake. However, impact of this is considered to be relatively small.	Embankment slopes shall be covered by vegetation as soon as possible to minimize erosion of slope. Construction will be undertaken in the dry season as much as possible.

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Hydrology	C	During construction, water flow in the river or channel may be temporarily altered, however its duration is short and area is limited. Thus, the impact is anticipated to be small. Examination on the hydrology shall be conducted during detailed design stage because it is needed for design of road drainage facilities.	Project will not change existing discharge condition. Materials will be properly disposed of so as not to block rivers, streams and watercourses.
Ecosystem	D	Proposed area is basically agricultural land and towns, and no endangered species are found in the record. Impact on the ecosystem is supposed to be minimal, except short period during construction, because the project is widening of existing road.	Compensatory planting of domestic tree species to the limited area under the elevated structures should be considered as necessary.
Natural Reserve	D	No natural reserve exists near the Project road.	
C- Social Environment			
Involuntary Resettlement	A-	Many houses/buildings and households relocation are required due to widening of National Road No.5.	Conduct census survey and local stakeholder meeting. Prepare RAP (Resettlement Action Plan) involving the following measures: PAPs (Project Affected Persons) must be acknowledged as an eligible for compensation. Identify the eligibility of non-titled people at the census survey intended to PAPs and ensure the compensation and support. Refer the previous/ongoing projects by JICA and IRC, determine the requirement for social vulnerability and compensate to them. Resettlement site must be prepared when PAPs need it. Inter-Ministerial Resettlement Committee (IRC) is responsible for solves the involuntary resettlement based on the Government policy.
Uneven distribution of harm and	A-	Under present Cambodian Law, provisions for (1) secure the payment to illegal settlers, (2) estimation for the compensation of resettlement, (3) assistance to the	Prepare RAP involving the following measure: -Assessed compensation for legal land or property ownership shall be based on the market price.

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
benefit		recovery of living are insufficient. Eventually unfairness may arise.	-Top up compensation method shall be applied. -Payment shall be carried out before resettlement. IRC will make the payment to illegal settlers due to government policy.
Community organization including organization for local governance	B-	There may be negative impact on community meeting and other community activities because of alteration of physical structure of the community (such as location of community center and relative position of houses) caused by land acquisition. Separation of community may occur due to the widened carriageway and increase of traffic volume which makes crossing the road from one side to the other makes difficult and hamper communication of the people.	Hold sufficient local stakeholder meetings in every stage and establish mutual understanding.
Existing Infrastructure	B-	There will be negative impact on the existing infrastructures including electric power line and telecommunication line which need to be relocated due to the widening of the road. On the other hand, positive impact is also expected because access to the site of such infrastructures will be improved. Also, access to public services such as hospital and school will also be improved. While the negative impacts occur only during construction and can be substantially mitigated by proper planning and implementation of relocation affected infrastructures, the positive impacts last for long period.	Social service utilities such as electric power line and telecommunication line will be diverted before starting the construction activity. Confirm the necessity of alternative sites in census survey and in case of need, secure the site.
Poor, indigenous, minority people	B-	There is a possibility that poor people may face disadvantage in the compensation for resettlement. On the other hand, job opportunities for poor people will be increase during construction such as employment as construction worker or open small businesses such as selling drinks and foods to construction workers.	Prepare RAP involving the following measure: -Define the displaced persons and criteria for determining their eligibility for compensation. IRC and provincial authorities must arrange a subsidy for poor people and vulnerable people as well as government policy to reduce poverty.

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Confrontation of stakeholders		There are no indigenous or minority people known to be living near the Project road.	Prevent or solve the conflicts through free and prior consultations between affected people and competence authorities. Encourage the cadastral registration programme.
Gender	B-	There is a possibility that conflicts arise in the roadside communities as the benefit and harm derived from the road improvement may vary among the stakeholders. At the planning stage, effort to reflect the opinion of the female on the road design is encouraged. Increase of employment opportunity for female due to the shortening of commuting time and development of economic activities in the region and improvement of daily life such as shortening of time spent going to/come back from market are also expected.	Feminine gender will be invited and join local stakeholder as well as male gender. Interview to feminine gender while in census survey will be considered. Support and take care the feminine sellers along the widening road.
Children's right	B-	Some children may face some difficulty going to school due to relocation of their houses. On the other hand, there are positive impacts such as improvement of traffic safety during going to, and coming back from, school due to separation of pedestrians and bicycles from higher speed traffic and shortening of travel time to/from school.	Secure the accessibility to go to school/hospital when select resettlement places.
Risks for Infectious disease such as AIDS/HIV	B-	Infectious disease may be brought by migrant construction workers during construction stage. On the other hand, access to large-scale hospitals will be improved resulting in improved opportunity for better treatment.	Contractor will be required to conduct a periodical health education to his personnel. Commune Health Post will conduct health education to migrant construction worker about the HIV/AIDs and other infectious disease.
Working environment	B-	Safety and sanitation, as well as third party accidents, during construction stage needs to be addressed. During construction, job opportunities for local workers will increase because there will be large demand for work force at construction site.	Construction personnel will be provided with the necessary safety gears such as protective hard hat, etc. Contractor provides the safety camps, sanitation water and food, and toilets. Contractors shall communicate with the provincial hospital in case of emergency.
Accident	B-	Construction worker or third party may be involved in the	Construction personnel will be provided with the necessary

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
		accident during construction stage. Possibility of accidents may increase during servicing stage due to increased travel speed of vehicles.	safety gears such as protective hard hat, etc. A sound traffic management and detour plans duly approved by the BTB and BMCH provincial authorities will strictly implement to minimize traffic congestions. Traffic enforcers and flagmen will be designated along the narrow road and construction site to assist in directing traffic flow.
2-Service Stage			
A- Physical Environment (Pollution)			
Air pollution	B-	Emission from traffic due to increment of vehicle during servicing stage is anticipated. On the other hand, traffic congestion will be reduced and part of increase of emission from increased traffic will be canceled out.	The regulation on fuel quality, importing old cars and emission gas control is to be prepared by MoE in the future. This regulation will improve the air quality, if the air pollution levels exceed significantly the standard. Volume of air pollutant is expected to reduce as a whole due to mitigated traffic congestion.
Waste	B-	In service stage, rubbish thrown from the vehicle may be increased because traffic volume will increase.	Provincial authorities will provide proper number of garbage bins in every bus station for users. Other shop owners must arrange the garbage bins. The waste in the service stage should be properly collected and disposed or recycled in compliance with rules in BTB and BMCH provinces.
Noise/Vibration	B-	Increase of noise and vibration during service stage is anticipated due to increase of traffic volume and travel speed of vehicles. On the other hand, noise and vibration may be improved due to smooth surface of road.	The proper countermeasures to reduce noise and vibration such as speed regulation and installation of sound barrier should be included in the plan and design. In residential area, the noise along the widening of north section of NR-5 should be periodically monitored. If the noise level reaches a significant level such as exceeding the environmental standards, the mitigation measures on noise, such as speed regulation, should be implemented.

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Malodor	B-	Malodor of exhaust gas produced by imperfect combustion of poorly maintained vehicle and exhaust gas from congested traffic are anticipated during service stage.	The Government's action to promote good maintenance of vehicles and compliance to MOE's regulation on the quality of vehicle emission gas should be implemented.
Global Warming	B-	Increment of CO ₂ emission during service stage is anticipated due to increment of traffic volume and speeding up of vehicle. On the other hand, in long term CO ₂ emission may be reduced due to reduction in traffic congestion.	The regulation on fuel quality, importing old cars and emission gas control is to be prepared by MoE in the future. This regulation will improve the air quality, if the air pollution levels such as CO ₂ exceeds significantly the standard.
Water pollution	C	There is a possibility that the water quality will be aggravated in service stage due to increase of population and economic/industrial activities in the region induced by the road improvement. However, measurement of such aggravation of water quality is difficult.	All commercial buildings and factories have to install the garbage bins and disposal the garbage into a landfill. Sewage has to go through septic tanks before being discharged into the public drainage system. The domestic wastes are strictly prohibited from being thrown into rivers and stream and collected by the local authorities or private sector and dumped the designated dump site to prevent further pollution of water.
Land subsidence	C	In service stage, there is a possibility that development of local industries will cause increase in pumping up of ground water resulting in land subsidence. However it is difficult to measure impact of road improvement.	The local authorities should consider regulate excess pumping of ground water in case land subsidence is observed.
Soil Contamination	D	There is no soil contamination during service stage.	
B-Natural Environment			
Topography/Geography	D	There is no topography impact during the serving stage.	
Ecosystem	D	Proposed area is basically agricultural land and towns, no endangered species are found by the record. Impact on the ecosystem shall be minimal because serving time stage does not affect to the ecosystem.	
Natural	D	No natural preserve near proposed road	

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Reserve			
C- Social Environment			
Community organization including organization for local governance	B-	Separation of community may occur due to the widened carriageway and increase of traffic volume and travelling speed which make crossing the road from one side to the other makes difficult and hamper communication of the people. On the other hand, positive impact that communication between the regions is strengthened due to shortening of travel time is also expected.	Install traffic signal on the sections passingurbanized areas, including Thma Koul and Mongkol Borei Town, to promote safe and easy crossing of road by pedestrians.
Confrontation of stakeholders	B-	There is a possibility that conflicts between local people and new comers occur due to increment of commercial establishment and economical activities.	Prevent or solve the conflicts through free and prior consultations between affected people and competent authorities.
Gender	B-	Women are vulnerable to risk of traffic accident which is caused by the increase of traffic volume and vehicle speed. Increase of employment opportunity for female due to the shortening of commuting time and development of economic activities in the region and improvement of daily life such as shortening of time spentgoing to/come back from market are also expected.	Feminine gender will be invited and join local stakeholder as well as male gender. Regulate speed in urbanized areas Install traffic signal and slow speed signin urbanized areas. Implement traffic safety campaign to both pedestrians and drivers.
Children's right	B-	Children are vulnerable to risk of traffic accident which is caused by the increase of traffic volume and vehicle speed. On the other hand, there are positive impacts such as improvement of traffic safety during going to, and coming back from, school due to separation of pedestrians and bicycles from higher speed traffic and shortening of travel time to/from school.	Install traffic signal on slow speed signwhere school/hospital is near. Vehicle speed shall be limited where school/hospital isnear. Implement traffic safety education to school children.
Risks for infectious disease such as AIDS/HIV	B-	In service stage, long-distance truck drivers and other transport business people may bring infectious disease. On the other hand, access to large-scale hospitals will be improved resulting in improved opportunity for better treatment.	Local authorities should implement campaign on risks of infectious disease and HIV/AIDs.

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Accident	B-	Possibility of accidents may increase during service stage due to increased travel speed of vehicles.	Regulate speed in urbanizes areas and at hazardous spots. Install traffic signal and signs in urbanizes areas and hazardous spots.
Local Economy as Employment and livelihood	A+	During service stage, economic activities will be promoted due to improvement of traffic and transportation conditions and more employment opportunities will be derived from shortening of travelling time.	
Poor, indigenous, minority people	D	Job opportunities for poor people will be increase during serving stage such as transport their agricultural products to the market and they open small businesses such as selling drinks and foods to passengers. There are no indigenous or minority people known to be living near the Project road.	
Cultural heritage	D	There is no known cultural heritage near the project road.	
Working environment	A+	In service stage, commuting time to/from work place will be shortened and fatigue during commutation will be eased owing to comfortable riding condition.	
Existing Infrastructure	A+	During this stage, positive impact is also expected because access to the site of such infrastructures will be improved. Also, access to public services such as hospital and school will also be improved.	

5.4.4 Construction of Battambang Bypass and Serei Saophoan Bypass

Impacts of BTB Bypass and SS Bypass are very similar both in nature and in magnitude. Thus, they are presented in one table to avoid redundancy.

Table 5-5 Reason of Assessment and Mitigation Measures for Battambang and Serei Saophoan Bypass

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
I-Pre-construction and Construction Stages			
A-Physical Environment (Pollution)			

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Air pollution	B-	Emission from construction equipment and dust arisen by construction activities are anticipated.	Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that they are in adequate working conditions. Regular preventive maintenance service of construction equipment and machineries will strictly comply with national standard of Ministry of Environment. Proper work schedules should be prepared considering not to concentrate the construction equipment at a certain point for long time. Water shall be sprayed to reduce the dust. Trucks carrying soils and gravels should be covered to avoid spills of soil/gravel and dust. The contractor shall prepare a dust control program. If the residents and pedestrians complain about the dust and gas, the supervision consultant and contractors should reconsider the construction method. The regulation on fuel quality, importing old cars and emission gas control is to be prepared by MoE in the future. This regulation will improve the air quality, if the air pollution levels exceed significantly the standard.
Waste	B-	Solid waste and polluted water are anticipated to be produced by construction activities.	Contractor will be required to facilitate proper re-use and disposal plan, and manage the construction waste. Because the surplus soil containing bentonite may cause negative impact on drainage condition in agricultural land; the proper disposal site should be selected. The consultant of supervision should monitor the waste disposal. Bitumen, diesel and waste oil shall be handled and stored carefully to prevent leakage or spill. Waste oil shall be collected, stored in drums and disposed at a site approved by the Engineer (according to provincial authority's advice). Waste oil storage shall be in drums, raised off the ground.

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
			covered to keep rain out and surrounded by a bund to contain any spills and simplify clean up. The Contractor shall prepare Spill Contingency Plan (including measures to be taken and equipment to be used) to ensure adequate clean up of any spills. Provincial authority should maintain close consultation with the contractor on the collection of garbage. Proper work schedules should be prepared considering not to concentrate the construction equipment at a certain point for long time. Temporary noise barriers such as corrugated metal sheets shall be installed around the construction sites near residential areas to maintain noise level within permissible level if necessary. High noise generating construction activities will be scheduled during daytime only (06:00am – 06:00pm) to avoid noise disturbance to adjacent residential areas, and other noise-sensitive areas. Contractor shall be required to use low-vibration equipped machinery whenever it is necessary. The explanation and consultation to the affected persons prior to the construction should be conducted to obtain the understanding about the potential impacts including information of the positive impacts such as promotion of the local socio-economic activity. If the local people complain about noise and vibration, the consultant of the supervision and the contractors should reconsider the construction technique. In residential area, the noise across the proposed bridge and intersection NR-57 should be periodically monitored. If the noise level reaches a significant level such as exceeding the environmental standards, the mitigation measures on noise
Noise/Vibration	B-	Noise and Vibration arising from construction equipment/vehicle during construction stage is anticipated.	

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Malodor	B-	There is a possibility that malodor arises from the construction equipment, particularly asphalt mixing plant, during construction. Such malodor may be transported by wind and reach to the urbanized area although it will be diluted.	control should be conducted. Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that they are in the optimum working conditions. Regular maintenance service of construction equipment and machinery shall be practiced and machinery will strictly comply with air quality standard of Ministry of Environment. Asphalt mixing plant shall be constructed at location remote from residential areas.
Global Warming	B-	CO ₂ emission from construction equipment during construction stage is anticipated.	Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that these are in the adequate working conditions. Regular maintenance service of construction equipment and machinery shall be practiced and machinery will strictly comply with national standard. The regulation on fuel quality, importing old cars and emission gas control is to be prepared by MoE in the future. This regulation will improve the air quality, if the air pollution levels such as CO ₂ exceeds significantly the standard.
Water pollution	C	Water quality of the Steung Sangkae River and Steung Serei Saopnoan River at the crossing points of bypasses may be influenced by construction of the proposed bridges.	Concrete castings shall be closely supervised to prevent spillage. All formworks shall be secured prior to casting to ensure failure will not occur. Temporary sanitation facilities such as portable toilets and garbage bins will be provided by the contractors to ensure that the domestic wastes to be generated by the construction personals are properly handled and not thrown into the drainage to prevent further pollution. Contractors will be required to conduct daily routine equipment and machinery check-ups to ensure that these are in adequate working conditions.

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
			Regular maintenance service of construction equipment and machinery shall be practiced. Contractors will be prohibited from washing the construction tools along the river, streams, reservoirs and other public water to prevent further pollution. In bridge construction works across the Steung Sangkae River, the supervision consultant and contractor should monitor and control the turbid water as necessary.
Land subsidence	C	There are soft ground areas along the proposed bypass. Land subsidence is anticipated near the road caused by the weight of additional soil which is added to the existing rice field for bypass. Further study will be conducted in detailed design stage.	In the detailed design stage, the detailed geological surveys should be conducted. The proper structure design and construction technique should be considered on the basis of the survey results. The supervision consultant and contractor should monitor the ground subsidence. If the ground subsidence occurs, the consultant and contractors should reconsider the construction technique.
Soil Contamination	D	There is a possibility that newly filled soil on the proposed bypass may be eroded and flow into the nearby agricultural land. However, the area of impact is limited and recovery to original condition is possible by removing the eroded soil.	
B-Natural Environment			
Topography/Geography	B-	Topography will be altered because new embankment is constructed in the flat agricultural land.	Design height of the embankment as low as possible. Cover embankment slope with vegetation to reduce impression of man-made structure.
Sedimentation	B-	There is a possibility that filled soil will flow to the river due to heavy rain during construction stage and eventually sediment at the bottom of Tonle Sap Lake cannot be denied. However, the Bypass is located upstream-side of National Road No.5 and BFB/SS City and more than 50km away from Tonle Sap Lake. Thus, the impact should be minimal.	Embankment slopes shall be covered by vegetation as soon as possible to minimize erosion of slope. Construction will be undertaken in the dry season as much as possible.
Ecosystem	B-	There is a possibility that bypass may separate the activity area of wild animal. The area that the bypass traverses has	Compensatory planting of domestic tree species to the limited area under the elevated structures should be considered as

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
		been developed either as agricultural area or residential area, and existence of endangered species has not been reported. Bypass is located upstream-side of National Road No.5 and BTB/SS City and more than 50km away from Tonle Sap Lake. Thus, the impact should be minimal.	necessary. Provision of cross drainage (pipe culverts) may help crossing of road by animals, reptiles and amphibious.
Hydrology	C	Impact on the surface water flow may be anticipated because a new embankment is constructed in the flat agricultural land. However, hydrology in the area surrounding of the bypass will be studied and drain facilities will be planned/designed in the detail design stage so that the influence of bypass construction will be minimal.	In the design stage, the detailed hydrological and drainage capacity survey should be conducted. The proper structure design and execution scheme should be considered on the basis of the survey results.
Natural Reserve	D	No natural reserve exists near the proposed bypass.	
C- Social Environment			
Land use and local resources	A-	Bypass is to traverse agricultural land to avoid resettlement and considerable area of agricultural land will be lost. On the other hand, access from south-western part of BTB City to NR-5 will be improved and transportation of rice which is principal local product of the region will be strengthened, and geographical range of rice consumption will be expanded.	Improve productivity of agriculture, especially that of rice production by introduction of high-productivity species and other methods.
Uneven distribution of harm and benefit	A-	Under present Cambodian Law, provisions for (1) secure the payment to illegal settlers, (2) estimation for the compensation of resettlement, (3) assistance to the recovery of living are insufficient. Eventually unfairness may arise. Due to the change of traffic flow, the income of the shops which are operating along the existing National Road No.5 (within the urbanized area of BTB/SS City) may be reduced while newly set up shops along newly constructed bypass will start business and make profit from that.	Prepare RAP involving the following measure: -Assessed compensation will base on the market price. -Top up compensation method will be applied. -Payment will be carried out before resettlement. IRC will solve the compensation of resettlement.
Involuntary Resettlement	B-	Some houses need to be relocated along the bypasses.	Conduct census survey and local stakeholder meeting. Prepare RAP (Resettlement Action Plan) involving the following measures:

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
			PAPs (Project Affected Persons) must be acknowledged as an eligible for compensation. Identify the eligibility of non-titled people at the census survey intended to PAPs and ensure the compensation and support. Refer the previous/ongoing projects by other donors, determine the requirement for social vulnerability and compensate to them. Resettlement site must be prepared when PAPs need it. Inter-Ministerial Resettlement Committee (IRC) is responsible for solves the involuntary resettlement.
Community organization including organization for local governance	B-	There will be negative impact that community structure may change due to the separation by the newly constructed bypass. However, occurrence of this impact is limited in the area near the intersections with NR-5 since the bypasses traverse agricultural land where houses are sparsely located. On the other hand, positive impact that communication between the regions is strengthened due to shortening of travel time is also expected.	Hold sufficient local stakeholder meetings in every stage and establish mutual understanding.
Poor, indigenous, minority people	B-	There is a possibility that poor people may face disadvantage for the compensation of resettlement. During construction, there will be substantial demand for construction workers. Also, some people can operate small business such as selling drinks and foods to construction workers. Minority people are not living in the proposed area.	Prepare RAP involving the following measure: -Define the displaced persons and criteria for determining their eligibility for compensation. IRC arranges a subsidy for poor people and vulnerable people.
Gender	B-	At the planning stage, female tends to be given less opportunity to present their opinions. Positive impact that employment opportunity for female increase due to the shortening of travelling time and development of local economy in the region is generally expected.	Feminine gender will be invited and join local stakeholder as well as male gender. Interview to feminine gender while in census survey will be considered.

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Working environment	B-	Safety and sanitation, as well as third party accidents, during construction stage needs to be addressed. During construction, job opportunities for local workers will increase because there will be large demand for work force at construction site.	Construction personnel will be provided with the necessary safety gears such as protective hard hat and safety. Contractor provides the safety camps, sanitation water and food and toilets are enough. Contractors shall communicate with the provincial hospital in case of emergency.
Risks for infectious disease such as AIDS/HIV	B-	Infectious disease may be brought by migrant construction workers during construction stage. On the other hand, access to large-scale hospitals will be improved resulting in improved opportunity for better treatment.	Contractor will be required to conduct a periodical health education to his personnel. Commune health post will conduct health education to migrant construction worker about the HIV/AIDS disease.
Accident	B-	Construction worker or third party may be involved in the accident during construction stage. Numbers of traffic accidents in the urban area is expected to decrease while there will be new cases of traffic accidents on the bypass in the service stage.	Construction personnel will be provided with the necessary safety gears such as protective hard hat, etc. A sound traffic management and detour plans duly approved by the BTB provincial authority will strictly implement to minimize traffic congestions. Traffic enforcers and flagmen will be designated along construction sites to assist in directing traffic flow.
Local Economy as Employment and livelihood	A+	During construction stage, local economy will be enhanced because many local people will be employed as construction worker, as well as food, fuel and necessary goods consumed at the work site will be locally purchased.	
Existing Infrastructure	D	Very limited impacts are anticipated since there is no important infrastructure along the bypass.	
Children's right	D	Some children may face some difficulty going to school due to relocation of their houses. However, this impact is limited since the number of relocated families is not large.	
Cultural heritage	D	No cultural heritage has been known near the proposed bypass.	
Landscape	D	Alteration of landscape is anticipated because embankment will be constructed in the flat agricultural land. However the	

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
2-Service Stage			
A-Physical Environment (Pollution)			
Air pollution	B-	Emission from traffic in the newly constructed bypass during service stage is anticipated, but emission will be reduced in the existing urban area because considerable portion of the traffic in the city will be diverted to the bypass. No substantial change in total emission from traffic is anticipated. Development of local industrial and economic activities induced by the bypass may cause increase in emission of exhaust gases.	Monitoring of ambient air away from NR-5 and bypasses (so-called "background air quality") will give an indicator of improvement or deterioration that might have occurred around stations. The regulation on fuel quality, importing old cars and emission gas control is to be prepared by MoE in the future. This regulation will improve the air quality, if the air pollution levels exceed significantly the standard.
Waste	B-	In service stage, it is anticipated that rubbish be thrown from the vehicle to the roadside where there has not been such phenomena.	BTBand BMCH provincial authorities shall advise the transportation service companies to arrange the garbage bins or garbage package in their vehicles. Provincial authorities shall install a sign board to throw rubbish from vehicle to the roadside. Provincial authority shall educate all passengers about the rubbish management in their vehicles not to throw the rubbish to the roadside. Provincial authority shall find all people who throw the rubbish to the roadside.
Noise/Vibration	B-	Increase of noise and vibration during service stage is anticipated along the newly constructed bypass. However, the bypass is remote from urbanized area and impact will be limited.	Regular periodic monitoring is carried out to ensure compliance to standards at the bypass. Coordination with related agencies and local authorities will be made to reduce the noise/vibration impact. The proper countermeasures to reduce noise and vibration such as slow speed near school and hospital.
Malodor	B-	Malodor of exhaust gas produced by imperfect combustion of poorly maintained vehicle is anticipated during service stage. However, the bypass is remote from urbanized area and	The Government's action to promote good maintenance of vehicles and compliance to MOE's regulation on the quality of emission gas should be implemented.

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Global Warming	B-	impact will be limited. New CO ₂ emission from the traffic on the bypass is anticipated. On the other hand, CO ₂ existing urban area will be reduced. Thus, no substantial change in total emission is anticipated. Development of local industrial and economic activities induced by the bypass may cause increase in emission of CO ₂ .	The regulation on fuel quality, importing old cars and emission gas control is to be prepared by MOE in the future. This regulation will improve the air quality, if the air pollution levels such as CO ₂ exceeds significantly the standard.
Water pollution	C	Water quality of the river at bypasses shall be examined. Water quality may be worsened during service stage due to the development of the area where new commercial buildings or factories will be constructed.	All new commercial buildings or factories have to install the garbage bins and disposal into a landfill. For sewage has to discharge into septic tanks before discharge it into the public drainage system. The domestic wastes to be generated by the local authorities or private sector to collect the garbage and not thrown into the drainage to prevent further pollution.
Land subsidence	C	In service stage, there is a possibility that development of local industries will cause increase in pumping up of ground water resulting in land subsidence. However it is difficult to measure impact of road improvement.	Relevant provincial authorities should monitor the ground subsidence. If the ground subsidence occurs, the authority should regulate ground water pumping.
Soil Contamination	D	In the service stage, there will be very limited possibility of erosion of embankment.	
B-Natural Environment			
Ecosystem	B-	Separation of wild animal activity area, if occurs by construction of the bypass may continue in the service stage.	Monitor movement of animals, reptiles and amphibians across the bypass and provide paths to guide them to safe route, by such provide a path covered by shrubs.
Hydrology	D	Drainage facilities will be designed and constructed to minimize change of existing flow of surface water.	
Sedimentation	D	In the service stage, there will be very limited possibility of erosion of embankment.	
Natural Preserve	D	No natural preserve near proposed road	
C-Social Environment			
Community	B-	There will be negative impact that community structure may	Hold sufficient local stakeholder meetings and establish

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
organization including organization for local governance		change due to the separation by the newly constructed bypass. However, such separation is limited since the bypasses are traversing sparsely populated agricultural land. On the other hand, positive impact that communication between the regions is strengthened due to shortening of travel time is also expected.	mutual understanding.
Uneven distribution of harm and benefit	B-	Due to the change of traffic flow, the income of the shops which are operating along the existing National Road No.5 (within the urbanized area of BTB/SS City) may be reduced while newly set up shops along newly constructed bypass will start business and make profit from that.	Local authorities and involved department of BTB/BMCH/Provincesshouldadvise those who may be affected by decrease in traffic to be prepared for reduction of traffic.
Confrontation of stakeholders	B-	There is a possibility that conflicts arise in the roadside communities as the benefit and harm derived from the road improvement may vary among the stakeholders.	Prevent or solve the conflicts through free and prior consultations between affected people and competent authorities.
Children's right	B-	Children are the vulnerable to risk of traffic accident which is caused by the traffic on the bypass.	Vehicle speed shall be limited near school or hospital. Implement traffic safety education to school children.
Risks for infectious disease such as AIDS/HIV	B-	In service stage, long-distance truck drivers and other transport business people may bring infectious disease. On the other hand, access to large-scale hospitals will be improved resulting in improved opportunity for better treatment.	Local authorities should implement campaign on infectious disease and HIV/AIDS.
Accident	B-	There will be new cases of traffic accidents on the bypass while the number of traffic accidents in the urbanized areas of BTB/SS City is expected to decrease.	Vehicle speed on the bypass shall be limited as necessary.
Local Economy as Employment and livelihood	A+	During service stage, economic activities will be promoted due to improvement of traffic and transportation conditions and more employment opportunities will be derived from shortening of travelling time.	
Existing Infrastructure	A+	Positive impact on the existing infrastructures such as power cable and telephone line is expected because access to the site shall be improved by construction of a new road. Access to public services such as hospital and school is	

Item	Magnitude of Impact	Reason of Assessment	Mitigation Measures
Poor, indigenous, minority people	D	improved. In service stage, increase of income of the poor is expected caused by increase of job/business opportunity due to shortening of travelling time. Minority people are not living in the proposed area.	

5.5 Estimation of Impact of Project on Noise and Air Quality

Impact of the improvement of NR-5 on the living environment (noise and gas emitted by traffic) is estimated to know whether or not the impact is critical. Since there are no established method for estimating noise and emission gas in Cambodia, the methods widely used in Japan are adopted.

- So-called 'Plume Model' and 'Puff Model' are used for calculation of dispersion/dilution of emission gases
- The model proposed by Japan Society of Acoustics is used for calculation of noise.

These models are adjusted using the measured data of current situation as presented in Subsection 17.5.2 above. However, the adjusted model shows some deviations from the actually measured data depending on the time zone. Thus, this adjustment cannot eliminate all the discrepancies between the measured data and calculated values. In addition, the data as listed below, which are indispensable for the above models, are not available in Cambodia.

- Data of wind (average wind speed and prevailing wind direction at the site): used in calculation of dilution of emission gas.
- Data on amount of gas (NO₂, SO₂ etc) emitted by one vehicle by type of vehicle (large vehicle, passenger car, motorcycle etc)
- Data on level of noise emitted by one vehicle by type of vehicle (large vehicle, passenger car, motorcycle etc)

Thus, the estimation needs to be made based on arbitrary assumptions for these factors. The assumptions adopted in the estimation, as well as details of the models used are presented in Appendix 5-1. Basic conditions of estimation of noise level and concentration of emission gases are as follows:

- Both noise level and concentration of emission gases are estimated at KP 300 (in the north of BTB City)
- Both noise level and concentration of emission gases at 20m from the center line of the road are calculated.
- Traffic volumes as shown in the table below are used:

Table 5-6 Traffic Volume Used in Estimation of Noise and Gas Emission

Year	Year 2021		
Vehicle Type	MC	LV	HV
Traffic Volume	24,647	6,492	1,527

5.5.1 Noise Level

The results of estimation of noise are as shown in Table 5-7.

Table 5-7 Estimated Noise Level

Time Zone	Estimated Noise Level (LAeq; dB)	Cambodian Standard (Commercial, Service & Mixed Area)
6:00– 18:00	67.7	70
18:00– 22:00	66.2	65
22:00– 6:00	64.9	50

It should be noted that these noise levels are calculated at 20m from the centerline of the road (future boundary of ROW) while the current noise level was measured at

approximately 7.5m from the centerline (current boundary of ROW). Thus, increase from the current noise level as described in Subsection 4.1.7 is relatively small.

5.5.2 Emission Gas

Estimated concentration of gas emitted from traffic is as shown in Table 5-8.

Table 5-8 Estimated Concentration of Emission Gases(Unit: mg/m³; PPM)

Pollutant	Background	Emission Gas From NR-5	Total	Cambodian Standard
NO ₂	0.005	0.00117	0.00617	0.1
SPM	N.A	0.00022	-	0.33
SO ₂	0.003	0.00038	0.00338	0.3

While the estimated levels of concentration of NO₂, SO₂ and SPM are well below the Cambodian Standard, Total level of concentration of SPM (sum of background and that emitted by traffic) cannot be calculated because the current background concentration of SPM could not be measured in this Survey due to the limitation of measuring equipment. (PM10 and PM2.5 were measured.) However, it can be said that concentration level of SPM emitted by the traffic is in the order of magnitude of 1/10,000 of the Cambodian Standard.

6. ANALYSIS OF ALTERNATIVES

6.1 Improvement of North Section of National Road No.5

Options for Improvement of North Section of National Road No.5 are as follows.

Option-0: No improvement

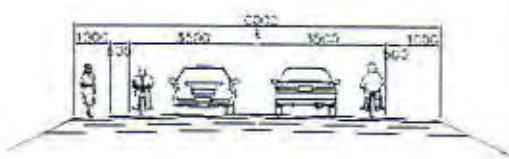
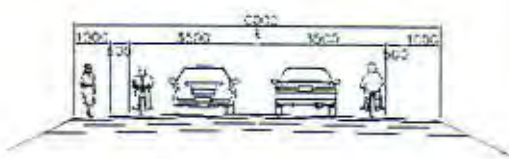
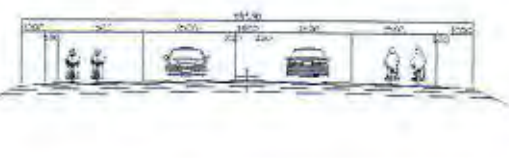
Option-1: Pavement Improvement only

Option-2: Widening to 4-lane road

Option-3: Widening to 2-lane with motorcycle lanes on both side.

Outline of these options are summarized in Table 6-1. Advantages and disadvantages of options are compared in Table 6-2.

Table 6-1 Description of Options for Improvement of North Section of National Road No.5

Option	Description & Feature	Schematic Drawing
Opt-0: Zero Option	No improvement	
Opt-1: Only pavement is improved to asphalt concrete. Existing road width is maintained	Existing road width is maintained. Pavement is improved to asphalt concrete from current DBST in order to reduce maintenance cost and to improve chances of traffic accident of motorcycles by reducing the occurrence of pavement breakage.	
Opt-2: Widen to 4-lane road with asphalt concrete pavement	Widen to 4-lane road to accommodate the increased traffic in the future. Smooth traffic is secured. Traffic safety is improved by separating high-speed traffic such as passenger cars from slow traffic such as motorcycles.	

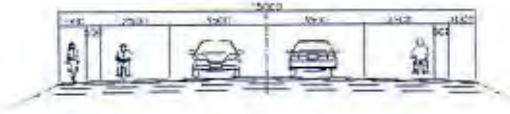
Option	Description & Feature	Schematic Drawing
Opt-3: Widen to one lane for 4-wheeled vehicles and additional lane for motorcycles in one direction. Pavement is improved to asphalt pavement	Widen to accommodate the increased traffic as well as to secure traffic safety by separating high-speed traffic from slow traffic. Width of motorcycle lane is planned to be narrower than regular lane to minimize land acquisition and resettlement.	

Table 6-2 Advantage and Disadvantage of Options for Improvement of North Section of National Road No.5

Options	Advantage	Disadvantage	Remarks
Opt-0: Zero Option (No improvement, no widening)	<u>Social Impact</u> -No resettlement needed, basically.	<u>Social Impact</u> -There is high possibility of traffic congestion as traffic volume increases in the future. Traffic congestion will result in increase in exhaust gas and air pollution. -High-speed traffic, such as passenger cars and slow traffic, such as motorcycle, agricultural tractor and bicycles travel in the same lane resulting in higher possibility of traffic accident.	
	<u>Engineering and Economic Aspects</u> -No project cost is required.	<u>Engineering and Economic Aspects</u> -Travel speed of traffic will become slow and economic activities is hampered resulting in hindered regional development. -Existing pavement (DBST) does not possess sufficient bearing capacity to support increasing heavy traffic and maintenance cost will increase in future.	
Opt-1: Only pavement is improved to asphalt concrete. Existing road width is maintained.	<u>Social Impact</u> -Same as Alt - 0 <u>Engineering and Economic Aspects</u> -Sufficient bearing capacity of pavement is secured resulting in reduction in maintenance cost in future.	<u>Social Impact</u> -Same as Alt - 0 <u>Engineering and Economic Aspects</u> -Same as Alt - 0 except that maintenance cost is reduced.	
Opt-2: Widen to 4-lane road with asphalt concrete pavement	<u>Social Impact</u> -Possibility of traffic congestion in the future is reduced due to increased traffic capacity, resulting in reduced possibility of increase in air pollution. -Diverted traffic from NR-6 can be accommodated and smooth traffic can be secured if severe accident occurs on NR-6.	<u>Social Impact</u> -Large number of resettlement is required. -There is a possibility that accident increase due to increase in vehicle speed which is induced by improvement of road.	Traffic safety can be improved by engineering measures such as installation of guard rail and clear pedestrian crossing, education such as campaign to pedestrians and drivers.

Options	Advantage	Disadvantage	Remarks
Opt - 3: Widen to one lane for 4-wheeled vehicles and additional lane for motorcycles in one direction. Pavement is improved to asphalt pavement	<u>Engineering and Economic Aspects</u> -Smooth traffic is secured -Smooth traffic promote social activities and regional development. -During construction, job opportunities of local worker increase and various consumable goods are procured from local shops. Thus local economy is stimulated.	<u>Engineering and Economic Aspects</u> -Larger project cost than that of Alt - 3 is required.	and enforcement.
	<u>Social Impact</u> -Same as Alt - 2 -Number of resettlement is smaller than that of Alt-2	<u>Social Impact</u> -Large number of resettlement, although less than that of Alt-2, is required. -As traffic volume will increase and widening will become necessary in future, resettlement or set-back of houses will become necessary again.	
	<u>Engineering and Economic Aspects</u> -Same as Alt - 2, but to less extent. -Project cost is less than that of Alt-2	<u>Engineering and Economic Aspects</u> -Travel speed of vehicles will increase resulting increase possibility of traffic accident. -Smooth traffic is secured in usual occasions, but traffic congestion may occur if the traffic on NR-6 divert to NR-5 for some reason such as severe traffic accident on NR-6.	
			Same as Alt - 2 with regard to traffic safety.

6.2 Alternative Routes of Battambang Bypass

6.2.1 Evaluation of Options

Construction of a bypass is planned and implemented to enable smooth and safe traffic without widening roads in urbanized area and avoid large scale relocation of houses and families. Advantages and disadvantages of constructing BTB Bypass and widening existing streets in the city are compared in Table 6-3.

Table 6-3 Advantages and Disadvantages of Battambang Bypass

Option	Advantage	Disadvantage
Option Zero: No Improvement	<u>Social Aspects</u> -No resettlement is needed. <u>Engineering and Economic Aspects</u> -No project cost is required.	<u>Social, Engineering and Economic Aspects</u> -Traffic congestion and traffic accidents increase as traffic demand increases due to economic growth. -As the results of above, air pollution, noise and vibration due to traffic increase. -Sound urban development may be hampered because of traffic congestion.
Option-1: Construction of Bypass	<u>Social Aspects</u> Large scale relocation is not necessary. <u>Engineering and Economic Aspects</u> -Traffic congestion and traffic accidents in the city are reduced. -As the results of above, air pollution and noise/vibration in the city is reduced -If properly planned, a bypass can guide urban development in the future in a desirable form.	<u>Social Aspects</u> -Considerable area or agricultural land needs to be converted to Right of Way. -Some business in the existing urbanized area may lose some business opportunity due to decrease in traffic volume in the city.
Option-2: Widening of Streets in City	<u>Social Aspects</u> -Substantial loss of agricultural land is not necessary.	<u>Social Aspects</u> -Large scale relocation of houses and families becomes necessary. <u>Engineering and Economic Aspects</u> -Traffic volume passing through the city is not reduced and air pollution, noise and possibility of traffic accidents in the city is not greatly reduced. -Concentration of population and business in central area of the city is accelerated.

As can be seen in the above, construction of a bypass is expected to bring about many advantages to the city and city of BTB.

6.2.2 Alternative Routes

In total, six alternative routes, three by DPWT of BTB Province and three by the JICA Team, have been proposed. The alternatives routes proposed by DPWT BTB are basically to utilize the existing streets or roads while the alternatives routes proposed by the JICA Team basically detour the urbanized area and construct new roads in the agricultural area in the outskirts of BTB City.

These alternative routes are shown in Figure 6-1. Their advantages and disadvantages are compared in Table 6-3.



Figure 6-1 Alternative Routes of Battambang Bypass

Table 6-4 Advantage and Disadvantage of Alternatives of Battambang Bypass

Alternative	Advantage	Disadvantage
Alt-0: Zero Option (Bypass is not constructed)	-No land acquisition and resettlement is required.	-Through traffic flows into urbanized area of the city and causes traffic congestion and traffic accident. -Noise, vibration and air pollution in the urbanized area increased.
DPWT - 1 Length = 13km* Resettled houses = 180**	-Local residents generally want the road in front of their houses improved. Thus, this alternative is welcomed by the local residents or communities.	-Large number of houses needs to be relocated. -Through traffic flows into urbanized area of the city and causes traffic congestion and traffic accident. -Alignment of the road is not preferable and there is a possibility of traffic congestion and traffic accident.
DPWT - 2 Length = 11km* Resettled houses = 400**	-Same as above	-Large number of houses needs to be relocated. -Through traffic flows into urbanized area of the city and causes traffic congestion and traffic accident. -Alignment of the road is not preferable and there is a possibility of traffic congestion and traffic accident.
DPWT - 3 Length = 18km* Resettled houses = 60**	-Same as above	-Large number of houses needs to be relocated. -Through traffic flows into urbanized area of the city and causes traffic congestion and traffic accident.
JICA - 1 Length = 30km* Resettled houses = 80**	-Objective of bypass, that is to divert through traffic to outside of urbanized area, is attained. -Alignment is sufficiently away from the existing urbanized area and function of bypass will be maintained in the future.	-Length is long compared to JICA - 2, resulting in larger project cost than that of JICA - 2. -Considerable area of agricultural land is lost.
JICA - 2 Length = 14km* Resettled houses = 70**	-Same as above -Shortest among the alternatives proposed by JICA Team.	-If the urbanized area will expand in the future, the roadside land use will be urbanized resulting in reduction in function of bypass. -Substantial area of agricultural land is lost, although less in extent than JICA - 1.
JICA - 3 Length = 34km* Resettled houses = 50**	-Same as above -Number of houses to be relocated is minimum among the alternatives proposed by JICA Team	-Traverses near the protected area of Tonle Sap Lake and there is a possibility of negative impact to the natural environment will occur. -There is a possibility of hydrological impact due to construction of road embankment in the vicinity of Tonle Sap Lake. -Length is longest among the alternatives. Also traverses soft ground area. Thus, additional construction cost is required.

* Approximate length, ** Numbers of houses to be relocated are temporary and may change after further survey.

Table 6-5 Comparison of Consultant-1A and Consultant-1C

Alternative	Length	Advantage	Disadvantage
Consultant-1A	30 km	-Widening of BTB City-Ou Sanda (KP 273) is not necessary. -Travel distance between SSe and Phnom Penh is shorter than that of Consultant-1C. -The function of bypass (smooth traffic) will be maintained in long future. -There is sufficient space for expansion of BTB City in long future.	-South connection point with existing NR-5 is far from existing urbanized area of BTB City -Thus, may give less impact on expansion of BTB City in short term or medium term. -Larger construction cost
Consultant-1C	23 km	-South connection point with existing NR-5 is near to the existing urbanized area of BTB City -Thu, contribute to expansion of BTB City in short term or medium term. -Small construction cost	-Widening of Puk Chhma (KP 280)- Ou Sanda (KP 273) will be necessary in future. -Travel distance between SS and Phnom Penh become longer than that of Consultant-1A. -In long future, urbanized area of BTB will expand and the function of bypass (smooth traffic) will be reduced. -In long future, expansion of BTB City will be limited to the bypass.

Source: Progress report, JICA Study Team, August 2011

The evaluation of these two alternative routes can be summarized as below:

- Consultant-1A is preferable from viewpoint of long distance traffic and city development in long future.
- Consultant-1C is preferable from viewpoint of traffic around BTB City and medium-term city development.
- Differences of advantages and disadvantages between the two alternatives are not large.
- Thus, both alternatives are technically reasonable plans.

After consultation between the MPWT, BTB Province and JICA Team, JICA-1C was selected as the most preferable route.

6.3 Alternative Routes of Serei Saophoan Bypass

6.3.1 Evaluation of Options

The discussions same with those on BTB Bypass can be applied to the case of Serei Saophoan Bypass.

Table 6-6 Advantages and Disadvantages of Battambang Bypass

Option	Advantage	Disadvantage
Option Zero: No Improvement	<u>Social Aspects</u> -No resettlement is needed. <u>Engineering and Economic Aspects</u> -No project cost is required.	<u>Social, Engineering and Economic Aspects</u> -Traffic congestion and traffic accidents increase as traffic demand increases due to economic growth. -As the results of above, air pollution, noise and vibration due to traffic increase.

Option	Advantage	Disadvantage
		- Sound urban development may be hampered because of traffic congestion.
Option-1: Construction of Bypass	<u>Social Aspects</u> - Large scale relocation is not necessary. <u>Engineering and Economic Aspects</u> - Traffic congestion and traffic accidents in the city are reduced. - As the results of above, air pollution and noise/vibration in the city is reduced - If properly planned, a bypass can guide urban development in the future in a desirable form.	<u>Social Aspects</u> - Considerable area or agricultural land needs to be converted to Right of Way. - Some business in the existing urbanized area may lose some business opportunity due to decrease in traffic volume in the city.
Option-2: Widening of Streets in City	<u>Social Aspects</u> - Substantial loss of agricultural land is not necessary.	<u>Social Aspects</u> - Large scale relocation of houses and families becomes necessary. <u>Engineering and Economic Aspects</u> - Traffic volume passing through the city is not reduced and air pollution, noise and possibility of traffic accidents in the city is not greatly reduced. - Concentration of population and business in central area of the city is accelerated.

As can be seen in the above, construction of a bypass is expected to bring about many advantages to the city and city of SS.

6.3.2 Alternative Routes

One alternative route and four alternative routes were proposed by DPWT, BMCH Province and JICA Team, respectively, as shown in Figure 6-3. The route proposed by DPWT, BMCH connects western suburbs of SS to NR-5 at the middle of SS and Mongkol Borei. JICA-1 is also to connect same points but following an alignment which avoids reservoirs, streams and other water bodies to minimize construction of culverts.

Please note that all of JICA-2 to JICA-4 are to extend the JICA-1 to the south of Mongkol Borei Town and follow the same alignment with JICA-1 between the northwestern intersection with NR-5 and the intersection at the middle point of NR-5 between SS City and Mongkol Borei Town. From the middle point between SS City and Mongkol Borei Town, JICA-2 to JICA-3 follow different alignment.

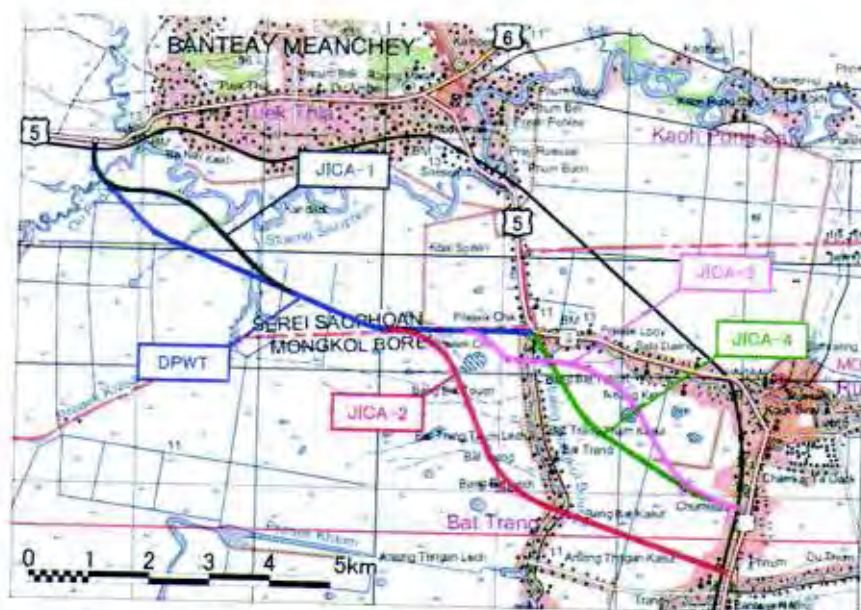


Figure 6-3 Alternative Routes of Serei Saophoan Bypass

Advantages and disadvantages of these alternative routes are compared in Table 6-6.

Table 6-7 Comparison of Alternatives of Serei Saophoan Bypass

Alternative	Advantage	Disadvantage
DPWT L = 8.6km	Short and construction cost is minimum.	Traffic needs to pass through city of Mongkol Borei (Ruessei Kraok)
JICA-1 L = 8.7km	Same as DPWT. Avoid irrigation channel and does not need a bridge to cross the channel.	Sam as above.
JICA-2 L = 13.7km	Through traffic can bypass both SS and Mongkol Borei.	Bypass can connect to NR-5 only at the both ends of the bypass.
JICA-3 L = 13.4km	Same as above Can connect to NR-5 at the middle of SS and Mongkol Borei through the existing district (?) road.	A little twisty alignment
JICA-4 L = 13.3km	In the fund is not sufficient, the section to bypass Mongkol Borei can be constructed later.	There will be intersection at the middle of SS and Mongkol Borei which reduce the travel speed.

Considering the advantages and disadvantages as described above, JICA-3 was selected as the most preferable route.

7. ENVIRONMENTALMANAGEMENT PLAN

7.1 Introduction

Environmental Management Plan (EMP) consists of a set of mitigation measures and monitoring plan to be taken into consideration to eliminate, offset or reduce adverse environmental and social impacts to acceptable levels. The plan also includes the actions needed to be taken to implement these measures. Generally, EMP covers problems of physical, natural and social environment. In this report, EMP mainly focuses physical and natural environmental problems because the monitoring and management of social environmental problems are presented separate report on Resettlement Action Plan (RAP).

EMP is considered to be an operational document that will be frequently updated by the project owner (MPWT) with assistance/advice of supervision consultant and MOE to reflect the activities on site. As activities commence, the EMP will be reviewed and revised according to various project activities.

7.2 Objective of Environmental Management Plan

Objective of EMP is to show the tasks and methods to achieve the targets of environmental mitigation measures. Actual status and outcome of environmental mitigation measures need to be monitored to assure that mitigation measures are effective. Overall Institutional Framework

7.2.1 Stakeholders

Various stakeholders are involved in the environmental management of a road project, as listed below:

(a) Contractor

Primarily responsible for implementation and monitoring of environmental mitigation/protection measures during construction stage.

(b) Supervision consultant

Employed by MPWT, monitors, advises and supervises the day-to-day environmental management implemented by contractor during construction stage under the general supervision of, and on behalf of, MPWT. He/she is also responsible for some items of environmental monitoring which do not belong to the responsibility of contractor, such as air quality along the project road.

(c) MPWT

Assumes overall and ultimate responsibility as the project owner.

(d) MOE

Responsible for protection of environment as the line ministry. MOE and MPWT should maintain close consultation on the environmental matters.

(e) Local community (Commune/District) and local residents

Local residents are the direct receptors of environmental impact. Thus, they are expected to report any problem arising from implementation of the project. Such report, or complaint, is often brought to the contractor through the office/official of relevant Commune and/or District. Thus, Commune and District is also involved.

(f) DPWT of relevant Province

DPWT can be mediator between local community and MPWT.

(g) Consultant for detail design

Responsible for incorporating necessary migration measures into detail design, with approval of MPWT as the project owner. He/she is also often appointed by MPWT to do surveys for collecting base line data in the pre-construction stage.

Tasks of the main stakeholders are described below:

7.2.2 Tasks of Contractor

In the usual contract of civil works for road projects, the contractor is stipulated to be responsible for protection of environment in accordance with stipulations in the Contract and

applicable laws and regulations. He/she is required to take actions needed for this purpose. These actions includes the following

- (1) Maintenance of construction equipment to maintain emission gas and noise within admissible level
- (2) Installation of noise barrier fence as necessary
- (3) Prevention of pollution of public water possibly caused by foundation/substructure work in rivers and other work
- (4) Construction of asphalt mixing plant at the location sufficiently far away houses to prevent nuisance by offensive odor of heated bitumen.

The contractor is also responsible for training of employees and workers on the environmental protection/management to achieve the objectives of the tasks as described above.

7.2.3 Tasks of Supervision Consultant

Supervision consultant is employed by the project owner (MPWT) and his/her duty is day-to-day management of the project on behalf of the employer. One of his/her important tasks is monitoring and advice on environmental management. He/she is also tasked with monitoring

7.2.4 Tasks of Ministry of Public Works and Transport

MPWT is ultimately responsible for environmental monitoring and management as the project owner. With assistance and support of the supervision consultant, MPWT assumes the responsibility of implementation of environmental mitigation plan and monitoring implemented by the contractor.

When a crucial environmental problem arises, MPWT should consult with MOE and ask for advice.

It is proposed that a few officials of the Project Management Unit be appointed to be in charge of environmental management and monitoring. They shall supervise the contractor and consultant for environmental management and monitoring, as well as coordinate with relevant official of ME.

7.2.5 Tasks of Ministry of Environment

MOE is responsible for conservation of good environment. Thus, MOE needs to consult or advice to MPWT when difficult an environmental problem occurs. Currently, however, such system is not fully established and operational.

Environmental management and monitoring in the service stage (the stage where the project roads are open to traffic after the project is completed) needs to be conducted by MPWT's own manpower since the contractor and supervision consultant are gone. Thus, close consultation needs to be held between MPWT and MOE to establish a workable environmental management

7.2.6 Communication and report preparation

Communication between the stakeholders is very important. Many abnormalities caused by the Project are first found by local people. Such abnormalities need to be properly treated before it they worsen. Thus communication channel between the local residents or local community and contractor or supervision consultant needs to be established. For this purpose, name of person of contractor and/or consultant to be contacted should be notified to relevant officials of local communities including Commune and District.

Any adverse phenomena need to be recorded for the future monitoring and follow-up including those conducted in the service stage. Therefore, periodical (such as quarterly)

reports on environmental management and monitoring should be prepared and submitted to MPWT.

7.3 Environmental Management Plan

Environmental Management Plan (EMP) is prepared to ensure that the mitigation measures proposed in Chapter 5 are properly implemented and the identified impacts are prevented or mitigated in a systematic and cost-effective manner. EMP consists of mitigation measures and monitoring plans. These include institutional aspects as well as appropriate staffing and training. Therefore, a dedicated MPWT and environmental agencies must be assigned the responsibilities of managing and monitoring the implementation of the EMP to ensure proper consideration on the environmental and social aspects throughout the entire life cycle of the Project.

Proper implementation of feasible mitigation measures is expected to reduce potentially significant adverse environmental impacts to acceptable levels in cost effective measures.

Table 7-1 Environmental Mitigation Plan

Environmental Impact	Project Activities	Proposed Mitigation Measures	Budget USD	Institutional Responsibilities Implementation	Supervision
I: PRE-CONSTRUCTION AND CONSTRUCTION STAGE					
A: Physical Environment					
Air pollution	Air quality impacts due to gaseous and dust emissions from construction equipment and construction activities	- Strictly implement approved Dust Control Plan - Wherever possible, use electrically-powered equipment - Construction equipment and vehicles shall be well-maintained and shall meet MOE's emission standards - Store excavated materials outside road reserve, but where there is no area, spoils shall be loaded and transported immediately - Clean road surfaces of debris/spoils from construction equipment and vehicles - Undertake daily cleaning of paved routes around the pier construction sites - Impose speed limits on construction vehicles to minimize road dust in areas where sensitive receptors are located - Provide prior notification to the community on schedule of construction activities. - The wastewater septic tank facility shall be properly maintain - Solid wastes shall be regularly removed from the depot to disposal sites.	To be included in the contract of construction works	Contractor	MPWT/Supervision Consultant
		- Installation of cofferdam as necessary. - Strict control of waste oil and other waste.	To be included in the contract of construction works	Contractor and engineer	MPWT/PIU, Supervision Consultant
		- Separate solid waste into hazardous, non-hazardous and reusable waste streams and store temporary on site - Undertake regular collection and disposal of wastes to sites approved by authorities. - Wastewater shall be treated at the depot's industrial treatment plant - Office building shall be provided with toilets and septic tanks to handle domestic sewage	To be included in the contract of construction works	Contractor	MPWT/Supervision Consultant
Water quality	Water pollution due to bridge construction Spill of waste oil and other waste				
General wastes	General wastes produced through construction activities				

Environmental Impact	Project Activities	Proposed Mitigation Measures	Budget USD	Institutional Responsibilities	
				Implementation	Supervision
Noise and vibration		-Offices, workshops and other areas within the depot shall be provided with waste collection bins or receptacles. -Installation of temporary noise barrier fence around the sites, if necessary.			
	Noise and vibration impacts due to operation of construction equipment and other activities	-All construction equipments and vehicles shall be well maintained -No noisy construction – related activities shall be carried out during night (6:00pm-6:00am). -As much as possible, use quiet equipment and working method -Provide prior notification to the community on schedule of construction activities.	To be included in the contract of construction works	Contractor	MPWT/Supervision Consultant
Subsidence	Local land subsidence caused by the weight of additional embankment for widening of NR-5 and new embankment of bypasses	-Detailed soil investigation at subsidence-prone locations -Observation of movement of ground surface -Slow down of embankment speed. -Rectification of tilted structures/houses and ground surface to the original condition	To be included in the contract of construction works	Contractor	MPWT/Supervision Consultant
Malodor	Offensive odor from poorly maintained construction equipment, vehicles asphalt mixing plant	-Routine check-up and proper maintenance of construction equipment and vehicles -Construct asphalt mixing plant far away from houses or residential areas.	To be included in the contract of construction works	Contractor	MPWT/Supervision Consultant
	Emission of CO ₂ from construction equipment	-Routine check-up and proper maintenance of construction equipment to secure correct combustion. -Use equipment powered with electric motor where available and possible.	To be included in the contract of construction works	Contractor	MPWT/Supervision Consultant

Environmental Impact	Project Activities	Proposed Mitigation Measures	Budget USD	Institutional Implementation	Responsibilities Supervision
B: Natural Environment					
Topography	Additional embankment for widening of NR-5 and new embankments for bypasses will alter topography	-Cover slopes of new embankments with vegetation to reduce impression of man-made structure.	To be included in the cost of construction works	Contractor	MPWT/Supervision Consultant
Sedimentation	There is a possibility that filled soil will flow into the river due to heavy rain.	-Embankment slopes are covered by vegetation as soon as possible to minimize erosion of slopes. Embankment works are executed in dry season as much as possible.	To be included in the cost of construction works	Contractor	MPWT/Supervision Consultant
Hydrology	Flow of river water may be altered during bridge construction	-Install water pump to secure same volume of water to flow the bridge construction site -Install sufficient number of bridges and culverts at necessary locations of bypasses	To be included in the cost of construction works	Contractor	MPWT/Supervision Consultant
	New embankment of bypasses may alter the flow of surface water				
C: Social Environment					
As for mitigation measures for social impact caused by resettlement, please refer Resettlement Action Plan which has been prepared as a separate volume.					
Risks for Infectious disease such as AIDS/HIV	Infectious disease may be brought by migrant construction workers.	-Contractors will be required to conduct periodical health check and education to his personnel.	To be included in the cost of construction works	Contractor	MPWT/Supervision Consultant
Working environment	Safety and sanitation construction	-Construction personnel shall be provided with necessary safety gears such as protective hard cap. -Contractor shall provide camps, sanitation water and toilets as the cost of	To be included in the cost of construction works	Contractor	MPWT/Supervision Consultant

Environmental Impact	Project Activities	Proposed Mitigation Measures	Budget USD	Institutional Responsibilities	
				Implementation	Supervision
	personnel as well as third party accidents	necessary.	construction works		
Accident	Construction workers or third party may be involved in accident	-Construction personnel shall be provided with necessary safety gears such as protective hard cap. -Traffic management to secure traffic safety shall be planned and implemented.	To be included in the cost of construction works	Contractor	MPWT/Supervision Consultant
2: SERVICE STAGE					
Air quality	Air quality impacts due to emissions of vehicle	-All vehicles shall be well-limited of gas emission and shall meet MOE's emission standards -Impose speed limits on all vehicles to minimize emission in areas where sensitive area such as residential and hospital areas.	To be filled later	Provincial authorities	MPWT & MOE
Water quality	Water quality in rivers & streams may worsen due to increase of population and economic/industrial activities	-Improve sewerage system and increase capacity of sewage water treatment plant -Prohibit dumping of garbage into rivers and streams	To be filled later	Provincial authorities	MOE & MO
Waste	Waste from bus/taxi stations and different activities along the road	-Waste collection bins shall be provided -Garbage shall be collected regularly -station shall be provided toilets and other facilities -Solid waste generated from different activities will be safely	To be filled later	Provincial authorities	MPWT & MOE
Noise/vibration	Increase of noise/vibration due to increase in traffic volume and vehicle speed	-Speed regulation as necessary	To be filled later	Provincial authorities and traffic police	MPWT & MOE
Malodor	Malodor may be emitted by poorly	-Enforcement of poorly maintained vehicles -Establishment of vehicle inspection system	To be filled later	MPWT	MPWT

Environmental Impact	Project Activities	Proposed Mitigation Measures	Budget USD	Institutional Responsibilities	
				Implementation	Supervision
	maintained vehicles				
Global warming	Emission of CO ₂ may increase due to increase in traffic volume	-Promotion of introduction of vehicles with less emission of CO ₂ such as hybrid vehicles and electric motor vehicles	To be filled later	MOE & MPWT	MOE & MPWT
Subsidence	Excess pumping up of ground water for industrial activities	-Monitor and regulate excess pumping of ground water	To be filled later	Provincial authorities	MOE
Ecosystem	Bypass may separate activity areas of wild animals	-Monitor movement of animals across the road and provide paths to guide them to safe route by such as providing a path covered by shrubs.	To be filled later	Provincial authorities	MPWT & MOE
Gender and children's right	Women and children are vulnerable to traffic accident caused by increase in vehicle speed	-Regulate vehicle speed as necessary such as in urban areas, near school and near hospitals.	To be filled later	Provincial authorities and traffic police	MPWT & MOE
Accident	Traffic accident may increase due to increase in vehicle speed	-Regulate vehicle speed as necessary such as in urban areas, near school and near hospitals.	To be filled later	Provincial authorities and traffic police	MPWT & MOE

7.4 Monitoring Plan

Environmental monitoring program is a vital process of Environmental management. It helps in signaling the potential problems that might result from the Project and allow prompt implementation of effective corrective measures and ensuring that environmental protection is achieved through early detection of negative environmental impacts. The environmental monitoring will be required throughout the construction and service stages.

The main objectives of environmental monitoring are:

- to assess the changes in environmental conditions,
- to monitor the effective implementation of mitigation measures, and
- to warn significant deteriorations in environmental quality for further prevention action.

Monitoring programs will be designed for a number of parameters. The monitoring results will be fed into the decision making process as a trigger for the implementation of corrective actions, in order to maintain compliance with environmental laws and regulations, ensure environmental protection and workplace safety, as well as ensure appropriate operation of the mitigation measures and the management plans.

In order to meet the above objectives for the Project, the following parameters need to be monitored:

- Air quality
- Noise and vibration,
- Surface water quality,
- Subsidence
- General waste management
- Hydrology

In some instances and upon availability of baseline measurements, it may be needed that the monitoring program to measure background levels of different parameters such as air quality, noise and water quality be initiated before construction begins. This monitoring information will serve as the baseline data for comparison.

It is important to note here that environmental monitoring is a dynamic process. The proposed locations, parameters, and frequencies are subject to further changes, based on the results of the first monitoring round(s).

7.4.1 Monitoring in Construction Stage

(a) Air Quality

Visual inspection of exhaust gases from construction equipment shall be carried out by the construction contractor, under the supervision of the project.

Ambient air quality and noise levels will be monitored before the construction and at regular intervals during the construction stage.

The results of monitoring are compared to the baseline data during construction. Results of air quality monitoring are also compared to limits set in the standard of Sub-Decree on Air Pollution Control and Noise/Vibration Disturbance, 2000.

Sites for air quality monitoring includes the storage facilities for dust generating materials, construction depots, diesel engine areas, etc. Parameters recommended for air quality monitoring are: Suspended Particulate Matter (SPM, measured by concentration of PM10 and

PM2.5)¹⁰ Nitrogen Dioxides (NO₂) and Sulfur Dioxide (SO₂), which should comply with national standard.

(b) Noise and Vibrations

Sites for noise and vibrations monitoring include areas where heavy machinery or equipment, e.g. pavement breaker is working. Increased noise intensity is anticipated to mainly impact on site workers and communities neighbouring construction sites. As such, measurement of noise caused by such machinery or equipment shall be surveyed at the boundary of land plot nearest to the construction site. Noise levels recorded shall be compared to levels set within the standard of Ministry of Environment.

(c) Quality of surface water

Monitoring of water quality will be conducted in rivers, streams, reservoirs and other water bodies where works of the Project is executed. Initial monitoring of the impact of Project (construction activities) shall be made through visual observation of water and/or condition of construction works. Whenever pollution due to construction activity is suspected, water is sampled and quality of water is analyzed.

Typical items of analysis are pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS). However, other items may be analyzed as deemed necessary.

(d) General waste

Monitoring of the liquid/slurry and solid waste disposal stream shall be strictly followed (through documentation of waste handling procedures/operations).

(e) Subsidence

Primary method of monitoring of subsidence shall be interview to the local people and visual inspection of the ground surface made at subsidence-prone locations. Subsidence-prone locations are identified through detailed geotechnical investigation conducted prior to the start of construction. Method of detecting subsidence caused by construction works is observation of tilting/deformation of houses and other structures and settlement of ground surface.

(f) Hydrology

Change and obstruction of water flow is monitored at rivers and streams where bridge construction work is executed. Primary method of monitoring is visual observation of flow of water, as well as the method of construction works and mitigation measures. When any serious change of water flow (in volume or velocity) is detected, measuring equipment shall be used to measure the change quantitatively.

7.4.2 Monitoring in Service Stage

(a) Air Quality

The Projects, in the service stage, is expected to reduce traffic congestion, compared to what is assumed if the Project is not implemented. Thus, the Project expected to reduce air pollutants emitted by traffic. On the other hand, there is a view that the Project will bring

¹⁰ Standard of Cambodia for suspended particulate material stipulates standard for Suspended Particulate Matter (SPM). However, currently there is no equipment for measuring SPM and only equipment for measuring PM₁₀ and PM_{2.5} is available in Cambodia. Thus measurement of PM₁₀ and PM_{2.5} is tentatively proposed until such time that either equipment of SPM becomes available.

about increase in traffic volume and emission gas. For this reason, it is proposed that ambient air quality be surveyed in the service stage of the Project road.

It is proposed to monitor SO_2 , NO_2 and SPM (MP2.5 & PM10) at 3 locations: suburbs of BTB, suburbs of SS and the boundary of BTB Province and BMCH Province. Air sample are to be taken at 2 point (one at boundary of ROW and 200 – 500m away from ROW) Monitoring would be carried out by the Ministry of Environment (MOE) or provincial authorities every 3 months, or 2 times in dry season and 2 times in rainy season), as necessary.

(b) Noise and Vibrations

Noise and vibration are proposed to be every 3 month basis (4 times per year). The measured noise levels will be compared to the levels stated in Chapter 4 of this report.

Moreover, sites for ambient noise monitoring would include segments of the alignment that are very close to residential aggregates.

According to the regulations of Royal Government of Cambodia, MOE or provincial authorities shall monitor on a noise level meter, if necessary. This would reduce noise monitoring costs on the long run.

The fund for monitoring on the noise and vibration measurement of public projects is in charge of the MOE or provincial authority which requests the budget to the Ministry of Economic and Finance.

(c) General waste

A solid waste will be maintained to include volumes of waste for re-use, recycle and/or final disposal. Treatment procedures and final fate of solid wastes (including delivery to licensed contractors) will be recorded and kept.

(d) Subsidence

Monitoring of subsidence shall be conducted at selected location where subsidence is anticipated to be clearly seen. Most common method of finding subsidence is visual observation of raising up of buildings and other structure supported by firm foundation. As ground surface subsides, there will be gap between the ground floor and the ground surface. Thus it look like the building has risen up.

Table 7-2 Environmental Monitoring and Management System for Widening and Bypass

Parameters	Location	Means of Monitoring	Frequency	Implemented by	Responsible Agency Supervised by
A-Construction Stage					
Air quality	Depot of construction equipment Construction site Boundary of ROW nearest to construction site	- Visual inspection of mechanical condition and exhaust gas - Visual observation of dust - Measurement of SO ₂ , NO ₂ and SPM	Every day before working Every day 2 times in dry season and 2 times in rainy season	Contractor	MPWT/Supervision Consultant & MOE
Water quality	River, stream, reservoir and other public water body where construction works are executed.	Visually observation on the water quality. If any pollution is suspected, pH, TSS, BOD and COD and other items shall be measured.	Visual inspection is done every day.	Contractor	MPWT/Supervision Consultant & MOE
Noise/Vibration	Boundary of land plot nearest to the construction site	Noise and vibration caused by heavy machinery and equipment	When noise/vibration level exceeding the Cambodian standards is suspected When local residents complain	Contractor	MPWT/Supervision Consultant & MOE
General waste	Waste storage at construction site	Amount of Slurry and other construction waste Amount of General waste	Every day	Contractor	MPWT/Supervision Consultant & MOE
Subsidence	Subsidence-prone locations along the Project road	Visual inspection and interview to the local people	1 time/week to 1 time/month depending on situation	Contractor	MPWT/Supervision Consultant
Hydrology	Rivers, streams and reservoirs where construction works are executed	Visual inspection on volume and speed of water flow	Every day	Contractor	MPWT/Supervision Consultant
B-SERVICE STAGE					
Air quality	- BTB-KP 300 (road site) and 200m away from road site. - BTB- Bypass intersection with NR-57 (road side) and 200m away from road side. - BMCH-KP 356 (road	Sampling and analysis of SPM ₁₀ , SPM _{2.5} , SO ₂ and NO ₂	2 times in dry season and 2 times in rainy season	Provincial authority	MPWT and MOE

Parameters	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented by	Supervised by
	site)and 200m away from road site.				
Noise/Vibration	-BTB-KP 300, ROW boundary	Noise and vibrations	2 times in dry season and 2 times in rainy season	Provincial authority	MPWT and MOE
	-BTB- Bypass intersection with NR-57, ROW boundary -BMCH-KP 356 , ROW boundary				
General waste: Solid waste and garbage	A long the road and public gathering	- Volumes of waste for re-use, recycle and/or final disposal -Treatment procedures and final fate of solid wastes	Surveyed 1 time per year based on the data of institution for garbage collection.	Provincial authority	MPWT and MOE
Subsidence	Building and other structure in BTB Province and BMCH Province	Rising up of building is visually inspected	2 times in dry season and 2 times in rainy season	Provincial authority	MPWT

7.5 Staffing and Training

In order to ensure the competence of the project personnel in undertaking the environmental management procedures and plans, training will be conducted for the personnel according to their particular responsibility.

- Training programs shall include guidelines for safety, actions required in case of emergency, fire protection at construction site, environmental risk analysis, etc.
- Training of staff is also important to ensure proper implementation and monitoring of mitigation measures. Accordingly, the training plans shall be developed in accordance with the management and monitoring programs of the present study.
- Training programs shall be directed towards different levels of expertise at the project, i.e. workers, engineers, senior engineers, etc. Such training program will involve different aspects of environmental as well as workplace health and safety.
- Staff training activities shall include first aid training, quality control and environmental management and monitoring training as well as road construction safety precautions. Operation workers would also be trained on safe handling of equipment and wastes and on the use of protective equipment.
- All staff will also be required to attend annual refresher courses.
- Contractors that perform work on site will be required to show evidence of appropriate health, safety and emergency response training. An orientation program will be developed to advise contractors and site visitors on basic health, safety, and emergency procedures such as emergency signals and evacuation routes. Contractors on short-term assignments who do not have safety and emergency response training will work under the supervision of the company staff.

Table 7-3 Institutional Strengthening and Training for Implementation Requirements

Institutional Strengthening Activity	Position(s)	Responsibilities		Cost Estimates (USD)
		Implementation	Supervision	
Establishing the responsible Institution	- Director - Environmental Specialist - Health Specialist - Safety Specialist	Institutional capacity building consultant	- MPWT/Supervisor - Management	1,500,000
Training of road construction staff	- Director - Environmental Specialist - Health Specialist - Safety Specialist	Training and environmental consultant	- MPWT/Supervisor - Management	1,000,000
Environmental awareness	MPWT general staff and site inspectors	Public awareness and environmental consultant	- MPWT/Supervisor - Environmental consultant	5,000
Training of environmental inspectors	Staff of different MPWT, DPWT of Provinces and operations regions	Training and environmental consultant	- MPWT/Supervisor - Environmental consultant	1,500,000
Training of Contractors	Construction Contractors	Public awareness and environmental consultant	- MPWT/Supervisor - Environmental consultant	5,000

8. CONCLUSIONS

NR-5 Rehabilitation Project is a very important road infrastructure development project to promote socio-economic development of BTB and BMCH Provinces. This EIA study has been conducted in accordance with the requirement of the JICA Guidelines. The conclusions of this EIA are summarized below:

- (i) All environmental documents are prepared based on JICA Guidelines.
- (ii) The EIA has shown that the Project will give both adverse and positive impacts.
- (iii) The significant adverse environmental impacts of the Projects are involuntary resettlement and land acquisition. Also certain adverse social impacts are anticipated to occur associated with the land acquisition and resettlement.
- (iv) Some impacts on air pollution, noise/vibration, water pollution, waste, malodor, global warming, topography, sedimentation, and ecosystem are anticipated. These impacts can be substantially mitigated through proposed mitigation measures.
- (v) Environmental Management Plan (EMP) has been prepared to facilitate implementation of mitigation measures. EMP includes the institutional framework for implementation and monitoring of the Environmental Mitigation Measures. Relevant institutions are proposed to coordinate for effective implementation and monitoring of the proposed mitigation measures.

Appendix 4-1

Water Depth and Flow Velocity of Rivers/Stream of Water Quality Analysis

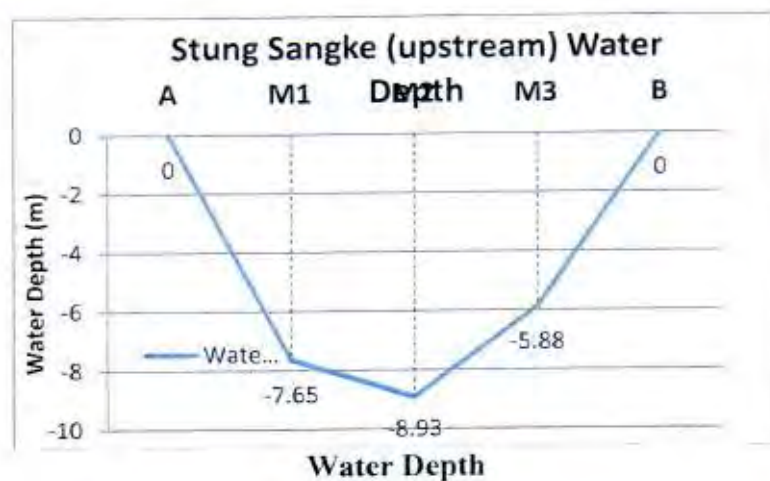
Water depths were surveyed using "Global Water WL16U Water Level Loggers"
Water flow velocities measured using "Global Water FP101-FP201 Global Flow Probe".

1. Steung Sangkae River

a. **Sampling sites:** Steung Sangkae River (Planned bridge of BB bypass)

Date: 8/13/2011 **Time:** 16:03

Weather: Clear Sky



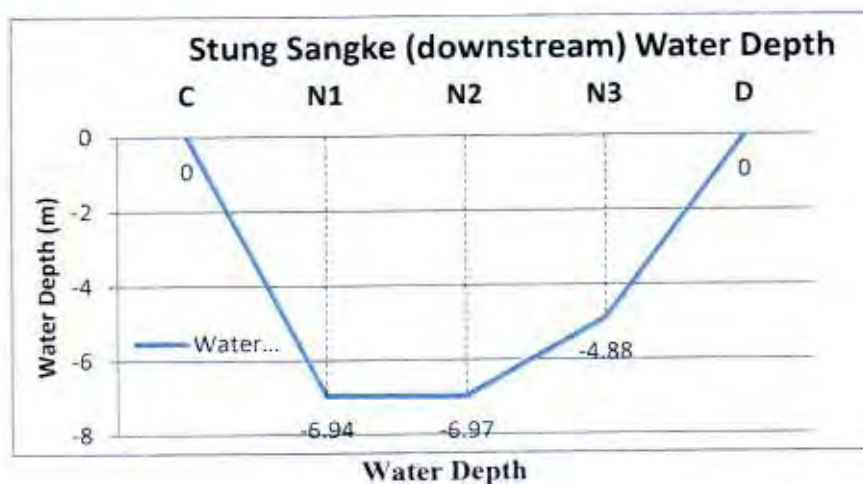
Flow Velocity

Point	Water level (m)	velocity (20 cm from water surface)		velocity (50 cm from water surface)		velocity (100cm from water surface)	
		Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)
A	0	-	-	-	-	-	-
M1	-7.65	0.85	0.9	0.71	1	0.92	1.1
M2	-8.93	0.94	1.2	1.03	1.1	1.02	1.1
M3	-5.88	0.52	0.6	0.56	0.6	0.57	0.6
B	0	-	-	-	-	-	-

b. **Sampling site:** Steung Sangkae River (2km downstream from BB bypass)

Date: 8/13/2011 **Time:** 18:10

Weather: Clear Sky



Flow Velocity

Point	Water level (m)	velocity (20 cm from water surface)		velocity (50 cm from water surface)		velocity (100cm from water surface)	
		Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)
C	0	-	-	-	-	-	-
N1	-6.94	0.87	0.9	0.79	1	0.71	0.9
N2	-6.97	0.85	1	0.87	1	0.92	1
N3	-4.88	0.44	0.5	0.55	0.6	0.55	0.7
D	0	-	-	-	-	-	-

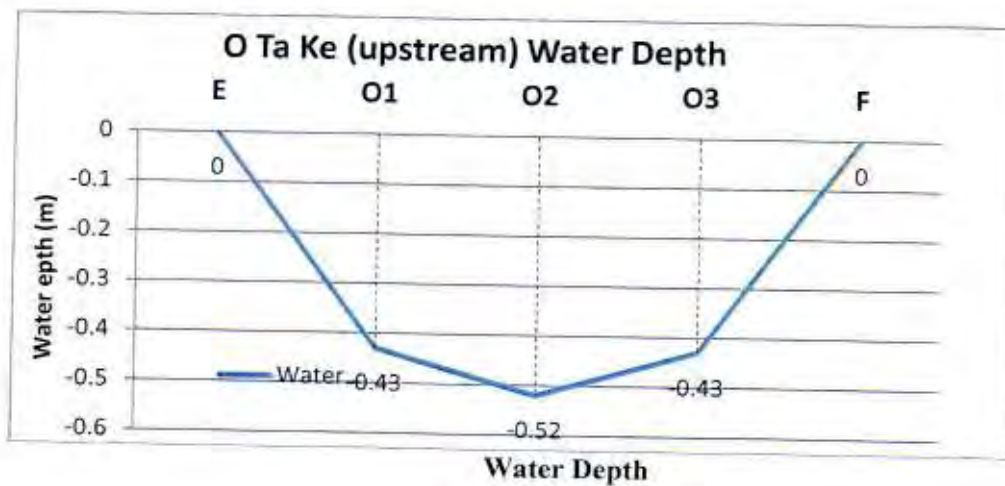
2. O Ta Ke Stream

a. Sampling site: O Ta Ke (Upstream)

Date: 08/14/2011

Time: 9:09

Weather: Clear Sky



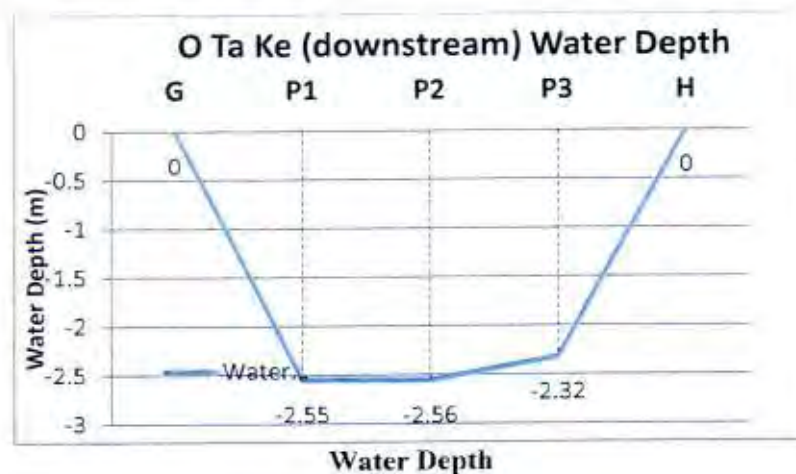
Point	Water depth (m)	velocity (20 cm from water surface)		velocity (0.6 of water depth)	
		Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)
E	0	-	-	-	-
O1	-0.43	0.06	<0.1	0.05	<0.1
O2	-0.52	0.25	0.3	0.34	0.4
O3	-0.43	0.1	0.2	0.03	<0.1
F	0	-	-	-	-

b. Sampling sites: O Ta Ke Stream (downstream)

Date: 08/14/2011

Time: 11:09

Weather: Clear Sky



Flow Velocity

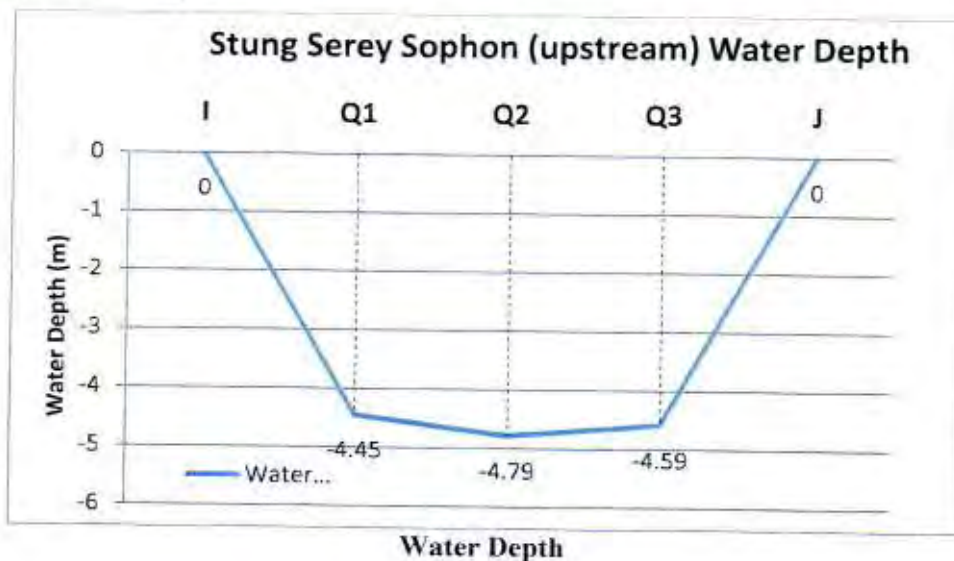
Point	Water level (m)	velocity (20 cm from water surface)		velocity (50 cm from water surface)		velocity (100cm from water surface)	velocity (0.6 of water depth)		
		Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)
G	0	-	-	-	-	-	-	-	-
P1	-2.55	0.05	<0.1	0.1	0.1	0.09	0.1	0.09	0.1
P2	-2.56	0.09	0.2	0.08	0.1	0.26	0.2	0.07	0.1
P3	-2.32	<0.1	<0.1	0.02	<0.1	0.06	0.1	0.04	<0.1
H	0	-	-	-	-	-	-	-	-

3. Steung Serei Saophoan River

a. **Sampling sites:** Steung Serei Saophoan (Bridge of NR 5)

Date: 8/13/2011 **Time:** 16:03

Weather: Clear Sky



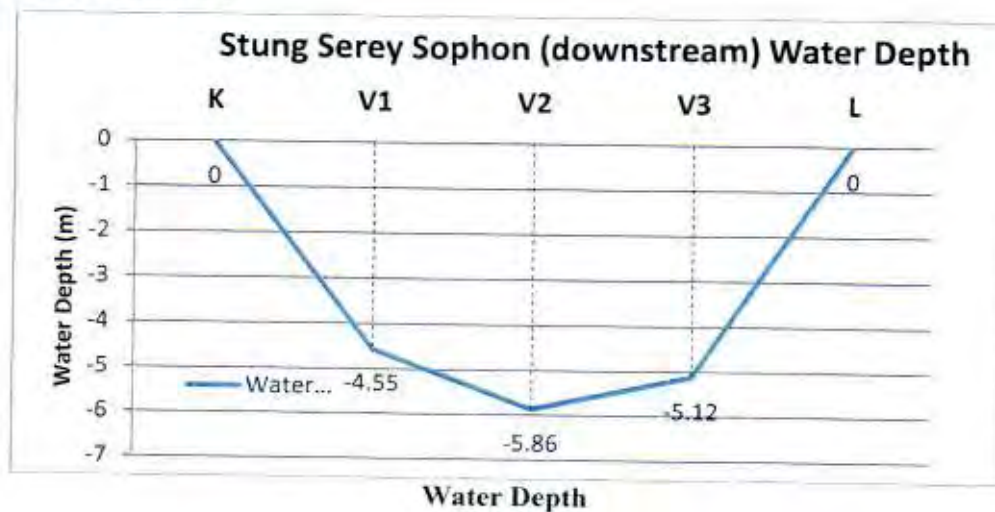
Flow Velocity

Point	Water level (m)	velocity (20 cm from water surface)		velocity (50 cm from water surface)		velocity (100cm from water surface)	
		Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)
A	0	-	-	-	-	-	-
M1	-7.65	0.85	0.9	0.71	1	0.92	1.1
M2	-8.93	0.94	1.2	1.03	1.1	1.02	1.1
M3	-5.88	0.52	0.6	0.56	0.6	0.57	0.6
B	0	-	-	-	-	-	-

b. **Sampling sites:** Stung Serey Sophon (downstream)

Date: 8/13/2011 **Time:** 16:52

Weather: Clear Sky



Flow Velocity

Point	Water level (m)	velocity (20 cm from water surface)		velocity (50 cm from water surface)		velocity (100cm from water surface)	
		Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)	Average (m/s)	Max (m/s)
K	0	-	-	-	-	-	-
V1	-4.55	0	<0.1	0	<0.1	0	<0.1
V2	-5.86	0	<0.1	0	<0.1	0	<0.1
V3	-5.12	0	<0.1	0	<0.1	0	<0.1
L	0	-	-	-	-	-	-

Appendix 17-2
Method and Assumptions Adopted in
Estimation of Noise and Gas Emission

1. Estimation of Noise

(i) Model for estimation

The model adopted to estimate traffic noise is the model developed by the Acoustic Society of Japan. This model has been widely used in Japan for estimation of road traffic noise.

This model is expressed as follows:

(a) Basic model: Basic model is as follows.

$$L_{Aeq} = 10 \log_{10} \left(10^{L_{AE}/10} \frac{N}{3600} \right) = L_{AE} + 10 \log_{10} N - 35.6$$

Where,

L_{Aeq} : Equivalent noise level [dB]

N : Traffic volume [veh/h]

And,

$$L_{AE} = 10 \log_{10} \left\{ \frac{1}{T_0} \left(\sum_i 10^{L_{Ai}/10} \cdot \Delta t_i \right) \right\}$$

Where,

L_{Ai} : Time fluctuation of noise level at A-characteristics, $\Delta t_i = \Delta l_i / V_i$ [s]

T_0 : Unit time [s]

Δl_i : Length of i th section of the road [m]

V_i : Average travel speed of vehicles on i th section of the road [m/s]

(b) Propagation Model: Propagation is calculated by the following formula.

$$L_{Ai} = L_{WA,i} - 8 - 20 \log_{10} r_i + \Delta_{cor,i}$$

Where,

L_{Ai} : Noise level from i th point propagated to the point of measurement at A characteristics [dB]

$L_{WA,i}$: Noise power level of the vehicle at i th point at A characteristics [dB]

r_i : Distance between i th point and the point of measurement [m]

$\Delta_{cor,i}$: Correction factors dependent on conditions of propagation [dB]

(c) Power Level of Vehicles Noise: Power level of vehicle noise is calculated by the following formula.

$$L_{WA} = a + b \log_{10} V + C$$

Where,

- L_{WA} : Average travel speed of vehicles [km/h]
 a : Coefficient dependent on the type of vehicle (See table below)
 b : Coefficient dependent on vehicle speed; 30 for deceleration and constant speed, 10 for acceleration and unstable speed
 C : Coefficient for other conditions, such as type of pavement surface

Table of coefficient a:

Type of Vehicle	Constant Speed (40 – 140 km/h)	Unstable Speed
Small Vehicle	46.7	82.3
Large Vehicle	53.2	88.8

(ii) Assumptions

Following conditions are assumed:

- Point of calculation of noise level
- Distance from the road: 20m from the centerline of the road
- Height: 1.2m from ground surface
- Traffic volume: Traffic volume estimated at Station No. 7

Year	Year 2021			Year 2030		
	MC	LV	HV	MC	LV	HV
Station 5	3,693	3,672	18,90	5,623	5,106	2,610
Station 6	34,713	5,554	2,756	54,063	7,612	3,700
Station 7	24,647	6,492	1,527	38,560	9,253	2,110
Station 8	12,700	4,827	2,774	19,807	7,245	3,687

MC: Motorcycle LV: Passenger car, Small truck etc HV: Large truck, Large bus etc

2. Estimation of Gas Emission from Traffic and Its Diffusion (NOx and SPM)

(i) The models adopted in the estimation of emission gas are those widely used in Japan.

(a) Windy Condition: Under the condition with wind velocity of 1.0m/sec or larger, so-called 'Plume Model' is adopted.

$$C(x, y, z) = \frac{Q}{2\pi \cdot u \cdot \sigma_y \cdot \sigma_z} \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \left[\exp\left\{-\frac{(z-H)^2}{2\sigma_z^2}\right\} + \exp\left\{-\frac{(z+H)^2}{2\sigma_z^2}\right\} \right]$$

Where,

- $C(x, y, z)$: Concentration of NO_x at point (x,y,z) (ppm)
 (or concentration of SPM(mg/m³))
 Q : Emission of NO_x from the source (ml/s)
 (For SPM mg/s)
 u : Average wind velocity (m/s)
 H : Height of source of emission (m)
 σ_y, σ_z : Width of diffusion in horizontal direction (y), and vertical direction (z) (m)
 x : Distance from the source of emission in the direction of wind(m)
 y : Horizontal distance in the direction of x axis (m)
 z : Vertical distance perpendicular to x axis (m)

(b) Calm Air Condition: Under calm air condition with wind speed of 1.0 m/sec or less, so-called 'Puff Model' is adopted.

$$C(x, y, z) = \frac{Q}{(2\pi)^{3/2} \alpha^2 \gamma} \left\{ \frac{1 - \exp\left(\frac{-\ell}{t_0^2}\right)}{2\ell} + \frac{1 - \exp\left(\frac{-m}{t_0^2}\right)}{2m} \right\}$$

Where,

$$\ell = \frac{1}{2} \cdot \left\{ \frac{x^2 + y^2}{\alpha^2} + \frac{(z - H)^2}{\gamma^2} \right\} \quad m = \frac{1}{2} \cdot \left\{ \frac{x^2 + y^2}{\alpha^2} + \frac{(z + H)^2}{\gamma^2} \right\}$$

- t_0 : Time corresponding to initial diffusion (s)
 α, γ : Coefficient on width of diffusion
 x : Distance measured in the direction of wind direction (m)
 y : Horizontal distance measured perpendicular to x axis (m)
 z : Vertical distance measured perpendicular to x axis(m)

$$t_0 = \frac{W}{2\alpha}, \quad W = \text{carriageway width}$$

And $\alpha = 0.3, \gamma = 0.18$ (day time), 0.09 (night time)

(ii) Assumption

Assumed conditions are as follows:

(a) Wind speed and direction

Since there are no data of average wind speed and average wind direction, average of the

maximum wind speed as shown below:

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	Direction	NE	SW	S	S	NW	SW	SW	E	SW	NE	N	NE
	Speed	5	5	4	5	14	7	10	8	6	5	5	5
2011	Direction	NW	NW	N	SE	S	W	W	SW				
	Speed	6	5	5	7	12	8	10	12				

Gust factor of 2.5 was adopted to estimate average wind speed from maximum wind speed.

(b) Point of estimation of concentration

- Distance from road: 20m from centerline of the road
- Height: 1.5m from ground surface

ANNEX 1: Photos of Environment and Pollution at Project Site
1- Natural Environmental Situation at Initiated Bypass



2- Bypass Situation intersection with NR.57



3- Bypass Situation connected with NR.5 at Kbal Khmauch Area



4- Landfill & Road Situations at Thmakal Market



5- Landfill at O Taky Market



6- Interview with seller at O Taky Market



7- Activities of Water Sampling



O Ta Ke's Water Sampling (near bridge)



O Ta Ke's Water sampling is 2Km away from bridge



Water Sampling at Proposed Bridge (Stung Sangke)



2Km away from proposed bridge



Water Sampling at Stung Serey Sophon
(Nearby bridge)



Water Sampling is 2Km away from bridge at Stung Serey
Sophon

8- Measurement of Depth, Width and Velocity of River and Stream Water



Proposed Bridge at Stung Sangke



2Km away from Proposed Bridge



O Ta Ke Stream



Stung Serey Sophon

9- Measurement of Noise/Vibration and Air Quality Analysis



10- Interview with local people on the natural environment and Pollution



Interview with local people at Bypass intersection with No.57



Interview with local people at Kampong Ampil Village where is near Proposed Bridge of Stung Sangke



Interview with local people at Banteay Meanchey Province

ANNEX 2

1-Air Quality Analysis


ក្រសួងបរិស្ថាន
នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន
អវិយាល័យបរិស្ថាន ធំ ចិត្តាគ
Ministry of Environment
Department of Pollution Control
Laboratory Office

លេខ / N° : ២០១១.០៨.០១

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ
Kingdom of Cambodia
Nation Religion King

របៀបវារៈប្រតិបត្តិការវិភាគ

Analysis Report

Name of Company: **ក្រុមហ៊ុន CES Co., Ltd**
 Survey Point: **Battambang Bypass Intersection with NR N°57, Road Side (X=298717, Y=1443910)**
 Sampling date: **08 August, 2011**
 Sampling Period: **10: 00 AM to 10: 00 AM next day**

Table Result of Air Quality Monitoring

លរ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឯកតា Unit	លទ្ធផល Result	ស្តង់ដារ Standard	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	Suspended Particulate Matter(SPM ₁₀)	mg /m ³ N	0.025	-	High Volume Sampler
2	Suspended Particulate Matter(SPM _{2.5})	mg /m ³ N	0.441	-	Low volume sampler
3	Nitrogen Dioxide (NO ₂)	mg /m ³ N	0.011	0.1	Saltzman Method
4	Sulfur Dioxide (SO ₂)	mg /m ³ N	0.005	0.3	Pararosaniline Method

Note:
 1- Humidity 61.60 %RH (Custom AHLT-100, Anemometer %RH, Temp, Lux)
 2- Temperature 33.52 °C
 3- Weight Concentration Measuring Method Based on Filtration Collection
 4- មានគ្រឿងផ្សេងៗទៀតនៅក្នុងប្រភេទប្រភេទនេះ។

បានឃើញនៅ ថ្ងៃទី០៧ ខែ សីហា ឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន
 Was seen on date:
 Director Department



ចេញអោយនៅ ថ្ងៃទី០៧ ខែ សីហា ឆ្នាំ២០១១

ប្រធានការិយាល័យ

Date of Issue:
 Laboratory Chief


លោក ឈុន



ក្រសួងបរិស្ថាន
នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន
គារីយោងយង់សោធន៍ ទី១ ភ្នំពេញ
Ministry of Environment
Department of Pollution Control
Laboratory Office

លេខ /N°/.....២០.....

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

Kingdom of Cambodia
Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ
Analysis Report

Name of Company: **ក្រុមហ៊ុន CES Co., Ltd**
 Survey Point: Battambang Bypass Intersection with NR N°57, 200m away from Road, (X=298651, Y=1443948)
 Sampling date: 11 August, 2011
 Sampling Period: 08:00 AM to 08:00 AM next day

Table Result of Air Quality Monitoring

លរ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឆ្នាក់ Unit	លទ្ធផល Result	ស្តង់ដារ Standard	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	Suspended Particulate Matter(SPM ₁₀)	mg /m ³ N	0.016	-	High Volume Sampler
2	Suspended Particulate Matter(SPM _{2.5})	mg /m ³ N	0.170	-	Low volume sampler
3	Nitrogen Dioxide (NO ₂)	mg /m ³ N	0.005	0.1	Saltzman Method
4	Sulfur Dioxide (SO ₂)	mg /m ³ N	0.003	0.3	Pararosaniline Method

Note:
 1- Humidity: 59.72 %RH (Custom AHLT-100, Anemometer %RH, Temp, Lux)
 2- Temperature: 32.05 °C
 3- Weight Concentration Measuring Method Based on Filtration Collection
 4- មានភ្លើងភ្នាក់ងារនៅក្នុងបន្ទប់ប្រតិបត្តិការ

បានឃើញនៅ ថ្ងៃទី១៤ ខែសីហាឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន
 Was seen on date:
 Director-Department



ចេញអោយនៅ ថ្ងៃទី១៤ ខែសីហាឆ្នាំ២០១១

ប្រធានការិយាល័យ

Date of Issue:
 Laboratory Chief

លេខ ៤៨ រុក្ខវិទ្យា



ក្រសួងបរិស្ថាន
នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន
ការិយាល័យពិសោធន៍ និង វិភាគ
Ministry of Environment
Department of Pollution Control
Laboratory Office

លេខ : N°/...០៧/...២០១១

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

Kingdom of Cambodia
Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ
Analysis Report

Name of Company: **ក្រុមហ៊ុន CES Co., Ltd**
Survey Point: Battambang KP 300, Road Side (X=298017, Y=1451085)
Sampling date: 07 August, 2011
Sampling Period: 09: 00 AM to 09: 00 AM next day

Table Result of Air Quality Monitoring

លរ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឆ្នាក់ Unit	លទ្ធផល Result	ស្តង់ដារ Standard	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	Suspended Particulate Matter(SPM ₁₀)	mg /m ³ N	0.065	-	High Volume Sampler
2	Suspended Particulate Matter(SPM _{2.5})	mg /m ³ N	0.311	-	Low volume sampler
3	Nitrogen Dioxide (NO ₂)	mg /m ³ N	0.007	0.1	Saltzman Method
4	Sulfur Dioxide (SO ₂)	mg /m ³ N	0.005	0.3	Pararosaniline Method

Note:
1- Humidity 61.50 %RH (Custom AHLT-100, Anemometer %RH, Temp, Lux)
2- Temperatur 31.14 °C
3- Weight Concentration Measuring Method Based on Filtration Collection
4- មានឡើងវិញក្នុងការវិភាគលើលទ្ធផល។

បានឃើញនៅ ថ្ងៃទី០៧ ខែសីហា ឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន
Was seen on date:
Director, Department



ចេញអោយនៅ ថ្ងៃទី០៧ ខែសីហា ឆ្នាំ២០១១
ប្រធានការិយាល័យ

Date of Issue:
Laboratory Chief

លោក-វេជ្ជ



ការយល់ឃើញសាច់ ខ្លី ថ្លៃ

Ministry of Environment
Department of Pollution Control
Laboratory Office

លេខ / N° / ២០០៧

ព្រះរាជាណាចក្រកម្ពុជា
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Kingdom of Cambodia

Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ

Analysis Report

Name of Company: **ក្រុមហ៊ុន** CES Co., Ltd

Survey Point: Battambang KP 300, 200m away from Road, (X=298161, Y=1451087)

Sampling date: 12 August, 2011

Sampling Period: 09: 00 AM to 09: 00 AM next day

Table Result of Air Quality Monitoring

ល.រ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឆ្នាត Unit	លទ្ធផល Result	ស្តង់ដារ Standard	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	Suspended Particulate Matter (SPM ₁₀)	mg /m ³ N	0.038	-	High Volume Sampler
2	Suspended Particulate Matter (SPM _{2.5})	mg /m ³ N	0.262	-	Low volume sampler
3	Nitrogen Dioxide (NO ₂)	mg /m ³ N	0.005	0.1	Saltzman Method
4	Sulfur Dioxide (SO ₂)	mg /m ³ N	0.003	0.3	Pararosaniline Method

Note:

- 1- Humidity 58.80 %RH (Custom AHI-1=100; Anemometer %RH, Temp, Lux)
- 2- Temperature 35.28 °C
- 3- Weight Concentration Measuring Method Based on Filtration Collection

បានឃើញនៅ ថ្ងៃទី១៧ ខែ សីហាឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន

Was seen on date:

Director Department



ចេញអោយនៅ ថ្ងៃទី១៧ ខែ កញ្ញា ២០១១

ប្រធានការិយាល័យ

Date of Issue:

Laboratory Chief

CHL

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លេខ ៤៨ រៀងៗ ព្រះសីហនុ ទន្លេចាសាក់ ខណ្ឌកោះកុង ភ្នំពេញ ទូរស័ព្ទលេខ៖ ០២៣ ២១០ ៤៩២



ព្រះរាជាណាចក្រកម្ពុជា
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ប្រតិបត្តិការត្រួតពិនិត្យគុណភាពខ្នាត
 Analysis Report

Name of Company: ក្រុមហ៊ុន CES Co., Ltd
 Survey Point: Banteay Meanchey KP 356, Road Side (X=281951, Y=1499380)
 Sampling date: 06 August, 2011
 Sampling Period: 08: 00 AM to 08: 00 AM next day

Table Result of Air Quality Monitoring

លរ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឯកតា Unit	លទ្ធផល Result	ស្តង់ដារ Standard	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	Suspended Particulate Matter(SPM ₁₀)	mg /m ³ N	0.061	-	High Volume Sampler
2	Suspended Particulate Matter(SPM _{2.5})	mg /m ³ N	0.242	-	Low volume sampler
3	Nitrogen Dioxide (NO ₂)	mg /m ³ N	0.006	0.1	Saltzman Method
4	Sulfur Dioxide (SO ₂)	mg /m ³ N	0.004	0.3	Pararosaniline Method

Note:
 1- Humidity: 58-70 %RH (Custom AHI.T-100, Anemometer %RH, Temp. Lux)
 2- Temperature: 33.05 °C
 3- Weight Concentration Measuring Method Based on Filtration Collection
 4- មានត្រួតពិនិត្យជាប្រចាំប្រចាំថ្ងៃ

បានឃើញនៅ ថ្ងៃទី១៧ ខែសីហា ឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន
 Was seen on date:
 Director Department



ហេង-ណារ៉េត

ចេញអោយនៅ ថ្ងៃទី១៧ ខែសីហា ឆ្នាំ២០១១
 ប្រធានការិយាល័យ

Date of Issue:
 Laboratory Chief

(Signature)

អេក-ឡូ



ក្រសួងបរិស្ថាន
នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន
ការិយាល័យពិសោធន៍ និង វិភាគ
Ministry of Environment
Department of Pollution Control
Laboratory Office

លេខ ៧៧១/២០១១

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

Kingdom of Cambodia
Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ
Analysis Report

Name of Company: **ក្រុមហ៊ុន CES Co., Ltd**
 Survey Point: **Banteay Meanchey KP 356, 200m away from Road, (X=281898, Y=1499371)**
 Sampling date: **13 August, 2011**
 Sampling Period: **10: 00 AM to 10: 00 AM next day**

Table Result of Air Quality Monitoring

លរ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឆ្នាត Unit	លទ្ធផល Result	ស្តង់ដារ Standard	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	Suspended Particulate Matter(SPM ₁₀)	mg /m ³ N	0.027	-	High Volume Sampler
2	Suspended Particulate Matter(SPM _{2.5})	mg /m ³ N	0.143	-	Low volume sampler
3	Nitrogen Dioxide (NO ₂)	mg /m ³ N	0.004	0.1	Saltzman Method
4	Sulfur Dioxide (SO ₂)	mg /m ³ N	0.003	0.3	Pararosaniline Method

Note:
 1- Humidity 56.00 %RH (Custom AHE.T-100 Anemometer %RH Temp. Lux)
 2- Temperature 34.15 °C
 3- Weight Concentration Measuring Method Based on Filtration Collection.

បានឃើញនៅ ថ្ងៃទី១៧ ខែសីហាឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន
 Was seen on date:
 Director Department



ហេង-ណារ៉េត

ចេញអោយនៅ ថ្ងៃទី១៧ ខែសីហាឆ្នាំ២០១១
 ប្រធានការិយាល័យ

Date of Issue:
 Laboratory Chief

(Signature)

ចេញ-រដ្ឋ

2- Noise/Vibration Measurement



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 Kingdom of Cambodia
 Nation Religion King
 ក្រសួងបរិស្ថាន
 នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន
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 Ministry of Environment
 Department of Pollution Control
 Laboratory Office
 លេខ: N°/.....

របៀបវារៈវាស់ស្ទង់ Analysis Report

Name of Company: ក្រុមហ៊ុន CES Co., Ltd

Survey Point: Battambang Bypass Intersection with NR N°57

Date: 08 August, 2011

Table Results of Measuring Noise Level

Survey Period		Noise Level dB(A)				Remarks
		L _{Aeq}	Standard	L _{max}	L _{min}	
Day	6:00 - 7:00	60.1	70	76.3	44.8	
	7:00 - 8:00	62.7		77.4	44.6	
	8:00 - 9:00	61.8		76.3	44.4	
	9:00 - 10:00	60.6		78.3	44	
	10:00 - 11:00	61.4		77.9	47.4	
	11:00 - 12:00	58.9		73	44.8	
	12:00 - 13:00	60.1		74.9	44.6	
	13:00 - 14:00	61.6		77.4	45.1	
	14:00 - 15:00	62.8		76.1	46.5	
	15:00 - 16:00	62.7		80.8	48.2	
	16:00 - 17:00	63.1		78	50.8	
	17:00 - 18:00	62		79.8	47.9	
Evening	18:00 - 19:00	64	Noise Level Standard 65 dB	84.5	47.2	
	19:00 - 20:00	62.4		76.1	44	
	20:00 - 21:00	60.6		74.3	44.1	
	21:00 - 22:00	61		74.6	44.3	
Night	22:00 - 23:00	59.6	50	75.1	44.5	
	23:00 - 00:00	56.7		72.5	44.2	
	00:00 - 1:00	55.5		73.4	44.9	
	1:00 - 2:00	52.9		71.8	44.3	
	2:00 - 3:00	51.6		72.1	44.2	
	3:00 - 4:00	50.8		69.6	44.7	
Night	4:00 - 5:00	55.6	50	74.3	44.6	
	5:00 - 6:00	58.6		75.2	44.1	
	24 hours Average	59.46		75.81	45.34	

Remark1: The unit of noise data in this table is dB(A).

Remark2: Noise level standard by the sub-degree on Air and Noise Pollution Control in Cambodia.

Remark3: Sound Level Meter NL-21

បានធ្វើការវាស់នៅថ្ងៃទី០៧ ខែសីហាឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន

Was seen on date:
 Director Department



លោក-អ្នកប្រឹក្សា

ធ្វើការវាស់នៅថ្ងៃទី០៧ ខែសីហាឆ្នាំ២០១១

ប្រធានការិយាល័យ

Date of Issue:

Laboratory Chief

(Signature)

លោក-អ្នកប្រឹក្សា

លេខ: ៨៨ រៀងរាល់ ព្រះសីហនុ ទេសចរណ៍ ខណ្ឌព្រៃនគរ ភ្នំពេញ ថ្ងៃសុក្រ ០២៣ ២០១១ ៤៩៦



ក្រសួងបរិស្ថាន

នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន

ការិយាល័យពិសោធន៍ និង វិភាគ

Ministry of Environment
Department of Pollution Control
Laboratory Office

លេខ / N° / ២០០៨ បាត់ដំបង

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

Kingdom of Cambodia

Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ

Analysis Report

Name of Company: ក្រុមហ៊ុន CES Co., Ltd

Survey Point: Battambang Bypass Intersection with NR N°57

DURATION: 24 h

Date: 08-August-2011

Table Results of Measuring Vibration Level

Survey Period Day time	Standard of Type 1*	Leq (db)	Survey Period Nigh time	Standard of Type 1*	Leq (db)	Remark
06:00 - 07:00	Max 65 db Day time	20.9	18:00 - 19:00	Max 60 db Nigh time	20.3	
07:00 - 08:00		21.8	19:00 - 20:00		20.1	
08:00 - 09:00		21.7	20:00 - 21:00		19.6	
09:00 - 10:00		22.4	21:00 - 22:00		19.8	
10:00 - 11:00		24.4	22:00 - 23:00		18.6	
11:00 - 12:00		24.3	23:00 - 24:00		18.5	
12:00 - 13:00		22.1	24:00 - 01:00		17.3	
13:00 - 14:00		22.6	01:00 - 02:00		17.6	
14:00 - 15:00		23.1	02:00 - 03:00		18.4	
15:00 - 16:00		22.4	03:00 - 04:00		18.9	
16:00 - 17:00		22.5	04:00 - 05:00		19.1	
17:00 - 18:00		21.5	05:00 - 06:00		20.5	
Average		22.5	Average		19.1	

Remark1. The unit of Vibration data in this table is db.

Remark2. Vibration level standard is Environmental Quality Standard of Japan

Remark3. Vibration Level Meter FM-53A

Remark4. Type 1 - Residential area.

បានឃើញនៅ ថ្ងៃទី០៧ ខែសីហាឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន

Was seen on date:
Director Department



ហេង ណារ៉ុន

ចេញអោយនៅ ថ្ងៃទី០៧ ខែសីហាឆ្នាំ២០១១

ប្រធានការិយាល័យ

Date of Issue:

Laboratory Chief

(Signature)

សេក ឌី

លេខ ៤៨ ព្រះវិហារ ព្រះសីហនុ ទន្លេបាសាក់ ខណ្ឌចំការមន ភ្នំពេញ ទូរស័ព្ទលេខ: ០២៣ ២១០ ៤៩២



ក្រសួងបរិស្ថាន
នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន
គណៈរដ្ឋមន្ត្រីសេដ្ឋកិច្ច និង វិស័យ
Ministry of Environment
Department of Pollution Control
Laboratory Office
លេខ / N° / ២៣៧ ២០១១

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ
Kingdom of Cambodia
Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ

Name of Company: **ក្រុមហ៊ុន CES Co., Ltd** Analysis Report

Survey Point: **Battambang KP 300**

Table Results of Measuring Noise Level

Date: 07 August, 2011

Survey Period		Noise Level dB(A)				Remarks
		L _{Aeq}	Standard	L _{max}	L _{min}	
Day	6:00 - 7:00	66.9	70	84.2	50.8	
	7:00 - 8:00	64.8		80.9	49.6	
	8:00 - 9:00	68.4		91	49.1	
	9:00 - 10:00	65.8		79.8	48.7	
	10:00 - 11:00	65		90.9	48.3	
	11:00 - 12:00	65.6		82.2	55.4	
	12:00 - 13:00	68.3		92.6	52.5	
	13:00 - 14:00	66.4		92.6	52.1	
	14:00 - 15:00	68		86.4	52.7	
	15:00 - 16:00	67.8		93.5	52.8	
	16:00 - 17:00	67.9		91.2	52.5	
	17:00 - 18:00	67.5		91.6	53.1	
Evening	18:00 - 19:00	67.5	65	83.2	53.9	
	19:00 - 20:00	66.5		84.6	49.2	
	20:00 - 21:00	65		82.5	50.1	
	21:00 - 22:00	62.9		79	49.2	
Night	22:00 - 23:00	62.6	50	77.9	48.9	
	23:00 - 00:00	61.3		75.5	48.2	
	00:00 - 1:00	60.4		75.1	48.8	
	1:00 - 2:00	63.1		76.4	49.3	
	2:00 - 3:00	65.6		77.3	48.9	
	3:00 - 4:00	65.9		77.6	48.8	
	4:00 - 5:00	66.8		83.2	48.1	
5:00 - 6:00		66.1		80.9	49.1	
24 hours Average		65.67		83.75	50.42	

Remark1 The unit of noise data in this table is dB(A).
 Remark2 Noise level standard by the sub-degree on Air and Noise Pollution Control in Cambodia.
 Remark3 Sound Level Meter NL-21

បានឃើញនៅ ថ្ងៃទី១៧ ខែសីហាឆ្នាំ២០១១

ចេញអោយនៅ ថ្ងៃទី១៧ ខែសីហាឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន

ប្រធានការិយាល័យ

Was seen on date:
 Director's Department

Date of Issue:
 Laboratory Chief



(Signature)

តេក.ជឿ

សោច-ណារ៉េត

លេខ ៤៨ រុក្ខវិធី ព្រះសីហនុ ទន្លេបាសាក់ ខណ្ឌកោះកុង ភ្នំពេញ ចូលស័ព្ទលេខ: ០២៣ ២១០ ៤៩២



ក្រសួងបរិស្ថាន
នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន
គណៈកម្មាធិការសាងសង់ ទី២ វិភាគ
Ministry of Environment
Department of Pollution Control
Laboratory Office
លេខ / N°/ ២២ ២០១១

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ
Kingdom of Cambodia
Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ
Analysis Report

Name of Company: ក្រុមហ៊ុន CES Co., Ltd
Survey Point: Battambang KP 300
DURATION: 24 h
Date: 07-August-2011

Table Results of Measuring Vibration Level

Survey Period Day time	Standard of Type 1*	Leq (db)	Survey Period Nigh time	Standard of Type 1*	Leq (db)	Remark
06:00 - 07:00	Max 65 db Day time	29.6	18:00 - 19:00	Max 60 db Nigh time	30.6	
07:00 - 08:00		26.6	19:00 - 20:00		29.4	
08:00 - 09:00		25.5	20:00 - 21:00		30.8	
09:00 - 10:00		26.2	21:00 - 22:00		29.8	
10:00 - 11:00		30.1	22:00 - 23:00		21.1	
11:00 - 12:00		30.4	23:00 - 24:00		28.3	
12:00 - 13:00		30.7	24:00 - 01:00		28.1	
13:00 - 14:00		30.6	01:00 - 02:00		21.9	
14:00 - 15:00		31.1	02:00 - 03:00		25.6	
15:00 - 16:00		29.1	03:00 - 04:00		23.4	
16:00 - 17:00		29.2	04:00 - 05:00		26.3	
17:00 - 18:00		21.5	05:00 - 06:00		29.4	
Average		28.4	Average		27.1	

Remark1: The unit of Vibration data in this table is db.
Remark2: Vibration level standard is Environmental Quality Standard of Japan
Remark3: Vibration Level Meter FM-33A.
Remark4: Type 1 Residential area

បានឃើញនៅ ថ្ងៃទី ០៧ ខែ សីហា ឆ្នាំ ២០១១
ប្រធាននាយកដ្ឋាន
Was seen on date:
Director Department



ហេង-ណារ៉េត

ចេញអោយនៅ ថ្ងៃទី ០៧ ខែ សីហា ឆ្នាំ ២០១១
ប្រធានការិយាល័យ
Date of Issue:
Laboratory Chief

CH
គេង-ឡៃ



ក្រសួងបរិស្ថាន

នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន

ការងារបរិស្ថាន ខ័ណ្ឌ វិភាគ

Ministry of Environment
Department of Pollution Control
Laboratory Office

INB / N° / ២០១១ ០២០១

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

Kingdom of Cambodia

Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ

Name of Company: ក្រុមហ៊ុន CES Co., Ltd Analysis Report

Survey Point: Banteay Meanchey KP 356

Table Results of Measuring Noise Level

Date: 06 August, 2011

Survey Period		Noise Level dB(A)				Remarks
		LAeq	Standard	Lmax	Lmin	
Day	6:00 - 7:00	65.1	70	81.6	49.4	
	7:00 - 8:00	65.2		80.8	49.5	
	8:00 - 9:00	65.8		92.6	47.9	
	9:00 - 10:00	64.3		85.8	46.4	
	10:00 - 11:00	65.1		88	47.8	
	11:00 - 12:00	65.2		88.2	47.7	
	12:00 - 13:00	65.3		87.3	48.9	
	13:00 - 14:00	64.5		89.1	48.9	
	14:00 - 15:00	67.6		90.9	49.1	
	15:00 - 16:00	66.8		77.5	48.2	
	16:00 - 17:00	64.9		86.4	50.3	
	17:00 - 18:00	64.8		84.2	48.9	
	18:00 - 19:00	65.2		85.2	48.9	
	19:00 - 20:00	63.5	Noise Level Standard	80.4	47.2	
Evening	20:00 - 21:00	65.1		80.8	47.6	
	21:00 - 22:00	61.3		75.1	45.1	
	22:00 - 23:00	58.2		70.1	43.3	
Night	23:00 - 00:00	57.8	50	75.6	43.6	
	00:00 - 1:00	60.4		78.7	40.8	
	1:00 - 2:00	58.6		72.4	40.6	
	2:00 - 3:00	54.7		71.6	38.9	
	3:00 - 4:00	52.3		68.6	38.1	
	4:00 - 5:00	59.6		75.9	43.7	
	5:00 - 6:00	65.3		79.4	47.6	
24 hours Average		62.78		81.09	46.18	

Remark1. The unit of noise data in this table is dB(A)

Remark2. Noise level standard by the sub-degree on Air and Noise Pollution Control in Cambodia

Remark3. Sound Level Meter SL-21

បានឃើញនៅ ថ្ងៃទី ០៦ ខែ សីហា ឆ្នាំ ២០១១

ប្រធាននាយកដ្ឋាន

Was seen on date:
Director Department



ហេង ណារ៉េត

ចេញអោយនៅ ថ្ងៃទី ០៦ ខែ សីហា ឆ្នាំ ២០១១

ប្រធានការិយាល័យ

Date of Issue:
Laboratory Chief

CH N

ចេញ ១៩

លេខ ៤៨ ព្រឹត្តិ ព្រះសីហនុ ទន្លេបាសាក់ ខណ្ឌការពារ ភ្នំពេញ ទូរស័ព្ទលេខ: ០២៣ ២១០ ៤៩២



ព្រះរាជាណាចក្រកម្ពុជា
 ជាយកដ្ឋានគ្រួសារនិងបរិស្ថាន
 ក្រសួងបរិស្ថាន និង វិស័យ
 Ministry of Environment
 Department of Pollution Control
 Laboratory Office

លេខ / N°: ២៥ ២០១១

ព្រះរាជាណាចក្រកម្ពុជា
 ជាតិ សាសនា ព្រះមហាក្សត្រ

Kingdom of Cambodia
 Nation Religion King

របៀបវារៈប្រឡងវិស័យ Analysis Report

Name of Company: ក្រុមហ៊ុន CES Co., Ltd
 Survey Point: Banteay Meanchey KP 356
 DURATION: 24 h
 Date: 06-August-2011

Table Results of Measuring Vibration Level

Survey Period Day time	Standard of Type 1*	Leq (db)	Survey Period Nigh time	Standard of Type 1*	Leq (db)	Remark
06:00 - 07:00	Max 65 db Day time	20.7	18:00 - 19:00	Max 60 db Nigh time	22.8	
07:00 - 08:00		20.5	19:00 - 20:00		20.2	
08:00 - 09:00		21.8	20:00 - 21:00		19.5	
09:00 - 10:00		22	21:00 - 22:00		19.1	
10:00 - 11:00		37.3	22:00 - 23:00		18.8	
11:00 - 12:00		24	23:00 - 24:00		19.7	
12:00 - 13:00		24	24:00 - 01:00		20	
13:00 - 14:00		22.7	01:00 - 02:00		19.3	
14:00 - 15:00		21.8	02:00 - 03:00		18.4	
15:00 - 16:00		23.3	03:00 - 04:00		20.3	
16:00 - 17:00		24.5	04:00 - 05:00		21.6	
17:00 - 18:00		22.6	05:00 - 06:00		22.6	
Average		23.8	Average		20.2	

Remark1: The unit of Vibration data in this table is db.
 Remark2: Vibration level standard is Environmental Quality Standard of Japan
 Remark3: Vibration Level Meter VM-53A
 Remark4: Type 1 Residential area

បានឃើញនៅ ថ្ងៃទី០៧ ខែសីហា ឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន
 Was seen by date:
 Director Department



ហេង ណារ៉ុន

ចេញអោយនៅ ថ្ងៃទី០៧ ខែសីហា ឆ្នាំ២០១១

ប្រធានការិយាល័យ

Date of Issue:
 Laboratory Chief

(Signature)

សេក ឌី

លេខ ៤៨ រុក្ខវិទ្យា ព្រះសីហនុ ខេត្តស្វាយរៀង ខណ្ឌចំការមន ភ្នំពេញ ទូរស័ព្ទលេខ: ០២៣ ២១០ ៤៤២

3- Water Quality Analysis



ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ
Kingdom of Cambodia
Nation Religion King
ក្រសួងបរិស្ថាន
នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន
គោលការណ៍បរិស្ថាន និង ចំណុះ
Ministry of Environment
Department of Pollution Control
Laboratory Office

លេខ / N°/ ០១០៤៨៧. ២០១១

របៀបវារៈប្រតិបត្តិការប្រតិបត្តិការ Analysis Report

ប្រភពសំណាក/Sample Source : ក្រុមហ៊ុន CES Co., Ltd					
ថ្ងៃ ខែ ឆ្នាំទទួលសំណាក/Date: 08/8/2011					
ប្រភេទសំណាក/Type of Sample: Sample.SW1 Propose សំណាកទឹកស្ទឹងសង្កែ ភូមិកំពង់ពិល ឃុំរតនាម័យ ស្រុកសង្កែ					
ខេត្តបន្ទាយមានជ័យ . X- 0304487. Y- 1443038					
លរ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឆ្នាក់ Unit	លទ្ធផល Result	ស្តង់ដារ Standard(*)	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	pH	-	7.97	6.5 - 8.5	pH-EC & TDS meter
2	Total Suspended Solid (TSS)	mg/l	120.00	25 - 100	Method 2540 D
3	Biochemical Oxygen Demand (BOD)	mg/l	0.40	1.0 - 10.0	Method 5210 B
4	Chemical Oxygen Demand (COD)	mg/l	1.87	-	JIS K 0102
Note: ១ ការវាយតម្លៃសំណាក តាមក្រុមហ៊ុន និងការវាយតម្លៃសំណាកទឹកប្រតិបត្តិការស្ទឹងសង្កែ កំពង់ពិល ឃុំរតនាម័យ ស្រុកសង្កែ ខេត្តបន្ទាយមានជ័យ ។					
២ (*) កំរិតស្តង់ដារសំណាកទឹកស្ទឹងសង្កែ កំពង់ពិល ឃុំរតនាម័យ ស្រុកសង្កែ ខេត្តបន្ទាយមានជ័យ ។					

បានឃើញនៅ ថ្ងៃទី១៧ ខែសីហាឆ្នាំ២០១១
ប្រធាននាយកដ្ឋាន

Was seen on date:
Director Department



ហេង-ណារ៉េត

ចេញអោយនៅ ថ្ងៃទី១៧ ខែសីហាឆ្នាំ២០១១

ប្រធានការិយាល័យ

Date of Issue:

Laboratory Chief

CH R

ចេត-ឡៃ



ព្រះរាជាណាចក្រកម្ពុជា

នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន

ការិយាល័យពិសោធន៍ និង វិភាគ

Ministry of Environment

Department of Pollution Control

Laboratory Office

លេខ : N°/.....

ព្រះរាជាណាចក្រកម្ពុជា

ជាតិ សាសនា ព្រះមហាក្សត្រ

Kingdom of Cambodia

Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ

Analysis Report

ប្រភពសំណាក/Sample Source : ក្រុមហ៊ុន CES Co., Ltd					
ថ្ងៃ ខែ ឆ្នាំទទួលសំណាក/Date: 08/8/2011					
ប្រភេទសំណាក/Type of Sample: Sample.SW2 Propose សំណាកទឹកស្ទឹងសង្កែ ភូមិវត្តភ្នំ ឃុំវត្តភ្នំ ស្រុកសង្កែ					
ខេត្តបន្ទាយមានជ័យ, X-0305053, Y-1444942					
លរ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឆ្លាត Unit	លទ្ធផល Result	ស្តង់ដារ Standard(*)	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	pH	-	7.91	6.5 - 8.5	pH-EC & TDS meter
2	Total Suspended Solid (TSS)	mg/l	96.00	25 - 100	Method 2540 B
3	Biochemical Oxygen Demand (BOD)	mg/l	0.60	1.0 - 10.0	Method 5210 B
4	Chemical Oxygen Demand (COD)	mg/l	2.04	-	HS K 0102

Note: ១ ការយកសំណាក ការរក្សាទុក និងការដឹកជញ្ជូនសំណាកទឹកមកមន្ទីរពិសោធន៍ តំបែង ក្រុមហ៊ុនអនុវត្តដោយខ្លួនឯង ។
 ២ (*) ស្តង់ដារស្តង់ដារជាតិសំណាកទឹកនៅតាមសំណង់ទឹកសាធារណៈសំរាប់ការប្រើប្រាស់នៅក្នុងទឹក

បានឃើញនៅ ថ្ងៃទី ១៧ ខែ សីហា ឆ្នាំ ២០១១

ប្រធាននាយកដ្ឋាន

Wasan Sopha date:
Director Department



ហេង ណារ៉េង

ចេញអោយនៅ ថ្ងៃទី ១៧ ខែ សីហា ឆ្នាំ ២០១១

ប្រធានការិយាល័យ

Date of Issue:

Laboratory Chief

(Signature)

ឆេក ឡុង

លេខ ៤៨ រុក្ខវិទ្យា ព្រះសិប្បតុ ទន្លេបាសាក់ ខណ្ឌចំការមន ភ្នំពេញ ត្រូវបានបោះពុម្ព ០២៣ ២១០ ៤៩២



ក្រសួងបរិស្ថាន

នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន

ការិយាល័យពិសោធន៍ ទី១ ភ្នំពេញ

Ministry of Environment
Department of Pollution Control
Laboratory Office

លេខ /N°/ ៩៦ ០២០១១

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

Kingdom of Cambodia

Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលពិភាក្សា

Analysis Report

ប្រភពសំណាក/Sample Source : ក្រុមហ៊ុន CES Co., Ltd					
ថ្ងៃ ខែ ឆ្នាំទទួលសំណាក/Date: 08/8/2011					
ប្រភេទសំណាក/Type of Sample: Sample SW01 KP305 សំណាកទឹកអូរកៅកែ ភូមិត្រស ឃុំអូរគាត់ ស្រុកថ្មបាញ់					
ឧត្តមន្ទីរមានជ័យ - X= 0295600, Y= 1454924					
លរ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឆ្នាត Unit	លទ្ធផល Result	ស្តង់ដារ Standard(*)	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	pH	-	7.59	6.5 - 8.5	pH-EC & TDS meter
2	Total Suspended Solid (TSS)	mg/l	94.00	25 - 100	Method 2540 D
3	Biochemical Oxygen Demand (BOD)	mg/l	0.85	1.0 - 10.0	Method 5210 B
4	Chemical Oxygen Demand (COD)	mg/l	2.48	-	JIS K 0102

Note: ១ ការប្រើប្រាស់សំណាក ត្រូវតែប្រើប្រាស់ក្នុងរយៈពេល ២៤ ម៉ោង បន្ទាប់ពីការប្រមូល។
២ (*) កំរិតគុណភាពស្តង់ដារតាមការកំណត់របស់ក្រសួងបរិស្ថាន។

បានឃើញនៅ ថ្ងៃទី១៩ ខែសីហា ឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន

Was seen on date:

Director Department



ប្រធាន-លាភី

ចេញអោយនៅ ថ្ងៃទី១៩ ខែសីហា ឆ្នាំ២០១១

ប្រធានការិយាល័យ

Date of Issue:

Laboratory Chief

(Signature)

លេខ-៩៦

លេខ ៤៨ រៀង ព្រះសិបាត ទន្លេសាបា ខណ្ឌចំការមន ភ្នំពេញ ទូរស័ព្ទលេខ: ០២៣ ២១០ ៤៩២



ក្រសួងបរិស្ថាន

នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន

ការិយាល័យពិសោធន៍ ទឹក ចំណី

Ministry of Environment

Department of Pollution Control

Laboratory Office

លេខ / N° / ៥១២០១១ ២០១១

ព្រះរាជាណាចក្រកម្ពុជា

ជាតិ សាសនា ព្រះមហាក្សត្រ

Kingdom of Cambodia

Nation Religion King

ប្រតិច្ចឹប្រតិបត្តិការវិភាគ

Analysis Report

ប្រភពសំណាក/Sample Source : ក្រុមហ៊ុន CES Co., Ltd

ថ្ងៃ ខែ ឆ្នាំទទួលសំណាក/Date: 08/8/2011

ប្រភេទសំណាក/Type of Sample: Sample.SW02 KP305 សំណាកទឹកអូរខ្សែលូស ភូមិខ្សែលូស ឃុំអូរតាគី ស្រុកថ្មបាញ់ ខេត្តបន្ទាយមានជ័យ . X: 0297008, Y: 1456004

លរ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឆ្លាត Unit	លទ្ធផល Result	ស្តង់ដារ Standard (*)	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	pH	-	7.32	6.5 - 8.5	pH-EC & TDS meter
2	Total Suspended Solid (TSS)	mg/l	86.00	25 - 100	Method 2540 D
3	Biochemical Oxygen Demand (BOD)	mg/l	1.00	1.0 - 10.0	Method 5210 B
4	Chemical Oxygen Demand (COD)	mg/l	3.19	-	JIS K 0102

Note: ១ ការប្រើប្រាស់សំណាក ក្នុងករណីនេះ គឺជាសំណាកទឹកអូរខ្សែលូស (សំណាក) ក្រុមហ៊ុនអនុវត្តដោយខ្លួនឯង ។
២ (*) កំរិតកំណត់ស្តង់ដារគ្រប់គ្រងគុណភាពទឹកនៅតាមបំណងទឹកសាធារណៈ សំណាកស្រាវជ្រាវនៅក្នុងទឹក

ចេញអោយនៅ ថ្ងៃទី១៧ ខែសីហា ឆ្នាំ២០១១

ប្រធានការិយាល័យ

Date of Issue:

Laboratory Chief

បានឃើញនៅ ថ្ងៃទី១៧ ខែសីហា ឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន

Was seen on date:

Director Department



បេក្ខ-ណារេត

Handwritten signature of the Laboratory Chief

លោក-វេជ្ជ

លេខ ៨៨ ក្រវីថី ព្រះសីហនុ ទន្លេតាសាត់ ខណ្ឌចំការមន ភ្នំពេញ ទូរស័ព្ទលេខ: ០២៣ ២១០ ៤៩២



ក្រសួងបរិស្ថាន
 នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន
 ការិយាល័យពិសោធន៍ និង វិភាគ
 Ministry of Environment
 Department of Pollution Control
 Laboratory Office

លេខ /N°/.....

ព្រះរាជាណាចក្រកម្ពុជា
 ជាតិ សាសនា ព្រះមហាក្សត្រ

Kingdom of Cambodia
 Nation Religion King

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ

Analysis Report

ប្រភពសំណាក/Sample Source : ក្រុមហ៊ុន CES Co., Ltd					
ថ្ងៃ ខែ ឆ្នាំទទួលសំណាក/Date: 08/8/2011					
ប្រភេទសំណាក/Type of Sample: Sample SW1 KP358 សំណាកទឹកស្ទឹងសេរីសោភ័ណ ភូមិព្រៃបូស្សី ឃុំព្រះពន្លា					
ស្រុកសេរីសោភ័ណ ខេត្តបន្ទាយមានជ័យ, X= 0281642, Y= 1501542					
ល.រ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឆ្នាត Unit	លទ្ធផល Result	ស្តង់ដារ Standard(*)	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	pH	-	7.96	6.5 - 8.5	pH-EC & TDS meter
2	Total Suspended Solid (TSS)	mg/l	46.00	25 - 100	Method 2540 D
3	Biochemical Oxygen Demand (BOD)	mg/l	2.05	1.0 - 10.0	Method 5210 B
4	Chemical Oxygen Demand (COD)	mg/l	4.62	-	JIS K 0102
Note: ១ ការយកសំណាក តាមក្របខ័ណ្ឌ និងការដឹកជញ្ជូនសំណាកទឹកមកមន្ទីរពិសោធន៍(តំបន់)ក្រុមហ៊ុនអនុវត្តដោយខ្លួនឯង ។ ២ (*) ព័ត៌មានស្តង់ដារគុណភាពទឹកនៅតាមតំបន់ទឹកសាបាណៈសំរាប់អភិវឌ្ឍន៍ប្រើនៅក្នុងទឹក					

បានឃើញនៅ ថ្ងៃទី១១ ខែសីហា ឆ្នាំ២០១១
 ប្រធាននាយកដ្ឋាន
 Was seen on date:
 Director/Department



ហេង-ណារ៉េត

ចេញអោយនៅ ថ្ងៃទី១១ ខែសីហា ឆ្នាំ២០១១
 ប្រធានការិយាល័យ
 Date of Issue:
 Laboratory Chief

(Signature)
 លោក ឈុន



ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ
Kingdom of Cambodia
Nation Religion King
ក្រសួងបរិស្ថាន
នាយកដ្ឋានគ្រប់គ្រងគុណភាពបរិស្ថាន
គម្រោងសាងសង់ស្ថានីយ៍ ទឹក ទឹកស្អាត
Ministry of Environment
Department of Pollution Control
Laboratory Office

លេខ /N°/.....

ព្រឹត្តិប័ត្រលទ្ធផលវិភាគ

Analysis Report

ប្រភពសំណាក/Sample Source : ក្រុមហ៊ុន CES Co., Ltd					
ថ្ងៃ ខែ ឆ្នាំទទួលសំណាក/Date: 08/8/2011					
ប្រភេទសំណាក/Type of Sample: Sample.SW2 KP358 សំណាកទឹកស្ទឹងសេរីសោភ័ណ ភូមិទាប ឃុំព្រះពន្លា					
ស្រុកសេរីសោភ័ណ ខេត្តបន្ទាយមានជ័យ X= 0282272 Y= 1503431					
លរ No	ប៉ារ៉ាម៉ែត្រ Parameter	ឆ្នាត Unit	លទ្ធផល Result	ស្តង់ដារ Standard(*)	វិធីសាស្ត្រវិភាគ/ឧបករណ៍ Method/Equipment
1	pH	-	7.53	6.5 - 8.5	pH-EC & TDS meter
2	Total Suspended Solid (TSS)	mg/l	42.00	25 - 100	Method 2540 D
3	Biochemical Oxygen Demand (BOD)	mg/l	1.73	1.0 - 10.0	Method 5210 B
4	Chemical Oxygen Demand (COD)	mg/l	3.93	-	JIS K 0102
Note: ១ ការយកសំណាក ការប្រមូល និងការដឹកជញ្ជូនសំណាកទឹកមកបង្កើតសោតន៍ តំបន់ ក្រុមហ៊ុននេះបានដោយខ្លួនឯង ។ ២ (*) កំណត់សំណត់ស្តង់ដារគុណភាពទឹកនៅតាមកំប៉ងទឹកសាធារណៈសំរាប់ប្រើប្រាស់ផ្ទះនៅក្នុងទឹក					

បានឃើញនៅ ថ្ងៃទី១៨ ខែសីហា ឆ្នាំ២០១១

ប្រធាននាយកដ្ឋាន

Was seen on date:

Director Department



មេច-ណារក

ចេញអោយនៅ ថ្ងៃទី១៨ ខែសីហា ឆ្នាំ២០១១

ប្រធានការិយាល័យ

Date of Issue:

Laboratory Chief

CH W

លេខ-៤៥