The Preparatory Study On The Siem Reap Water Supply Expansion Project In The Kingdom Of Cambodia
JICA Study Team
(NJS Consultants Co., Ltd. in association with Kokusai Kogyou Co., Ltd.)

Our Ref. No.: SR/2009/10/23
23 October 2009
Mr. Som Kunthea
General Director
Siem Reap Water Supply Authority

H. E. Som Kunthea

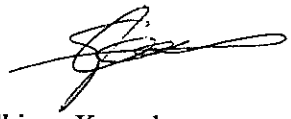
I'm especially pleased to send you my congratulations and best wishes for success of the Steering Committee and the Stakeholder Meeting.

I prepared a draft report and CD for Initial Environmental Impact Assessment (IEIA) for Siem Reap Water Supply Expansion Project. Your staff can arrange, revise and compile the report by using PC. After you prepare an official letter and submit IEIA report with it to Minister of Environment through Provincial Environmental Department (Mr. Lun KANEL, Director), it takes more than 30 working days to get permission from MOE.

Officially you should revise the Interim Report to be submitted by JICA Study Team at the beginning of December 2009. However, SRWSA has to begin EIA at the beginning of February, according to the direction of MOE. Therefore, we need to get the direction of MOE as soon as possible, by the end of January at latest.

I hope you would manage to begin the study for full-scale EIA at the beginning of February next year.

Sincerely Yours



Shinya Kawada
Environmental and Social Considerations
JICA Study Team

The Siem Reap Water Supply Expansion Project in The Kingdom of Cambodia

Initial Environmental Impact Assessment (Draft)

October 2009

Siem Reap Water Supply Authority

Abbreviation

APSARA	National Authority for the Protection of the Site and Development of Angkor
BOD	Biochemical Oxygen Demand
CL	Chlorine
CNMC	Cambodia National Mekong Committee
COD	Chemical Oxygen Demand
DOA	Siem Reap Provincial Department of Agriculture
DOE	Siem Reap Provincial Department of Environment
DOFi	Siem Reap Provincial Department of Fisheries
DOFo	Siem Reap Provincial Department of Forest
EIA	Environmental Impact Assessment
HCL	Hydrogen Chloride
IEE	Initial Environmental Examination
IEIA	Initial Environmental Impact Assessment
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japan International Cooperation Agency
MAFF	Ministry of Agriculture, Forest and Fisheries
MOE	Ministry of Environment
NR	National Road
PM	Particulate Matter
SRWSA	Siem Reap Water Supply Authority
SS	Suspended Solid
TOR	Terms of Reference
TSA	Tonle Sap Authority
TSBR	Tonle Sap Biosphere Reserve
TSP	Total Suspended Particulate
UNESCO	United Nation, Educational, Scientific and Cultural Organization

1 Project Summary

1.1 Project Title

The Siem Reap Water Supply Expansion Project in The Kingdom of Cambodia

1.2 Type of the Study

The Type of the Study is a feasibility study. Initial Environmental Impact Assessment (IEIA) shall be conducted mainly for selection of appropriate new water source and intake method, and Environmental Impact Assessment (EIA) shall be conducted for Feasibility Study on the priority project to be implemented in short term.

1.3 Methodology and Result of Screening

Screening system for IEIA and EIA is under consideration in Cambodia and it may be a similar type of JICA's Guidelines according to Department of EIA, Ministry of Environment (MOE). Therefore, for this project screening was carried out based on JICA's guidelines. The criteria of JICA are as follows;

Category A: likely to have significant adverse impacts

Category B: potential adverse impacts are less than those of Category A projects

Category C: likely to have minimal or little adverse impacts

The project is classified as 'Category B' because the mitigation measures can be considered although every alternative of the project may give some impact on environmental and social situation.

Three alternatives of water source are as follows: (refer to Figure 1-1)

1) Surface Water from Tonle Sap Lake (pipe intake or a new canal construction)
2) Surface Water from irrigation canal of West Baray
3) Groundwater from new wells near Tonle Sap Lake

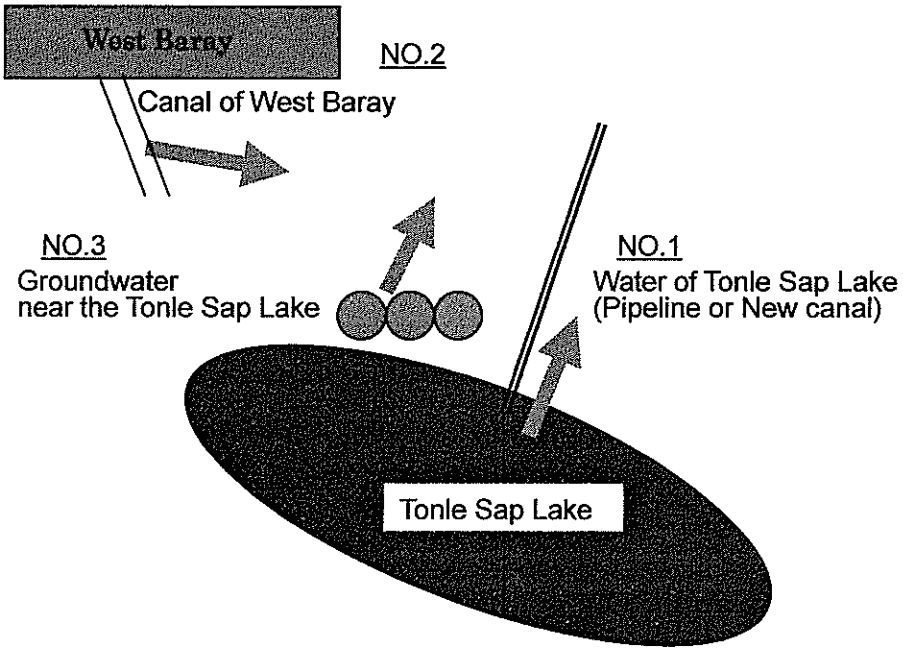


Figure 1-1 Three Alternatives of Water Source

The result of screening for three alternatives is as shown in Table 1-1.

There may be possibility of fourteen impacts on environmental and social situation as follows:

i) Local economy such as employment and livelihood
ii) Land use and utilization of local resources
iii) Cultural heritage
iv) Water Usage or Water Rights and Rights of Common
v) Infectious diseases such as HIV/AIDS
vi) Groundwater
vii) Flora, Fauna and Biodiversity
viii) Landscape
ix) Air Pollution
x) Water Pollution
xi) Waste
xii) Noise and Vibration
xiii) Ground Subsidence
xiv) Accidents

1.4 Responsible agencies which implement the project

Siem Reap Water Supply Authority, under Ministry of Industry, Mines and Energy

1.5 Outline of the Project

1.5.1 Purpose of the Project

The objective of this study is to conduct feasibility study for expansion of the water supply system in Siem Reap Town including the followings:

- Selection of appropriate new water source and intake method
- Conduct of F/S on the priority project to be implemented in short term
- Evaluation of current status of groundwater use and development of monitoring system
- Preparation of long-term water supply system development plan (for target year of 2030)
- Technology transfer to counter parts of the Cambodian side

1.5.2 Study Area

The study shall cover whole Siem Reap District consisting of 13 communes and 1 commune of Kanndeak in Prasat Bakong District as shown in Figure 1-2.

1.6 Project Description

Since alternatives of water source and way of intake are studied at this stage, project description in detail for EIA will be described at Feasibility Study stage.

Table 1-1 The Result of Screening for Three Alternatives

(X: Some impact is expected, No mark: Little impact)

No	Impacts	Rating	Siem Reap Water Supply Expansion Project: Tonle Sap Surface Water (Pipe or New Canal)	Rating	West Baray Canal	Rating	Groundwater near Tonle Sap
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.							
1	Involuntary Resettlement		No resettlement		No resettlement		No resettlement
2	Local economy such as employment and livelihood						
3	Land use and utilization of local resources	X	Change of land use	X	Change of land use	X	Change of land use
4	Social institutions such as social infrastructure and local decision-making institutions						
5	Existing social infrastructures and services						
6	The poor, indigenous and ethnic people						
7	Misdistribution of benefit and damage						
8	Cultural heritage			X	West Baray is a cultural heritage.	X	Possibility of impact on cultural heritage
9	Local conflict of interests						
10	Water Usage or Water Rights and Rights of Common	X	Impact on fishing & navigation	X	Impact on irrigation.		
11	Sanitation						
12	Hazards (Risk) Infectious diseases such as HIV/AIDS	X	Possibility during construction	X	Possibility during construction	X	Possibility during construction
Natural Environment							
13	Topography and Geographical feature						
14	Groundwater					X	Pumping-up of groundwater
15	Soil Erosion						
16	Hydrological Situation						
17	Coastal Zone (Mangroves, Coral reefs, Tidal flats, etc.)						
18	Flora, Fauna and Biodiversity	X	Impact on flora and fauna	X	Impact on flora and fauna	X	Impact on flora and fauna
19	Meteorology						
20	Landscape	X	Appearance of new facility	X	Appearance of new facility	X	Appearance of new facility
21	Global Warming						

Pollution							
22	Air Pollution	X	Use of chlorine	X	Use of chlorine	X	Use of chlorine
23	Water Pollution	X	Effluent from facility after treatment	X	Effluent from facility after treatment	X	Effluent from facility after treatment
24	Soil Contamination						
25	Waste	X	Sludge generated after filtration	X	Sludge generated after filtration	X	Sludge generated after filtration
26	Noise and Vibration	X	Noise generated from facility	X	Noise generated from facility	X	Noise generated from facility
27	Ground Subsidence					X	Pumping-up of groundwater
28	Offensive Odor						
29	Bottom sediment						
30	Accidents	X	Possibility during construction	X	Possibility during construction	X	Possibility during construction

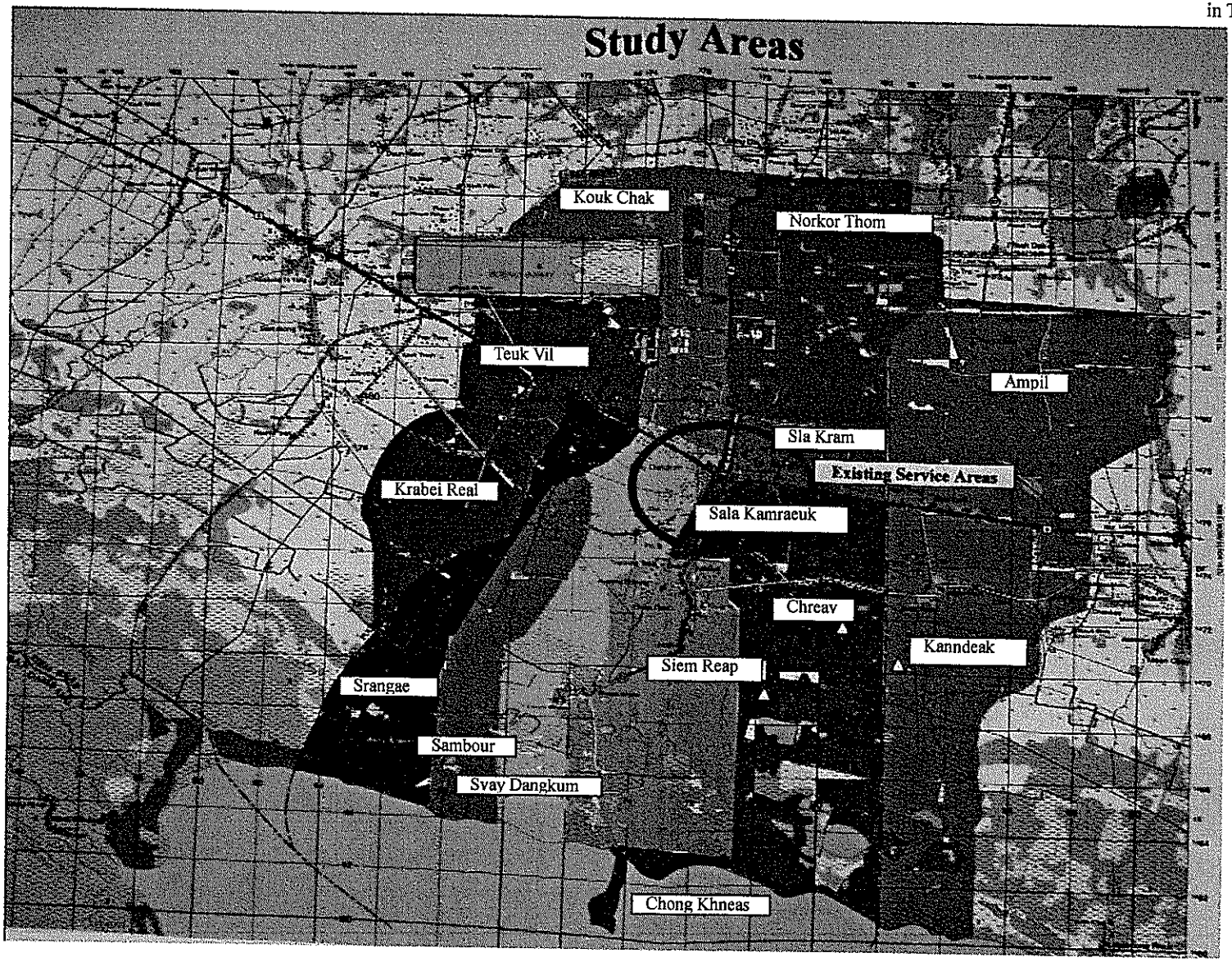


Figure 1-2 Study Area (13 Communes in Siem Reap District + Kanndea Commune) *(Source: JICA Study Team)*

2 Environmental Restriction for the Project

2.1 The Protected Area

2.1.1 The Protected Area stipulated by MOE

MOE stipulates five kind of natural protected areas, National Park, Wildlife Sanctuary, Landscape Protected Area, Multiple Use Area and Heritage Protected Area. Within the study area there are two kind of protected area, Angkor Landscape Protected Area and Tonle Sap Multiple Use Area. The location is shown in Figure 2-1 and the definitions are as follows;

- Landscape Protected Area

  A land or water area where the nature, ecosystem and cultural heritage should be protected from destruction by human and there is a special beautiful area, and normally there is rich biodiversity. To prevent this traditional area from destruction or to conserve this area is more important than to develop it for human beings' lives.

- Multiple Use Area

  A land or water area which has much natural system and needs protection management of biodiversity and sustainable ecosystem. More over, it can give natural products and services for community's use demand.

The facility for the project like water treatment facility should not be constructed in these areas.

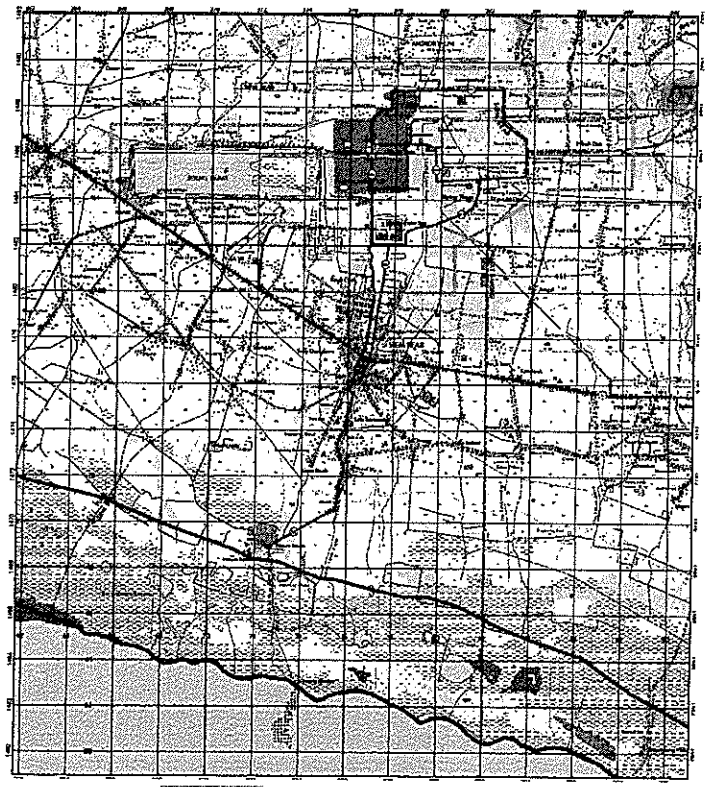


Figure 2-1 Natural Protected Area by MOE

(Source: Natural Resource Assessment and Environmental Data Management Department, MOE)

2.1.2 The Protected Area stipulated by MAFF

The Department of Fisheries, Ministry of Agriculture, Forest and Fisheries (MAFF) stipulates Fish Sanctuary, Community Fisheries, Fishing Lot and Strictly Protected Inundated Forest Area. Within the study area there are three kinds of areas, Community Fisheries, Fishing Lot and Strictly Protected Inundated Forest Area. The location is shown in Figure 2-2.

Community Fisheries prepare a Community Fishing Area Management Plan and Community Fishing Area Agreement and contribute to poverty reduction of local community.
The fishery domain is the state property. It can cover public or private land in the flooding season (management of these fisheries does not affect the ownership of the lands). (Article 9, Law on Fisheries)

There are about 37 Fishing Lots in Tonle Sap Lake at present although there were more than 50 lots before. In 2001, the government embarked on an extensive reform of the fisheries sector by improving access by the poor to the Fishing Lots. The government repealed 495,000 ha of officially auctioned Fishing Lots, a reduction of 53% in the size of the official Fishing Lots to allow the poor to access common fisheries resources. Industrial fishing is based on the Fishing Lots or concessions which were allocated through an auction system for exclusive exploitation over a two-year period. The Fishing Lot, NO.4, only one belonging to the Siem Reap Provincial area, can be leased for as much as 80 million Riels (US$200,000) a year (source: Provincial Department of Fisheries). The artisanal and family fishermen are not permitted to enter the Lot and fish outside it during an open season of fishing from October to May.

Strictly Protected Inundated Forest Area is set for sustainability of fishery resources and for important aquatic habitats to feed, spawn and breed since 1962.

The facility for the project like water treatment facility should not be constructed in these areas and pipeline should not be set through the heavily wooded areas.

Department of Forest stipulates Community Forests which can fulfill same function as Community Fisheries. They prepare Community Forest Management Plan and Community Forest Agreement for implementing the sustainable use and development of forest resources.
There is no Community Forest in the study area, although there are some Community Forests in northern mountainous area.

There is no protected area designated by Department of Agriculture in the study area.

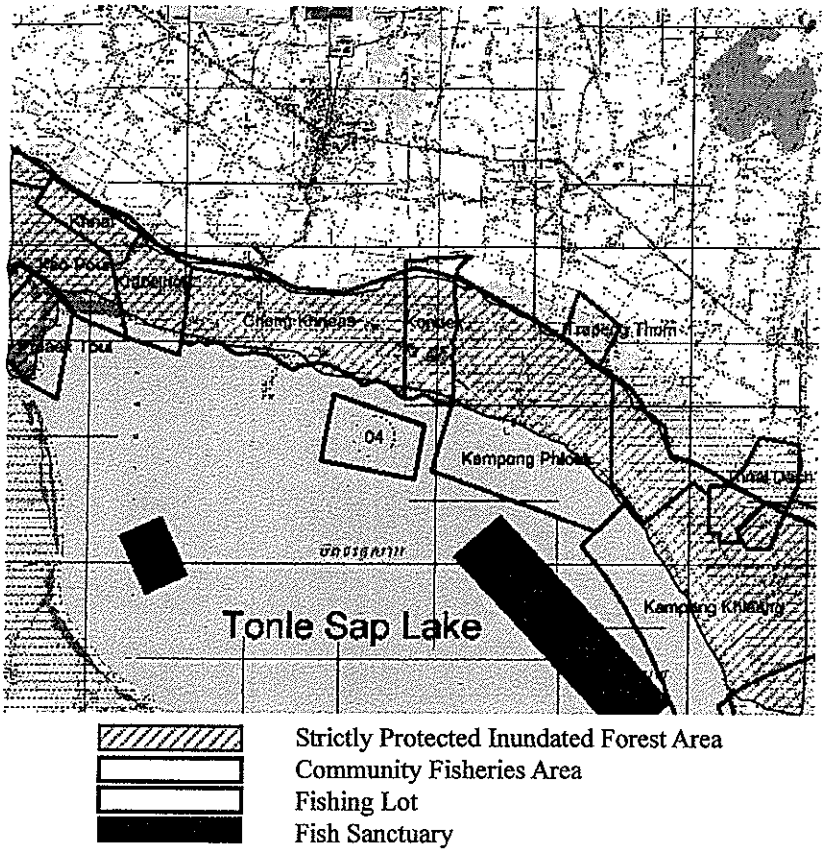


Figure 2-2 The Protected Area by Department of Fisheries

(Source: Fisheries Administration, MAFF)

2.1.3 The World Cultural Heritage Area inscribed by UNESCO

On 14th December 1992, Angkor was inscribed in the World Heritage List and the World Heritage in Danger covering the area of 401km2 with 90 temples as shown in Table 2-1.

Angkor was inscribed on the basis of the following criteria:

1. it represents a unique artistic achievement, a master piece of creative genius;
2. it has exerted great influence over a span of time, within a cultural area of the world, on developments in architecture, monumental arts, and landscaping;
3. it bears a unique exceptional testimony to a civilization which has disappeared; and
4. it is an outstanding example of an architectural ensemble which illustrates a significant stage in history.

Also the Angkor Park was inscribed under five conditions as below:

(a) Enact adequate protective legislation

(b) Establish an adequately staffed national protection agency

(c) Establish permanent boundaries based on the UNDP project

(d) Define meaningful buffer zones

(e) Establish monitoring and coordination of the internationally conservation effort.

These conditions were successively fulfilled. A Royal decree of 19th February 1995 providing a legal

basis for the creation of the Autorité pour la Protection du Site et l'Aménagement de la Région d'Angkor (the National Authority for the Protection of the Site and Development of Angkor called APSARA Authority– conditions (a) and (b)). This acronym is a Khmer common word and signifies "celestial dancer".

Table 2-1 The Temples inscribed in World Cultural Heritage List

No	Name	METERIAL
Monument inside Angkor Thom 26		
1	Baphuon	sandstone
2	Bayon	sandstone
3	Porte de la Victoire, Angkor Tom	sandstone
4	Porte des morts, Angkor Tom	sandstone
5	Porte Nord, Angkor Tom	sandstone
6	Porte Ouest, Angkor Tom	sandstone
7	Porte Sud, Angkor Tom	sandstone
8	Khleang nord	laterite & sandstone
9	Khleang Sud	laterite & sandstone
10	Palais Royal	laterite & sandstone
11	Pr. Chrung nord est	laterite & sandstone
12	Pr. Chrung nord ouest	laterite & sandstone
13	Pr. Chrung sud est	laterite & sandstone
14	Pr. Chrung sud ouest	laterite & sandstone
15	Mangalartha 487	sandstone
16	Monument 486	laterite & sandstone
17	Pr. Sour Prat	laterite & sandstone
18	Prah Palilay	laterite & sandstone
19	Prah Pithu tour T	laterite & sandstone
20	Prah Pithu tour U	sandstone
21	Prah Pithu tour V	sandstone
22	Prah Pithu tour X	sandstone
23	Prah Pithu tour Y	sandstone
24	Tep Pranam	laterite & sandstone
25	Terrasse des Elephants	sandstone
26	Terrasse du Roi Lépreux	sandstone
Monuments to the South of Angkor Thom 10		
27	Angkor Vat	sandstone
28	Baksei Chamkrong	brick laterite & sandstone
29	Phnom Bakheng	brick & sandstone
30	Bay Kaek 499	brick & sandstone
31	Pr. Bei	laterite & sandstone
32	Pr. Kuk Chak	laterite & sandstone
33	Pr. Patri	brick & sandstone
34	Pr. Kantal Preah Chantol	brick & sandstone
35	Pr. Taset	brick & sandstone
36	Ta Prohm Kel	sandstone
Monument to the East of Angkor Thom 23		
37	Banteay Kdei	laterite & sandstone
38	Sras Srang	laterite & sandstone
39	Banteay Samrè	laterite & sandstone
40	Baray Orientale	brick & sandstone
41	Bat Chum	brick laterite & sandstone
42	Chapelle de l'Hopital Est	laterite & sandstone
43	Chau Say Tevoda	sandstone
44	Kuthvara	laterite & sandstone
45	Leak Neang	laterite & sandstone
46	Mebon Oriental	brick laterite & sandstone
47	Pr. Kamnap	laterite
48	Pr. Kravann	brick & sandstone
49	Pr. Top	brick & sandstone
50	Pr. Top 2	laterite
51	Pr. Tor	brick & sandstone
52	Spean Tor	laterite
53	Pre Rup	brick laterite & sandstone
54	Prei Prasat (720 or 745)	laterite & sandstone
55	Spean Thmar	laterite & sandstone
56	Ta Keo	laterite & sandstone
57	Ta Nei	laterite & sandstone
58	Ta Prohm	laterite & sandstone
59	Thommanon	laterite & sandstone
Monument to the north of Angkor Thom 10		
60	Banteay Prei	laterite & sandstone
61	Krol Ko	bricl & sandstone
62	Krol Romeas	laterite & sandstone
63	Neak Poan	laterite & sandstone
64	Banteay Thom	laterite & sandstone
65	Pr. Prei Prasat	laterite & sandstone
66	Pr. Tonlé Snguot	sandstone
67	Preah Khan	laterite & sandstone
68	Prah Pithu	laterite & sandstone
69	Ta Som	laterite & sandstone
Monuments to the West of Angkor Thom 12		
70	Ak Yum	brick & sandstone
71	Baray Occidental	
72	Chapelle de l'Hopital Ouest, Angkor Thom	laterite & sandstone
73	Mebon Occidental	laterite & sandstone
74	Kas Ho	brick & sandstone
75	Kuk Khpop	brick & sandstone
76	Phnom Rung	brick & sandstone
77	Pr. Trapeang Ropou	
78	Pr. Trapaang Sen	
79	Prei Khmeng	brick & sandstone
80	Pr. Prei Prasat	brick & sandstone
81	Vat Khnat	brick laterite & sandstone
Monument close to the Siem Reap river 3		
82	Phnom Krom	brick & sandstone
83	Peah Enn Kosei	brick laterite & sandstone
84	Vat Atvear	laterite & sandstone
Group Rolous 6		
85	Bakong	brick laterite & sandstone
86	Lolei	brick & sandstone
87	Prei Monti	laterite & sandstone
88	Pr. Trpeang Torteung Thngay	brick & sandstone
89	Pr. O Kaek	brick & sandstone
Group Banteay Srei 1		
90	Banteay Srei	brick, laterite & sandstone

(Source: UNESCO Phnom Penh Office)

2.1.4 The Protected Area designated by APSARA

Angkor Archaeological Area is protected by APSARA shown in Figure 2-3, in accordance with the recommendation of UNESCO.

The definition of four kinds of zone is as follows; (source; APSARA homepage)

Zone1: Monumental Sites

Areas which contain the most significant archaeological site in the country and therefore deserve the highest level of protection.

Zone 2: Protected Archaeological Reserves

Areas rich in archaeological remains which need to be protected from damaging land use practices and inappropriate development. They will most frequently surround monumental Sites, providing protection to adjacent areas of known or likely archaeological importance. Zone 1 and 2 require intensive management aimed at integrating archaeological and visitor interests with local interests and needs.

Three main Monumental Sites identified in the region are those of Angkor, Rolous and Banteay Srei. Each lies within a Protected Archaeological Reserve which, in the case of the Angkor site, acts as a buffer zone. Additional sites could be added at a later date to protect and manage areas such as Beng Mealea, Koh Ker, or Preah Khan in Kompong Svay.

The three sites, including their Archaeological Reserves zones, cover the areas with the highest density of archaeological remains, including the original sites of the ancient Angkorian capital, with most of the well-known temples and many ancient hydrological structures such as the barays, canals and dikes. The Protected Archaeological Reserve around the Angkor site also contains a large local population whose interests are to be protected.

The Angkor Monument Site and its Archaeological Reserve comprises an area of more than 350 square kilometers. It contains:

/the original Angkor Park as designated in 1925 and reconfirmed with minor modifications during the subsequent decades;

/additional areas which together constitute the core of the Angkor Monumental Site;

/a protection zone to safeguard archaeological sites in the surrounding landscape (zone2); and

buffer areas, particularly between Siem reap and Angkor Vat, which are necessary to conserve the integrity of the Monumental Sites, Preserve the area as a tourist attraction and prevent all development not essential to the protection of the cultural heritage.

Zone 3: Protected Cultural Landscapes

Areas with distinctive landscape characteristics which should be protected on a account of their traditional features, land use practices, varied habitats, historic building, or man-made features from the past or of recent origin that contribute to the cultural value or reflect traditional lifestyles and patterns of land use. Cultural Landscapes may also serve to safeguard visual perspectives and relationships between significant features which contribute to their historic or aesthetic value. Protected Cultural Landscapes are subject to regulations aimed at controlling damaging and disruptive activities.

The ancient canalized river valleys of the Stung Siemreap and Stung Roluos from where they flow off the

Phnom Kulen to their mouths at the Tonle Sap have been designated Protected Cultural Landscapes. The ancient causeways running from the Angkor site northwest to Banteay Srei are Cultural Landscapes extending the protected areas of the Angkorian heritage and further into the surrounding environment. These areas may be expanded and other areas zoned for protection at a later date.

Zone 4: Sites of Archaeological, Anthropological or Historic Interest

Including all other important archaeological sites, but of less significance than Monumental Sites, that require protection for research, education or tourist interest. The sites and areas are subject to regulations aimed at controlling damaging activities similar to those applying to Protected Archaeological Reserves. A number of the more important below and above-ground archaeological sites identified within the Siem Reap region, such as Phnom Krom, Wat Athvea and Chau Srei Vibol are indicative of the areas included in Zone 4. Other sites may be included in the future.

Zone 5: The Socio-economic and Cultural Development Zone of the Siem Reap region, comprising the whole of Siem Reap Province, is the largest zone to which protective policies apply.

This comprehensive zone covers an area of 10,000 square kilometers including the Phnom Kulen, the shores of the Tonle Sap and the Angkor plain. It conforms largely to the catchment area of greater metropolitan Angkor during the ancient period and is rich in remains of both prehistoric and historic civilization. The region also contains important natural areas which are to be protected and others to be protected and others to be developed in a sustainable manner.

The region is to managed as a multiple-use area with an emphasis on economic and social development of cultural tourism. Development activities which could potentially damage the archaeological, the natural, or the social heritage harbored in the province are regulated by comprehensive coordination policies. Archaeological and environmental impact assessments are to be carried out in advance of any project proposed in the region. The intention is not to hold back development but to ensure that it be appropriately located and directed, at all times taking into consideration the requirements of heritage conservation.

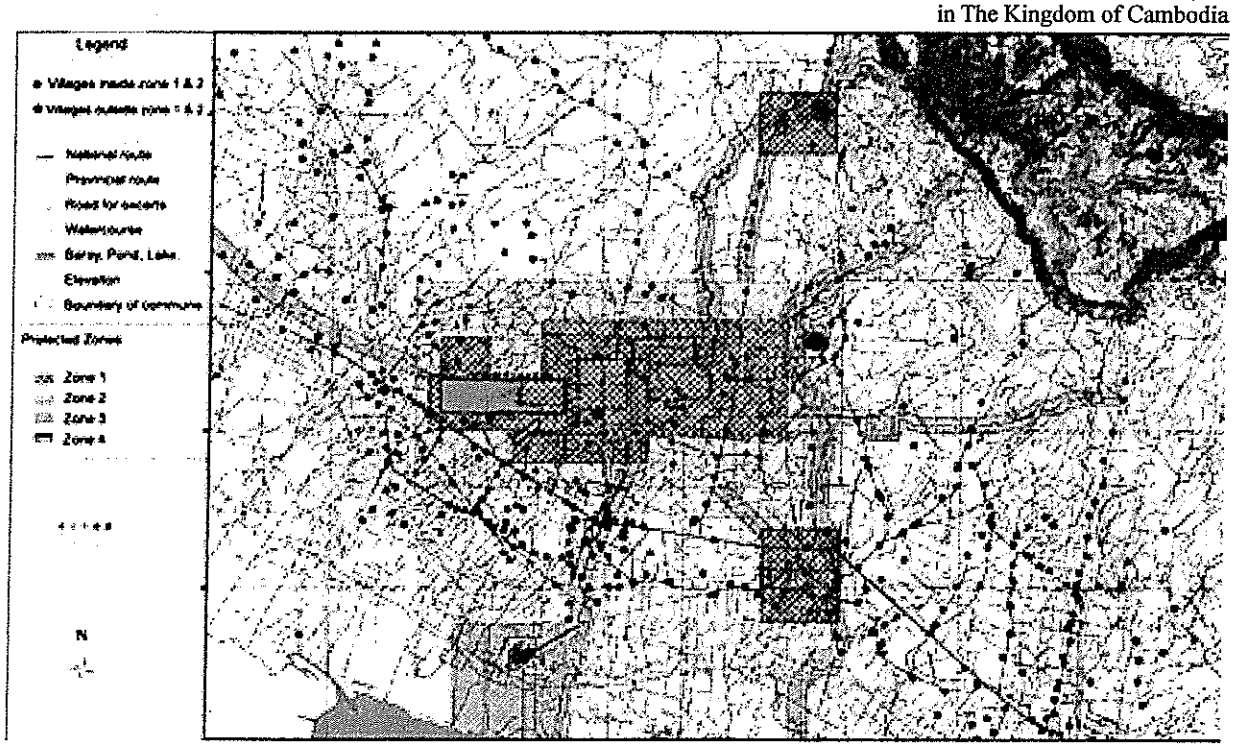


Figure 2-3 APSARA Protected Area

(Source: APSARA Website)

2.1.5 Tonle Sap Biosphere Reserve Area by UNESCO

Tonle Sap Biosphere Reserve is divided into core areas, a buffer zone and a flexible transition zone. Within the study area there are transition area and buffer zone as shown in Figure 2-4. There is no core zone which is defined likewise national park or wildlife sanctuary.

The transition area is limited between the outer boundary of the buffer zone and National Road N5 and N6. It is the integrated economic zone, which is managed for sustainable agriculture, human settlement and land use, without having adverse effects on the flooded forest, water quality and soils of the region around the Tonle Sap Lake.

The buffer zone covers the area of 541,482ha. Its boundary corresponds to the outer boundary of the Tonle Sap Multiple Use Area.

The buffer zone surrounding such core areas which is covered by flooded forest of a variety of species. Activities are managed to be consistent to the protection and conservation plan of the core areas. Fishery activities and other development plans will be managed based on existing law and regulations in a co-ordinated and cooperative manner. The buffer zone is also subject to experimental research and discovery of method for the management of flooded forest, fishery, agriculture, housing settlement, land use, water resources, navigation and tourism to ensure their sustainability, increased production, while preserving the environmental quality and fish.

The facility for the project like water treatment facility should not be constructed in the buffer zone area.(Refer to "Multiple Use Area" in Figure 2-1)

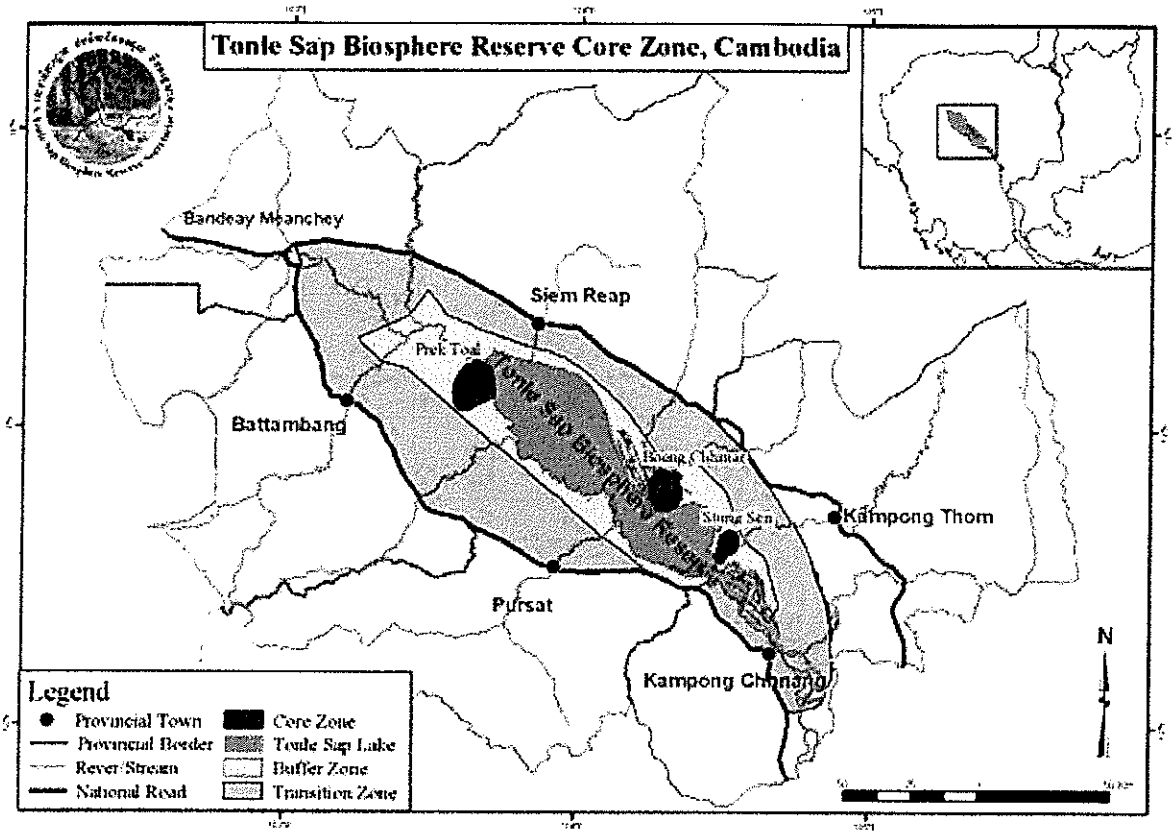


Figure 2-4 Tonle Sap Biosphere Reserve

(Source: Website)

2.1.6 Provincial Conservation Area protected by Community

The Boeng Peareang Lake had been protected by the community. In 2006 the biodiversity of the area was studies by experts involving Department of Environment in Province (DOE). There are big trees in inundated forest and many kind of birds build their nest on the trees. DOE prepared a document to submit to MOE and got approval of Natural Conservation Area including the Boeng Peareang lake with signatures of Minister of Environment and Provincial Governor in 2008. Total area is 3,098ha as shown in Figure 2-5. Although pipelines of water supply expansion project can be set in the Conservation Area, passing of pipelines through the lake itself should be avoided.

The Polav Lake had been protected by Kondeck Community Fisheries. In 2008 the lake of 4ha was decided as Fish Conservation Area (Sanctuary) signed by Minister of Agriculture, Forest and Fisheries as shown in Figure 2-5. Setting pipelines through the Polav Lake should be also avoided.

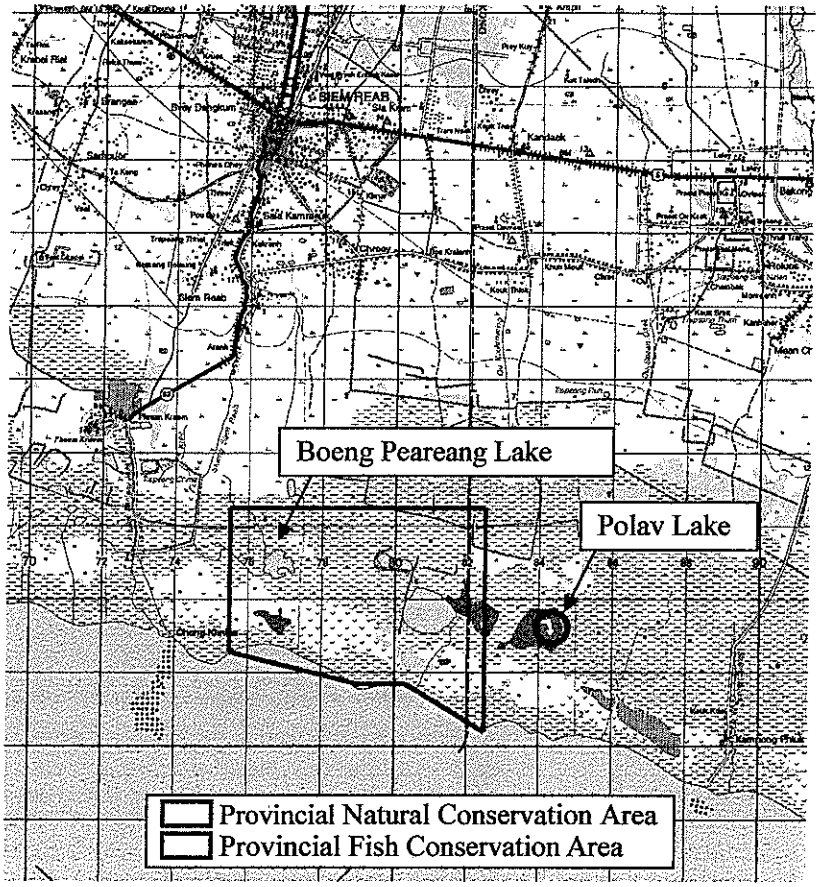


Figure 2-5 Provincial Conservation Area

(Source: Siem Reap Provincial Department of Environment and Kondeck Community Fisheries)

2.2 Land Acquisition and Involuntary Resettlement

Although the system of land acquisition seems to be generally complicated and difficult in Cambodia, buying and selling of land is easy according to the opinion of Department of Agriculture and Department of Land Management in Siem Reap Province. Change of land use from agricultural land to another kind of land is not strictly limited and implemented based on a contract agreement between a seller and a buyer. Local governmental organization has no power to control private dealing. It is said that a coordination committee, consisting of the representative from relevant organization, would be set up by Provincial Governor if some conflict rises up between them, and that forced transfer of local people is difficult even for development of infrastructure in case they are living legally on their own land.

3 Description of Environmental Resources

3.1 Physical Resources

Source: Chapter V. Urban Infrastructure and Environmental Management, Siem Reap: Urban Development in the Shadow of Angkor

3.1.1 Air

Data on carbon dioxide (CO_2) emissions exists for the East Asia Pacific region as a whole and for other low-income countries as a category but specific data for Cambodia seems to be unavailable (c.f. World Bank 2006). The concentration of nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and carbon monoxide (CO) in Siem Reap meet Cambodia's air quality standards (in JICA 2006c). Emission is presumed to come from power generators and vehicle traffic given the absence of large-scale industry in the country. And while there is no data on particulate matters (PM) or total suspended particulates (TSP), the district is dusty. Traffic lifts dust off the roads, including ones that are unpaved or under construction. Also because Siem Reap is part of the alluvial plains, sandstone deposits from the escarpment make the surface ground sandy.

However, during rainy season, TSP in the air is washed down by daily heavy rain.

3.1.2 Water

a. Siem Reap River

Domestic sewage, commercial waste, agricultural run-off, and untreated solid waste pollute surface and groundwater in the country. Increasing concentrations of coliform bacteria, a presence in water that indicates fecal contamination, represent a serious health risk, especially during April and July. Sedimentation from land clearing, from both commercial and subsistence farming, also contribute to overall decrease in water quality (World Bank 2003). While recent survey samples of groundwater have shown no heavy metal contamination of groundwater in Siem Reap District, iron and manganese content is higher than permitted by the World Health Organization (JICA 2005 survey, JICA 2006). The cause is likely corrosion of iron pipes and pumps. This high iron content, while without direct health effects, does affect taste and color, and is associated with higher cleaning and repair costs. The same survey shows high levels of pH (acidity), nitrate, and fluoride which make water unsafe to drink without treatment, while shallow aquifers are often contaminated with microbes (JICA 2005). Siem Reap River and Tonle Sap are contaminated with effluents as both are the final discharge points for the drainage system (Figure 3-1). The volume loads of these water bodies dilute pollutants that become less harmful to human and animal life. Water quality of water bodies also vary by season and by flood level. However, high volumes of feces, urine and gray water are released daily in inland and ground water bodies in the country. There are regional differences in BOD. Siem Reap River contains chemical and biological pollutants due to domestic waste discharged into it, but water can be flushed out with upstream water during the rainy season.

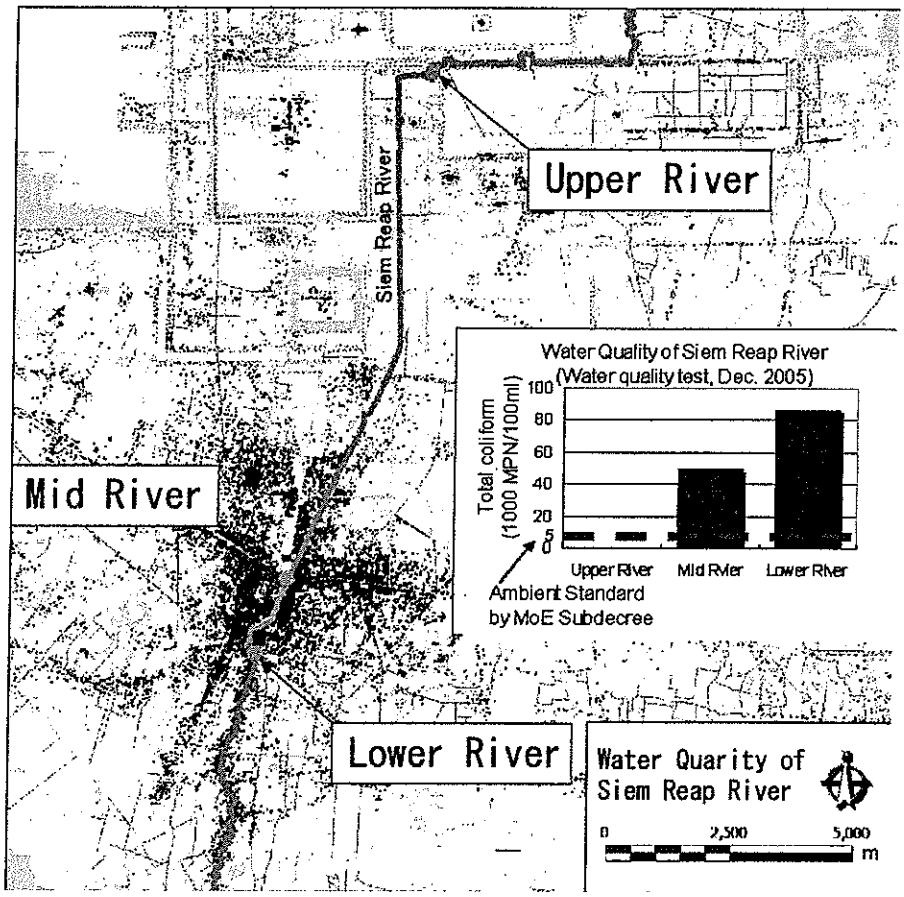


Figure 3-1 Water Quality of Siem Reap River

(Source: The Study on Integrated Master Plan
For Sustainable Development of Siem Reap / Angkor Town)

b. Tonle Sap Lake

Two study teams, Capacity Building for Water Supply System in Cambodia (JICA) and Key Consultant Cambodia (KCC) conducted recently water sampling and analysis in Tonle Sap Lake. The sampling points are located on the area about 2.5km east to Chong Khneas in Kbal Chhroy Mleang. The former sampled water weekly from March to June for physical and chemical analysis of 9 parameters, such as Iron, Manganese, Ammonia, Sulfate, Turbidity, Alkalinity, Color, pH and Conductivity. Sampling was carried out at two points near the bank and few hundred meters apart from the shore line at the same time. Although the difference between two points is not significant, three items of iron, turbidity and color exceed Drinking Water Quality Standard of MIME (Table 3-1 & Table 3-2).

The latter team carried water analysis on 29 June, 2009 for 32 parameters including physical, chemical, organic and micro-organic one like Odor, Taste, Transparency, Total Suspended Solid, Total Dissolved Solid, Turbidity, Color, pH, Alkalinity, Nitrite, Nitrate, Ammonia, Chloride, Total Nitrogen, Total Phosphate, Hardness, Fluoride, Iron, Manganese, Copper, Zinc, Lead, Cadmium, Arsenic, Mercury, Cyanide, Dissolve Oxygen, Phenol, Chlorophyll a, Hyxavalent Chromium, Total Coliform and *E. Coli.* Three parameters of iron, turbidity and color show high value (Table 3-3). In comparison with the Thai,

Surface Water Quality Standard, water quality of Tonle Sap Lake is a match for Class 2. Therefore, the lake water can be used for water supply system expansion after ordinary water treatment process.

Table 3-1 Water Quality of Tonle Sap Lake (JICA)

Testing Date	Sample N. 1, Location N = 1313574, E = 10352277, Depth = 0.33m								
	Fe mg/L	Mn mg/L	NH3 - N mg/L	SO4 mg/L	Turbidity (NTU)	Alkalinity (mg/L)	Color (TCU)	pH	Conduc. (µs/cm)
03/25/09	3.01	0.10	0.15	< 2	240.00	26.30	149.38	7.60	81.00
04/03/09	2.67	0.10	0.17	< 2	99.60	21.33	154.29	7.66	69.00
04/09/09	3.22	0.20	0.28	4.00	457.00	19.33	240.83	6.81	64.90
04/22/09	3.29	0.40	0.48	8.00	1860.00	22.67	271.15	6.66	88.80
04/29/09	2.09	0.30	0.36	8.00	356.00	69.33	131.80	6.81	172.50
05/05/09	2.94	0.00	0.21	4.00	546.00	44.67	75.36	7.24	139.30
05/18/09	3.40	1.00	0.43	6.00	1618.00	43.33	167.12	7.05	122.30
05/20/09	6.13	0.00	0.33	4.00	618.00	34.66	570.67	7.28	115.70
05/27/09	4.91	0.30	0.41	< 2	589.00	34.67	570.67	6.91	117.00
06/02/09	6.87	0.10	0.46	< 2	873.00	28.00	108.45	6.85	94.50
06/08/09	7.14	4.20	0.32	< 2	570.00	38.67	74.40	7.47	115.50
06/16/09	6.60	0.90	0.27	< 2	393.00	45.33	82.01	7.43	129.50
06/23/09	6.01	0.10	0.26	2.00	386.00	48.67	99.65	7.38	123.20
AVERAGE	4.48	0.59	0.32	2.77	661.97	36.69	207.37	7.17	110.25
MIME, DWQS[1]	0.3	0.1	1.5	250	5	-	5	6.5-8.5	1600
Thai, SWQS[2]	-	1*	0.5*	-	-	-	-	5-9**	-

Mark* means Class 3, Mark** means Class 2,3 &4

Table 3-2 Water Quality of Tonle Sap Lake (JICA)

Testing Date	Sample N.2, Location N = 1313370, E = 10352232, Average Depth = 0.80m								
	Fe mg/L	Mn mg/L	NH3 - N mg/L	SO4 mg/L	Turbidity (NTU)	Alkalinity (mg/L)	Color (TCU)	pH	Conduc. (µs/cm)
03/25/09	3.78	0.30	0.28	< 2	239.00	28.00	135.41	7.50	82.00
04/03/09	2.71	0.00	0.03	< 2	154.00	22.00	182.89	7.88	75.90
04/09/09	3.67	0.10	0.28	3.00	309.00	21.66	267.07	7.08	65.60
04/22/09	6.57	0.40	0.70	6.00	813.00	25.33	570.67	6.71	101.90
04/29/09	5.47	0.10	0.25	4.00	439.00	46.66	429.48	7.59	138.00
05/05/09	3.52	0.20	0.49	5.00	411.00	46.67	138.44	7.53	136.40
05/18/09	1.33	0.60	0.03	5.00	485.00	42.00	61.03	7.34	124.20
05/20/09	6.26	0.00	0.30	< 2	543.00	36.00	570.67	7.75	112.50
05/27/09	5.58	0.20	0.29	< 2	746.00	28.67	570.67	6.99	110.00
06/02/09	13.20	0.50	0.24	< 2	548.00	33.33	85.37	6.94	107.40
06/08/09	6.99	3.60	0.20	< 2	457.00	53.33	94.94	7.65	137.70
06/16/09	6.99	0.50	0.39	< 2	571.00	44.67	63.92	7.46	120.30
06/23/09	6.01	0.50	0.36	< 2	496.00	45.33	105.62	7.81	117.10
AVERAGE	5.55	0.54	0.30	1.77	477.77	36.43	252.01	7.40	109.92
MIME, DWQS[1]	0.3	0.1	1.5	250	5	-	5	6.5-8.5	1600
Thai, SWQS[2]	-	1*	0.5*	-	-	-	-	5-9**	-

Mark* means Class 3, Mark** means Class 2,3 &4

Table 3-3 Water Quality in Tonle Sap (KCC)

Sample No. 1, Average Depth = 1.9m, Location X = 378209, Y = 1462006

No.	Description of Item	Unit	Result	MIME[1]-DWQS	Thai[2]-SWQS
A	Microbiological Test				
1	Total coliform	Count/100ml	9.3×10^2	0	5000(2), 20000(3)**
2	E.coli	MPN/100ml	56	0	1000(2), 4000(3)
B	Physical and Chemical Test				
3	pH		7.7	6.5-8.5	5-9: Class3,4,5
4	DO	mg/l	5.4	-	6 (2), 4(3), 2(4)
5	Total Suspended Solid (TSS)	mg/l	498	-	-
6	Odour	-	Slight muddy	-	-
7	Taste (Threshold taste)	-	Accept	-	-
8	Color	Pt-4	100	-	-
9	Turbidity	NTU	200	5	-
10	Transparency	Dept (cm)	2.5	-	-
11	Nitrite (NO_2)	mg/l	ND<0.1	3	-
12	Nitrate (NO_3)	mg/l	2.53	50	5.0: Class3
13	Ammonium-N	mg/l	0.05	1.5	0.5: Class3
14	Chloride	mg/l	6.81	250	-
15	Total nitrogen	mg/l	3.5	-	-
16	Total phosphate	mg/l	1.04	-	-
17	Iron	mg/l	3.333	0.3	-
18	Manganese	mg/l	0.056	0.1	1.0: Class3
19	Hardness	mg/l	107	300*	-
20	Total Dissolve solid (TDS)	mg/l	55.5	800	-
21	Alkalinity	mg/l	190	-	-
22	Cyanide	mg/l	ND<0.04	0.07	0.005: Class3
23	Mercury	mg/l	0.002	0.001	0.002: Class3
24	Copper	mg/l	ND<0.0003	1	0.1: Class3
25	Zinc	mg/l	0.006	3	1: Class3
26	Lead	λ/γμ	0.003	0.01	0.05: Class3
27	Hexavalent chromium	λ/γμ	0.01	-	0.05: Class3
28	Cadmium	λ/γμ	ND<0.2	-	0.005: Class3
29	Arsenic	λ/γμ	0.001	0.05	0.01: Class3
30	Fluoride	mg/l	0.23	1.5	-
31	Phenols	mg/l	ND<0.025	-	0.005: Class3

Note:
* Hardness is expressed as mg/L of CaCO3
(2):=Class2, (3)=Class3, (4)= Class4
[1] Ministry of Industry, Mines and Energy, Drinking Water Quality Standard
[2] Thailand, Surface Water Quality Standard

3.2 Ecological Resources

3.2.1 Biodiversity

Source1: 5.Biodiversity and Protected Areas, Environmental Action Plan 1998-2002
Source2: Tonle Sap / Great Lake Field Trip, Mekong River Commission Secretariat, Environment Training Program (ETP)-Block 1

The Tonle Sap Lake is an important symbol of national identity for Cambodians. From the days of the Great Angkor Kingdom until today, natural resources from the Tonle Sap have supported large human settlements.

The lake has a unique hydrological relationship with the Mekong River, to which it connects via the Tonle Sap River. During the monsoon season (June-October), the Tonle Sap River regulates flood water from the Tonle Sap. As the flow of the Mekong River increases, the flow of the Tonle Sap River reverses from a downstream direction backwards into Tonle Sap. Therefore, during the rainy season, when the lake is about 250km long and 100km wide, it is the largest freshwater lake in Asia. It shrinks to about 120km in length and 35km in width during the dry season. The Tonle Sap is surrounded by a floodplain 20-40km wide; comprised mostly of flat land, this floodplain is inundated at various depth and dominated by inundated forests and rice fields. The water surface expands from 2,500-3,000km^2 during the dry season to 11,000-13,000 km^2 in the rainy season. Average depth of the Tonle Sap Lake changes from 1-2m to 8-10m. The storage capacity of the lake changes from 1,300mil.m^3 to72,000 mil.m^3.

Because of the economic, social and cultural significance of the Tonle Sap' rich biodiversity it has been included in national protected areas system as "Multiple Use Area."

At least 115 species of plants and about 850 species of fish have been recorded in the Tonle Sap Lake and the lower Mekong River.

Angkor is within an area that is thought to support regionally and globally significant populations of rare and endangered species, including 17 mammals (mostly large game), 24 birds (primarily water birds), 2 reptiles and 2 fish species.

In order to conserve biodiversity of Tonle Sap, three Core Areas are stipulated as an important natural protected area in Tonle Sap Biosphere Reserve.

3.2.2 Fauna

Source: Tonle Sap / Great Lake Field Trip, Mekong River Commission Secretariat, Environment Training Program (ETP)-Block 1

a. Birds

Flooded forest and its associated rich food chain of Tonle Sap Lake become attractive breeding and feeding habitats for many water-birds, including rare and endangered species. Two sites of high

water-bird concentration are Preak Toal and Moat Khla Boeng Chhmar. Preak Toal is of particular interest for in this area many threatened bird species were identified.

Both of them are protected as Core Area of Biosphere Reserve.

b. Fish

Tonle Sap Lake is well known for its rich diversity of life, of which fish is the most important biological resources. Fish and fisheries play a significant role in the tradition, culture and economy of Cambodian people. Nearly 70% of protein intake is from fish, which is crucial to the food security of the large low-income population.

In Tonle Sap Lake about 200 fish species are identified, belonging to 127 different genus and 47 families, of which nearly 70 species are of commercial value. The Fishery Department classifies freshwater fishes into three main groups.

i) The white fish are mainly Cyprinidae, Schibeidae, Siluridae and Notopteridae, most of which are migratory. These species are associated with large streamriver, but breed in the flooded forest areas in the flooding season.

ii) The black fish are members of the Clariidae, Ophicephalidae, Bagridae and Anabantidae. They can survive in more adverse and varied environmental conditions (low oxygen levels, some acidity, some salinity) and can stay in the swamps year round. They migrate to the flooded forest during the rainy season for breeding and reproduction.

iii) Smaller, fast growing and prolific species (opportunists), which are able to utilize the flood period for prolific reproduction and growth. The group consists mainly of ciprinids (Thynnichthys thynnoides, Dangila siamensis, Cirrhinus julieni).

c. Reptile

Historically, Tonle Sap Lake was home to many reptile species, including crocodiles, turtles and snakes, whose evidence can be found on the wall of the Temple Bayon and Angkor Wat. Report from fishermen and local people show the decline in number of reptiles due to catch for consumption and trade.

d. Mammals

Elephants no longer live in the area and there have been no recent sightings of the Irrawady dolphin. Most of dolphins were died during 1975-78 as reported by local people. No recent survey of mammals has been conducted, but civets, otters, macaques and monkeys are seen.

3.2.3 Flora

Source: Tonle Sap / Great Lake Field Trip, Mekong River Commission Secretariat, Environment Training Program (ETP)-Block 1

Flooded forest is the major vegetation type of the inundated area. Most species are deciduous, leaf fall taking place under water during the inundation. When the water recede there is a new flush of leaves. Flowering occurs during a short period in July/August so that fruit and seed set before the next inundation. Major habitats include aquatic vegetation, inundated forest, tropical evergreen forest and inundated xerophytic shrubland.

Aquatic vegetation occurs on lake surfaces, lake edges and on some rivers. The main species are Pistia stratiotes, Salvinia sp, Utricularia sp (water lily). Nymphaea sp, Trapa nasans (water chestnut), Ipomea reptans, Polygonum barbatum, ludwigia adscendens, Eichhornia crassipes (water hyacinth).

3.2.4 Forest

Source: Tonle Sap / Great Lake Field Trip, Mekong River Commission Secretariat, Environment Training Program (ETP)-Block 1

A tall, gallery forest (5-15m), dense in place occurs on shores. This habitat is dominated by Barringtonia actangulata and Diospyros cambodiana. Woody lianas include Combretum trifoliatum, Breynia rhamnoides and Acacia spiralis. Shrub include Brownlowia paludosa, Cudrani cambodiana, Dalbergia entadides, ficus heterophylla, Gmelina asfatica, Hymenocardia wallichii and Vitex holoadenon.

3.2.5 Threatened Species

Source: Boeung Tonle Chhmar Core Area, Tonle Sap Biosphere Reserve, Management Plan 2008-2012, & Stung Sen Core Area, Tonle Sap Biosphere Reserve, Management Plan 2008-2012

Birds;

The TSBS is a globally important site for colony-nesting waterbirds (Table 3-4), supporting "the largest remaining fragment of a bird megafauna that was once widespread across much of Southeast Asia" (Davidson *et al.* 2001). Currently known nesting sites are located primarily in and immediately adjacent to the Prek Toal Core Area.

Fish;

At minimum 143 fish species have been recorded in the Tonle Sap Lake, the Tonle sap River and the surrounding floodplain (Davidson 2006). Sixteen of these are known to be of international conservation concern (Table 3-5).

Reptile;

The Tnle Sap is possibly the single most important wetland for reptile conservation in Southeast Asia (Goes 2005), supporting significant populations of several threatened species (Table 3-6). Relatively little

survey work has been conducted, and many species are now difficult to observe in the field due to low population densities (Davidson 2006).

Mammals;

The mammalian fauna of the TSBR is not particularly diverse, but includes several species that are listed as globally threatened, and that may remain in internationally significant numbers (Davidson 2006). Globally threatened mammals occurring in the TSBR are slow Loris (either northern slow *loris Nycticebus bengalensis* or pygmy slow loris *N. pygmaeus*, both listed as Vulnerable), long-tailed macaque *Macaca fascicularsis* (Near-threatened), German` s silver leaf monkey *Trachypithecus villosus germaini* (Data Deficient), hairy-nosed otter *Lutra sumatrana* (Data Deficient), smooth otter *Lutrogale perspicillata* (Vulnerable), and fishing *cat Prionaihurus viverrirus* (Vulnerable).

All large wild herbivores (Eld` s deer *Cervus eldi*, hog deer Axis *porcinus*, wild water buffalo *Bubalus bubalis*, Asian elephant *Elephas maximus*) and Irrawaddy dolphin *Orcaella brevirostris* have been extirpated from the TSBR.

Amphibians;

Very little information on amphibians is available for the TSBR, and none specifically for Stung Sen Core Area, although it is noteworthy that at least two species (non frog and one toad) occur in the adjacent deepwater rice agro-ecosystems of Kampong Thom province (Davidson 2006). The amphibian fauna is expected to show close affinities with that in adjacent lowlands, which includes at least 18 species (Davidson 2006, citing B. Stuart in *litt*, 2005).

Table 3-4 Water-bird Species of Conservation Concern Occurring in the Tonle Sap Biosphere Reserve

Species	International Status	Significance
Greater Adjutant Leptoptilos dubius	IUCN Endangered	TSBR support the second largest colony in the world (>10% of global Population). Additional survey are Required to document possible breeding colonies in Stung Sen
Lesser Adjutant Leptoptilos Javanicus	IUCN vulnerable	TSBR support the largest colony in Southeast Asia (4% of global population). Occurs at Stung Sen, but additional surveys are required to document possible breeding colonies
Spot-billed Pelican Pelecanus Philippensis	IUCN vulnerable	TSBR support the largest colony in the world(20% of global population). Occurs at Stung Sen
Milky Stork Mycteria Leucura	IUCN vulnerable	TSBR support the only colony in mainland and Southeast Asia
Masked Finfoot Heliopais Personata	IUCN vulnerable	TSBR Population likely of global significance
Oriental Darter Anhinga melanogaster	IUCN Near-threatened	TSBR supports the largest colony in Southeast Asia (>10% of global population). An important breeding colony occurs in the Stung Sen area
Black-headed Ibis Threskiornis melanocephalus	IUCN Near-threatened	TSBR supports the largest colony in Southeast Asia (4-8% of Global population)
Painted Stork Mycteria leucocephala	IUCN Near-threatened	TSBR supports the largest colony in Southeast Asia (20% of global population)
Black-necked Stork Ephippiorhynchus asiatucus	IUCN Near-threatened	Breeds in Prek Toal
Grey-headed Stork Fish-Eagle Ichthyophaga ichthyaetus	IUCN Near-threatened	TSBR population likely of global significance. Stung Sen area supports a significant breeding concentration
Little Cormorant Phalacrocorax niger	IUCN least concern (but TSBR population is internationally significant)	TSBR population>1% of Asian biogeographic population. Occurs in Stung Sen
Indian Cormorant Phalacrocorax fuscicollis	IUCN least Concern (but TSBR population is internationally significant)	TSBR population>1% of Asian biogeographic population
Great Egret Casmerodius albus	IUCN least Concern (but TSBR population is internationally significant)	TSBR population>1% of Asian biogeographic population, Occurs in Stung Sen
Asian Open-bill Anastomus Oscitans	IUCN least (but TSBR population is internationally significant)	TSBR population>1% of Asian biogeographic population
Wooly-necked Stork Ctconia episcopus	IUCN lest concern (but TSBR Population is regionally significant)	Threatened a breeding species in adjacent countries
Glossy Ibis Plegadis faclcinellus	IUCN least Concern (but TSBR population is regionally significant)	Threatened as a breeding species in Adjacent countries
Purple Heron Ardea purpurea	IUCN least Concern (but TSBR population is regionally significant)	Threatened as a breeding species in adjacent countries. Occurs in Stung Sen
Great Cormorant Phalacrocorax carbo	IUCN least Concern (but TSBR population is regionally significant)	Threatened a breeding species in adjacent countries

(Source: Boeung Tonle Chhmar Core Area, Tonle Sap Biosphere Reserve, Management Plan 2008-2012)

Table 3-5 Fish Species of Conservation Concern Occurring in the Tonle Sap Biosphere Reserve

Species	International Status	Significance
Mekong Giant Catfish Pangasian odon gigas	IUCN Critically Endangered, CITES Appendix I	Tonle Sap lake and Tonle Sap river (a migratory corridor for mature fish) are important habitat areas
Leaping Barb Chela caeruleostigmata	IUCN critically Endangered	Not record from Tonle Sap lake, possibly occurs
Jullien` s Golden Carp Probarbus Jullient	IUCN Endangered; CITES Appendix 2	Recorded from Tonle Sap lake
Laotian Shad Tenualosa Thibaudeaui	IUCN Endangered	Populations have recently drastically declined due to factors outside of the Tonle Sap
Tricolor Sharkminnow Balantiochdilos melanopterus	IUCN Endangered	Depicted on FIA` S Endangered Fishes of Cambodia
Asian Bonytongue/ Asian Arowana Seleropages formosus	IUCN Endangered; CITES Appendix I	Occurrence in TSBR nor Confirmed
Thicklip Barb Probarbus labeamajor	IUCN Data Deficient	Record in Tonle Sap, but little know
Giant Pangasius Pangasius sanitwongsei	IUCN Data Deficient	Becoming increasingly rare throughout its range
Giant Barb Carlocarpio siammensis	Not listed, but requires urgent evaluation and Immediate conservation Attention	Numbers have declined drastically
Puntioplites bulu	Not listed	Formerly common, but has recently become very rare. Depicted on FIA` s Endangered Fishes of Cambodia. Occurrence in TSBR requires confirmation
Sabretoothed Thryssa Lycothrissa crocodilus	Not listed	Depicted on FIA` s Endangered Fishes of Cambodia
Four-barred Tigerfish Datntioides quadrifasciatus	Not listed	Occurrence in TSBR not confirmed. Depicted on FIA` s Endangered Fishes of Cambodia
Wallago leeri	Not listed	Occurrence in TSBR not confirmed. Depicted on FIA` s Endangered Fishes of Cambodia
Albulichthys albuloides	Not listed	Depicted on FIA` s Endangered Fishes of Cambodia
Elephant-ear Gourami Oxonedus exodon	Not listed	Occurrence in TSBR not confirmed. Depicted on FIA` s Endangered Fishes of Cambodia
Botia genus	Not listed	Several species recorded in first half of 20th Century, but no recent records

(Source: Boeung Tonle Chhmar Core Area, Tonle Sap Biosphere Reserve, Management Plan 2008-2012)

Table 3-6 Reptile Species of Conservation Occurring in the Tonle Sap Biosphere Reserve.

Species	International Status	Significance
Siamese Crocodile Crocodylus Siamensis	IUCN Critically Endangered	Small numbers persist, Occurs in Stung Sen
River Terrapin Batagur Baska	IUCN Critically Endangered	Probably extinct in TSBR
Asian Giant Softshell Turtle Pelochelys cantorii	IUCN Endangered	Reported from the Tonle Sap, but no confirmed specimens or photographs
Yellow-headed Temple Turtle Hieremys annandalii	IUCN Endangered	TSBR population may be the most important in Cambodia. Occurs in Stung Sen
Burmese Python Python molurus	IUCN Near Threatened	Occurs in TSBR
Asian Box Turtle Cuora amboinensis	IUCN Vulnerable	Now uncommon in TSBR. Occurs in Stung Sen
Black Marsh Turtle Siebenrockiella crassicollis	IUCN Vulnerable	Rare, but TSBR population may be the most important in region
Giant Asian Pond Turtle Heosemys grandis	IUCN Vulnerable	Considered to be scarce
Malayan Snail-eating Turtle Malayemys subtrijuga	IUCN Vulnerable	Reportedly the most numerous turtle around the Tonle Sap, but declining across its range. Occurs in Stung Sen
Asiantic Softshell Turtle Amyda cartilaginea	IUCN Vulnerable	Common to rare around the Tonle Sap, populations have recently declined. Occurs in Stung Sen

(Source: Boeung Tonle Chhmar Core Area, Tonle Sap Biospher Reserve, Management Plan 2008-2012)

3.3 Socio-economical Resources

3.3.1 Population

The information of population by village obtained during stakeholder hearing is as shown in Table 3-7. Populations of Svay Dangkum and Kouk Chak are 29,173 and 27,444 respectively. However, they are different from the result of census data 34,878 and 19,214 (2009). Since each total 56,617 and 54,092 of two communes is almost same respectively, the way of combination of villages may be different.

3.3.2 Infrastructure

Source: Chapter V. Urban Infrastructure and Environmental Management, Siem Reap: Urban Development in the Shadow of Angkor

Over $800 million has been invested in rehabilitating the country's roadways since the mid-1990s since the royal government identified rehabilitation as a stimulus to sustainable economic recovery. The road network is the principal mode through which people and goods move and covers approximately 39,000km throughout the country. There are seven national roads that make up the primary highways or 4,800km (NR 1 to 7) of roadways. Of this, 2,700km have been rehabilitated. Primary highways split off into secondary highways, also considered provincial roads of which 2% are paved.
The conditions on lesser roads can be quite poor with some areas in effect isolated during the rainy season. Many unpaved roads in the peri-urban area of Siem Reap are made of laterite, a reddish clay-like material that is hard when dry and slippery when wet, or macadam, broken stone used in compact layers for road surfacing. Poor road conditions are related to drainage problems that afflict the city.

When the study team visited every Commune Center to conduct public hearing from the representative of Commune, it was found that community roads had not been developed enough to transport goods easily by motorcycle and car, and sometimes a usual passenger car could not pass the road after heavy rain. Some representatives of Commune say they have been requesting budget for road improvement to Provincial Governor. Some Communes have been waiting for supply of electricity and also tab water and others have a hard time of solid waste management.

Table 3-7 Population in Study Area (2009)

Commune/Village	Household	Population
Sla Kram	8,441	36,116
1 Sla Kram	270	1,450
2 Boeng Doun Pa	962	3,686
3 Chong Kausu	3,311	14,831
4 Dak Pou (Urban)	806	3,454
5 Banteay Chas	1,271	5,086
6 Treang	860	3,770
7 Mondol Bei	961	3,839
Svay Dangkum	6,152	29,173
1 Kan Trak	241	1,228
2 Kouk KraSang	162	786
3 Svay Chey	154	738
4 Por Bos	125	865
5 Phnea Chey	135	643
6 Thmey	215	1,006
7 Vihea Chen	937	4,896
8 Svay dong Kum	316	1,583
9 Stueng Thmey	782	2,839
10 Hondul I	608	2,069
11 Hondul II	73	395
12 Tphul	802	3,868
13 Krous	559	2,930
14 Sala Kan Seng	1,043	5,327
Kouk Chak	6,505	27,444
1 Trapeang Seh	2,894	9,014
2 Veal	996	3,397
3 Teaksen Tboung	806	5,201
4 Khvien	327	1,375
5 Kouk Chan	267	1,710
6 Kouk Beng	253	1,275
7 Kouk Tnaot	409	2,245
8 Nokor Krau	553	3,227
Sala Kamraeuk	4,171	23,635
1 Wat Bour	1,217	6,917
2 Wat Svay	867	4,971
3 Wat Damnak	737	4,363
4 Sala kamraeuk	290	1,589
5 Ta Vien	720	3,942
6 Chon Long	187	1,100
7 Trapeang Traeng	153	753
Norkor Thum	1,396	6,639
1 Rohal	282	1,143
2 Srah Srang Cheung	188	999
3 Sra SrangTboung	148	735
4 Kravan	216	938
5 Areaks Svay	112	548
6 Anhchanh	450	2,276
Chreav	1,716	9,492
1 Chreav	141	771
2 Khnar	633	3,616
3 Bos Kralanh	209	1,214
4 Ta Chek	128	634
5 Veal	277	1,262
6 Krasang	198	1,183
7 Boeng	130	812
Chong Khneas	1,061	5,970
1 Phum Muoy	174	775
2 Phum Pir	119	647
3 Phum Bei	118	764
4 Phum Buon	125	606
5 Phum Pram	74	499
6 Phum Prammuoy	144	730
7 Phum Prampir	307	1,949
Sambour	720	3,622
1 Sambuor	196	953
2 Phonv	155	760
3 Takong	139	686
4 Chrey	115	582
5 Veal	115	641
Siem Reap	3,003	17,898
1 Spean Chreav	482	2,856
2 Pou	488	2,962
3 Aranh	540	3,307
4 Pralay	151	862
5 Kakranh	459	2,638
6 Krasang Roleung	168	874
7 Phnum Kraom	439	2,801
8 Triek	276	1,598
Srangae	1,129	6,566
1 Kaksekam	270	1,576
2 Thnall	310	1,784
3 Rokathum	90	531
4 Prey Thum	117	694
5 Srangae	157	849
6 Chan Loang	113	704
7 Ta Chak	72	428
Teuk Vil	1,912	9,898
1 Kouk Dong	388	1,648
2 Sandan	316	1,740
3 Chrey	237	1,172
4 Brayut	107	564
5 Banteay Chhue	167	955
6 Tek Vil	91	515
7 Brey Chas	142	761
8 Teuk Thla	102	520
9 Brey Thmey	155	991
10 Chey	207	1,032
Krabei Real	1,430	7,621
1 Taros	126	648
2 Roka	154	911
3 Prey Por	70	396
4 To Tea	85	549
5 Kra Sang	84	560
6 Trapang Veng	85	453
7 Po Pil	74	435
8 Kouk Dong	132	687
9 Beng	186	889
10 Bra Ma	163	827
11 Khna	115	594
12 Prey Kroch	156	672
Ampil	1,242	6,671
1 Prey Kuy	151	821
2 Kouk Chan	167	841
3 Thnol Bak	73	366
4 Bos Thom	54	301
5 Trach Chhrum	85	401
6 Kiri Manon	214	1,186
7 Tapang	95	494
8 Trapang Run	140	746
9 Bang Koung	179	1,024
10 Thnort	84	491
Kanndeak	2,447	12,059
1 Kouk Thlok	290	1,419
2 Trapang Tem	233	1,082
3 Khun Moun	209	983
4 Chres	202	997
5 Ou	291	1,337
6 Spean Kaek	281	1,463
7 Trang	170	917
8 Chrey	362	1,839
9 Kouk Thnort	238	1,194
10 La ork	171	828

Total
Household= 41,325
Population= 202,804

(Source: Date from Chief of Commune)

3.3.3 Land use

Source: 3.Fisheries and Floodplain Agriculture in the Tonle Sap Region, National Environmental Action Plan 1998-2002

The soils in the floodplain of the Tonle Sap are generally poor in fertility. The three major soil types found in this area are a) young lacustrine alluvial soils, b) alluvial soils, c) acid sulphate soils. The young lacustrine soils were formed from colluvial and alluvial outwash from acidic and basic rocks from the upland areas bordering the Tonle Sap lake, and from silt and clay deposits carried by the floods of the Mekong river.

Current land spread from southern part of Siem Reap City to Tonle Sap Lake is occupied with wet season rice[1] field for the most part, and partly with flooded rise[2] field and abandoned field covered by grass as shown in Figure 3-2. According to the information from Provincial Department of Agriculture, productivity of the land is 3～3.5 ton/ha and it is fertile compared with poor land of 1.5～2.0 ton/ha, despite the information mentioned above.

There is inundated forest along the Tonle Sap Lake shore and a majority of this forest has been logged over at least once.

[1] Wet season rice: the rice is grown in the water during May and October/November
[2] Flooded rice: the seeds are scattered on dry land and flooded during March/April and January/February.

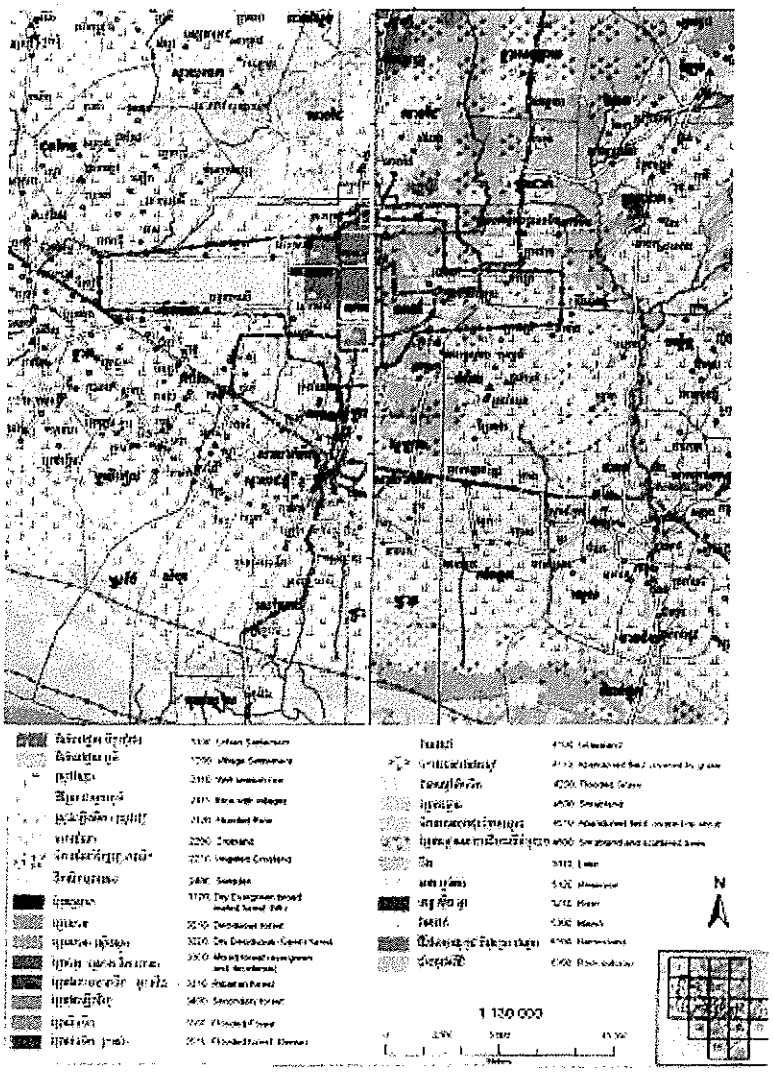


Figure 3-2 Land Use Map

(Source: Provincial Department of Agriculture)

3.3.4 Public Health and Welfare

In majority of Communes in study area drinking water is provided from well and water quality is not good enough to drink directly. They use water from well after boiling.

No information of public health and welfare could be obtained from Commune representative except Chong Kneas where floating village is located. Most of all people in floating village drink water from Tonle Sap Lake after boiling. There is concern of water-borne diseases and chief of the Commune requests improvement of Community Health Center.

Source: Chapter V. Urban Infrastructure and Environmental Management, Siem Reap: Urban Development in the Shadow of Angkor

Traffic accidents are the second biggest public health concern after HIV/AIDS according to the secretary of state of MPWT (*Phnom Penh Post* 28 August 2008). Road improvements and motorization have led to a greater number of accidents and causalities. Most accidents in Siem Reap involve motorbikes, which are also the most popular form of transport.

3.3.5 Condition of Economy

There are many Communes which have a higher proportion of farmers in the study area. They are also affected by worldwide economic depression, and construction workers in some Communes have lost their job because of hanging up of new building construction.

The rate of the population under the poverty line is as shown in Table 3-8. (Source: Task 1.5 Perspectives of the Poor on Tourism, Tourism Sector Assessment, 6th March 2009, Empowerment of the Poor in Siem Reap-Scoping and diagnostic work)

The highest rate is 89% of Commune Ampil in Siem Reap District, and second one is 74% of Commune Kanndeak in Prasat Bakong District.

Table 3-8 Rate of the Population under the Poverty Line

No	Name of Commune	Rate of people under poverty line
1	Sla Kram	48
2	Svay Dangkum	53
3	Kouk Chak	57
4	Sala Kumraeuk	46
5	Norkor Thom	70
6	Chreav	35
7	Chong Khneas	64
8	Sambour	22
9	Siem Reap	45
10	Srangae	51
11	Teuk Vil	43
12	Krabei Real	65
13	Ampil	89
14	Kanndeak	74

(Source: Empowerment of the Poor in Siem Reap-Scoping and diagnostic work)

4 Public Participation

4.1 Public Hearing from Local People

According to advice from MOE, the study team conducted public hearing from representative of community level, like Chief, Deputy Chief and/or Secretary of 14 Communes. After explanation of the study, interview was carried out. The main questions are as follows:

(ア) Population

(イ) How to get drinking water at present

(ウ) Quality of drinking water

(エ) Opinion of water supply system expansion

(オ) Willingness to pay

(カ) Environmental issue

(キ) Opinion on water source

The result of hearing is summarized in Table 4-2.

There are some Communes without electricity, and some chiefs say it would be so hard for local people to pay water charge although they have been waiting for safe and clean drinking water provided by a new system.

In addition to this, Stakeholder Hearing from the representative of three Community Fisheries was carried out in the study area. They have been managing their Community Fisheries in accordance to Community Fishing Area Management Plan.

They hope the project facility would not be an obstacle against navigation of fishing boat and not give a significant impact on fishing area.

Table 4-1 Community Fisheries in the study area

NO	Name of Community Fisheries	Member	
		Family	Total
1.	Krabeiriel	867	1,385
2.	Chong Khneas	706	1,116
3.	Kondek	1,083	1,550

4.2 Public Hearing from Other Stakeholders like Provincial and Central Government

The public hearing from other stakeholders than local people was conducted. Each opinion was collected after study team member explained the outline of the project and showed three kinds of alternatives of water source, a) surface water from Tonle Sap Lake, b) surface water from the canal of West Baray, and c) groundwater from the area near Tonle Sap Lake.

The result is as shown in Table 4-3 & Table 4-4.

Table 4-2 Public Consultation (1) Stakeholder Hearing from Commune in Project Site

NO	Commune	Water source	Water Quality	Mitigation Measures	Tap Water	Fee	Environmental Problem	Electri city	Others	Profession	Popula tion	Stakeholder
1.	Sla Kram	Well 90% Tab 10%	No good /iron	Boiling	More than 50% waiting for a long time	No problem	Water pollution of SR River /Market odor /Wastewater		Water from Tonle Sap is best /Groundwater not available /APSARA Zone 60%	Business 40% /Government 20% /Construction 10%	36,111	Chief (1)
2.	Svay Dangkum	Well 70% Tab 30%	Usable /No good	Digging new wells	Very happy /Waiting for a long time	No problem /Having experience	Solid waste in the river		Groundwater far from Angkor is better.		29,173	Deputy, Secretary, Village Chiefs (12)
3.	Kouk Chak	Well 99% Tab 0.2% (1 well for 10 households)	No good	Boiling /International NGO	Very happy (groundwater is restricted)	Should be paid	Solid waste in the river			Farmer 80% Shop 15%	27,444	Chief Secretary (5)
4.	Sala Kumraeuk	Well 90% Tab 10%	No good /Red/yellow due to iron	No mitigation measures /Claim for water to Radio station from local people	Very happy/ Saving time	Same as electricity	Odor from Toilet /Solid waste /Noise /Water pollution in waterway		Under construction of drainage by AFD		23,635	Chief (1)
5.	Nokor Thom	Well 100%	Red due to Iron in two villages	/Boiling & Filtering /NGO digging new wells	Very happy (wells give impact to Angkor)	No problem	Low awareness for environment /No toilet		Water source from Siem Reap is better	Farmer 70% /Handicraft /Construction worker	6,639	Chief /Commune council member (9)
6.	Chreav	Pump 85% Haul well 15%	Good 30% No good 55% (iron/oil)	Filtering No boiling NGO from Japan analyzing	Happy	Should be paid	Solid waste /Air pollution from company & Bus /Odor from slaughter		Tonle Sap Lake water is polluted, but pumping groundwater gives impact.	Farmer 80% Some fishermen	9,492	Chief, /Deputy /Deputy (3)
7.	Chong Khneas	On land; buying (1,000riel/30ltr) On water; buying 10% Using Lake water 40%	Tonle Sap Lake water is polluted.	Boiling /RACHA(NGO) advises for filtering.	Happy /Good chance to move on land	Easy (daily paying for drinking water now)	No space for waste site /No toilet /Noise of Boat		250 families are extremely poor. /Medical service level by Health Center is very low.	Fishermen 70% Boat driver 15% Shop 10% No farmer	5,970 Floating village (50%)	Chief (1)
8.	Sambour	Pump 482 Haul well 162	Usable /No good	Boiling /Help by ADRA, MONTHI, RESUT	Very happy	Should be paid	No				3,622	Chief /Deputy /Secretary (4)

NO	Commune	Water source	Water Quality	Mitigation Measures	Tap Water	Fee	Environmental Problem	Electri city	Others	Profession	Popula tion	Stakeholder
9.	Sla Kram	Well 90% Tab 10%	No good /iron	Boiling	More than 50% waiting for a long time	No problem	Water pollution of SR River /Market odor /Wastewater		Water from Tonle Sap is best /Groundwater not available /APSARA Zone 60%	Business 40% /Government 20% /Construction 10%	36,111	Chief (1)
10.	Siem Reap	Well /Rainwater /Mineral water (20ltr)	Good/No good (yellow due to iron & oil)		Very Happy	No problem	Solid waste Low awareness of local people /Water pollution in Siem Reap River		Pumping groundwater gives impact on Angkor and water from Baray gives impact on agriculture. Tonle Sap Lake water is best.	Farmer 70～75%	17,898	Chief (1)
11.	Srangae	Well /Buying 30% $1.5/24ltr	Usable /No good 30%	Getting from other good well	Very happy	Should be paid	Economy	Yes, but hard to pay		Farmer	6,566	Deputy (1)
12.	Teuk Vil	Well 80% Tab 20%	Good	—	Unknown	Should be paid	Noise from Aircraft & traffic			Farmer 80%	9,898	Chief (1)
13.	Krabei Real	Well 80%	No good Brown/ Yellow due to iron & oil	NGO from Japan adivises.	Happy	Very Hard (Small income)	No good road condition /Economy	No electri city		Farmer	7,621	Secretary (3)
14.	Ampil	Well	No problem	Education by Rotary International Organization	Better than well	The poor cannot pay.	No odor due to remove of disposal site to other commune	No electri city		Farmer 100%	6,671	Chief Secretary (4)
15.	Kanndeak	Well	No good	Boiling /Filtering /Rotary International Organization sets 70 filters.	Useful in the future	Hard	Noise from national road	User 20%		Farmer 80% /Fishermen /Construction worker	12,059	Chief Deputy (4)

(Source: JICA Study Team)

Table 4-3 Public Consultation (2) Stakeholder Hearing from Local Government

NO	Provincial Department	Position	Name	Access	Opinion
1.	Environment	Director	Mr. Lun KANEL	012-406-555	IEIA and EIA should be conducted consulting with DOE and The project owner, SRWSA should submit the IEIA and EIA report not to MOE directly, but to DOE at first. Pumping –up of groundwater may give some impact on cultural site.
2.	Land Management	Deputy Manager	Mr. Poch NATH	012-717-279 /011-577-799	If the dispute between land owner and project owner comes about, provincial governor sets up committee for the land.
3.	Fisheries	Deputy of Cantonment	Mr. Prin SAVIN	012-821-584	The protected areas set by MAFF should be paid attention not to give a significant impact on fisheries. Negotiation regarding construction of new open canal in Strictly Protected Inundated Forest Area may take a long time.
4.	Agriculture	Director	Mr. Moeurng SONITYA	011-927-000 /012-927-000	It is not so difficult to change the land use from agriculture to other use. It depends on negotiation and contract between sellers and a buyer.
5.	Forest	Director of Cantonment	Mr. Chheang TOLA	012-881-877	When the location of the project is planned concretely, the project owner should come to consult with local government before any decision.

Table 4-4 Public Consultation (3) Stakeholder Hearing from Central Government and Others

NO	Organization	Department	Name	Access	Opinion
1.	Tonle Sap Authority	Permanent Vice-Chairman, Secretary General	Mr. Say SAMAL	089-719-007	Planning for long term more than 20 years is most important. Both of water source from West Baray and groundwater are not enough to supply drinking water in the future. Surface water should be utilized in the foreseeable future.
2.	MOE	Deputy Director, EIA	Mr. Duong SAMKEAT	012-880-240	Public consultation should be conducted after completion of EIA report and opinions from stakeholders should be attached to the EIA report when it is submitted to MOE.
3.	MOE	Deputy, Natural Resource assessment	Mr. Suon MEAN	011-873-993	Multiple Use Area can be used for some projects, in consideration of giving no significant impact on natural resources.
4.	MOE	Director, National Park	Mr. Meng Mony REAK	012-943-909	Multiple Use Area should be utilized to improve the poor local people's living. Pipeline for safe drinking water may be able to be set in the Multiple Use Area.
5.	MOAFF	Deputy Director General, Fisheries Administration	Mr. Ing TRY	012-735-099	Fishing Lot should not be disturbed even due to the project of public infrastructure improvement. As regarding Community Fisheries, project owner should explain clearly content of the project to members of the Community Fisheries in advance and get their agreement.
6.	UNESCO	National Programme Officer, Culture Unit	Mr. Bun Hok, LIM	012-556-277	Project owner should conduct archaeological excavation if he wants to use water from West Baray as water source. Whether pumping-up of groundwater give impact on the cultural site or not depends on the distance between water wells and the site.

4.3 Stakeholder Meeting

The stakeholder meeting was organized by the project owner, SRWSA, at Pacific Hotel Siem Reap on 21st October 2009. The report on the meeting is as follows.

- Date & Time: 8:30-12:40 21st October 2009
- Place for Meeting: Pacific Hotel Siem Reap
- Method of Public Information: Invitation Letter, E-mail & Mobile phone
- Manner of Presentation: Power point, Microphone, Distribution of Handout
- Number of participant: 44 persons (Governor's Office, Dpt. of Agriculture, Forestry, Fisheries, Land Management, Public Works and Transportation, Water Resources and Meteorology, Environment, AFD, ADB, GTZ, APSARA, Communes, others)
- Facilitator: Mr. Kong SOKVAN, Director of Production & Commercial
- Interpreter: Mr. Cheav CHANNY, Deputy General Director, SRWSA / Ms. Reath Kanha, Assistant of JICA Study Team
- Program of the Meeting

NO	Time	Theme	Presenter
	8:30- 9:00	Registration	Staff of SRWSA
	9:00- 9:10	Opening Address	Mr. Som KUNTHEA General Director, SRWSA
	9:10- 9:40	Outline of Project	Mr. Yoshihiko SATO Leader, JICA Study Team
	9:40-10:20	Process of Water Source Selection	Mr. Hiroshi OKADA JICA Study Team
	10:20-10:30	Coffee Break	Staff of SRWSA
	10:30-11:10	Initial Environmental Impact Assessment & Scoping for EIA	Mr. Shinya KAWADA JICA Study Team
	11:10-11:30	Question and Answer	Mr. Cheav CHANNY Deputy General Director, SRWSA
	11:30-11:40	Closing Address	Mr. Bun THARITH Vice Governor of Siem Reap Province
	11:50-12:40	Lunch Time	

- Minutes of Meeting

Question or Answer
1. Cost of construction for tap water Question: How much cost should be burdened by each house for connecting newly to water pipe? Answer: 520,000 riels (approximately 130 US$) 2. Disposal of Sludge Question: Where do you thaw the sludge discharged from water treatment facility? Answer: At present water treatment facility the sludge is dried up in the pit and then stored in the premises.

- Appendix
  - i) Participant List
  - ii) Material used for presentation
  - iii) Photographs

5 Initial Environmental Impact Analysis

5.1 Methodology

According to an advice from Department of EIA in MOE, Initial Environmental Impact Assessment was conducted based on JICA's Guidelines for Environmental and Social Considerations. In reference to current environmental situation obtained from existing reports, impact due to implementation of the project was assessed and evaluated. Since the project owner, Siem Reap Water Supply Authority, has been operating a water supply system, similar environmental impacts given by the existing facility, like air pollution of chlorine, water pollution of wastewater and noise emitted from facility, were studied.

5.2 Environmental Impact and Mitigation Measures

According to JICA's Environmental Checklist, Initial Environmental Impact Assessment (or Initial Environmental Examination) was conducted to select environmental items to be assessed and to prepare Terms of Reference for EIA.

The result including mitigation measures to be considered at IEIA level is as shown in Table 5-3.

a. Land use and utilization of local resources

The land use is changed from the land for agriculture and inundated forest into project site. Alteration of agricultural land, inundated forest area and fishery domain for Community Fisheries should be minimized for the project site.

b. Cultural heritage

West Baray is a cultural heritage and the surrounding area is located in Zone 1 of APSARA Protected Area. Project owner shall obey the advice from APSARA not to give significant impact on the cultural heritage. There may be some impact on cultural heritage if huge amount of groundwater is pumped up.

c. Water Usage or Water Rights and Rights of Common

Tonle Sap: New pipelines or a new canal should be set not to be an obstacle against navigation of fishing boats and not give significant impact on fishing area.

West Baray: Water from the canal of West Baray should be utilized not to give significant impact on irrigation during dry season. Monitoring plan should be formulated for water management.

d. Hazards (Risk) / Infectious Diseases such as HIV/AIDS

Workers come from outside during construction and may pose risk of spreading infectious diseases. Project owner and/or contractor should make a health management plan and conduct workers' healthcare every day during construction.

e. Groundwater

Appropriate water volume to be pumped up should be analyzed not to give significant impact on the wells in the surrounding area.

f. Flora, Fauna and Biodiversity

Flora, fauna and biodiversity may be partly lost. Measures should be considered to mitigate impact on aquatic life around the intake. Inundated forest area to be lost should be minimized. Field survey for flora and fauna should be conducted along the site for pipelines or a new canal for EIA.

g. Landscape

New facilities appear after completion of the project and may give some impacts to the existing landscape. The appearance should be harmonized with the surrounding area. Tonle Sap Lake is one of resources of tourism owing to beautiful inundated forest. The design to disturb landscape from offshore should be avoided. Since the area around West Baray and part of existing canal is located in Landscape Protected Area of MOE, impact on the landscape should be minimized.

h. Air Pollution

There is usually no significant impact on the air except a critical incident.Chlorine from chlorine storage facilities and chlorine injection facilities will not be a cause of air pollution because the project owner, SRWSA has same kind of experience at current water treatment facility.

Detecting instrument of chlorine will be set around injection facility. Chlorine leaked accidentally in the operation room will be ventilated by plenum system.

Although there is no standard of chlorine in the air except chloride CL (20mg/m3) and HCL (200mg/m3) in Cambodia, monitoring plan and emergency plan should be developed to prevent air pollution due to chlorine.

i. Water Pollution

There is usually no significant impact on river water except a critical incident because pollutants, such as SS, BOD, COD contained in effluents discharged from water treatment facility can comply with the effluent standards in Cambodia. Monitoring plan and emergency plan should be developed to prevent water pollution due to unusual discharge of wastewater.

Table 5-1 Standard of Wastewater

NO	Para meters	Unit	Allowable limits for pollutant substance discharging to	
			Protected public water area	public water area and sewer
1	SS	mg/l	<50	<80
2	BOD	mg/l	<30	<80
3	COD	mg/l	<50	<100

j. Waste

There is little impact if the sludge is regularly taken away to the final disposal site of solid waste and disposed of properly. At the present, project owner, SRWSA, takes away the sludge from lagoon to the storage pit and dispose of it on a premise. Since sludge will increase according to water volume to be supplied, it will be difficult to dispose on a premise and it should be transported to a proper disposal site. Although there is no standard of sludges generated by the water purification facility except the standard of "sludge waste from factory wastewater treatment and product manufacturing processes", monitoring plan should be developed.

k. Noise & Vibration

There is usually little impact on the surrounding area due to noise and vibration emitted from water treatment facility because they are small. Power generator used at the time of blackout should be stored in the closed room to prevent strong noise from getting out directly.

Table 5-2 Standard of Noise

Unit; 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 Kindergarden	45	40	35
2	Residential area Hotels Administration Offices House	60	50	45
3	Commercial and service area and mix	70	65	50
4	Small industrial factories intermingling in residential areas	75	70	55

l. Ground Subsidence

Ground subsidence may occur due to excessive use of groundwater. The location of wells and water volume to be pumped up for this project should be decided after scientific analysis not to give significant

impact on the surrounding area and archaeological sites.

m. Accidents

There may be accidents during construction. The contractor should prepare Safety Management Plan including Safety Education Plan for labors.

Medical care system should be set up also.

Table 5-3 Environmental Impact and Mitigation Measures

No	Impacts	Tonle Sap	West Baray	Ground water	Description
1.	Land use and utilization of local resources	B	B	B	Change of land use from the land for agriculture and inundated forest into project site Alteration of agricultural land, inundated forest area and fishery domain for Community Fisheries should be minimized for the project site.
2.	Cultural heritage	C	B	B	Tonle Sap; Little impact should be given on the cultural heritage. West Baray; West Baray is a cultural heritage. Groundwater; Possibility of some impact if huge amount of water is pumped up.
3.	Water Usage or Water Rights and Rights of Common	B	B	C	Tonle Sap; New pipelines or canal should be set not to disturb navigation and fishing. West Baray; Water from West Baray should be utilized not to give significant adverse impact to irrigation during dry season. Monitoring plan should be formulated for water management.
4.	Hazards (Risk) Infectious diseases such as HIV/AIDS	B	B	B	Workers come from outside during construction. Project owner and/or contractor should make a health management plan and conduct workers' healthcare every day during construction.
5.	Groundwater	C	C	B	Appropriate water volume to be pumped up should be analyzed not to give significant impact on the wells in the surrounding area.
6.	Flora, Fauna and Biodiversity	B	C	B	Flora, fauna and biodiversity may be partly lost. Field survey should be conducted for EIA. Inundated area to be altered for the project should be minimized.
7.	Landscape	B	B	B	New facilities appear after completion of the project and may give some impact to the existing landscape. The appearance should be harmonized with the surrounding area.
8.	Air Pollution	B	B	B	There is usually no significant impact on the air except a critical incident. Monitoring plan and emergency plan should be developed to prevent air pollution due to chlorine.
9.	Water Pollution	B	B	B	There is usually no significant impact on river water except a critical incident because wastewater is discharged from the water treatment facility not exceeding the standard of Cambodia. Monitoring plan and emergency plan should be developed to prevent water pollution due to unusual discharge of wastewater.

No	Impacts	Tonle Sap	West Baray	Ground waterp	Description
10.	Waste	B	B	B	There is little impact if the sludge is regularly taken away to the final disposal site of solid waste and disposed of properly.
11.	Noise and Vibration	B	B	B	There is usually little impact on the surrounding area due to noise and vibration emitted from water treatment facility because they are small. Power generator used at the time of blackout should be stored in the room to prevent strong noise from getting out directly.
12.	Ground Subsidence	C	C	B	The location of wells and water volume to be pumped up should be decided not to give significant impact on the surrounding area and archaeological sites.
13.	Accidents	B	B	B	There may be accidents during construction. The contractor should prepare Safety Management Plan including Safety Education Plan for labors. Medical care system should be set up also.

6 Conclusion and Recommendation

6.1 Environmental Management Plan

a. Impacts during Construction

Adequate measures shall be considered to reduce impacts during construction like noise, vibrations, turbid water, dust, exhaust gases and wastes, and also on natural environment (ecosystem) and social environment. Health and safety education (e.g., traffic safety, public health) shall be provided for project personnel, including workers.

If the measures are not adequate, grading of impact would be A, significant impact.

Detailed mitigation plan shall be prepared in Feasibility Study.

b. Monitoring

SRWSA shall develop and implement monitoring program for the environmental items that are considered to have potential impacts, including the items, methods and frequencies, and also establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework), although any regulatory requirements are not pertaining to the monitoring report system identified, such as the format and frequency of reports from the project owner to the regulatory authorities.

Regular monitoring of adverse impact during construction and operation is important as much as assessment of impact in order to keep potential impact under the criteria used for EIA.

6.2 Terms of Reference for EIA (Draft)

Environmental Impact Assessment (EIA) Report for this project should be prepared according to the following Terms of Reference (TOR), based on "*Draft Guideline for conducting Environmental Impact Assessment (EIA) Report, Department of EIA Review and Monitoring, MOE.*"

6.2.1 Project Summary

Project's goals, main objectives, methodologies and key measures for reduction of environmental impacts are described in the EIA Report.

6.2.2 Introduction

- *Type, size and location of the project*
- *Background of the project's location*
- *Within the framework of national and international laws and legislation standards*

6.2.3 Purpose of the Project

The purpose of the project for present and future is explained clearly.

6.2.4 Project Description

① *Briefing alternatives: size, location, timeframe (stages of project construction and project operation) and source of labor forces*

② *The production process: sources and quantity of raw materials to be used and finished products*

③ *Machinery requirement to run the project*

④ *Methodologies of wastes disposal in order to determine any environmental impacts*

⑤ *Description and quality of solid and liquid waste to be disposed and discharged, sources of noise and vibration resulting from the process of this project (construction, operation) and the emission of particles into the atmosphere*

⑥ *Project planning*

6.2.5 Description of Environmental Resources

a. *Physical resources:*

➢ *Air*

Compilation of information based on the existing reports and data

➢ *Water*

Compilation of the result of field survey in the study as well as information based on the existing reports and data

➢ *Land*

Compilation of information based on the existing reports and data

b. *Ecological resources:*

➢ *Bio-diversity*

Compilation of the result of field survey data of fauna and flora as well as information based on the existing reports and data

➢ *Fauna*

Field survey of fauna is conducted along pipelines and/or new canals (if any), and within and around the water treatment facility site, regarding mammal, bird, amphibian, reptile, insect and fish, in dry season, in addition to compilation of information based on the existing reports and data

➢ *Flora*

Field survey of flora is conducted along pipelines and/or new canals (if any) and within and around the water treatment facility site in dry season in addition to compilation of information based on the existing reports and data

➢ *Forest*

Field survey of inundated forests is conducted along pipelines and/or new canals (if any) and within and around the water treatment facility site in dry season during flora survey, in addition to compilation of information based on the existing reports and data

c. *Socio-economical resources:*

Compilation of the result of stakeholder hearing survey in the study as well as information based on the existing reports and data for the following items.

- *Population*
- *Infrastructure*
- *Land use*
- *Public health and welfare*
- *Condition of economy*

6.2.6 Public Participation

Stakeholder Hearing was already conducted from the representatives of 14 communes in the study area as well as from Siem Reap Provincial Departments of Fisheries, Agriculture, Forest, Land Management and Environment, and from Ministry of Environment and Tonle Sap Basin Authority.

In October Stakeholder Meeting will be held to collect opinions on EIA scoping (how to carry out EIA study) from stakeholders and also in March 2010 another Stakeholder Meeting will be held to collect opinions on Draft EIA Report prepared by SRWSA.

6.2.7 Environmental Impact Analysis

All significant environmental impacts resulting from the project should be described in this part, which includes: Methodologies to identify the scope of the environmental impacts by using the Matrix table and Environmental impacts during construction, operation and accumulative impact.

After decision of water source, intake system and location of water treatment facility and completion of Feasibility Study, EIA scoping will be revised and field survey of fauna and flora will be conducted.

The environmental items to be analyzed will be selected among the followings (refer to Table 5-3).

- Land use and utilization of local resources
- Cultural heritage
- Water Usage or Water Rights and Rights of Common
- Hazards (Risk)
- Infectious diseases such as HIV/AIDS
- Groundwater
- Flora, Fauna and Biodiversity
- Landscape
- Air Pollution
- Water Pollution
- Waste
- Noise and Vibration
- Ground Subsidence
- Accidents

6.2.8 Environmental Impact Mitigation Measures

Environmental impact mitigation measures should be considered for items with significant impact.

6.2.9 Economical Analysis and Environmental Value

Benefits of the project should be indicated comparing with cost of the local environmental damages

6.2.10 Environmental Management Plan

The plan includes the Environmental Protection Measures in the stage of construction and operation, and the Environmental Monitoring Program in the stage of construction and operation.

6.2.11 Institutional Capacity

It is demonstrated that the project owner has institutional capacity to carry out the work associated with execution of the EIA and the implementation of the mitigation measures, such as organization structure, budget/schedule, staff skills and methodological tools and equipment.

6.2.12 Conclusion and Suggestion

The assessment of environmental impacts both of positive and negative aspects with full accountability and responsibility in the process of reporting the EIA as well as addressing some possible suggestions implicated in the project will be described.

6.2.13 Reference

7 References

1) Chapter V. Urban Infrastructure and Environmental Management, Siem Reap: Urban Development in the Shadow of Angkor

2) The Study on Integrated Master Plan For Sustainable Development of Siem Reap / Angkor Town, JICA

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4) Tonle Sap / Great Lake Field Trip, Mekong River Commission Secretariat, Environment Training Program (ETP)-Block 1

5) Boeung Tonle Chhmar Core Area, Tonle Sap Biosphere Reserve, Management Plan 2008-2012

6) Stung Sen Core Area, Tonle Sap Biosphere Reserve, Management Plan 2008-2012

7) 3.Fisheries and Floodplain Agriculture in the Tonle Sap Region, National Environmental Action Plan 1998-2002

8) Task 1.5 Perspectives of the Poor on Tourism, Tourism Sector Assessment, 6th March 2009, Empowerment of the Poor in Siem Reap-Scoping and diagnostic work

9) National Resources-based Development Strategy for The Tonle Sap Area CMB/95/033 final Report Main Report May 1998

10) Integrated Resource Management and Development in the Tonle Sap Region Draft Report July 2001

11) Monitoring of Large Waterbirds at Prek Toal Tonle Sap Great Lake 2001-2007 November 2007

12) A review of the Status and Distribution of Large Waterbirds in the Tonle Sap Biosphere Reserve October 2008

13) The Biodiversity of the Tonle Sap Biosphere Reserve 2005 Status Review March 2006

14) The Compilation of Legal Instruments Related to Community Fisheries in the Kingdom of Cambodia

15) Law on Environmental Protection and Natural Resource Management 1996

16) Sub-Decree on Environmental Impact Assessment Process NO.72 ANRK.BK 11 August 1999

17) MOE, Decree for Protected Area (not English)

18) Implementation Strategy for Urban Water Supply Policy November 2006 The World Bank

19) Sub-Decree on Solid Waste Management, NO. 36 ANRK.BK

20) Royal Decree on Establishing Protected Cultural Zones May 1994

21) Sub-Decree regarding Organization and Functioning of the Office of Director General of the

APSARA Authority

22) Sub-decree establishing the Special Police Crops for the Protection of Cultural Heritage

23) Law on Water Resouces Management of the Kingdom of Cambodia, 29 June 2007

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25) Sub-Decree on Ater Pollution Control, NO.27 ANRK. BK April 06, 1999

26) Sub-Decree on Social Land Concessions NO19 ANK/BK/March 19 2003

27) Royal Decree on Creation Authority Tonle Sap 29 June 2009

28) Royal Decree on The Establishment and Management of Tonle Sap Biosphere Reserve 1st October 2001

29) Sub-Decree on the Establishment, Role and Functions of the Secretariat for Tonle Sap Biosphere Reserve

30) Law on Forest „ NS/RKM/0802/016, August 31 2002

31) Law on Fisheries,NS/RKM/506/011, May 21 2006

32) Land Law August 30 2001

33) Social and environmental impact of ADB development projects on the livelihoods of Cambodian people, Mak Sithirith Summary of Presentation at Conference on "Accounting for Development" June 23-24, 2000, University of Sydney

34) The Implication of Environmental Legal Tools to Water Environment in Cambodia, Chris Sokha

35) Workshop on Land Management for Ministry of Land Management, Urban Planning and Construction organized by Ministry of MLMUPC, GTZ and ADB 09-11 November 2000 Workshop Document

36) National Biodiversity Strategy and Action Plan Ministry of Environment April 2002 FAO/UNDP/GEF Project CMB/98/G33

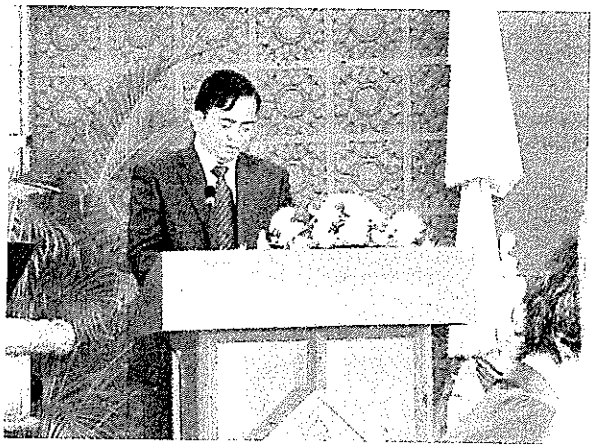
37) Technical Report on the Final Draft Land-Use Plan fro Siem Reap District, Report prepared by District Master Plan Team Siem Reap, October o1, 2007

38) Improvement of Siem Reap River Upgrade the Existing Sewerage System and Construction of Wastewater Treatment Plant Siem Reap Province, Initial Environmental Examination, July 2008, The Export-Import bank of Korea

8 Appendix

8.1 Photographs of Stakeholder Meeting

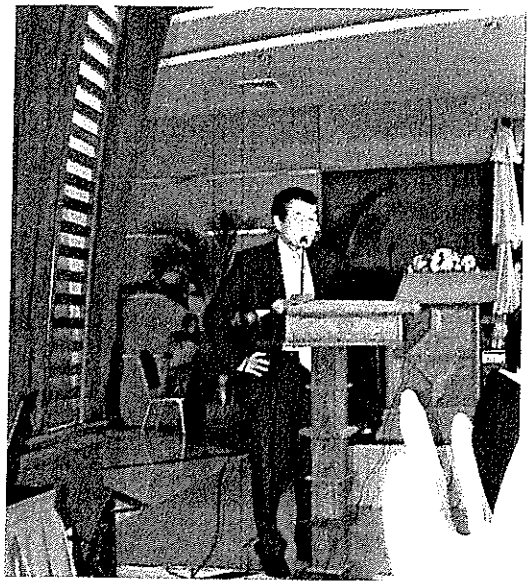
Address of Vice Governor



Address of General Director of SRWSA

Main Guests

Participants



Leader of JICA Study Team

Process of Water Source Selection

8.2 Material used for Presentation in the Stakeholder Meeting

គំរោងផ្តល់ជំនួយឧស្សាហកម្មសៀមរាប

ការវាយតំលៃផលប៉ះពាល់បរិស្ថានលើកដំបូង

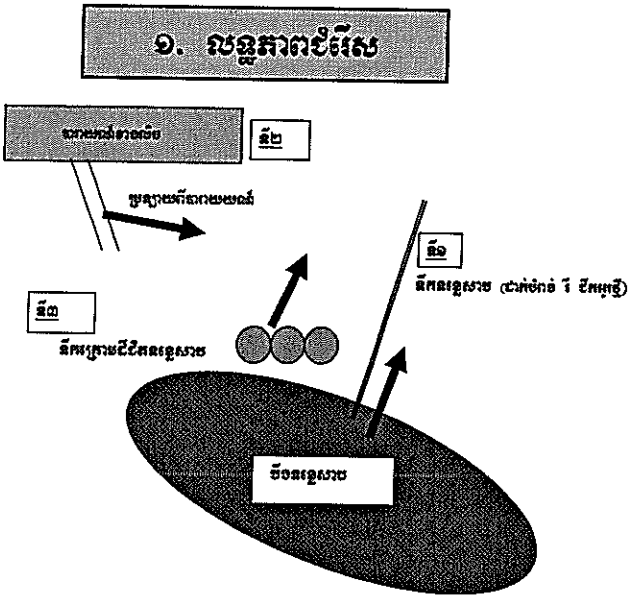
រដ្ឋាករឧទ្យានសៀមរាប

ក្រុមសិក្សាគំរោងរបស់ភ្នាក់ងារសហប្រតិបត្តិការណ៍អន្តរជាតិជប៉ុន

(JICA)

ការវាយតំលៃផលប៉ះពាល់បរិស្ថានដំបូង

១. លក្ខណៈពិសេស



២. ចំណាត់ថ្នាក់ (១)

ល.រ	ផលប៉ះពាល់	ទន្លេ	បាយ	ក្រោមដី	ចំនាកស្រាយ
១	ការស្ទុះត្រជាចិត្តពីលំនៅ				
២	សេដ្ឋកិច្ចប្រជាជនក្នុងតំបន់ ដូចជា ការងារ ជីវភាព				ផលប៉ះពាល់វិជ្ជមានអាចទទួលយកបាន
៣	ការប្រើប្រាស់ដី និង ធនធានមានជីវជាតិក្នុងតំបន់	✓	✓	✓	ផ្លាស់ប្តូរការប្រើប្រាស់ដី
៤	ស្ថានភាពសង្គម ហេដ្ឋារចនាសម្ព័ន្ធ និង ការសំរេចចិត្ត ប្រស់ប្រជាជន				
៥	បង្កើតហេដ្ឋារចនាសម្ព័ន្ធសង្គម និង សេវាកម្ម				
៦	ប្រជាជនក្រីក្រ ទីចាល់ និង អ្នកម្ចាស់ស្រុក				
៧	ការបាត់បង់ការរំលែកផលចំនេញ និង ការបំផ្លាញ				
៨	បេតិកភណ្ឌវប្បធម៌ (សម្បត្តិវប្បធម៌បុរាណ)		✓		
៩	ជំនាស់របស់ប្រជាជនលើផលប្រយោជន៍				
១០	ការប្រើប្រាស់ទឹក ឬ សិទ្ធប្រើប្រាស់ទឹក និង សិទ្ធជាប្រមូ	✓	✓		ប៉ះពាល់រវិជ្ជមានដល់ការទេសាទ និង ផ្គត់ផ្គង់ទឹក
១១	រនាម័យ				
១២	ភាពប្រឈមនឹងជំងឺ ដូចជា ជំងឺអេដស៍ជាដើម	✓	✓	✓	អាចកើតមានក្នុងពេលសាងសង់

២. ចំណាត់ថ្នាក់ (២)

ល.រ	ផលប៉ះពាល់	ទន្លេ	បាសាយ	ក្រោមដី	ចំនុចស្រាយ
១៣	ភូលេខភូមិសាស្ត្រ និង ទីតាំង				
១៤	ទឹកក្រោមដី			✓	ប៉ះពាល់ទឹកក្រោមដី
១៥	ការហូរច្រោះដី				
១៦	ស្ថានភាពទឹក				
១៧	តំបន់ឆ្នេរ				
១៨	ព្រៃឈើ សត្វព្រៃ និង ជីវចំរុះ	✓	✓	✓	ប៉ះពាល់ព្រៃឈើ និង សត្វព្រៃ
១៩	ឧត្តុនិយម				
២០	តំបន់ទេសភាព	✓	✓	✓	ការលេចឡើងនៃរោងចក្រថ្មី
២១	ការតំរាមកំហែងរបស់ពិភពលោក				
២២	ការប៉ះពុលបរិយាកាស	✓	✓	✓	ប្រើប្រាស់សារធាតុក្អូរ
២៣	ការប៉ះពុលទឹក	✓	✓	✓	កាកសំនល់ក្នុងពេលប្រតិបត្តិការណ៍
២៤	កង្វក់ដី				

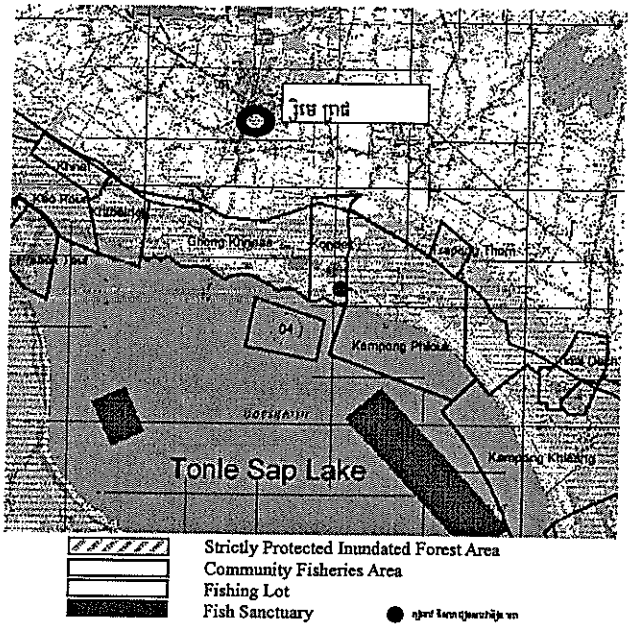
ល.រ	ផលប៉ះពាល់	ទន្លេ	បាសាយ	ក្រោមដី	ចំនុចស្រាយ
២៥	កាកសំនល់	✓	✓	✓	បន្សល់ទុក ៣ក់ កាកខាប់ ក្នុងពេលដំណើរការ
២៦	សំលេងរំខាន និង រំញ័រ	✓	✓	✓	មានសំឡេងចេញពីក្នុងរោងចក្រ
២៧	ការស្រុតដី			✓	ប៉ះពាល់ពេលដាក់បំពង់លើទឹកក្រោមដី
២៨	ភ្លិនមិនល្អ				
២៩	ចរន្តទឹកបាតក្រោម				
៣០	គ្រោះថ្នាក់	✓	✓	✓	អាចកើតមានក្នុងពេលសាងសង់

ការចាត់ចំណាត់ថ្នាក់ប្រភេទ

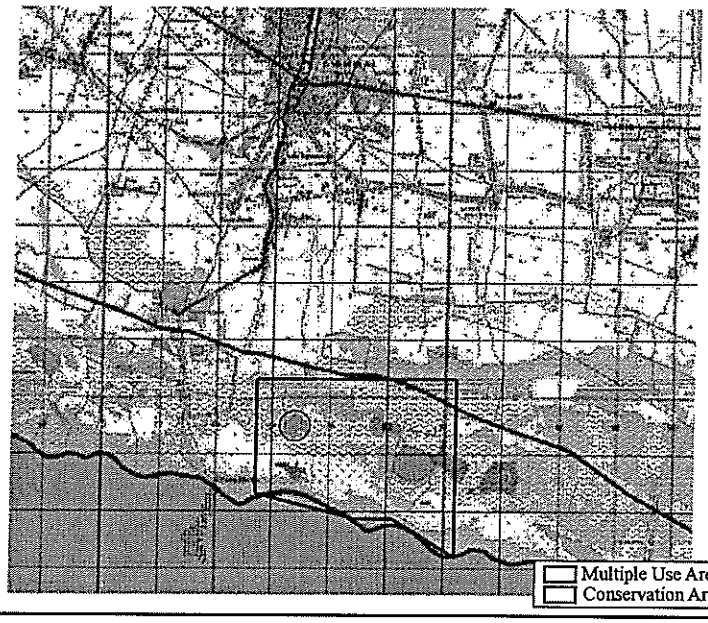
- ក្រុម A: មានផលប៉ះពាល់ច្រើនជ្រុង
- ក្រុម B: ឥទ្ធិពលនៃការប៉ះពាល់គិចតួចជាងក្រុម A
- ក្រុម C: មានផលប៉ះពាល់គិចតួច

ការធ្វើចំណាត់ថ្នាក់កំនត់លើប្រភេទ B

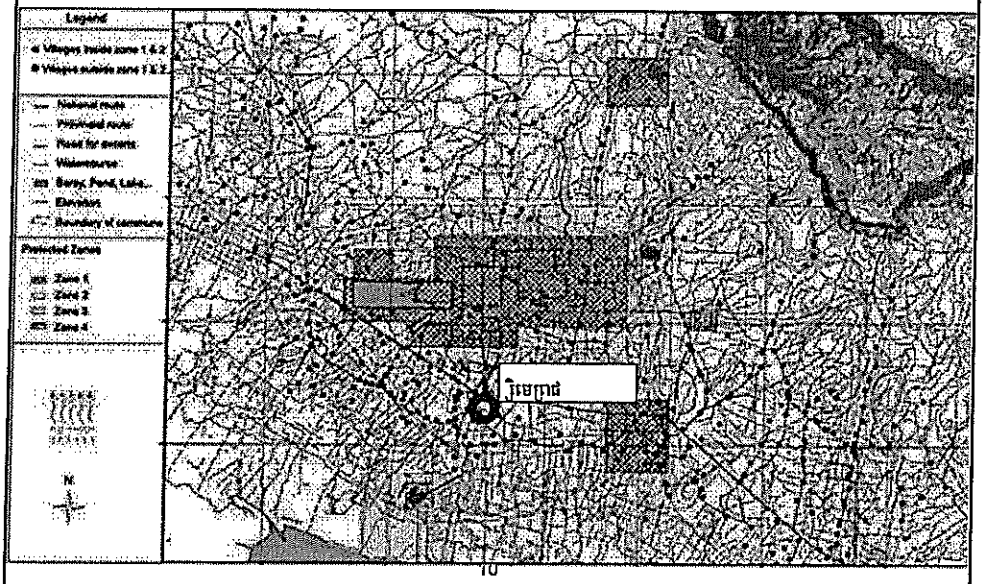
៣. តំបន់ការពារ (ដែនទេសាន)



៣. តំបន់ការពារ (ដែនបរិស្ថាន)



៣. តំបន់ការពារ (ដែនអង្គារអរគប្បរ)



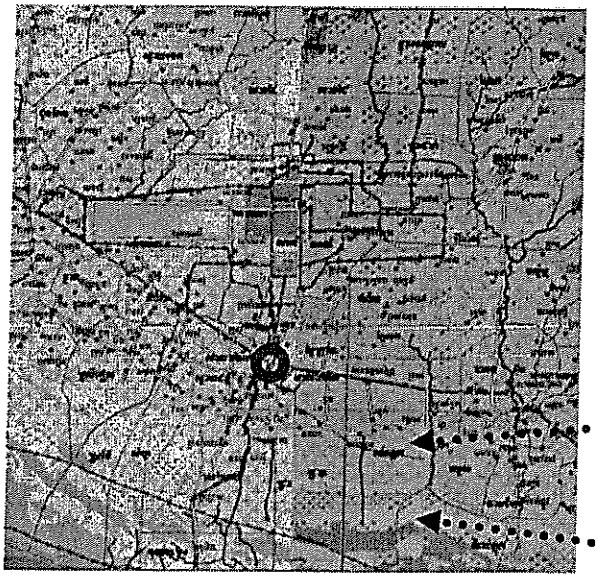
៤. ស្ថានភាពបច្ចុប្បន្ន

ល.រ	ផលប៉ះពាល់	បំនកស្រាយ
១	ការប្រើប្រាស់ដី និង ធនធានមានជីជាតិក្នុងតំបន់	ស្រែស្រូវវស្សា ស្រូវរដូវ ស្មៅ ព្រៃលិចទឹកចន្លោះទីប្រជុំជន និង ទន្លេសាប ។
២	បេតិកភណ្ឌវប្បធម៌	សម្បត្តិវប្បធម៌បុរាណរាចនិង មិនទៅចន្លោះទីប្រជុំជន និង បឹងទន្លេសាបទេ រលើកលែងតែតំបន់មានស្រាប់ ។
៣	ការប្រើប្រាស់ទឹក រឺសិទ្ធិប្រើប្រាស់ទឹក និង សិទ្ធិទូទៅ	-អ្នកនេសាទធ្វើដំណើរទៅមកក្នុងបឹង និង ព្រៃលិចទឹក ។ -ទឹកចេញពីបារាំងខាងលិចប្រើប្រាស់ក្នុងការស្រោចស្រព ។
៤	ការប្រឈមនឹងការគ្រងជំងឺ ដូចជា ជំងឺអេដស៍	
៥	ទឹកក្រោមដី	ទឹកក្រោមដីត្រូវប្រើប្រាស់ដោយប្រជាជនក្នុងស្រុក និង សណ្ឋាគារជាច្រើន ។
៦	ព្រៃឈើ សត្វព្រៃ និង ជីវចំរុះ	សត្វដូចជា ចាក្រី ជនិកសត្វ ល្មូន និង អង្គែបហ៊ីង ផែលរស់នៅក្នុងតំបន់ស្តួលទាំងបឹងនៃ ផែនអភិរក្សថ្មៃចិងទន្លេសាប និង តំបន់អភិរក្សជំរកត្រីពង ។
៧	តំបន់ទេសភាព	ក្រសួងបរិស្ថានបានកំនត់ឈ្មោះ និង បែងចែកតំបន់ការពារទេសភាពជុំវិញតំបន់អង្គរ ។
៨	ការបំពុលខ្យល់	ការបំពុលខ្យល់ចេញពីយានយន្តទៅបរិយាកាស ឈើយក្រឡឬបរិញ្ញាតមរយៈ ទឹកភ្លៀង ។ទៅវិញវិត្រាំងមានធូលីតាមផ្លូវបង្កំចុះឡើង ។

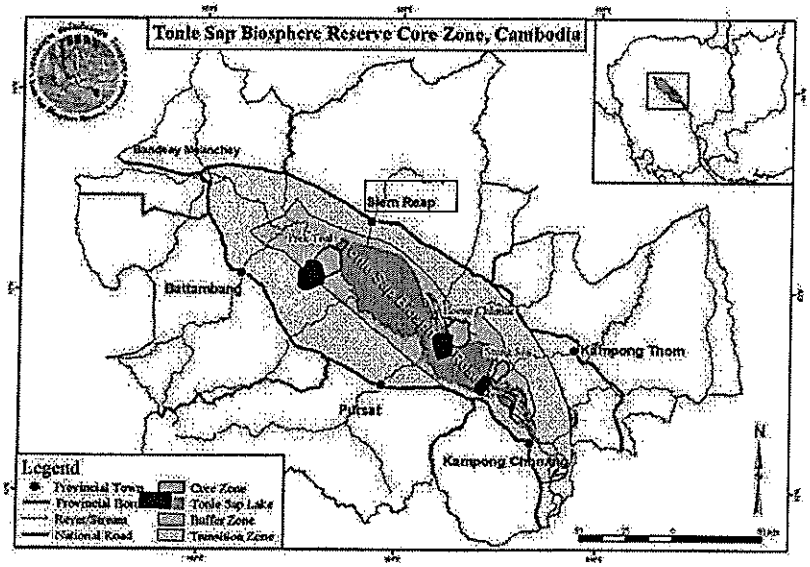
៤. ស្ថានភាពបច្ចុប្បន្ន

៩	ការបំពុលទឹក	ទឹកបឹងទន្លេសាបមិនសូវមានការបំពុលច្រើនទេ ដោយយោងទៅលើការវិភាគរបស់ក្រុមសិក្សា គំរោងរបស់អង្គការ JICA ។ ទឹកទៅស្ទឹងសៀមរាបទទួលរងការបំពុល ប៉ុន្តែទៅវិញវិស្សាទឹក ជំនន់កាត់បន្ថយបណ្តុំជាតិពុលមួយចំនួន ។
១០	កាកសំនល់	កាកសំនល់ក្នុងក្រុងត្រូវបានប្រមូលដោយក្រុមហ៊ុនឯកជន និង បាត់ចោលទៅកន្លែងគំនរសំរាម ។
១១	សំលេងរំខាន និង រំញ័រ	សំលេងរំខានចេញពី យានយន្ត ។
១២	ការស្រុតដី	មានការបាក់ស្រុតដីតិចតួចទៅតំបន់សៀមរាប ។
១៣	គ្រោះថ្នាក់ផ្សេង១	

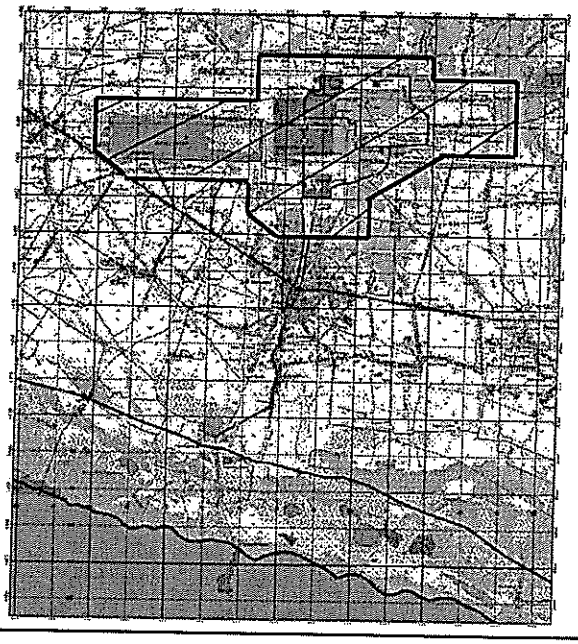
ការប្រើប្រាស់ដី



តំបន់ស្នូលផ្នែបីឯទន្លេសាបដោយ UNESCO



តំបន់ការពារធនធានធម្មជាតិ ដោយក្រសួងបរិស្ថាន



៥. ការវាយតំលៃស្ថានភាពលំបាក និង ផលប៉ះពាល់បរិស្ថានដ៏ប្លែ

ល.រ	ផលប៉ះពាល់	ទន្លេ	ព្រៃឈើ	ព្រោមដី	ចំនុចស្រាយ
១	ការប្រើប្រាស់ដី និង ធនធានមាន ជីជាតិក្នុងតំបន់	B	B	B	ប្តូរការប្រើប្រាស់ពីដីកសិកម្ម និងព្រៃលិចទឹកទៅជាដីសំរាប់តំណែង ការកែប្រែដីកសិកម្ម ដីព្រៃលិចទឹក និង ដែនសហគមន៍នេសាទ គួរតែកាត់បន្ថយសំរាប់ទឹកតំណែងតំរែង។
២	បេតិកភណ្ឌវប្បធម៌	C	B	C	បារាយណ៍ខាងលិច គឺជាតំរង់សម្បត្តិវប្បធម៌។ តំបន់សម្បត្តិវប្បធម៌ គួរតែមានការបះពាល់តិចតួចបំផុតក្នុងអំណើ ដែលទឹកខន្ធេ និង ទឹកក្រោមដីកំណាត់ជាតើបរិមាណប៉ុន្មានត្រូវចុច។
៣	ការប្រើប្រាស់ទឹក វិសីធ្វើប្រើប្រាស់ទឹក និង សិទ្ធិទូទៅ	B	B	C	-ទន្លេសាប : ប្រព័ន្ធបំពង់ ជីកអូរ គួរត្រូវបានកំនត់ដោយស្ថានការ រំខានដល់ដំណើរដ្ឋងកាត់ និងការនេសាទ។ -បារាយណ៍ : ទឹកចេញពីបារាយណ៍គួរតែត្រូវអោយប្រើប្រាស់ មិនត្រូវធ្វើអោយមានការបះពាល់ដល់ការស្រោចស្រព។ រំជនការត្រួតពិនិត្យគួរតែត្រូវរៀបចំសំរាប់ការគ្រប់គ្រងទឹក។
៤	ភាពប្រឈមនឹងការដ្ឋងដំដីចុចជា ជំងឺអេដស៍ជាដើម	B	B	B	ក្នុងពេលសាងសង់កម្មការមកពីស្រុកក្រៅ។ម្ចាស់តំណែង និង ក្រុមហ៊ុន សំនង់គួរតែបង្កើតព័ត៌មែរក្សាសុខភាព និងការត្រួតពិនិត្យ ជាប្រចាំ ក្នុងពេលសាងសង់។

៥. ការវាយតំលៃស្ថានភាពលំហូរ និង ផលប៉ះពាល់បរិស្ថានដីបូទ

៥	ទឹកក្រោមដី	C	C	B	បរិមាណទឹកសមរម្យដែលត្រូវបូមនឹងត្រូវវិភាគដោយមិនធ្វើអោយមានផលប៉ះពាល់លើអណ្តូងនៅតំបន់ជុំវិញទេ។
៦	ព្រៃឈើ សត្វព្រៃ និង ជីវចំរុះ	B	C	B	-ព្រៃឈើ សត្វព្រៃ និង ជីវចំរុះអាចត្រូវបាត់បង់មួយផ្នែក។ -ការធ្វើការស្ទង់មតិគួរតែត្រូវពិនិត្យសំរាប់ការវាយតំលៃផលប៉ះពាល់បរិស្ថាន។
៧	តំបន់ទេសភាព	B	B	B	-មានភោងចក្រផលិតទឹកបន្ទាប់ពីការបញ្ចប់តំរោង និង អាចធ្វើអោយមានផលប៉ះពាល់ដល់លើការពង្រីកដី។ -ការកើតមាននេះអាចនឹងគំរាមកំហែងដល់តំបន់ជុំវិញ។
៨	ការបំពុលខ្យល់	B	B	B	-គ្មានការប៉ះពាល់ច្រើនដែលបញ្ហាកំលើការបំពុលទេ។ -ផែនការត្រួតពិនិត្យ និង សង្គ្រោះគួរតែរអភិវឌ្ឍដើម្បីការពារការបំពុលខ្យល់របស់សារធាតុក្អូរ។
៩	ការបំពុលទឹក	B	B	B	-គ្មានផលប៉ះពាល់ច្រើនធ្ងន់ធ្ងរលើទឹកស្តិងចោទឡើងទេ ព្រោះសំនល់ទឹកគឺត្រូវបញ្ចេញពីភោងចក្រតាមលក្ខណៈបច្ចេកទេស។ -ផែនការត្រួតពិនិត្យ និង សង្គ្រោះ គួរតែរអភិវឌ្ឍដើម្បីការពារការបំពុលទឹកដោយផ្តែកលើករណីកាកសំនល់មិនធម្មតា។

៥. ការវាយតំលៃស្ថានភាពលំហូរ និង ផលប៉ះពាល់បរិស្ថានដីបូទ

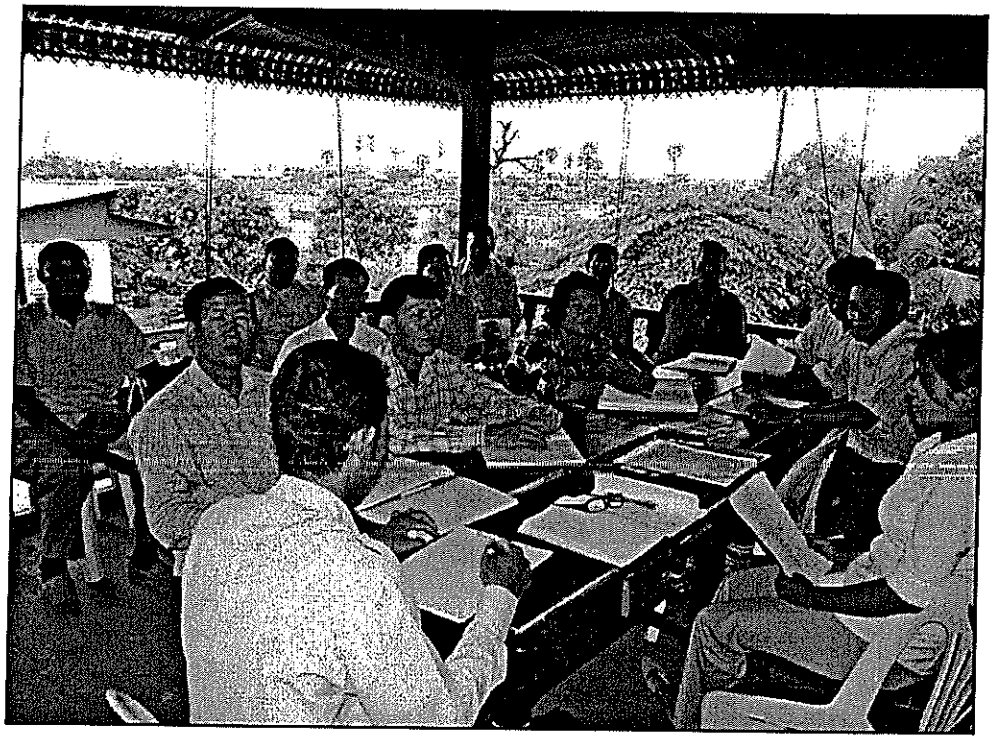
១០	កាកសំនល់	B	B	B	មានផលប៉ះពាល់តិចតួចបើសិនសំនល់កកំត្រូវបានដឹកយកទៅចោលទៅចោលកន្លែងចាក់សំរាម និង ត្រូវកំនត់រោយជាក់លាក់។
១១	សំលេងរំខាន និង រំញ័រ	B	B	B	-មានផលប៉ះពាល់តិចតួចជាទូទៅ លើតំបន់ជិញដោយសំលេង និង រំញ័រចេញពីភោងចក្រផលិតទឹកពីព្រោះភោងចក្រទាំងនោះតូច។ -ម៉ាស៊ីនភ្លើងនឹងត្រូវប្រើនៅពេលភ្លើងដាច់ ហើយគួរតែតំកល់ក្នុងបន្ទប់ដើម្បីការពារសំលេងខ្ទាំងចេញក្រៅ។
១២	ការបាក់ស្រុតដី	C	C	B	ទីតាំងអណ្តូង និង បរិមាណដែលត្រូវបូមគួរតែត្រូវសំរេចអោយត្រឹមត្រូវគ្មានការប៉ះពាល់ដល់តំបន់ជុំវិញ និង ព្រៃសាខបុរាណ។
១៣	គ្រោះថ្នាក់ផ្សេងៗ	B	B	B	-អាចកើតមានគ្រោះថ្នាក់ក្នុងពេលសាងសង់ ក្រុមហ៊ុនសំនង់ និង ម្ចាស់ជំនួយគួរតែរៀបចំផែនការសុវត្ថិភាព រួមបញ្ចូលទាំងផែនការអប់រំសុវត្ថិភាពសំរាប់កម្មករ។ -ប្រព័ន្ធចែចាំសុខភាពគួរបង្កើតជាដែរ។

៦. ពត៌មានពីក្នុងតំបន់ (ឃុំ-សង្កាត់)

លរ	ឃុំ-សង្កាត់	ប៉ាន់ស្មានការកាត់បន្ថយ ស្ថានការណ៍លំបាក	ប្រព័ន្ធទឹកស្អាត	អត្ថិ សនិ	ផ្សេងៗ	ប្រជាជន
១	ស្វាយក្រាម	ជាំទឹក	ច្រើនជាង៥០% រង់ចាំជាយូរមកហើយ		ទឹកទន្លេសាបល្អបំផុត ។ទឹកក្រោមដីមិន អាចយកបានព្រោះជាប់តំបន់អប្សរា៦០%	៣៦ ១១១ ន
២	ស្វាយដង្គុំ	ជីកអណ្តូងថ្មី	រីករាយ ចាំការផ្តល់ជូន		យកទឹកក្រោមដីឆ្ងាយពីអង្គរជាការប្រសើរ	២៩ ១៧៣ ន
៣	គោកធក	ជាំទឹក/ អង្គការអន្តរជាតិ	រីករាយ(ទឹកក្រោមដីគឺ មានកំនត់)			២៧ ៤៤៤ ន
៤	សាលាកំពឹក	គ្មានការកាត់បន្ថយស្ថាន ភាព ។ប្រជាជនតភ្ជាប់ទៅ កម្មវិធីទិញ្ញីពីបណ្តាទឹក ។	រីករាយ សន្សំពេលវេលា		ស្ថិតក្រោមការសាងសង់បំពង់បង្ហូរដោយ ភ្នាក់ងារអភិវឌ្ឍបារាំង (AFD)	២៣ ៦៣៥ ន
៥	ឧតរង	ជាំទឹក ចំរោះ ជីកអណ្តូង	រីករាយ(អណ្តូងមាន ជំលបំរះពាល់)		ប្រភពទឹកពីស្ទឹងសៀមរាបគឺប្រសើរជាង ។	៦ ៦៣៩ ន
៦	ជ្រាវ	ច្រោះ មិនជាំ /អង្គការពី ជប៉ុន	រីករាយ		ទឹកទន្លេសាបទន្ទំលងនូវការបំពុល ប៉ុន្តែ ការខូងទឹកក្រោមដីមានការប៉ះពាល់ ។	៩ ៤៩២ ន

៦. ពត៌មានពីក្នុងតំបន់ (ឃុំ-សង្កាត់)

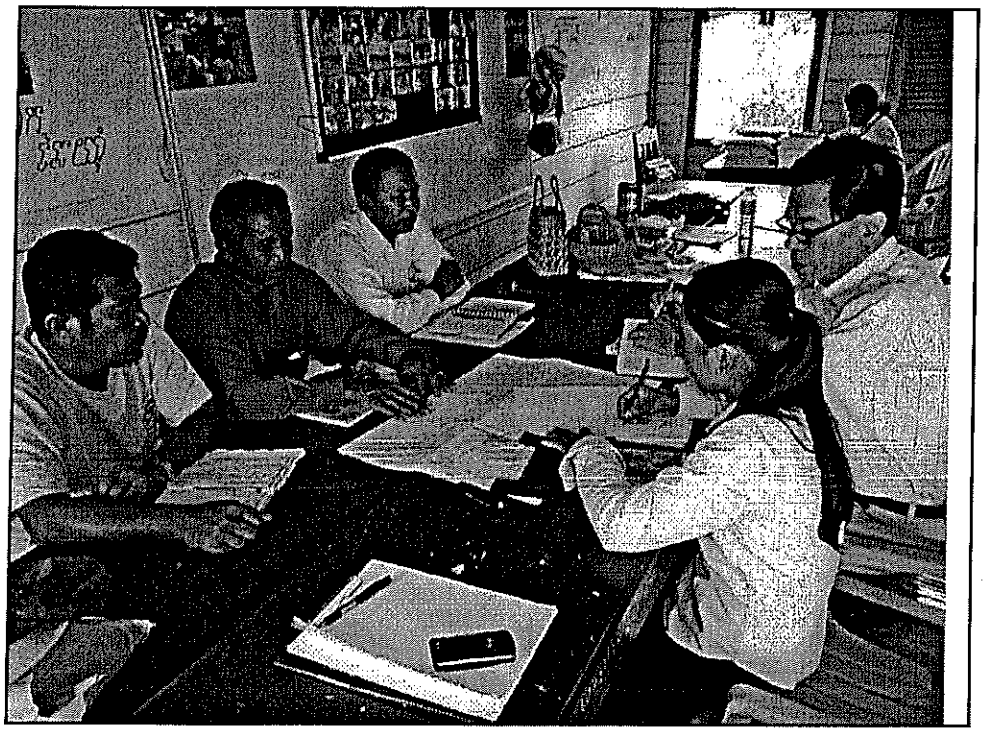
៧	ចុងឃ្នាស	ជាំ ទទួលការនែនាំ ពី អង្គការ RACHA	រីករាយ ការល្អក្នុងការ ផ្ទាស់ប្តូរទៅលើដី		២៥០គ្រួសារគឺក្រីក្រខ្លាំង ។ការថែទាំសុខ ភាពរបស់មណ្តលសុខភាពនៅខ្សោយ ។	៥ ៩៧០ ភូមិលិចទឹក
៨	សំបូរ	ជាំទឹក/ ឧបត្ថមពី អង្គរ មូនិធិវីស៊ុត	រីករាយណាស់			៣ ៦២២ ន
៩	ស្បែរមាប		រីករាយណាស់		ការខូងអណ្តូងក្រោមដីប៉ះពាល់ដល់តំបន់ អង្គរលើយទឹកពីបាយប៉ះពាល់កសិកម្ម ។ ទឹកទន្លេសាបល្អបំផុត ។	១៧ ៨៩៨
១០	ស្រែរំដេ	យកចេញពីអណ្តូងដទៃ	រីករាយណាស់	មាន		៦ ៥៦៦ ន
១១	ទឹកវិល		មិនដឹង			៩ ៨៩៨ ន
១២	ក្រចីរវៀល	នែនាំពីអង្គការជប៉ុន	រីករាយ	គ្មាន		៧ ៦២១ ន
១៣	អំពិល	ការអប់រំពីអង្គការអន្តរ ជាតិ	ល្អជាងអណ្តូង	គ្មាន		៦ ៦៧១ ន
១៤	កណ្តែក	ជាំ ច្រោះ កំនត់ដោយ អង្គការអន្តរជាតិ	សំខាន់ទាពេលអនាគត	ប្រើ ២០%		១២ ០៥៩ ន



ពត៌មានពីសហគមន៍នេសាទ

ពួកគាត់សង្ឃឹមថាតំរោងរោងចក្រមិនគួរជាឧបសគ្គនៃការធ្វើដំណើរនេសាទ និង ប៉ះពាល់ធ្ងន់ធ្ងរទៅនឹងតំបន់នេសាទទេ។

ល រ	ឈ្មោះសហគមន៍នេសាទ	សមាជិក	
		ស្ត្រី	សរុប
១	ក្របីរៀល	៨៦៧	១ ៣៨៥
២	ចុងឃ្នាស	៧០៦	១ ១១៦
៣	កណ្តែក	១ ០៨៣	១ ៥៥០



៦. ពត៌មានពីក្នុងតំបន់ (ស្ថាប័នរដ្ឋាភិបាលថ្នាក់ខេត្ត)

ល	មន្ទីរ	ពូនាទី	យោបល់ ឬ គំនិត
១	បរិស្ថាន	អគ្គនាយក	របាយការណ៍ IEIA and EIA គួរតែធ្វើដោយមានប្រឹក្សាយោបល់និង មន្ទីរបរិស្ថានហើយម្ចាស់គំរោង និងអ្នកជំនះអប្បុរាមិនគួរបញ្ជូនរបាយការណ៍ទៅក្រសួងដោយ ផ្ទាល់ទេត្រូវបញ្ជូនមកមន្ទីរជាមុនសិន ។ការខូងមីកក្រោមដីអាចប៉ះពាល់លើតំបន់វប្បធម៌ ។
២	ស្ថិរយោដី	នាយការង	ប្រសិនបើមានទំនាស់រវាងម្ចាស់កម្មសិទ្ធិនិង ម្ចាស់គំរោងខុគដ្ឋាល័យខេត្តនឹងបង្កើតឱ្យមាន គណៈកម្មាធិការជំលោះដីធ្លី ។
៣	ខ័ណ្ឌរដ្ឋបាលទេសាទ	ណាយការងខ័ណ្ឌ	តំបន់ការពារត្រូវកំនត់ដោយក្រសួងកសិកម្មរុក្ខាប្រមាញ់ និង ទេសាទគួរតែយកចិត្តទុកដាក់ លើជលប៉ះពាល់សំខាន់របស់ការទេសាទ ។ ការធ្វើឱ្យមានការសាងសង់អ្វីថ្មីនៅក្នុងតំបន់ព្រៃ លិចហាមឃាត់អាចចំនាយពេលយូរ ។
៤	កសិកម្ម	អគ្គនាយក	វាមិនជាការពិបាកក្នុងការផ្ទាស់ប្តូរពីដីកសិកម្មទៅជាដីប្រើប្រាស់ផ្សេង១ទេ វាអាស្រ័យលើ ការចរចារវាងអ្នកលក់ និង អ្នកទិញ ។
៥	រុក្ខាប្រមាញ់	អគ្គនាយកខណ្ឌ ព្រៃឈើ	ពេលមីតាំងគំរោងកំនត់ជាក់លាក់ហើយម្ចាស់គំរោងគួរទៅពិគ្រោះជាមួយស្ថាប័នពាក់ព័ន្ធមុន ពេលធ្វើការសំរេចចិត្ត ។

៦. ពត៌មានជាអ្នជ្ញាធរពាក់ព័ន្ធ(រដ្ឋាភិបាលកណ្តាល)

ល	ក្រសួង-ស្ថាប័ន	នាយកដ្ឋាន	គំនិត-យោបល់
១	អជ្ញាធរបឹងទន្លេសាប	នាយករងអចិន្ត្រៃលេខាធិការ	ការធ្វើផែនការយ:ពេលវែងលើសពី ២០ឆ្នាំមានសារៈសំខាន់ណាស់ ។ប្រភពទាំងពីរ គឺបារាយណ៍ និង ក្រោមដីមិនត្រូវគ្រប់គ្រាន់សំរាប់ផ្គត់ផ្គង់នាពេលអនាគតឡើយ ។ដូចនេះត្រូវតែធ្វើការប្រើប្រាស់សំរាប់ពេលអនាគត ។
២	ក្រសួងបរិស្ថាន	នាយករងផ្នែក EIA	ការពិគ្រោះជាមួយសាធារណៈជនត្រូវតែធ្វើឡើងបន្ទាប់ពីរបាយការណ៍ EIA ។ យោបល់អ្នកក្នុងតំបន់ត្រូវតែភ្ជាប់ជាមួយ របាយការណ៍ EIA ពេលបញ្ជូនទៅក្រសួងបរិស្ថាន ។
៣	ក្រសួងបរិស្ថាន	នាយករងផ្នែក វាយតំលៃធនធានធម្មជាតិ	តំបន់ប្រើប្រាស់ច្រើនយ៉ាងអាចនឹងត្រូវប្រើប្រាស់សំរាប់តំរោងមួយចំនួនក្នុងករណីគ្មានការប៉ះពាល់ច្រង់ច្រាលើសម្បត្តិវប្បធម៌ ។
៤	ក្រសួងបរិស្ថាន	អគ្គនាយកទន្សាវជាតិ	តំបន់ប្រើប្រាស់ច្រើនយ៉ាងត្រូវតែប្រើប្រាស់ដើម្បីការរស់នៅល្អប្រសើរ ។បំពង់ទឹកស្អាតអាចដាក់នៅក្នុងតំបន់ប្រើប្រាស់ច្រើនយ៉ាង ។
៥	ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និង នេសាទ	នាយករងរដ្ឋបាលព្រៃឈើ	ឲ្យតំនេសាទមិនត្រូវទទួលការបំផ្លាញទោះបីតំរោងនោះសំរាប់អភិវឌ្ឍហេដ្ឋារចនាសម្ព័ន្ធក៏ដោយ ។យោងទៅលើសហគមន៏នេសាទម្នាស់តំរោងត្រូវតែពន្យល់អោយបានច្បាស់ពីតំរោងទៅដល់សមាជិកសហគមន៏ជាមុន និង សុំការយល់ព្រម ។
៦	អង្គការ UNESCO	មន្ត្រីកម្មវិធីជាតិ-វប្បធម៌	ម្ចាស់តំរោងត្រូវជីកចេញនូវវត្ថុបុរាណចេញប្រសិនបើចង់យកទឹកចេញពីបារាយណ៍ ។ការដាក់[illegible]

៧.ការផ្តោតការខាយតំលៃផលប៉ះពាល់បរិស្ថាន (● តំបន់ចុះសួង់មតិ)

ល ះ	ផលចំះពាល់	ឧទ្ធសាច	បារាយណ៍	ឆីកក្រោមដី
១	ការប្រើប្រាស់ដី និង ធនធាន មានជីជាតិ	○	○	○
២	លេតិកគណ្តូវប្បធម៌			
៣	ការប្រើប្រាស់ទឹកវិស័ទ្ធិប្រើប្រាស់ទឹក និង សិទ្ធិទូទៅ	○	○	
៤	ភាពប្រឈមនឹងការផ្ទុងជំងឺដូចជា ជំងឺអេងស័ជាដើម	○	○	○
៥	ទឹកក្រោមដី			○
៦	ព្រៃឈើ សត្វព្រៃ និង ជីវចំរុះ	●		●
៧	តំបន់ទេសភាព	●	●	●
៨	ការបំពុលខ្យល់	○	○	○
៩	ការបំពុលទឹក	○	○	○
១០	កាកសំនល់	●	●	●
១១	សំឡេងរំខាន និង រំញ័រ	○	○	○
១២	ការជាក់ស្តែតដី			
១៣	គ្រោះថ្នាក់ជុំវិញ១	○	○	○

៨.ព្រៃឈើ សត្វព្រៃ និង ជីវចំរុះ

ល រ	ប្រភេទ	និយមសាស្ត្រ	តំបន់	រដូវ
១	ព្រៃឈើ	ពត៌មានពាក់ព័ន្ធការអង្កេតពូជឈើតាមផ្ទៃ	ប ៦-៨គម ១១០ម	ធ្នូ-មករា
២	ថនិកសត្វ	ពត៌មានពាក់ព័ន្ធការអង្កេតពូជសត្វតាមផ្ទៃ	ប ៦-៨គម ១២០ម	ធ្នូ-មករា
៣	ល្មូន	ពត៌មានពាក់ព័ន្ធការអង្កេតពូជសត្វតាមផ្ទៃ	ប ៦-៨គម ១១០ម	ធ្នូ-មករា
៤	មណ្ឌុសត្វ កង្កែប ប៉ីង	ពត៌មានពាក់ព័ន្ធការអង្កេតពូជសត្វតាមផ្ទៃ	ប ៦-៨គម ១១០ម	ធ្នូ-មករា
៥	ត្រី	បឹង ស្ទឹង ប្រពន្ធ័ទឹក ពត៌មានពីអ្នកនេសាទ	ប ២-៨គម ១១០ម	ធ្នូ-មករា
៦	បក្សី	ពត៌មានពាក់ព័ន្ធការអង្កេតពូជសត្វតាមផ្ទៃវិ សំបុក	ប ៦-៨គម ១៣០ម	តុលា- មករា

សូមថ្លែងអំណរគុណចំពោះការចូលរួម!

- ២១ តុលា ២០០៩
- រដ្ឋាភិបាលក្រុងសៀមរាប
- ក្រុមសិក្សាគំរោងរបស់ភ្នាក់ងារសហប្រតិបត្តិការណ៍អន្តរជាតិជប៉ុន(JICA)