

INITIAL ENVIRONMENTAL EXAMINATION

OF

GMS ROAD IMPROVEMENT PROJECT

CAMBODIA

JULY 2002

Acronyms

AADT	Average Annual Daily Traffic
BCPL	Banteay Chhmar Protected Landscape
CRE	Chief Resident Engineer
DFW	Department of Forestry and Wildlife; within MAFF
DoE	Department of the Environment; Provincial level of MoE
DOP	Department of Planning; within MPWT
dEMP	detailed Environmental Management Plan
ES	Environmental Specialist
GMS	Greater Mekong Sub-region
JICA	Japan International Co-operation Agency
MAFF	Ministry of Agriculture Forestry and Fisheries
MoE	Ministry of the Environment
MPWT	Ministry of Public Works and Transport
MRC	Mekong River Commission
NR	National Road
PIU	Project Implementation Unit
RAP	Resettlement Action Plan
RE	Resident Engineer
RoW	Right of Way
SCCA	Ang Trapang Thmor Sarus Crane Conservation Area
SEU	Social and Environmental Unit; within DOP of MPWT
TSBR	Tonle Sap Biosphere Reserve

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INITIAL ENVIRONMENTAL EXAMINATION

GMS: CAMBODIA ROAD IMPROVEMENT PROJECT

A. INTRODUCTION

1. The purpose of this Initial Environmental Examination report (IEE) is to provide an assessment of the environmental concerns that need to be taken into account with regard to the rehabilitation of part of National Road 6 (NR6) from Siem Reap to Sisophon and the remaining section of NR5 from Sisophon to Poiphet. Also included in the project are two provincial roads NR 56 and NR 68. The project proponent is the Department of Road Infrastructure, Ministry of Public Works and Transport, Royal Government of Cambodia.

2. The project is a road infrastructure project and consists of two components, (i) the reconstruction of 147 km of pavement, bridges and culverts from Siem Reap to Poiphet (NR6 and NR5) and (ii) the reconstruction of approximately 60 bridges along a 187 km loop road from Sisophon to Samrong (NR 56) and from Kralanh to Samrong (NR 68). The roads are located in the northwestern part of Cambodia, one of the poorest areas of the country. Due to many years of civil disturbance, roads within the area have suffered from neglect and have fallen into major disrepair. Implementation of the project will assist in promoting economic and social development in the project area of influence and promote general economic growth at national and sub-regional level.

3. The project has been classified as Category “B” and the IEE has been carried out in accordance with the procedures described in “Environmental Guidelines for Selected Infrastructure Projects” Office of the Environment, (ADB 1993). The IEE is prepared in the Bank’s IEE format as outlined in the “Environmental Assessment Requirements of the Asian Development Bank” (ADB 1998).

4. The IEE has been prepared under a Small Scale Technical Assistance (SSTA) provided by the Asian Development Bank (ADB) to the Cambodian Government to assist in developing an investment proposal for the rehabilitation of NR6 from Siem Reap to Sisophon and of NR5 from Sisophon to the Thai border at Poiphet and NR56 and NR68. The preparation of the document has been guided by Ministry of Public Works and Transport in cooperation with Ministry of Environment.

5. The IEE provides an initial screening of the activities to be carried out under the proposed project, with the intention of identifying potentially significant environmental impacts, determining appropriate mitigation measures, and identifying if any further environmental assessment is required.

B. DESCRIPTION OF THE PROJECT

6. The GMS Cambodia Road Improvement Project is a road reconstruction project and will be undertaken on the already classified national roads; NR5 and NR6, and provincial roads NR56 and NR68.

7. Information was collected from a variety of sources including the collection of basic information on population and attitudes at the village level. Other information has been collected from; (i) interviews of government and NGO officials in Phnom Penh, Siem Reap and Sisophon and (ii) existing reports. Due to the emerging situation that Cambodia finds itself in, information is often limited and in many cases not well understood by the line agency representatives. This is more

commonly the situation at the provincial level.

8. The rehabilitation of the Siem Reap to Poiphet section of NR5/NR6 will become an integral part in completing the upgrading of the GMS regional road network linking Thailand via Cambodia to Vietnam. As well as having major regional benefits the Siem Reap to Poiphet section will improve access to Angkor Wat and provide a major benefit to tourism in Siem Reap. Replacement of bridges along NR56 and NR68 will provide all-year, all-weather access to remote and poorly serviced rural areas and improve community accessibility to markets and social infrastructure, while facilitating easier access to growing employment opportunities in the surrounding urban areas.

9. The roads are located in the three provinces of; Siem Reap, Banteay Meanchey and Oddar Meanchey on low flat topography. The location of the roads is shown in Figure 1.

10. The rehabilitation of NR6 and NR5 consists of the following components.

- The upgrading and widening to an 11 m pavement of 100 km of NR6 from Siem Reap to Sisophon and 47 km of NR5 from Sisophon to Poiphet,
- raising approximately 102 km of NR6 and NR5 so that the road will be flood free
- the volume of additional earthworks¹ required in the upgrading is 1.17 million m³,
- the amount of sub-base required is estimated at 305,000 m³,
- the amount of rock required for base and pavement is estimated at 197,400 m³,
- replacement of all 43 bridges and 140 culverts along NR6 and NR5 which will include additional cross drainage and lifting of bridges so that greater capacity is provided in the drainage system to cope with raising the road above flood level,
- provision of service areas along the road,
- provision of at least a 1.5m wide pedestrian and cycle access lane on the shoulder of both sides of the road.

11. The following work will be undertaken on NR56 and NR68.

- replacement of approximately 60 bridges and culverts along NR56 and NR68.

12. Depending on Contractor preference, road materials will be sourced from various sites so as to reduce haulage costs. The principal materials required for construction of the roadworks are earth (1.17 million m³), gravel (or laterite, 305,500 m³) and crushed rock (197,400 m³). Earth is used for embankment construction. Gravel is used for sub-base construction. Crushed stone, requiring blasting, crushing, screening, and at times blending, is used for base-course construction and for bituminous surfacing. (Hopkins, R, 2002).

- Earth will be acquired from borrow pits, mainly located on private land outside the road RoW.
- Gravels are found in several scattered sandstone outcrops. These include; Damdek, 52 km from Siem Reap. At Phum Liep a steep hill rising to an elevation of 124 m has large quantities of suitable gravel. Other deposits occur at Sisophon and at Angdong Thmor 36 km from Sisophon towards Poiphet. This source is below the general ground level and while it has been

¹ Volumes of earthworks, sub-base and rock, are approximate only and are given here to establish the magnitude of the project's requirements. The actual volumes will be confirmed during detailed design.

extensively excavated it is expected that large quantities remain to be extracted.

- Crushed Stone is available at Damdek, Sisophon, and at Phnom Thom. Rock is hand quarried and broken at the first two sites while at Phnom Thom the rock is mechanically crushed in a well equipped privately owned quarry 18 km south of Sisophon beside NR5.

13. The Project construction activities will require many unskilled laborers for earthworks, and bridge and culvert construction for a period of three years. Employment in project construction will be an added source of income for project-affected households. Workers would be drawn from the surrounding villages. Both men and women would be recruited.

14. The project is expected to cost about \$78.0 million² and based on this preliminary figure, the project has an EIRR of 27.3 percent. Following completion of the project the Ministry of Public Works and Transport will maintain the road from a separate budget allocation. The project is expected to proceed to Detailed Design in September 2002. Construction is expected to commence in August 2003 with civil works completed by the end of 2006.

NR6/NR5: Right of Way (RoW)

15. The section of NR6 to be reconstructed commences at the junction of NR6 with the airport road at Siem Reap and terminates at Poipheth at the border checkpoint. The short length of road from the checkpoint to the border does not need to be improved, though a new border post is included as part of the project. The road is contained within a 60-m wide right of way (RoW) that, for the majority of its length, is reasonably well demarcated and respected by the surrounding communities. Outside the urban areas the RoW is used for rice cultivation while within the urban areas the RoW has been more intensively occupied with temporary structures and has been excavated for building foundations, which has left a series of large often water filled depressions within the RoW. These depressions are now used on an opportunistic basis as ponds for ducks and as buffalo wallows, while lotus may be grown in these and children use them to play in. They may or may not be incorporated within the road drainage system. If they are, a pipe or short bridge is normally used with the invert about 1 m below ground level so that the ponds do not entirely drain. In the rural areas where the RoW is used for rice production, the surface of the RoW is depressed by about 30 cm below the surrounding ground surface. Presumably this resulted from the RoW being used as source of embankment material at the time when the road was constructed sometime during the 1930's. Other uses within the RoW include duck farming which is carried out in about three small ponds that have formed below the bridge crossings in the poorer drained sections between Kralanh and Sisophon. A telephone cable is currently being laid within but close to the outer extremity of the RoW between Siem Reap and Sisophon. The cable is defined by a series of marker posts. Other services contained in the RoW include power poles which, are found in most of the larger villages and urban centers.

NR6: Siem Reap to Sisophon (100 km)

² All costs are in US\$.

16. From Siem Reap to Sisophon the road crosses a flat level plain that borders the upper extremity of the Tonle Sap flood plain at about 10.0 m asl. In this section drainage flows at right angles to the road. From Sisophon to Poiphet the road runs parallel to the drainage system and in this case cross drainage is not as critical. Along the road several small rises within the plain lift the road by about 3 – 5 m and on these elevated areas small urban areas such as Kralanh and Preah Netr Preah have developed so as to place them above the flood limits.

17. An irrigation canal that is linked to the Western Baray – part of the Angkor Wat complex – passes under NR6, 2.5 km from the junction of the airport road. The canal continues to follow close to the left-hand side of the road and within the RoW for about 3-km before leaving the RoW and heading towards the Tonle Sap. The road is reasonably densely settled for the first 16 km to Pouk³. The first 19-km section of the road is also reasonably well supplied with semi-mature shade trees along both sides of the road, the majority of which have been damaged and are badly disfigured. After about 25 km the bitumen surface gives way to an unsealed road and this continues all the way to Sisophon. In this section, the countryside opens out to a flat featureless plain that supports numerous sugar palms. The area is extensively farmed with rainfed/flooded paddy and any trees that are present are normally found on the tops of the low bunds that define the paddy areas. From Pouk the road continues to Kralanh about 53 km from Siem Reap where the road leaves the Siem Reap province and enters the province of Banteay Meanchey. Here a short bridge just outside Kralanh carries the road over the Stueng Sraeng that drains from the upper part of the Dangrek escarpment to the Tonle Sap. The road continues along this characteristically low featureless area to Phnum Liep, about 60 km from Siem Reap, where a sandstone hill protrudes from the plain. This will probably be used as a source of sub-base materials for the road. From Phnum Liep the road continues to Preah Netr Preah which is situated on a low north south tending rise about 80 km from Siem Reap. Stone carving is a feature of this village and these are sold from stalls along the roadside. From Preah Netr Preah the road continues to Sisophon across open flat country. Here the JICA report (1999) shows that the road may be flooded for most of the length to Sisophon. Along this section some of the paddy areas give way to open grassland areas which are grazed by small herds of cattle. Ponds that have formed in several of the smaller watercourses below the road are fenced and used as duck farms.

NR5: Sisophon to Poiphet (47 km)

18. Sisophon is the provincial headquarters for Banteay Meanchey Province and the town is situated on the lower slopes of a sandstone outcrop similar to the one at Phnum Liep. This outcrop is also being exploited as a source of rock for use within the township and as road base. The township has a population of 98,000 people and is at the junction of NR5 with NR6. Sisophon is a major transport center and truck stop place. There is no prepared truck parking place and the area that is used is very congested and during the wet season it is muddy. Past the urban center, trees (*Samanea saman*) reappear along both sides of the road. At the exit to Sisophon the longest and probably the oldest bridge (built 1938) is situated which spans the Stueng Sisophon. This is the 43rd and last bridge along the road and, similar to the other bridges, it has also failed and will be replaced. At this point a railway bridge and embankment is located just downstream of the road bridge. The railway used to link Phnom Penh with the Thai rail system, however the section from Sisophon to Poiphet was dismantled during earlier civil strife. No immediate plans for rehabilitation have been developed. From Sisophon to Poiphet the road crosses better drained soils and in this section small trees and shrubs start to reappear along the roadside. Like the preceding section the RoW and the private land along the road is used for rice growing.

³ Distances given are taken from the traffic lights on NR6 in the centre of Siem Reap.

19. About 9 km before Poiphet a small Buddhist shrine surrounded by four large Banyan trees (which are also the largest trees to be found anywhere within the RoW) is located close to the pavement on the northern side of the road at Andong Meas village. This is a significant shrine and travelers stop at the shrine to make offerings. The shrine together with the trees is the only item of cultural importance found within the road RoW. About 5 km outside Poiphet the road is under repair and this continues all the way to the border at Poiphet. Poiphet is a major road crossing to Thailand and the town also hosts several casinos and hotels. The area near the roundabout at the border checkpoint is congested with handcarts where loads are transferred from Thai vehicles and carried past the checkpoint and then reloaded on to vehicles on the Cambodian side of the border.

NR56 and NR68

20. Two national roads, NR56 from Sisophon to Samrong, a distance of 112 km, and NR68 from Kralanh to Samrong, a distance of 75 km, form a combined loop road 187 km long to the north of NR6. While both roads have recently been reconstructed with a laterite pavement, bridges were not included and many of these have now failed, leaving the area without all year access. The Project will rebuild about 60 bridges within these two roads. Approximately two thirds of the bridges are located along NR68, with the remaining one-third along NR56.

21. Samrong is the provincial headquarters of the newly formed province of Oddar Meanchey which, in comparison to the other two provinces, has significant levels of poverty. Provision of bridges and all year access will increase social benefits to these areas. Similar to NR6/NR5 the topography along both NR56 and NR68 is a flat plain that drains gently to the Tonle Sap.

NR56: Sisophon to Samrong (112 km)

22. NR56 commences at Sisophon in Banteay Meanchey and heads in a northerly direction to Samrong. The road is carried within a 50m RoW and in keeping with the other roads the RoW is reasonably well marked and respected, although typically within villages, temporary stalls have been constructed within the RoW. The road is gravel surfaced and despite being rebuilt last year, the surface has already failed in many places. Overall the bridges are in poor condition and two new concrete structures are being built along this road with USAID funds. Initially the road passes through paddy areas which after about 40 km gives way to remnant dry dipterocarp/woodland vegetation with paddy areas. In association with this change, the soils get progressively older and less fertile. Farming systems change from rainfed paddy land to occasional paddy and maize cultivation, with maize cultivation becoming increasingly more common towards Samrong. At Tama about 12 km from Sisophon the road crosses an old irrigation control structure which has a low shallow reservoir (< 2m deep at the control). The reservoir was empty at the time of the visit in late June and was covered in a short water tolerant grass. The gates appear as though they can still be operated, however the distribution channel below the control has filled in and in this condition the system would be incapable of realizing its claimed ability to irrigate 1000 ha during the wet season.

23. Thmar Pouk (40 km) marks the start of the Banteay Meanchey Protected Landscape, which then continues, on the northern side of the road for another 19 km through to Sras Chrei. The protected area boundary is situated alongside and on the northern side of the road. As common to the rest of the road the woodland has been cleared to provide an agricultural corridor that is between 500 – 1000 m wide on either side of the road. Within the length of road that skirts the protected area there are four villages along the roadside which include; Thmar Dek Kes (51 km); Banteay Chhmar Tbong (56 km); Banteay Chhmar Cheung (58 km); and Sras Chrei (59 km). At Sras Chrei the road veers away to the east from the protected area and heads to Samrong. Within the proximity of the protected areas and at about 52 km from Sisophon the road rises slightly and

traverses a long low ridge that is planted to tree crops, that includes mangoes, papaya and jackfruit.

24. At about 56 km NR 56 skirts the moat of the Banteay Chhmar Temple, while the main entrance to the temple complex is a further 2 km along the road at Banteay Chhmar Cheung. The temple is a major historic/cultural site but has not been developed as a tourism site. At 64 km from Sisophon the road leaves Banteay Meanchey province and enters Oddar Meanchey province at Thbeng Thmei and then continues as before northwards across the flat plain towards Samrong. Between Thbeng Thmei and Samrong there are 15 villages situated alongside the road. Unlike villages in Banteay Meanchey most of the villages in Oddar Meanchey have been established in about the last 10 years whose inhabitants are mainly composed of resettled refugees. During this time these communities have cleared a 0.5-1.0 km wide corridor on either side of the road through the woodland vegetation. Clearing still continues and sale of woodfuel forms an important income supplement for communities in the area. At Thbeng Thmei village (64 km) a village water supply pond is being constructed by the Seila Program, while at Sileam village (74 km) another pond is being constructed under Buddhist Development. This section of the road was recently upgraded and includes several laterite excavation areas along the road which were used for basecourse materials. The Halo Group a UXO team, is based at Or Preal (99 km) and have been active in clearing ordnance from around the area as this was the site of much of the last fighting during the Civil War. The road reaches Samrong after 112 km. Overall the road surface is in reasonable condition though all of the bridges are weak or broken. For the entire length of the road, the road passes through level topography and in the northern part of the road this is mainly covered by woodland vegetation. Overall, the area lacks development and due to the extensive areas of poor soils, and recent settlement, poverty is endemic in the area. Samrong has a population of 36,700 and is the provincial headquarters of Oddar Meanchey. Like the surrounding area, Samrong has few facilities.

NR68: Kralanh to Samrong (75 km)

25. NR68 commences at Kralanh in Siem Reap province and initially traverses a wide open plain that gives way to areas of low scrub and paddy about 25 km north of Kralanh. The road RoW is 50-m wide and remains clear apart from Chroy Neang Noun village (31 km north of Kralanh) where some of the village houses have moved onto the RoW. At 42 km from Kralanh, NR68 is carried on two ancient bridges of historic significance that were built at about the same time as Angkor Wat. The structures are close together. One of the bridges is 5 – 10 m long while the other is 200 m long. Both structures are in good condition and the Bridge Engineer notes that there are no signs of obvious structural distress in either structure and that the foundations appear to be well seated and on firm ground (MWH, 2002). The report (*op cit*) proposes that the bridges remain in service but use a concrete slab to improve vehicle load spread on the structures. Closer to Samrong, grazing land becomes increasingly common and lateritic soils appear together with dry dipterocarp/woodland vegetation. The laterite has been excavated for reforming the road, but typically the borrow pits have been abandoned without any finishing. After 75 km the road reaches Samrong.

C. DESCRIPTION OF THE ENVIRONMENT

1. Physical Resources

Geology

26. The road is situated at about 10 m asl on a large area of alluvium. In the area close to Siem Reap and to the north of NR6 this is mapped as older Alluvium of the Pleistocene to Tertiary era, while below the road this is mapped as Younger Alluvium of the Recent to Holocene era, (JSA, 1994).

Topography

27. The alluvium forms part of the Cambodian Central Plain that surrounds the Tonle Sap and encompasses the lower Mekong River system in Cambodia, which extends through to the Vietnam coast. The plain is featureless apart from a few scattered outcrops of Jurassic Sandstone that occur as small hills that rise steeply to about 100 m asl above the plain. These hills occur at Phum Liep, Sisophon and Phnom Thom and are the only sources of rock in the area. Elsewhere, several small low north-south tending ridges that typically rise 3-5 m above the plain occur and are sought after as urban sites so as to be above the flood level. These are typified by the settlements at Kralanh and Preah Netr Preah. From the Tonle Sap the plain rises imperceptibly at a gradient of about 0.03 percent for most of the way to north of Samrong where it encounters the lower slopes of the Dangrek escarpment that forms the boundary between Cambodia and Thailand. The range rises to heights of 800 m asl. The plain is drained by four medium sized watercourses that descend from the Dangrek escarpment towards the Tonle Sap. Once these encounter the plain they develop a pronounced meander all the way to the Tonle Sap. These include; (i) the Stueng Sraeng which crosses NR6 at Kralanh, 55 km from Siem Reap, (ii) the Stueng Kampong Kasang which crosses NR6 about 2 km past Phnum Liep, (iii) the Stueng Anglong Thma which crosses NR6 just before Preah Netr Preah and, (iv) the largest water course the Stueng Sisophon which crosses NR5 on the western side of Sisophon. Apart from the Stueng Sisophon, which is entrenched about 5 m below the ground surface, the other watercourses have shallower channels < 5 m deep. A secondary drainage system originates on the floodplain that collects localized runoff and then directs this to the main watercourses. Ultimately all runoff enters the Tonle Sap via the Stueng Sangkae at the northwestern end of the lake. Much of the area's drainage has been affected by a series of levees and drains that have been intentionally constructed in an effort to redirect the water so as to improve drainage. During the wet season when the Tonle Sap rises the area on both sides of the road and parts of the road in low-lying areas are extensively flooded. The annual flood limit of the Tonle Sap is established at about 10.0 m asl. Inundation at this level may last for about 20 days. Areas that are subject to inundation are shown in Figure 1.

Soils

28. Two types of soils have formed within the project area and these are defined by location. These are either (i) young alluvially sorted soils on the lower plains and (ii) older soils that have formed in the upper lowland areas closer to Samrong.

- (i) The young soils have limited profile development and are mainly sandy loams to sandy clay loams that are derived from sandstone. These soils have limited fertility and are situated in poorly drained sites that are subject to annual inundation and local flooding. From Sisophon towards Poiphet the soils become more friable and better drained which may be due to inclusions of limestone and basalt occurring

around Battambang.

- (ii) The older soils occur in the upper plain areas closer to Samrong and are only subject to intermittent flooding. These soils show greater clay development and eluviation to lower parts of the profile with overall greater profile development. The topsoils are shallow and are mainly sandy loams. Ferruginous gravels are present in the lower parts of the profile. These soils are commonly called “lateritic type soils”.

Unlike the younger soils the older soils have lower fertility and many of these areas remain under degraded woodland vegetation. The younger soils apart from those from Sisophon to Poiphet have limited fertility and where the soils are cultivated the topsoils are deficient in organic matter. Some inorganic fertilizers are used by the farmers to replace nutrients. However due to the overall low yield expectations in annually flooded land, farmers will only use fertilizers judiciously. While raindrop erosion has reduced the structure within the surface soils, no evidence of soil erosion or deposition is evident in any of the road cross drainage structures.

Climate

29. The climate⁴ of the area is characterized by distinct wet and dry seasons. The southwest monsoon establishes in May and lasts till October and produces the wet season, while from November to April the dry northeast monsoon occurs. Temperatures are high throughout the year with daytime maximum temperatures averaging close to 35°C in April just prior to the rains. With increased cloud cover from the southwest monsoon, daytime temperatures decrease, while a slight seasonal effect lowers the temperature to 30°C in December. The highest temperature recorded in Siem Reap was 40.8°C in April 1990, while the lowest recorded temperature was 13.6°C in January 1993, (JSA, 1994). Average rainfall at Siem Reap, (JSA, *op.cit*) is 1408 mm with about 80 percent of the rain falling in the wet season, 14 percent in the transition months (April and November) and the remaining 6 percent falling in December - March. January and February are the driest months with a combined rainfall of only 7 – 8 mm. Rainfall variability is greatest in the wet season, while the dry season is predictably much less variable. Evaporation averages 125 mm/month reaching 150 mm/month in March – April and declining to 110 mm/month in September – December. Six years of wind speed data measured at the Irrigation Office in Siem Reap (JSA, *op.cit*) from 1989 – 1994 shows that average wind speeds ranged from 1 – 3 m/s while maximum wind speeds commonly reach 20 m/s during the wet season. During the dry season the maximum wind velocities are lower and are commonly in the range of 6 – 8 m/s. Wind generally picks up from about mid-afternoon as the atmosphere heats. While the total amount of rainfall is adequate for rice growing, the distribution is often problematic and adverse crop dry spells are a feature of the wet season. This is more pronounced on the predominantly sandy soils that are a feature of the area, where percolation losses may reach 30 mm or more per month.

Surface water

30. The hydrology of the area is determined by three systems: (i) the hydrological conditions that prevail in the upper catchment areas of the Dangrek escarpment as modified by the nearly level plain area that surrounds the road and is evident as channelised flow in the four main drainage channels that cross the plains area, (ii) locally derived drainage that originates from the plain as overland flow. This becomes channelised below the road and then joins one of the main

⁴ The section on climate and hydrology has been adapted from the report, “*Natural Resources-Based Development Strategy for the Tonle Sap Area, Cambodia*”. Mekong River Commission Secretariat/UNDP, Phnom Penh, 1998.

watercourses and enters the Tonle Sap via the Stueng Sangkae, and (iii) the operation of the Tonle Sap itself. The Tonle Sap is the largest freshwater area in SE Asia and is an important regulating feature of the lower Mekong River, which by acting as storage, both moderates flood flows during the wet season and maintains low flows during the dry season. In normal years the Tonle Sap operates within the levels of 1.1 m asl and 10.0 m asl. As the road is set at about 10.0 m asl parts of the road that cross the plain at or below this level are influenced by back water effects of the Tonle Sap. Overall the hydrology of the plain is moderated by the low slopes. This increases storage, retards runoff and attenuates discharge. Floods appear to be synchronized with the flood height appearing to rise and fall on both sides of the road evenly since there are no indications of the development of any adverse hydraulic conditions that may arise should water be impounded behind the road embankment. This would be evident by scour below the embankment and deposition above the embankment. Nor is there any evidence of scour on the top of the embankment in sections where the road is flooded. It is concluded that overall the present hydrologic situation with regard to the road cross drainage is very benign. However, care will need to be taken to improve drainage when the road is raised to the flood free height as otherwise this will store more water above the embankment and increase the potential to damage the road and areas below the road. The dry season has a marked effect on the area's hydrology and limits flow to very low discharges in the defined channels, while no flow occurs in any of the secondary localized channels. Access to suitable drinking water is a major constraint in the area and this is especially so in the dry season when flows are very low. The water is especially turbid at this time and water from this source is normally unfit for drinking purposes. NR56 and NR68, having a northerly direction, have reduced cross drainage requirements in comparison to NR6 and NR5.

Groundwater

31. Groundwater is plentiful in the area and is evident in the shallow surface wells that are used for village water supplies. However water quality suffers during the dry season when lack of clean domestic water is a major household problem. In the upper areas wells and ponds are the main sources of water, but again poor water quality during the dry season makes the majority of these sources unfit for drinking water.

2. Ecological Resources

Forests and Vegetation

32. There are no forests alongside NR6 or NR5. NR 68 has some areas of degraded dry dipterocarp/woodland forest close to Samrong, while about half of the top section of NR 56 passes through a large area of this forest type. The forest has now been cleared for up to 1 km back from the road for agriculture. This also includes the area alongside the Banteay Meanchey Protected Landscape where NR56 forms the lower boundary to the area. Due to the lower agricultural production associated with these older, poorer soils many of the communities rely on collection and sale of wood fuel to supplement incomes in the areas towards Samrong. Fuelwood is sold alongside the roadside and the main market is Sisophon.

33. Forest and land-use statistics published by the Ministry of Agriculture, Forests and Fisheries (MAFF) shows that Deciduous Forest⁵ is the largest area of forest in both Banteay Meanchey (75,270 ha) and in Siem Reap Province⁶ (212,850 ha). Dense evergreen forest is 400 ha and

⁵ The category of deciduous forest appears to be erroneous and field inspection showed that this would be better classified as Dry Dipterocarp Forest or Open Woodland.

⁶ No figures are presented for Oddar Meanchey as the assessment was done before the formation of this province in 1999.

22,860 ha for each province respectively. Between 1992/93 and 1996/97, Landsat imaging showed that there has been an overall reduction in forest cover of 3.7 percent and 1.8 percent for the provinces respectively. The largest losses have occurred in Forest Re-growth with 2.4 percent recorded in Banteay Meanchey while 0.7 percent was recorded for Evergreen Disturbed Forest. No later figures are available. Areas of forest are shown in Figure 2.

34. Forests are divided into concession forests and protection forests. Concession forests, which may be harvested for sale, are shown in Figure 2. The allowable log harvest in 2002 for Siem Reap Province has been fixed at 5,000 m³. There are two concession forest holders operating in Siem Reap Province namely Samrong Wood Ltd. and TPP Cambodia Timber Product (Pte) Ltd. Samrong Wood is the only concessionaire still operating and the 5,000 m³ allocation is only available for this company. Apart from forest concession areas, about 20,000 ha of forest is managed as community forests by 31 forest communities. Under this arrangement the Forest Department hands over the management of the area to the community who must abide by a management plan that is supervised by the Forest Department. Under these arrangements the community has access to the forest and may remove forest products and cut trees for their own use but they are prohibited from selling the trees. Timber harvesting for sale is only allowed from forest concessions.

35. Sugar palms *Borassus flabberlifer* are a feature of the area and these occur within the paddy areas along NR6/NR5 and the lower areas of both NR56 and NR68. These are an important part of the local economy and the fruit and sap are used for making sweets and also for alcohol. Otherwise the other common plant is *Pandanus* spp. that is planted as a hedgerow along the rice field bunds. As these become habitats for rats, the pandanus hedges are often burnt prior to the rains. From Sisophon on to Poiphet where better drained areas occur both the sugar palm and pandanus give way to shrubs and low woody vegetation, where this has not been cleared for paddy areas. In the upper areas of NR56 and NR68, older soils support dry open woodland dipterocarp vegetation that is characterized by *Shorea obtusa* and *Dipterocarpus obtusifolius*. Grasses occurring in the open spaces between the low trees include; *Imperata cylindrica*, *Saccharum spontaneum* and *Desmodium* spp. Burning the grasses during the dry season has helped maintain the area as a fire-tolerant dipterocarp woodland.

36. The road embankments are vegetated by short thorny shrubs, grass and annual herbaceous weeds. These include *Calamus salifolius*, *Mimosa pigra*, *Acacia spiralis*, *Derris trifolia*, *Combretum trifortiatum*, *Croton caudatus*, *Popowia disospyrifolia*, and *Merremia hederaceae*. *Sesbania* is often planted along the roadside and closer to Sisophon and Siem Reap, Raintrees (*Samanea saman*) have been planted for shade as well as *Poinceana* sp. Along NR56 sugar palms are often planted in the sections closer to Sisophon. Where trees have been planted along the road, these have not reached maturity, many of which have been damaged due to their proximity to the road. Consequently they have little aesthetic value and function and there is no reason why these should not be removed if they are within 2 m of the road pavement. None of the vegetation has any biological conservation value.

Protected Areas

37. Protected Areas in Cambodia are under the control of the Ministry of Environment (MoE). Twenty-three protected areas were created 1993, of which seven are located at various distances from NR5 and NR6, and NR56 and NR68. Many of the protected areas are highly degraded and much of the fauna has been destroyed from lack of any effective control during the long period of civil unrest. All of the areas are under the control of the MoE apart from the Ang Trapang Thmor

Sarus Crane Conservation Area, which is under the control of the Ministry of Agriculture, Forest and Fisheries as it based on a reservoir area. Protected areas are classified as follows: (National Environmental Action Plan, 1998).

- i. Wildlife Sanctuary: Natural areas where nationally significant species of flora and fauna, natural communities, or physical features require specific intervention for their perpetuation. Equivalent to IUCN Category I: Strict Nature Reserve/Wilderness Area: Protected area managed mainly for science or wilderness protection.
- ii. National Park: Natural and scenic areas of significance for their scientific, educational and recreational values. Equivalent to IUCN Category II: National Park: Protected area managed mainly for ecosystem protection and recreation.
- iii. Protected Landscape: Nationally significant natural and semi-natural landscapes, which must be maintained to provide opportunities for recreation and tourism. Equivalent to IUCN Category V: Protected Landscape/Seascape: Protected areas are managed mainly for landscape/seascape conservation.
- iv. Multiple-use Management Area: Areas which provide for the sustainable use of water resources, timber, wildlife, fish, pasture and recreation with the conservation of nature primarily oriented to support these activities. Equivalent to IUCN Category IV: Protected area managed mainly for the sustainable use of natural ecosystems.

Protected areas in the provinces of Siem Reap and Banteay Meanchey are shown in Table 1 and Figure 2. Apart from the two later inclusions of the Tonle Sap Biosphere Reserve Area and the Sarus Crane Conservation Area, the other protected areas were established by Royal Decree in July 1993.

Table 1: Protected Areas in the Provinces of Siem Reap and Banteay Meanchey that are within the Proximity of the Road Projects

Protected Area	Province	Total Size (ha)	Characteristics
Angkor Protected Landscape	Siem Reap	10,800	This mainly forested area includes the Angkor temple complex, perhaps the single most important archaeological/ cultural site in southeast Asia.
Phnom Kulen National Park	Siem Reap	37,500	This area is within the watershed of the Siem Reap river. It is also an important archaeological site.
Kulen Promtep Wildlife Sanctuary	Siem Reap 27% Preah Vihar 73%	402,500	The largest area in the protected area system intended to protect the kouprey. The principal habitats are lowland open dipterocarp forest.
Tonle Sap Biosphere Reserve	Siem Reap 50% plus 4 other riparian provinces	316,250	The largest inland freshwater system in southeast Asia. Contains important wetland habitats, flooded forests and is rich in fish and avian biodiversity.
Ang Trapang Thmor Sarus Crane Conservation Area	Banteay Meanchey	12,650	Important site for the Eastern Sarus Crane and other water fowl that have established a habitat on the reservoir.
Ronem Daun Sam Wildlife Sanctuary	Banteay Meanchey 30% Battambang 70%	178,750	Lowland evergreen and semi-evergreen forest of unknown condition – no forest exists across the Thai border. Possibly holds pileated gibbon (an endangered primate).
Banteay Chhmar Protected Landscape	Banteay Meanchey	81,200	The area contains archaeological/cultural value. Otherwise the area is reported to be badly degraded.

(Source: National Environmental Action Plan, MoE, 1998, Tonle Sap Resource Management and Conservation, CNMC, 2001, Conservation Activities at Ang Trapeang Thmor Sarus Crane Conservation Area, WCS, 2001.)

Tonle Sap Biosphere Reserve

38. NR6 forms the boundary of the Transition Zone to the Tonle Sap Biosphere Reserve. (See Figure 3). The Transition Zone is the outermost zone and is the least important category of the Biosphere Reserve. In October 1997 the Lake was successfully nominated as a Biosphere Reserve under the Man and the Biosphere Reserve Program of UNESCO. The Tonle Sap Biosphere Reserve aims to fulfill three complementary functions, namely (i) conservation of landscapes, ecosystems, and species diversity; (ii) culturally, socially and ecologically sustainable development and (iii) research, monitoring and education. The Tonle Sap is the largest freshwater lake in Southeast Asia, covering an area of approximately 250,000 ha in the dry season. This extends to 1,000,000 ha during the wet season and is a major regulating feature of the Mekong River system. The fluctuation in level has created an immense wetland system and is the largest continuous area of savannah swamp forest and inundated forest in the entire Asian region. Over 200 fish species, 200 plant species; 46 mammals and 255 birds along with crocodiles, turtles, water snakes, molluscs and amphibians have been recorded in the Tonle Sap and its surrounding areas. The huge wetland system with its habitat diversity supports one of the most productive fisheries in Asia. The overall ecosystem is essential to the survival of the many globally significant species of birds, mammals and reptiles found around the lake. Despite the abundance of species all are in danger of being overexploited. Management regimes are now being developed and these are based on three zones

(i) a core area, (ii) buffer zone and (iii) a transition zone (see Figure 3). The following uses are permitted within each of the zones:

- i. The Core Zone, area 42,257 ha. Consists of three core areas, Prek Toal, (21,342 ha); Boeng Tonle Chhmar, (14,560 ha), which is also a Ramsar site; and Stoeng Sen, (6,355 ha). Core areas are set aside for the long term protection and conservation of natural resources and ecosystems in order to preserve flooded forest, fish, wildlife, hydrological systems and natural landscapes. Scientific research, monitoring and ecotourism are permitted. Activities that cause degradation and destruction of biodiversity are not permitted.
- ii. The Buffer Zone covers an area of 541,482 ha and coincides with the outer boundary of the Tonle Sap Multiple Use Area. The buffer zone is covered by diverse flooded forest species. Human activities are managed to be consistent with the protection and conservation plan of the core area. Fishing activities are allowed providing they meet existing laws and regulations. Activities that are allowed include research, fishing, agriculture, human settlement, land use, water resources, navigation and tourism to ensure their sustainability and increased production while preserving the environmental quality and fish.
- iii. The Transition Zone covers an area of 899,600 ha and is defined as the area between the buffer zone and NR6 on the northern side of the lake and NR5 on the southern side. The flexible transition area is the integrated economic zone and is managed for sustainable agriculture, human settlement and other land uses, without having adverse effects on the flooded forest, water quality and soils of the region around the Tonle Sap Lake.

39. Apart from the three core areas identified within the Core Zone, one Strictly Protected Fishery Domain is located within the buffer zone, while eight Fish Sanctuaries have been established on the permanent lake. The boundaries to the buffer zone and transition zone are shown in Figure 3 and, depending on location, are separated by about 15 – 20 km. The outer transition zone boundary has been defined by the Tonle Sap Biosphere Reserve Project Office as the alignment of NR6 as this boundary could be easily defined on the ground. Based on the definition of activities allowed for transitional areas, and in follow up discussions with the Tonle Sap Biosphere Reserve Project Office within the MoE in Phnom Penh, the rehabilitation of NR6 will not be in conflict with the objectives of the Biosphere Reserve.

The Banteay Chhmar Protected Landscape

40. NR56 forms the southern perimeter of the Banteay Chhmar Protected Landscape (BCPL). This area was included in the Act of the Royal Decree signed by King Preah Norodom Sihanouk on 11 November 1993. The Banteay Chhmar Protected Landscape covers an area of 81,200 hectares of flat plains covered by degraded dry dipterocarp/woodland forest. (MoE, 1998). Part of the BCPL is located within the Thmar Puok district of Banteay Meanchey Province and part within the Banteay Ampil District in Oddar Meanchey Province. The BCPL has a southern boundary of about 19 km of which only the northern 8 km section from Banteay Chhmar to Sras Chrei has a common boundary with NR56. The first 11 km section of NR56 from Thmar Pouk to Banteay Chhmar is situated about 500 m outside but parallel to the protected area. Development has occurred along NR56 that has intruded into the BCPL where woodland forest has been removed for about 1 km on either side of the road. Additionally, four villages; Sras Chrei, Banteay Chhmar Cheung, Banteay Chhmar Tbong, and Thmar Dek Kes are situated along NR68 within the BCPL, while a further three villages are situated inside the BCPL near to the Banteay Chhmar temple. Also included within the protected area boundary is the Banteay Chhmar temple, which is a large ancient cultural monument, dating back to the Angkor Wat period (the temple is discussed in a later section on cultural heritage). Due

to the significant amount of encroachment that has occurred into the protected area by villages the boundaries are currently being re-evaluated. A draft map prepared by the DoE in Sisophon shows the boundary alongside NR56 being moved inside the BCPL by 500 m. The Banteay Chhmar temple site is also proposed to be excluded with responsibility for this being handed to the Ministry of Fine Arts and Culture. A survey carried out by the Banteay Meanchey Provincial office of the MoE shows that the following forest and wildlife species are considered to occur in the Protected Landscape.

The results of the survey are shown in Tables 2 and 3 and typically represent the tree and wildlife species that still occur within the dry dipterocarp/woodland system of the upper part of the area.

Table 2: Forest Species found in the Banteay Chhmar Protected Landscape Area

Local Name	Scientific Name and Family
Phcheuk	<i>Shorae obtuse</i> , Dipterocarpaceae
Thnung	<i>Pterocarpus pedatus</i> , Papilionaceae
Sokorm	<i>Xylia dolabriformis</i> , Mimoseae
Raing Phnom	<i>Pentacams Siamensis</i> , Dipterocarpaceae
Cheou Teal	Dipterocarpaceae
Beng	<i>Pahudia Cochinchinensis</i> , Caesalpineae
Tbeng	<i>Dipterocarpus obtusifolius</i> , Dipterocarpaceae
Khlong	<i>Dipterocarpus tuberculatus</i> , Dipterocarpaceae
Por Pel	<i>Hopea recopei</i> , Dipterocarpaceae

Table 3: Wildlife Species found in the Banteay Chhmar Protected Landscape Area

Local Name	Common Name	Scientific Name
Chhlus	Red Muntjac (Red antelope)	<i>Muntiacus muntjak</i>
Chhruk prey	Wild boar	<i>Sus scrofa</i>
Sva traus	Monkey	<i>Macaca nemestrina</i>
Sakar	Small Asian Mongoose	<i>Herpestes javanicus</i>
Kandol Praing	Large Bandicoot Rat	<i>Bandicota indica</i>
Tonsay Koul	Siamese Hare	<i>Lepus peguensis</i>
Kong Keb	Frog	
Pos	Snake	
Steang	Hawk	<i>Microhierax caerulescens</i>
Tortea	Chinese Francolin	<i>Francolinus pintadeanus</i>
Kok Kor	Cattle Egret	<i>Bubulcus ibis</i>
Kok Krongmatyum	Intermediate Egret	<i>Egretta intermedia</i>
Kok Krongtouch	Little Egret	<i>Egretta garzetta</i>
Kok Krork	Chinese Pond-Heron	<i>Ardeola bacchus</i>
Khvek	Black-crowned Night-heron	<i>Nycticorax nycticorax</i>
Provek	Lesser Whistling-duck	<i>Dendrocygna javanica</i>
Sarikakoe Kor	Common Myna	<i>Acridotheres tristis</i>
Sarikakoe Krobei	White-vented Myna	<i>Acridotheres javanicus</i>
Kroling Krolong	Black-collared starling	<i>Sturnus nigricollis</i>

Local Name	Common Name	Scientific Name
Chap Phtas	Eurasian Tree-sparrow	<i>Passer montanus</i>
Lorlok bay	Brown Dove	<i>Streptopelia chinensis</i>
Lorlok Traing	Red Collared Dove	<i>Streptopelia traquebarica</i>
Antep Khmao	Black Drongo	<i>Dicrurus macrocercus</i>
Khleng Srark	Barn owl	<i>Tyto alba</i>
Pro Hit	Bronze-winged Jacana	<i>Metopidius indicus</i>
Kreal Khchong	Asian openbill	<i>Anastomus oscitans</i>
Lveachek Srok	Oriental Magpie-Robin	<i>Copsiurus balasiensis</i>
Aot Thom	Greater Coucal	<i>Centropus bengalensis</i>
Khtub Deyprey	Forest Wagtail	<i>Dendronanthus indicus</i>

Source: Environmental Department of Banteay Meanchey 2001.

The Ang Trapang Thmor Sarus Crane Conservation Area

41. The Ang Trapang Thmor Sarus Crane Conservation Area is situated midway between NR 56 and NR 68. The only access to the area is from NR 6 past Kralanh. The Ang Trapang Thmor Sarus Crane Conservation Area is 12,650 ha in extent (WCS, 2001) and was established in 2000 to protect a population of the Eastern Sarus Crane *Grus antigone sharpii* a Globally Threatened species that was found to have established a colony around the reservoir. The reservoir at Ang Trapang Thmor is about 22 km north west of Kralanh and consists of two dykes that hold back an area of about 784 ha of permanent water. The reservoir was developed during the Khmer Rouge period but never finished and the southern dyke has now been breached. The area contains four habitats; (i) open water (784 ha); (ii) wet grasslands (2,906 ha); (iii) woodland (2,596 ha) which grades northwards to dry dipterocarp forest, and (iv) rice fields (6,364 ha). The maximum population of Sarus Crane recorded on site was 200 birds in April 2000. Apart from the Sarus Crane a further eight Globally Threatened and six Globally Near Threatened bird species have been recorded in the area, together with 28 bird species of regional conservation concern. These include; the Bengal Florican, Palla's Fish Eagle, Red-headed Vulture, Greater Spotted Eagle, Oriental Darter, Black Headed Ibis, White Shouldered Ibis, Spot-billed Pelican, Milky Stork, Painted Stork, Black-necked Stork, Lesser Adjutant, Greater Adjutant, Asian Golden Weaver, Blue-breasted Quail, Comb Duck, Fulvous-breasted Woodpecker, River Lapwing, Black Kite, White-bellied Sea Eagle, Rufous-winged Buzzard, Great Cormorant, Great Bittern, Asian Openbill, Woolly-necked Stork and Red Avadavat. Eld's Deer a Globally Threatened Species is also resident in the area.

Wildlife Hunting

42. The Law on Forestry Management N° 35KRCH, of 25 June 1988, Chapter 4 (Hunting), Article 22 prohibits the hunting of wildlife. This law is now being revised and is currently before the National Assembly. Changes proposed to the law give greater definition to hunting activities.

43. In a poor society such as this, wildlife will continue to be hunted for reasons of livelihood, especially in the more remote forested areas. With peace and order being restored in these areas, bows and arrows and snares have mainly replaced automatic weapons. Some trade in wildlife and wildlife products has occurred and this included trade in the Sarus Crane and Eld's deer which were being collected from the Sarus Crane Conservation Area. Much of this has now been controlled by better policing activities carried out by MAFF officers in the case of the Sarus Crane Conservation Area (WCS, 2001), and elsewhere by MoE officers who have appointed rangers and created

checkpoints for managing and monitoring the protected areas. These include:

- i. Phnom Kulen National Park; 3 check points and 25 rangers,
- ii. Kulen Promtep Wildlife Sanctuary; 2 check points and 10 rangers,
- iii. Tonle Sap Multiple Use Area; 1 check point and 5 rangers,
- iv. Banteay Chhmar Protected Landscape Area; 3 checkpoints and 15 rangers.
- v. Ang Trapang Thmor Sarus Crane Conservation Area; 4 checkpoints and 4 wardens.

As well as maintaining the checkpoints and providing rangers the MoE has an active community education program to create environmental awareness especially within the rural communities.

44. No rare or endangered fauna are resident within or adjacent to the proximity of the roads. None of the roads passes through any forested or protected areas. The proximity of the road⁷ to the protected areas is shown in Figure 2 and discussed in Section D.

Fish

45. Fish are an important part of the diet of the people living around the road area. The road crosses a flood plain that is linked to the upper part of the Tonle Sap. Both the flood plain and the Tonle Sap are essential and linked components of the fisheries of the area. Over 200 species of fish are found in the Tonle Sap with 100 species regularly occurring in the fish catches (Nicolaas van Zillinge, et al, undated). This study shows that fish consumption is about 67 kg/person per year in central Cambodia and concluded that while catches are higher than in the past the increase in population and the number of fishers has outstripped the increase in catch. Furthermore those fish that have long maturity times e.g. the Giant Mekong catfish are most at risk as under current fishing practices these cannot survive long enough to reach maturity. Those fish with a short maturity time e.g. the Trei Riel are little affected by the fishing practices. Most of the fish species that are found in these areas do not have migratory patterns because the flood period is too short for breeding (snake head, catfish) while others have definite migratory preferences and will move into the flooded plain areas during August/September and move back to the Tonle Sap in October. Fish will move up the natural watercourses and as the flood plain is inundated the fish will move into these areas for feeding and breeding. What is of most importance to these fish is the maintenance of access to the floodplains for the health of fish stocks. Thus the provision of additional cross drainage which will be needed as part of the redesign for RN6 will provide increased opportunities for fish to move from inundated areas below the road to inundated areas on the upper side of the road. According to the MCR Fishery Project, the most commonly occurring fish found in the Tonle Sap that move to the flood plain together with their breeding requirements are shown in Table 4.

⁷ While Figure 2 shows the road passing through part of the BCPL, this is not the case. The road forms the peripheral boundary of the BCPL. This is due to the GIS layers not being properly synchronized.

Table 4: Fish commonly found in the Tonle Sap and Floodplain area

Local Name	Scientific Name	Comments
Trei Ros/ Ptuok	<i>Channa striata</i>	Migrates for breeding
Trei Andeng Tun	<i>Clarias macrocephalus</i>	Migrates for breeding
Trei Chhpin	<i>Barbodes gonionotus</i>	
Trei Riel	<i>Henicorhynchus siamensis</i>	
Chhlang	<i>Mystus filamentus</i>	
Trei Kes	<i>Micronema bleekeri</i>	
Trei Kagnchruk	<i>Botia modesta</i>	
Trei Kamphleanh	<i>Trichogaster trichopterus</i>	Migrates for breeding
Trei Kamphleav	<i>Kryptopterus moorei</i>	Migrates for breeding
Kanh Chanh Chras	<i>Pseudambassis notatus</i>	
Kanh Chos	<i>Mystus mysticetus</i>	Migrates for breeding
Kan Trob	<i>Pristolepis fasciata</i>	
Khong Veng	<i>Dangila lineata</i>	Migrates for breeding
Kranh	<i>Anabas testudineus</i>	Migrates for breeding
Kros phnom	<i>Poropuntius deauratus</i>	Migrates for breeding
Angkat Prak	<i>Cyclocheilichthys microlepis</i>	
Slat	<i>Notopterus notopterus</i>	
Ta Aun/ Kramorm	<i>Ompok bimaculatus</i>	
Sraka Kdam	<i>Cyclocheilichthys repasson</i>	Migrates for breeding

(Source: Department of Fisheries, Siem Reap)

46. Fish are caught by net, traps and hooked line, but increasingly electro-fishing methods are now being used. This appears to be an unintended outcome of the government's desire to hand control of fish resources back to communities. The MAFF have found it difficult to control this as the community appear to have interpreted the management requirements differently to the government officials who now have a difficult task in clawing back the situation. Furthermore many of the community consider that it is unfair of the government officials to target them for the illegal activity of electro-fishing as they do not see this being equitably enforced on the more affluent parts of the community.

3. Human and Economic Development

Population and Local Administrative Details

47. The 1998 census shows that the provinces of Siem Reap, Banteay Meanchey and Oddar Meanchey have a population of 723,900, 577,700 and 122,100 persons respectively. Sisophon and Siem Reap townships are the administrative centers for the first two provinces while Samrong is the administrative center for Oddar Meanchey. The province of Oddar Meanchey was formed in 1999 by amalgamating the northern portions of the other two provinces to form a separate administrative unit in the poorer northern area of Cambodia. Siem Reap has the largest urban population with 120,000 persons⁸, Sisophon has 99,000 while Samrong has 36,700 persons. Administration is carried out by a series of local government units that include differing levels of government and services. These are in decreasing order of responsibility: province > district > commune > village.

⁸ Siem Reap has been experiencing rapid expansion based on the development of the tourism industry in the area. The Hotellers Association considers that the current urban population of Siem Reap may be about 200,000 persons.

Population and administrative statistics are shown in Table 5.

Table 5: Provincial Population Details

Province	Total Districts	Total Communes	Total Villages	Total Families	Total Population
Siem Reap	12	88	882	130,903	723,920
Banteay Mean Chey	8	63	603	111,856	577,772
Oddar Meanchey	5	24	231	24,742	122,108

The population that are within the proximity of the road and are likely to benefit from the road are shown in Tables 6, 7 and 8 for NR6 and NR5; and NR56 and NR68 respectively.

Table 6: Population along NR6 and NR5 from Siem Reap to Poipheth

Province	Population	Villages
Siem Reap	232,150	40
Banteay Meanchey	201,260	33 [*]
Total	433,410	73 [*]

* Villages were counted from Sisophon to Poipheth from the 100,000 map.

Table 7: Population along NR56 from Sisophon to Samrong

Province	Population	Villages
Banteay Meanchey	10,388	16
Oddar Meanchey	52,797	31
Total	63,185	47

Table 8: Population along NR68 from Kralanh to Samrong

Province	Population	Villages
Siem Reap	13,741	17
Oddar Meanchey	8,949	8
Total	22,690	25

48. Tables 6, 7 and 8 show that, as a consequence of the project, the roads will have a direct impact on about 519,300 people that are living close to or alongside the road, these people are situated in 145 villages. The average household size is 5.5 persons/hh. Cambodia does not have a diverse ethnic mix and within the project area the main ethnic group is Khmer.

Poverty

49. Poverty is endemic in Cambodia where in 1999 GDP per capita was estimated at \$290 of which 36 percent were estimated to be affected by poverty. Rural poverty is higher at 40 percent versus 30 percent in urban areas. Oddar Meanchey province where fewer facilities exist and agricultural production is lower would have higher poverty than the national average.

Land Use

50. Some 20,000 ha of irrigation systems were constructed within the area during the 1960's and again during the Pol Pot regime from 1975 – 1979 for wet season irrigation. However today few of these systems are functioning due to poor design and lack of maintenance. Below the 10 m asl contour to the 8 m asl contour land can be flooded for two months or more in which case floating rice is the main crop and this is well adapted to the flood risk involved in such a locality. The share of agriculture in land use declines to 48 percent (MRC, 1998). Below the 8 m asl contour the land is flooded on average 4 months per year and the share of agriculture in land use declines further to 14 percent of the area.

Employment: Agriculture

51. The three provinces of Siem Reap, Banteay Meanchey and Oddar Meanchey are primarily agricultural provinces with rice growing as the main crop, which may be either grown as paddy rice or in areas below 10 m asl as floating rice. Communities along NR6 and NR5 are closer to the main centers of Siem Reap Sisophon and Poiphet than those along NR56 and NR68 and consequently have greater opportunities to seek alternative sources of income. Most communities along NR56 or NR68 within Oddar Meanchey by contrast have only been located in the area for less than 10 years and have limited access to alternative sources of income. Agriculture is the principal occupation of 90 percent of the population. Agriculture within a flood prone area such as this has high risks associated with it and farmers in the area have developed various strategies to reduce risk, which includes planting larger areas and using fewer inputs at lower rates. Consequently rice production is low, with erratic yields and in some situations not enough rice is grown to meet household requirements. With an average family size of 5.5 persons/ha and an annual clean rice requirement of 150 kg/person, 80 percent of the farmers that were covered by survey⁹ along NR6 would be self sufficient in rice production. The survey showed though, that little rice is available for sale and that 12 percent of the farmers would not grow enough to meet their needs. On the poorer soils in Oddar Meanchey where farmers do not grow enough rice, farmers supplement their incomes by selling fuel wood that is cut from the woodland forest adjacent to the road. Otherwise, if oxen are owned, these can be sold to supplement income.

52. Along NR6 and NR5, and the lower portions of NR56 and NR68, the dominant land use within the RoW and alongside the road is a mix of rainfed paddy rice and extensive grazing. Other land uses include tree crops (banana > papaya > coconut) within the villages while towards Samrong on higher ridges adjacent to NR56 larger tree crop farms have been established for mango and jackfruit plantations. In the northern areas around NR56 and more so around NR68, maize is grown as a major crop in areas that have been cleared from the dry woodland vegetation, where maize is used as a primary crop to prepare the land for rainfed rice. Grazing is more common on the extensive grassland areas that have formed on the lower plains below NR6. Cattle are a major component of the farming system and are used for both grazing and animal power. Buffalo are also

⁹ A farmer questionnaire was designed and 60 families were interviewed in 13 villages alongside NR6. As farm production is lower on the poorer soils alongside NR 56 and NR 68 in the Oddar Meanchey province, food and income deficiencies will be greater in this area.

present but are in much lower numbers than cattle.

53. In the rice-based farming system, only one crop is grown during the wet season. Land is opened with the first cultivation being done as soon as the soil is friable after the break of rains in May/June. Oxen are the main source of draught power, though hand tractors are becoming increasingly more common. Large tractors with disc ploughs are also used especially along NR6. A second cultivation is carried out as soon as weeds germinate from the first cultivation after which rice may be either broadcast direct onto the prepared area, or more commonly planted out from nursery stocks in June. The crop is then harvested between December and January after floodwaters have receded. Few inputs are used, local varieties are mainly used to cope with the long growing period, while some urea and 16-20-0 fertilizer may be used when the farmer is reasonably sure that the crop is safe from flood damage. Crop yields are low and are in the order of 700-800 kg/ha. The main pests of rice in decreasing order of importance are: rats > grubs > insects and birds. No dry season crop is grown.

Land Ownership

54. Along NR6 and NR5 land outside the RoW is privately owned. However as both NR56 and NR68 are newer roads these pass through government land, which have been officially settled by families from refugee camps after peace and order was restored in the mid 1990's. These families have cleared the woodland and occupied areas adjacent to the road. While the land is still government owned it is expected that these families will eventually receive title to these areas. Overall, farm size varies with distance from the main urban centers especially Siem Reap and also with flood risk. Properties close to Siem Reap range between 0.5 – 1.5 ha while at Preah Netr Preah farm size increases to 4.0 ha, and in Commune Phnum Leap, just before Sisophon farm size increases again to about 5.0 ha. Along NR56 and NR68 the paddy area that is worked by a family ranges between 2 – 5 ha. Where labor is limited (land preparation, planting and harvesting) on the larger farm areas along NR6 and NR5, many of the paddy areas are cultivated by 4 wheel tractors with disc ploughs. Along NR56 and NR68 oxen and buffaloes are the main source of traction. With reasonable access to land there are few landless people and those that are landless will frequently occupy land within the RoW. Large flocks of ducks are raised in three locations within the RoW along NR6 between Sisophon and Preah Netr Preah.

Infrastructure

55. An airport is located at Siem Reap which is serviced by a range of airlines providing domestic connections to Phnom Penh and international connections to Thailand, Laos and Vietnam. An airstrip is located at Samrong but there are no regular services. Electrification is restricted to those villages close to Siem Reap and Sisophon. Sisophon and Samrong have their own electricity supply and this is often unreliable. Otherwise villagers have to rely on battery power. Business activities in the villages include selling food in roadside stalls and in some villages the provision of basic machinery repairs. All villages have an informal market where stalls are set up to sell produce, while larger towns such as Pouk have formal market facilities. Service and repair industries are located in Siem Reap while Sisophon has a smaller industrial base. Several quarries in the area provide a range of employment. The largest employment opportunities are in tourism in Siem Reap and at the Poiphet border where large numbers of people are employed in transferring goods between vehicles, as these have to unload and reload at the border.

Tourism

56. Tourism is a major industry in Siem Reap and the city is now rapidly developing as one of the major tourism points of interest in Southeast Asia. Siem Reap has an amazing heritage of cultural artifacts including the extensive complex of Angkor Wat, which occupies about 200 ha. Apart from Angkor Wat there are also numerous other ancient temples and other sites of interest around Siem Reap including the Tonle Sap Lake, waterfalls and other protected areas. Tourism numbers and projections for Siem Reap are given in Table 9.

Table 9: Tourism Arrivals and Projections for Siem Reap

Arrivals	Year							Total 99-'01	%
	1999	2000	2001	2002	2003	2004	2005		
Air	28,980	155,829	88,129	n.a.				272,938	50.4
Boat	27,340	21,043	87,020	n.a.				135,403	25.0
Road	27,321	17,308	88,908	n.a.				133,537	24.6
Total	83,641	194,180	264,057	484,250	569,700	759,600	1,139,000	541,538	

Source: Ministry of Tourism Office, Siem Reap

57. There are currently 47 hotels in Siem Reap and possibly 1000 guesthouses though officially this is considered to be 150 – 200 guesthouses. Road arrivals are currently 25 percent of the tourism volume and the Ministry of Tourism in Siem Reap consider that of these 36,800 or 41 percent have arrived via the entry at Poiphet. The Ministry of Tourism have not evaluated the effect that an improved road may have on the tourist industry though they acknowledge that poor infrastructure, especially roads is the major reason for limiting tourism at present. When the road is upgraded they estimated that this might increase arrivals by 100,000 tourists through Poiphet as this would now expand the back packer industry, the main people to arrive by bus. It will probably have little adverse impact on domestic air travel, though international arrivals may be reduced as the airfare is considered to be expensive. In discussions with the Hotel and Guest House Operators Association they confirmed that an improved road would make a major improvement to the industry as this would create an alternative entry point and make access to Siem Reap much easier. Furthermore this would allow Siem Reap to be connected to the Thai tourism industry especially with regard to bus travel. Improvement of the road to Phnom Penh would also open up the area for Cambodian nationals for tourism and already this is a reasonably large component of the industry and in the year 2000 over 3,000 Cambodians visited Siem Reap. Tourism is now a major employer in Siem Reap and in one five star hotel, 350 Cambodian nationals are employed, of which about 40 percent are women. Of these 80 percent are employed from the local area. Other sources of employment are as tourist guides, drivers, working in restaurants and other supporting service industries. Tourism also provides opportunities for the development of handicraft industries in remote villages and is seen as the main way of providing employment opportunities for school leavers. This is exemplified by the development of a stone carving industry at Preah Netr Preah and silk weaving in outlying villages.

4. Quality of Life Values

Health and Education

58. Villages that are located along NR6 and NR5 have better access to health facilities due to better road conditions. Overall health facilities are rudimentary and poorly distributed. For more advanced care this is available at the provincial centers of Siem Reap and Sisophon. Oddar Meanchey Province, being recently formed and with a lower population, has fewer health facilities. Health statistics show that for the three districts that are adjacent to NR6, malaria is the fifth most common disease in the province, behind diarrhea, chest and skin infections. Malaria is commonly *Plasmodium falciparum* (80 percent of infections) with *P. vivax* 20 percent. Dengue is increasing and is more of a concern in densely settled urban areas. HIV/AIDS is spreading rapidly within Cambodia and today 2.8 percent of the population is considered to be infected, with greatest infection rates among high-risk groups. (UNAIDS, 2000). Poiphet, due to its location as a border town has a higher incidence and Dunbar (2002) quotes that in 2000, 7.3 percent of police, 37.3 percent of direct commercial sex workers, 11.3 percent of indirect sex workers and 4.7 percent of pregnant women attending ante-natal clinics were HIV positive. While this was a decrease from the previous year the incidence was still very high. People are generally reasonably well aware of the disease and as a result the prevalence of this disease is expected to decrease.

59. Villages are well supported with primary schools, however with the typical decrease in students attending secondary schools, secondary schools are available in only a few villages. Teachers are paid for by the central government but with low wages it is often difficult to recruit and retain teachers in remote villages with few facilities.

Village Water Supplies

60. Acceptable drinking water quality is one of the major limitations in the area. This is most pronounced in village water supply systems where water quality is frequently poor which is exacerbated during the dry season when open water sources become highly turbid. While piped water is available in Siem Reap, none of the villages are known to have any piped water supply systems, water being obtained from wells or ponds. Along NR56 some village water supply ponds are being developed on public land by various NGO groups which include Buddhist Development while at Tbei village a new pond has been built by the Seila Program a local NGO that is supported by the government and UNDP. Sanitation systems are provided in Siem Reap and Sisophon but otherwise septic tanks, pits and the surrounding areas are used. Following the collapse of the Pol Pot regime and the removal of the dictate on religious intolerance, there has been a re-birth in religion. Many of the older established villages have a temple, some of which are being refurbished.

Cultural Heritage

61. Apart from the World Heritage listed site at Angkor Wat there are numerous other old structures/monuments and items of cultural interest. Those within the vicinity of the road are listed below. Mitigation measures to avoid disruption of the sites are discussed in the following section.

- i. On NR5 a small Buddhist shrine and four large banyan trees is located close to the northern side of the road pavement and within the RoW at Andong Meas village, which is about 9 km before Poiphet. The shrine is being used as a wayside stopping area and the shrine together with the trees is of significance.

- ii. On NR68 two ancient sandstone bridges – one about 5-10 m long and the other 200 m long - dating from about the same period as Angkor Wat are located 42 km north of Kralanh. The bridges are currently being used to carry the road and appear to be structurally sound. Some of the parapet rails remain, though these are overgrown, otherwise parts of the parapet remain scattered around on the surface. From the road there is little evidence of the bridges as there is no change in road width or gradient at the site.

- iii. On NR56 the Banteay Chhmar temple is located about 60 km from Sisophon between the villages of Banteay Chhmar Tbong and Banteay Chhmar Cheung. The relic consists of a large ruined temple that is situated within a moat that is approximately 2 km square. The ruins appear to date from the Angkor Wat period. NR56 skirts the complex on the eastern side and is about 15 m away from the moat that is 30 m wide. The temple is situated about 300 m from the road inside a forested area. The temple complex is inside the boundaries of the Banteay Chhmar Protected Landscape Area.

D. SCREENING OF POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Screening of Environmental Impacts

The Initial Environmental Examination (IEE) is carried out using a checklist that contains a listing of the possible impacts that are associated with road and highway development. Impacts are reviewed as environmental problems that are due to; (i) project location; (ii) design; (iii) construction and (iv) operation. The impacts are allocated various degrees of intensity as follows:

D1 = no significant impact	D3 = moderate impact
D2 = small impact	D4 = major impact
? = impact could not be assessed	“+” = beneficial impact.

Impacts are qualitatively assessed and the following definitions have been adopted.

- no significant impact - (D1) – no impact from the intervention.
- small - (D2) – low probability of occurrence and low magnitude of any impact occurring on the environment.
- moderate - (D3) – moderate probability of occurrence and moderate magnitude of impact occurring on environment.
- major - (D4) – high probability of occurrence of impacts of high magnitude. These impacts may involve irreversible losses to the environment.

The impacts are defined before the application of any mitigation measures.

Duration of the impact is defined as:

- Short less than 1 year
- Medium 1 to 10 years
- Long more than 10 years

Mitigation measures are identified for all impacts.

Beneficial impacts are also reported, as the benefits arising from these can often offset the totality of the adverse impacts. However where irreversible losses are concerned it is unlikely that these will be replaced or substituted by beneficial impacts.

The checklist of potential impacts identified for the GMS Cambodia Road Improvement Project is shown in Table 10. As the roads are already built, the majority of the impacts are of an incremental nature. While several possible mitigation measures are available for the various impacts, due to space limitations within Table 10, only the main mitigation measures are shown. All of the mitigation measures are discussed within the text that follows in the next section.

62. The impacts that are shown in Table 10 are discussed in the following order; NR 6/NR 5, and then NR 56 and NR 68. Mitigation and monitoring requirements are also discussed. RE = Resident Engineer, while SEU = Social and Environmental Unit. The SEU is to be formed within the Department of Planning in the MPWT and this is discussed in detail in the next section. Where responsibilities are given for the RE or SEU the frequency of monitoring is given immediately afterwards. Thus this could be “RE daily”, which means that the Resident Engineer (or this person’s representative) will inspect the works on a daily basis.

Table 10: Matrix of Potential Environmental Impacts and Possible Mitigation Measures: Roads and Highways

Activity	Potential Impact	Significance*	Duration	Mitigation	Project Phase/Responsibility
1. Potential Impacts due to Location					
i. Encroachment on precious ecology (a) Intrusion into protected areas	Loss of environmental values	D2	Long	i. Strict operating conditions imposed in Contract Document ii. Monitoring of Contractor's activities	Design: Consultant Construction: MPWT; TSBR; BCPL
(b) Loss of forests (c) Changes to fish migration	Loss of forests Loss of fish stocks	D1 +D2	Long	Beneficial impact	Design: Consultant
ii. Encroachment on historical/cultural areas.	Loss of socio-cultural values	D4	Long Long	(a) Shrine at Andong Meas. Realign road or move shrine. (b) Ancient bridges: determine options during detailed design.	Design: Consultant
iii. Loss of infrastructure	Loss of services	D1			
iv. Loss of agricultural land for borrow pits.	Loss of livelihood	D3	Long	Develop alternative uses for borrow pit areas.	Design: Consultant
v. Loss of aesthetics from road cut and fill.	Loss of values	D1			
vi. Loss of roadside trees	Loss of shade and utility	D2	Medium	Replant roadside with new trees	Design: Consultant Construction: MPWT
2. Potential Impacts due to Design					
i. Alteration of surface water hydrology from raising road.	Increased erosion, possible road failure	D4	Long	Provide adequate cross drainage	Design: Consultant Construction: MPWT

MPWT = Ministry of Public Works and Transport; TSBR = Tonle Sap Biosphere Reserve Project; BCPL = Banteay Chhmar Protected Landscape
D1 = no significant impact; D2 = small impact; D3 = moderate impact; D4 = major impact; "+" = beneficial impact

* Significance is assessed prior to the adoption of any mitigation measures

3. Potential Impacts due to Construction						
i.	Increased erosion and sedimentation in streams from: (a) construction work area (b) work in stream channels	Loss of water quality Loss of water quality	D2 D2	Short Short	Re-vegetation of construction areas Limit work in channels to low flows	Construction: MPWT Construction: MPWT
ii.	Ground and water contamination by: (a) fuel, lubricants and asphalt (b) solid waste disposal	Loss of soil and water quality Loss of soil and water quality	D2 D2	Short Long	Fuel storage in properly designed facilities, careful refueling systems Solid waste management procedures	Construction: Contractor/ MPWT Construction: Contractor/ MPWT
iii.	Dust impacts	Loss of quality of life values	D2	Short	Road watering	Construction: Contractor/ MPWT
iv.	Noise impacts	Loss of quality of life values	D2	Short	Vehicle noise control; timing of work	Construction: Contractor/ MPWT
v.	Vibration impacts	Loss of quality of life values	D2	Short	Schedule work to minimize nuisance	Construction: Contractor/ MPWT
vi.	Damage to services	Loss of services	D2	Short	Contractor awareness of services	Construction: Contractor/MPWT
vii.	Damage to bridges and pavements	Loss of access	D3	Short	Truck overloading must be controlled. Use weighbridges.	Construction: Contractor/MPWT
viii.	Altered road conditions	Driver hazards	D2	Short	Reduce waiting time delays; signage	Construction: Contractor/MPWT
ix.	Health and Safety concerns: (a) Inadequate sanitation (b) lack of preparation for accidents and injuries (c) transmission of sexually communicable diseases (d) Stagnant water areas	Increased disease Lower worker productivity Spread of disease to communities Breeding habitats for mosquito vectors	D2 D2 D3 D2	Short Short Long Short	Provide sanitation and potable water Worker Health and Safety Plan (a) Pre-employment worker screening (b) Siting camps distant to communities Removal of still water areas	Construction: Contractor/MPWT Design: Consultant/MPWT Construction: Contractor Construction: Contractor/MPWT
x.	Worker concerns (a) impact on natural resources	Loss of wildlife	D2	Short	Labor agreements	Construction: Contractor/ MPWT
xi.	Dislocation of people within RoW	Loss of livelihood.	D3	Long	Resettlement and compensation plan	Construction: MPWT
xii.	Discovery of artifacts and relics	Permanent loss of cultural items	?	Long	Contractor awareness	Construction: Contractor/MPWT

MPWT = Ministry of Public Works and Transport; TSBR = Tonle Sap Biosphere Reserve Project; BCPL = Banteay Chhmar Protected Landscape
D1 = no significant impact; D2 = small impact; D3 = moderate impact; D4 = major impact; ? = magnitude of impact unknown, could not be assessed;
“+” = beneficial impact

* Significance is assessed prior to the adoption of any mitigation measures

4. Potential Impacts Arising from Project Operation						
i.	Increase in road accidents to people and livestock	Increased accidents	D3	Long	Driver & community awareness; signs	Operation: MPWT
ii.	Increased air pollution	Loss of quality of life values	D1	Long	Vehicle emission controls, driver awareness.	Operation: MPWT
iii.	Decreased dust	Pave roads	+D3	Long	Beneficial impact	
iv.	Increased noise	Pave roads	D1	Long	Heavy traffic noise controls	Traffic police
v.	Accidental risk of toxic spills	Air, water & ground pollution	D3	Long	Enforcement of transport regulations	Operation: MPWT
vi.	Unplanned settlement along RoW	Reduced utility of road	D3	Long	Enforcement of RoW control	Operation: MPWT
vii.	Accelerated loss of forests.	Loss of environmental values	D1?	Long	Monitoring and strict enforcement of regulations if necessary.	Operation: MPWT/DFW
viii.	Accelerated loss of wildlife	Loss of environmental values	D1?	Long	Monitoring and strict enforcement of regulations if necessary.	Operation: MPWT/DFW
5. Potential Environmental and Social Enhancement Impacts						
i.	Hiring of local communities	Improved social equity	+D4	Short	Beneficial impact	Construction: Contractor: MPWT
ii.	Reduced transport costs	Improved returns	+D3	Long	Beneficial impact	
iii.	Improved public access and transport for rural communities	Improved mobility	+D3	Long	Beneficial impact	
iv.	Tourism Benefits	Improved opportunities	+D3	Long	Beneficial impact	
v.	Decreased flooding of upstream farmland.	Accelerated removal of floodwater.	+D2	Long	Beneficial impact	

MPWT = Ministry of Public Works and Transport; DFW = Department of Forestry and Wildlife; TSBR = Tonle Sap Biosphere Reserve Project; BCPL = Banteay Chhmar Protected Landscape

D1 = no significant impact; D2 = small impact; D3 = moderate impact; D4 = major impact; ? = magnitude of impact unknown, could not be assessed

“+” = beneficial impact

* Significance is assessed prior to the adoption of any mitigation measures

1. Environmental Problems due to Project Location

i. Encroachment on Precious Ecology

(a) Intrusion into Protected Areas (D2)

63. The Tonle Sap Biosphere Reserve (TSBR). The alignment of NR6 forms the upper boundary to the Transition Zone of the Tonle Sap Biosphere Reserve (TSBR). The Transition Zone is the outermost zone and has the lowest conservation category of any of the management zones of the TSBR. Without clearly defined boundaries, management zones are traditionally hard to define and manage. As NR6 formed the approximate upper area of flooding of the Tonle Sap lake, the alignment of NR6 was chosen as the boundary for the Transition Zone as this provided a clear definition of the area for the purposes of the TSBR. In discussions with the TSBR management unit in Phnom Penh the proposed upgrading of NR6 was discussed and this was not regarded as posing any particular hazard to the TSBR. However as runoff will enter the Transition Zone from NR6, this has the potential to carry pollutants with it and during construction the Contractor's work will need to be monitored.

Mitigation: Particular care will need to be taken during construction to ensure that construction generated impacts are minimized. This would include all of the impacts identified in Section B of Table 10 that are associated with runoff borne pollutants. Conditions will need to be included in the Contract Documents to ensure that the Contractor is aware of the presence of the TSBR and the special requirements that this presents.

Monitoring: Construction: RE daily. SEU/RE/TSBR monthly or as required.

64. The Banteay Chhmar Protected Landscape (BCPL). The alignment of NR56 forms the southern boundary of the BCPL. As mentioned in the description of the BCPL, the boundary also incorporates four villages whose inhabitants have severely degraded the immediate boundary area to such an extent for fuelwood and agriculture lands that the DoE in Sisophon has proposed that the boundaries be rationalized by moving the boundary further inside the BCPL by at least 500 m. This would exclude the four villages on the road and a further three villages further inside the BCPL, near the Banteay Chhmar temple. It would also excise the Banteay Chhmar temple from MoE jurisdiction and hand this over to the Ministry of Fine Arts and Culture. While the Project will repair bridges within sections of road alongside the existing BCPL boundary, none of the work will be carried out within the BCPL. As the ground slopes away from the BCPL any pollutants generated by the bridge construction activities will not be carried into the BCPL. However during construction, the Contractor's work will need to be monitored by the SEU.

Mitigation: Because of the likely change in the BCPL boundary, this needs to be confirmed during Detailed Design. Responsibility: Consultant/SEU.

Monitoring: Construction; RE daily, SEU/RE/BCPL monthly or as required.

(b) Loss of Forests (D1)

- i. No areas of primary forest will be affected by the reconstruction of NR6/NR5.
- ii. No areas of primary forest (dry dipterocarp/woodland) will be cleared for any bridge building activities along NR56 and NR68.

Mitigation: None needed.

(c) Changes to fish migration (+D2)

65. The Tonle Sap floodplain is an important fish resource and fish move into the floodplain area each year as the Tonle Sap rises. It is recognized by fish biologists that any decrease in size or access to the floodplain will have an adverse effect on fish stocks. When the road embankment was built sometime in the 1930's, the presence of the road provided fewer opportunities for fish to pass through the embankment to flooded areas on the upper side of the road. However the Project will enhance movement through the embankment by constructing additional cross drainage structures which will be required to cope with drainage following the raising of the embankment. This is expected to have a small beneficial impact on fish movement into areas of the floodplain above the road.

Monitoring: None needed.

ii. Encroachment on Historical/Cultural/Monument Areas (D4)

66. A small Buddhist shrine and four large banyan trees are located by the roadside at Andong Meas village, about 9 km before Poiphet. Both the shrine and the trees are of significance to the local communities. With regard to the shrine and trees, the following options are possible.

- (a) Moving the shrine and relocating it to a new site. In discussions with government officials and the local community they stated that they had few objections if it was necessary to relocate the shrine. However this would require the trees to be re-established.
- (b) As the RoW is 60 m wide at the site it would be possible to quite easily realign the road within the confines of the RoW so as avoid the shrine.
- (c) Alternatively the road could be significantly diverted at this point and a service area established here for travelers to pull over away from the road. This would also create a safer and quieter zone for the shrine. Service areas are considered in the section on road safety.

Mitigation: Several alternatives are available for the shrine. The most suitable option will need to be established during Detailed Design. Responsibility: Consultant/SEU.

Monitoring: Validate actions to be taken before and during construction. Responsibility RE daily. SEU/RE monthly.

67. Two ancient bridges are located on RN 68 about 42 km north of Kralanh. One bridge is about 5-10 m long, the other 200 m long. The bridges were built at about the same time as Angkor Wat and even today the bridges remain as solid structures that are used to carry NR68. Due to its age this is a significant ancient monument and should be preserved.

Mitigation: During Detailed Design the Consultant Team and SEU will discuss strategies with the Ministry of Culture and Fine Art and the APSARA Authority to determine what options need to be taken to preserve these structures. Responsibility: Consultant/SEU.

Monitoring: Validate actions to be taken before and during construction. Responsibility RE daily. SEU/RE monthly.

(iii) Loss of Infrastructure (D1)

68. As there will be few changes needed to the road alignment, no infrastructure losses are known to occur as a consequence of location of the road.

(iv) Loss of Agricultural Land for Borrow Pits (D3)

69. Borrow pits will need to be located along NR6 and NR5 as a source of earth for sub-base material. Two possible sites are available for this; (i) within the RoW and (ii) outside the RoW.

- i. With regard to the first possibility the RoW is already occupied by farmers who utilize the area on an opportunistic basis. The location of these farmed areas close to the road also increases their attractiveness in terms of access as the surrounding areas are often flooded for up to 21 days during the wet season. The persons occupying these areas, recognize that they have no particular rights to occupancy, however as some of these people are also landless taking land within the RoW for borrow pits will adversely affect this group of people. Should the RoW be used as the source of material then the resulting excavation could resemble a long canal on either side of the road with no drainage outlets. Once this fills with water it would become a source of mosquito vectors and possibly increase malaria and other diseases within the area. Consequently due to the existing used being made of the RoW, the use of the RoW as a source of borrow pit material is not recommended.
- ii. Thus to reduce the impact on those farmers already using the RoW the option of siting the borrow pits as discrete excavated areas of about 1 ha on private land outside the RoW has been investigated. Land is not particularly limiting along NR6 and NR5 and the possibility of siting the borrow pits on privately owned land was explored with the local communities in a series of meetings to determine if the landholders were (i) agreeable in principle to the idea of siting the borrow pits on private land and (ii) ideas that the owners had with regard to suitable alternatives available for use of the borrow pits after the excavation was completed. Overall the farmers had no objections to siting the pits on private land providing they were compensated for the land. They were more receptive to the concept if the borrow pits could have a functional role after completion. The farmers suggested several possibilities and these included the use of the borrow pit; (i) as fish or duck ponds (ii) for community water storage and (iii) as storage areas for dry season irrigation. These options will need to be further evaluated and developed during Detailed Design.

Mitigation: Development of acceptable alternative uses for the borrow pit excavation areas that would have an overall beneficial advantage in terms of improved livelihood. Should it not be possible to develop community acceptable alternative uses for the borrow pits, the borrow pits will need to be battered and re-vegetated before being handed back to the owner.

Monitoring:

- i. Detailed Design; Acceptable concepts and designs will need to be further evolved together with the farmers. Responsibility: SEU/Consultant.
- ii. Construction: Checking Contractor's work. Responsibility: RE daily, SEU/RE monthly.

NR56 and NR68. While some material may be needed for lifting the bridge embankment, no significant quantities of fill will be required. With the large area of lateritic soil in the area and the presence of abandoned borrow pits, these may be re-opened as and when required. At completion these will need to be battered and re-vegetated.

(vi) Loss of Roadside Trees (D2)

70. Some trees have been planted too close to the edge of NR6 and will need to be removed, as they will create a traffic hazard on a wider road. These trees are scattered along much of the first 19 km section from Siem Reap to Sisophon. None of the trees are of any significant age and the majority have been damaged and deformed. Consequently there are no concerns with the judicious removal of those trees that will be within the formation width. A tree planting program is required to

replace these trees which would provide shade, but on the side or base of the embankment. Trees that would be suitable include *Samanea saman* a wide spreading tree that forms excellent shade and some of the tall rainforest trees as seen to grow along the road from Siem Reap to Angkor Wat. These appear to be *Dipterocarpus* and *Shorea* spp. This program will need to be included as part of the Contractor's activities and be included in the road specifications. During Detailed Design specifications for a roadside tree planting program will need to be developed. The cost of this program is included as part of the normal road construction costs and will provide opportunities for project affected people to be employed on this task as recommended in the Resettlement Plan.

Mitigation: A roadside tree planting program that would specify suitable shade trees and planting arrangements.

Monitoring: i. Detailed Design: develop tree-planting program. Responsibility: Consultant/SEU.
ii. Construction: Oversee tree planting program. Responsibility: RE daily, SEU/RE monthly.

NR56 and NR68. No tree-replanting program will be required.

2. Environmental Problems Related to Design

i. Alteration of Surface Water Hydrology and Drainage from Raising Road (D4)

71. The raising of the embankment of NR6 from Siem Reap to Sisophon to a flood free height without additional cross drainage will cause additional runoff to be held behind the embankment. This will require an engineering solution in terms of additional cross flow discharge capacity to be incorporated within the embankment. This may involve three possibilities; (i) increasing the discharge capacity of the existing bridges and culverts by widening them; (ii) the construction of additional cross drainage through the road embankment; and (iii) a system that increases capacity plus additional cross drainage. The concern is that should the new road drainage system be under-sized and change the flow pattern from the existing situation, serious downstream erosion may result at discharge points.

72. There are currently 43 bridges and about 140 culverts along NR6/NR5. The bridges are in bad repair and all will need to be replaced while the culverts will need to be inspected and a decision made as to whether to replace them.

73. The inspection of NR6/NR5 showed that all drainage discharge points situated at ground level are currently stable. Within the RoW there are no signs of upstream sedimentation nor are there any signs of downstream erosion. Also where the road is overtopped by flooding, there is no evidence of any embankment erosion.

74. It is concluded from the above that the road is currently having little effect on retaining runoff. While the area as a whole is subject to massive inundation, runoff moves at extremely low and controlled velocities. It is probable that both temporal and spatial conditions produce different runoff events with storm runoff occurring in the upper catchments being channeled safely past the embankment via the established watercourses. However for larger storm events that may cover the flood plain, runoff is retained and appears to rise and fall more or less evenly on both sides of the road. Flooding will furthermore be influenced by the back water level of the Tonle Sap.

75. To progress the design to a flood-free road it will be necessary to include additional road cross drainage. In discussions with the landholders there would be no objection to installing

additional cross drains as they would like to see the drainage improved as this is currently restricting access to their paddy areas and it is furthermore reducing yields. The results of the village interview showed that there was more concern for drainage relief on the upper side of the road as presumably the villagers considered that the road was responsible for holding back the runoff. However as there are no signs of erosion or deposition in the ROW, the overall conclusion is that the road is probably not exacerbating flooding, contrary to the perception that the farmers hold.

76. Inclusion of additional cross drainage for a flood-free road would not be difficult, as there are numerous 3 – 5 m wide shallow trapezoidal channels below the road. These have been excavated at intervals of about 1 km and were presumably part of a now defunct drainage or irrigation system. As stated in the section above on fish migration, additional cross-drainage would assist fish movement as well as meet farmer perceptions on improving drainage.

77. The use of the embankment to store water against and the possibility of enhancing water use within the RoW was also considered. Overall the analysis showed that there were major disadvantages to the local communities as these options will inundate upstream paddy areas and affect the livelihood of these landowners. Overall what the communities stated that they wanted better drainage, as this would reduce uncertainty with regard to rice yields.

Mitigation: A potentially major impact was judged for this item, as any road raising without additional cross drainage would be detrimental to the stability of downstream discharge areas and ultimately the road's stability. As the impact can be easily mitigated by cross drainage, there are few concerns with this item providing that:

- careful design is given to the outlet so as to avoid downstream scour developing.
- selection of additional cross drainage discharge locations needs to be done in consultation with (i) the local community and (ii) the Ministry of Water Resources and Meteorology.

Responsibility: MPWT/SEU and design team.

Monitoring: None needed, looked after as a design requirement by Consultant engineering design team.

NR56 and NR68. No additional cross-drainage will be required.

3. Environmental Problems Associated with the Construction Stage

The main construction activities include the following tasks:

- i. Widening and raising of the embankment of NR6/NR5. This will use a variety of earth, laterite and rock materials. This material will be sourced from pits and quarries. The material will need to be excavated at the pits, loaded onto trucks and hauled to the site where it will be dumped. Spreading may be done by hand labor, while the final finishing of the road surface will be done by machinery. Asphalt concrete will be used to complete the road surface. Quantities required include about 1.17 million m³ of earth; 305,000 m³ of gravel or laterite; and 197,400 m³ of crushed rock.
- ii. Construction of bridges and culverts. Both NR6/NR5; and NR56 and NR68. The bridge design recommends the use of pre-cast concrete beams that would be cast in a specialized concrete manufacturers site that would ideally be centrally located within the Project area. The beams would be transported to site and erected. Thus apart from the bridge abutments and possibly for large box culverts, the quantities of

sand, cement, aggregate and reinforcing steel, that would normally have been brought on site will be significantly reduced.

- iii. Embankment stabilization and rehabilitation: NR6/NR5. At the completion of construction all borrow pits, embankments and other exposed or disturbed areas will need to be battered to an acceptable slope, re-vegetated and stabilized. Temporary access roads to borrow pits and diversions around work areas will need to be removed. This would include ripping to break up ground compaction and re-establishing the original ground surface.
- iv. Resettlement and compensation: NR6/NR5. A plan is needed to address the social issues arising from people whose livelihoods are adversely effected by construction activities occurring within the RoW and privately owned lands where borrow pits and road diversions may have been sited. This is addressed by a separate Resettlement Plan.

As a result of these activities several impacts will arise especially on the physical, biological and human environments. These are discussed below.

i. Increased Erosion and Sedimentation in Streams

78. Work on excavated areas and within stream channels has the ability to provide additional sediment to the stream channels following the mobilization of this by rainfall and runoff. This may either be deposited within the excavated area or carried into the stream channel. Once in the stream channel the eroded material will be carried until it is deposited in a new area. Ultimately this will be the Tonle Sap, which is an important fishery resource. High levels of turbidity reduce light penetration into water bodies, clog fish gills and upset spawning areas. Two possible sources of eroded materials are those from excavation areas and work carried out in stream channels.

(a) Construction Work Areas (D2)

79. This will be common to NR6/NR5 and to a less extent to NR56 and NR68. Opening of construction work areas will be a concern wherever any excavation is done as this will expose bare soils and provide a source of material that can be eroded. This will include sites such as; borrow pits, quarries, road embankments, culverts and bridge abutments and road diversions. Excavation on these areas will only have limited impact, as most of the sediment will be retained at site due to the very low slopes and the inability of runoff to achieve carrying velocities.

Mitigation: Areas should be reshaped and re-vegetated as soon as possible after disturbance. This will also depend on the season and may require watering to achieve coverage before the wet season erosive rains arrive. Re-vegetation work has been identified as task that could be carried out by project affected people within the Resettlement Plan. Re-vegetation specifications will need to be drawn up during Detailed Design. Responsibility: Consultant and SEU.

Monitoring: Construction: RE daily, SEU/RE monthly.

(b) Work in Stream Channels (D2)

80. Excavation carried out within perennial stream channels for culverts and bridges will be the greatest source of sediments, as these will be easily mobilized. It is also possible that the road may

be diverted around the work area by a temporary fill embankment constructed within the watercourse. Care needs to be taken with any work within the stream channel, as this will provide a ready source of materials that can be entrained by a rising stream. This requirement is more for maintaining the hydraulic integrity of the watercourse as all of these have low velocities and any loss of channel capacity will have compounding flood effects. The watercourses at the time of inspection in May/June were very low, sluggish and extremely turbid due to the presence of highly repellent suspended particles. Excavation that may increase turbidity is unlikely to have any adverse effect on fish as these have already developed within this particular environment. Overall there are only four watercourses that have permanent water in them where strict adherence to these requirements will be needed. This will limit the area of impact.

Mitigation:

- i. Perennial channels. Care of channel, avoid unnecessary work within channel and dumping of excavated material into channel.
- ii. Non perennial water courses. Much of the impact can be eliminated by planning work during the dry season, which would allow the area to be cleaned up prior to the arrival of flows.

Monitoring: RE daily, SEU/RE monthly.

ii. *Ground and Water Contamination*

(a) *from Fuel, Lubricants and Asphalt (D2)*

81. Lubricants that enter the ground environment will render the area unusable and may pollute groundwater. Aquatic systems can be polluted by fuel and lubricants and asphalt entering these systems. Common to NR6/NR5 and NR56 and NR68.

Mitigation: Fuel and oil storage areas should be located well away from any watercourses and be provided with a concrete platform and be bunded so that any fuel leakage is stored on site. Additionally these areas should be provided with interceptor traps so that accidental spills cannot escape and contaminate the aquatic environment. Washing down water from machinery repair areas also needs to be directed into this system and held in retention areas for treatment. Refueling should wherever possible be carried out at the fuel storage area and not be permitted within or adjacent to watercourses. All waste oil and replacement oil and fuel filters should be stored and disposed of to acceptable industry standards. When the facility is no longer required the Contractor will need to remove the structures and also excavate and remove any contaminated soil. New soil should be brought in as required so that the ground surface is re-established

Bitumen should be heated by kerosene or gas. Fuelwood should not be used as an alternative.

Asphalt should not be applied during rain so as to avoid it being washed into watercourses.

Monitoring: Contractor, daily; SEU/RE monthly.

(b) *Solid Waste (D2)*

82. Materials brought onto site will generate a range of possible environmental pollutants of air and water resources. The main concerns will be from containers such as bitumen drums and plastic materials that may be brought on site as wrapping materials.

Mitigation: The Contractor will need to make arrangements for the storage, collection and disposal of solid waste during the Contract. If pits are excavated for disposal of solid waste these must be in keeping with waste disposal requirements as specified by the Ministry of Environment. Care will be

needed in selecting these sites so that groundwater is not affected. When construction is completed the Contractor must be directed to clean up the construction site by removing all equipment and buildings and carry out site remediation work.

Monitoring: Contractor daily, SEU/RE monthly.

iii. Dust Impacts (D2)

83. Dust from haulage vehicles as they bring road materials to site will be a problem for communities that live alongside the road during the dry season. Common to NR6/NR5 and NR56 and NR68.

Mitigation: The Contractor will be required to have a dust abatement program that includes spraying water on roads and work areas within villages and past houses that may be located close to the road. Sealing of urban areas should be given priority. Gravel crushing and screening areas and large concrete batching plants will not be required on site as bridge supports will be manufactured off-site and transported to site. Smaller quantities of aggregate, cement and reinforcing steel will need to be brought to site for bridge supports and culvert construction. Materials will need to be stored close to the site. Care will need to be taken in handling the materials so that wastage does not enter the watercourses. Bulk cement delivery rather than bags should be used wherever possible so as to reduce dust emissions and eventual problems with disposing of the large number of bags.

The Contractor will be required to maintain dust abatement procedures for the following: (i) where roads, construction sites and access areas pass through villages and (ii) at sites where workers are employed. As the rock quarries are privately owned dust abatement in these areas will be owner's responsibility.

Monitoring: Contractor/RE daily. SEU/RE monthly.

iv. Noise Impacts (D2)

84. Sources of noise include bridge pile driving, improper silencing of vehicles and equipment used on the road construction site. These will impact on human communities and will be most pronounced close to or within urban areas. Common to NR6/NR5 and NR56 and NR68.

Mitigation: The Contractor will need to ensure that; (i) machinery is adequately silenced and (ii) machinery and pile driving operations close to urban areas, should be restricted to daylight hours. Additionally employment of hand labor will reduce the need for many of the machinery operations.

Monitoring: Contractor/ RE daily; SEU/RE monthly.

v. Vibration Impacts (D2)

85. Vibration will occur during compaction if vibratory rollers are used. This has the greatest consequence in the proximity of brick and concrete structures. Common to NR6/NR5 and NR56 and NR68.

Mitigation: Overall as most of the structures along the road are wooden there should be little impact on buildings from vibration. Vibratory rollers should not be used in urban areas at night.

Monitoring: Contractor/RE daily, SEU/RE monthly.

vi. *Damage to Services (D2)*

86. Services within the RoW include electrical and telephone cables. Electrical cables are only found close to the major urban areas. A phone cable is now being laid within the RoW of NR6/NR5 between Siem Reap and Poiphet.

Mitigation: The Contractor will need to be aware of the location of these services so that disruptions are not caused. By placing the responsibility for any repair of the services with the Contractor will assist in avoiding damage to these service and inconvenience to the community.

Monitoring: Contractor/RE daily. SEU/RE monthly.

vii. *Damage to Bridges and Pavements (D3)*

87. All materials will be hauled by trucks to the Project site. Within Cambodia there is a tendency to overload the trucks and already several bridges along NR5 south of Sisophon show severe structural damage. Part of this is presumably attributable to overloaded trucks seen hauling crushed aggregate from the quarry at Phnom Thom towards Sisophon. Not only are the bridges affected but the pavement is also weakened and its life shortened by overloaded vehicles.

Mitigation: The Contractor will need to ensure that trucks do not exceed the bridge and pavement specifications. Provision of weigh bridge/s.

Monitoring: Contractor/RE; MPWT daily. SEU/RE monthly.

viii. *Altered Road Conditions (D2)*

88. Construction work will require traffic to be diverted around areas, or wait while work is being done. Common to NR6/NR5 and NR56 and NR68.

Mitigation: Proper warning signs and flagging will need to be displayed at the commencement of any road construction or diversion so as to forewarn drivers of changed road conditions. It is also important that old signage be removed so that drivers do not disregard notices as if they were out of date. This will be the responsibility of the Contractor.

Monitoring: Contractor/RE daily; SEU/RE monthly.

ix. *Health and Safety Concerns (D2)*

(a) *Inadequate Sanitation*

Worker camps can be unhygienic and affect worker health from poor sanitation and lack of potable water.

Mitigation: Camp and construction areas will need to be provided with septic sanitation facilities and potable water. No untreated human waste should be allowed to enter streams where it can affect downstream water quality, aquatic environments and human health.

Monitoring: Contractor daily, SEU/RE monthly.

(b) *Lack of Preparation for Accidents and Injuries (D2)*

Accidents inevitably happen and when they do the Contractor will need to have an effective Worker Health and Safety Plan that is supported by trained first aid personnel and emergency response facilities.

Mitigation: Preparation of a Worker Health and Safety Plan

Monitoring: Contractor daily, SEU/RE monthly.

(c) *Transmission of Sexually Communicable Diseases to the Local Community (D3)*

89. HIV/AIDS is prevalent within the project area and its spread has been assisted by transport workers frequenting brothels in Poiphet and Sisophon. (Dunbar, 2002).

Mitigation: When workers are hired from outside the community they should be subject to pre-employment screening and made aware of the dangers of HIV/AIDS. Work camps should be sited away from local communities. The Contractor is to ensure that staff/workers are aware of the risks associated with HIV/AIDS. An appropriate program is to be developed with the relevant ministry. Employment of local labor can reduce this concern as these people will return to their villages at night and act in accordance with accepted community norms.

Monitoring: Contractor, as required for pre-employment screening. SEU/RE monthly.

(d) *Stagnant Water Areas (D2)*

90. Temporary breeding habitats for mosquito vectors can be created in areas of stagnant water that may remain in borrow pits and in discarded solid waste such as plastics, old tires and metal containers that may be allowed to accumulate around worker camps. Malaria is present in the area and will favor clear stagnant water that may develop in any of these areas. Borrow pits and other excavation areas are unlikely to be a major problem as any water that is caught in them is expected to be turbid and unsuitable for the malaria mosquito larvae to develop in. However both the larvae of the malaria and dengue fever mosquito can develop in the cleaner water that may be unintentionally caught in discarded waste that is often discarded in the proximity of worker camps. Common to NR6/NR5 and NR56 and NR68.

Mitigation: A solid waste collection program must be established (See 3.ii.b). Employment of local labor, which reduces the need for worker camps, will also reduce the hazards of exacerbating malaria and dengue fever. Pre-employment medical checks of labor if required and provision of medical care for workers. This will be included in a Worker's Health Plan, which will be developed by the Contractor and which covers such items as communicable diseases, health and sanitation and waste management.

Monitoring: Check camps for discarded refuse. Validate worker health records. Contractor, daily; SEU/RE monthly.

x. *Worker Concerns*

91. Work camps additionally have the potential to create a series of adverse impacts on the surrounding natural resources. Common to NR6/NR5 and NR56 and NR68.

Impact on Natural Resources (D2)

92. A labor force that is not properly supplied with adequate rations or fuel will suddenly exacerbate demands on local supplies of fuelwood and wildlife. Along NR6/NR5 the area is mainly devoid of trees apart from the urban areas. Here there are few opportunities for fuelwood or wildlife hunting. However NR56 and NR68 have greater areas of woodland alongside the road and while the numbers of labor that are employed on bridge construction will be much smaller than along NR6/NR5 it is possible that the overall impact may be greater.

Mitigation: Where workers are hired by the Contractor from outside the area the Contractor will need to assume full responsibility for the actions of any workers. After informing the workers of their responsibilities with regard to conservation of natural resources, any worker found in breach of these requirements, especially with regard to hunting should be immediately dismissed. The Contractor must be responsible for providing kerosene for cooking and heating within any worker camps.

Monitoring: Contractor daily, SEU/RE monthly.

xi. Dislocation of People within the RoW (D3).

93. As the road is being rebuilt within an established RoW rather than a new road being constructed on a new alignment, there are limited resettlement and compensation requirements.

Mitigation: These issues will be addressed by a separate Resettlement Plan (RP). A few points that need to be considered in the RP include the following:

- (a) The livelihood of people within the ROW. Some of these people are landless and these will be most at risk from construction activities. Accordingly these people should be given priority in employment opportunities during construction while also seeking solutions to their landless state. These people include rice farmers and duck farmers.
- (b) Compensation will need to be addressed with regard to securing access onto private land where diversions may be required.
- (c) Borrow pits will need to be located outside the RoW on adjoining private land as the RoW is significantly occupied. Areas of land that will need to be acquired for the borrow pits will need to be compensated. Borrow pits and better sub-base material is more readily available along NR56 and NR68 where older lateritic soils are common. While haulage from these areas to NR6/NR5 will be longer, any excavation from these areas of government owned land will have a lower overall impact than on areas of privately owned land along NR6/NR5.

Monitoring: As specified in the RP.

xii. Discovery of Relics and Artifacts (?)

94. It is possible that during excavation relics may be discovered. If this happens the person making the discovery has to abide by the Law on Cultural Heritage, 1996, which requires that the discovery has to be reported to the responsible agency as defined by the law. Should relics be discovered during excavation work, the Contractor must stop the activity and immediately report this

to the local police, who informs the provincial governor who in turn informs the concerned agency to investigate the find. If after 30 days the concerned agency fails to make a decision and inform the Contractor or project proponent by official letter, then the project proponent can continue their activity.

Mitigation: Care needs to be taken during excavation to ensure that any relics that are discovered are preserved. If any are discovered the Contractor must abide by the requirements of the Law on Cultural Heritage, 1996.

Monitoring: Contractor daily, RE daily, SEU/RE monthly.

4. Environmental Problems Resulting from Project Operation

i. Increase in Road Accidents to People and Livestock (D3)

95. As a result of the improved road (NR6/NR5) and with long straight stretches and relatively long distances between the villages, it will be possible for vehicle speeds to increase from an average of about 40 kph (pre-construction) to possibly 100+ kph. This will have a consequent effect on increasing road accidents on a largely unskilled driver population. With higher speeds drivers, passengers, pedestrians and livestock will be increasingly involved in accidents. Accidents will also be expected to increase in urban areas where there is a potentially dangerous mix of slow and fast traffic using the same pavement. The JICA constructed section of NR6 from Siem Reap to 19 km out of Siem Reap has provided a 2 m wide cycle way alongside the road that effectively separates the slower traffic from the faster traffic.

Mitigation: For NR6/NR5 provision of a separate pedestrian and cycle way access lane about 1.5 m wide on either side of the road for its entire length. Additionally other measures to improve road safety include the following:

- Properly designed speed humps, speed signs and, possibly traffic signals within settlements.
- Complementary school and adult education programs dealing with road safety should be incorporated into the project as part of MPWT responsibility at the time of construction.
- As livestock and in particular cattle will use the road to walk back and forth to the villages where they are housed, farmers should also be made aware of their responsibilities with regard to the need to adequately control animals. At night large livestock (oxen and buffaloes) should be enclosed while during the day, livestock should be under the farmer's control so as to prevent them wandering uncontrolled along the road.
- Provision of Service Areas along the road will also improve driver safety by providing an opportunity for drivers to pull over at designated service areas to avoid fatigue. This concept needs to be further developed during Detailed Design and will need to address environmental concerns that resulting from the development of these areas. Issues that will need to be addressed include; provision of potable water, sanitation and disposal of solid and liquid waste.

Detailed Design: Development of road safety programs and evaluation of service area facilities if these are proposed for the road. Responsibility: MPWT/SEU, design engineer.

Monitoring: MPWT together with SEU, initially monthly for the first two years, then evaluated.

ii. Increased Air Pollution (D1)

96. NR6/NR5: Air pollution from vehicle operation and especially heavy diesel powered vehicles will become a problem within urban areas as heavy traffic numbers build up. This concern will be mitigated by air movement. Wind speed data shows that wind speed ranged from 1.0 – 3.0 m/s with gusts reaching up to 6 – 8 m/s. Topographically there is no impediment to air movement as there are no valleys present that may trap air. At the time of the visit in May/June there were no signs of any traffic-generated haze over Siem Reap. Thus while the air movement is not rapid it is not expected to allow air pollution to build up to intolerable levels along the road in the urban areas in the foreseeable future.

Mitigation: Normal air movement will reduce build up of fumes. Vehicles should be operated within acceptable emission limits. Traffic police should issue warnings, while persistent offenders should be fined.

Monitoring: Traffic police, as required. MPWT/SEU as required.

iii. Decreased Dust (+D3)

97. Noise and dust from unpaved areas is a major nuisance for roadside residents, especially those in built up areas. As traffic flows increase, this problem will get worse until road surfaces are paved. The project will pave NR6/NR5, which will have a major immediate beneficial impact on those people living alongside the road. During construction urban areas will be paved as a first priority over non-urban areas so as to reduce the dust hazard sooner.

Mitigation: Pave roads

Monitoring: None needed.

iv. Increased Noise (D1)

98. NR6/NR5: The main source of noise will be from heavy vehicle operation. Noise will be greatest when heavy vehicles down shift to tackle hills and moving away after having stopped. The nuisance factor will be greatest at night when people are trying to rest. There are no hills along the road that require significant down shifting but traffic may be expected to slow and start in towns as traffic conditions vary. As traffic reduces at night the amount of noise will also reduce. The AADT counts show that about 190 heavy vehicles pass through Kralanh each day, which is an average frequency of 7.5 vehicles per hour, or about one vehicle every 8 minutes. This is not an excessive number of heavy vehicles and this will be greater during the day and less in the evening as traditionally most of the heavy transport drivers pull over and rest for the night. However with NR6 now being a paved road all the way to Phnom Penh it is possible that driver habits may change and that greater use of the road may be made at night when the road is generally freer of traffic and certainly of smaller and slower vehicles. Presently traffic numbers are low and even allowing for an annual 6 percent growth in traffic the overall increase in heavy traffic will still not create unacceptable noise emission levels.

Mitigation: The paved road will assist in reducing noise. Other controls include; prohibition on the use of air brakes at night and fining drivers who operate vehicles without adequate silencers. There is no need for any particular noise abatement procedures which otherwise may require routing heavy traffic around urban areas.

Monitoring: Traffic police as required.

v. *Accidental Risk of Toxic and Non Toxic Spills from Increased Traffic Volumes (D3)*

99. With a wide range of materials entering Cambodia by truck from Thailand some of this will undoubtedly include toxic materials. This will be more common on NR6/NR5 than on NR56 and NR68. Currently transport operators face a poor road system with the attendant risks of a high proportion of accidents attributable to these poorly maintained roads. With the new road and better road conditions heavy transport accidents attributable to poor road conditions will decrease but accidents attributable to speed are likely to be several times greater. Thus as traffic densities and speeds increase there is increased likelihood of accidents and toxic materials being released into the air, ground and aquatic systems. To date there do not appear to have been any major accidental spills.

Mitigation: Safe road design standards and more importantly regulation of the transport of toxic materials will reduce the risk of accidental spills. Responsibility, MPWT/SEU, design engineers.

Monitoring: Traffic police as required. MPWT/SEU as required.

vi. *Unplanned Settlement along RoW (D3)*

100. Roads with their attendant higher volumes provide opportunities for local people to erect stalls and houses. Where this is uncontrolled, this results in the development of unplanned settlement occurring along the road with attendant delays in traffic flow and increases in traffic accidents. Poor planning and regulation is the main cause of this problem. Schools and hospitals and other government services do not need to be built on main roads where they present a traffic hazard and instead can easily be built on minor roads. To avoid the benefits of the road being lost under the onslaught of additional uncontrolled settlement MPWT needs to regulate the road development within the RoW so that traffic flow is not jeopardized.

Mitigation: establishing RoW ownership by MPWT. Use of boundary markers.

Monitoring: MPWT/SEU as required.

vii. *Accelerated loss of Forests (D1)*

101. Improved access to an area can sometimes result in accelerated loss of forests due to illegal logging. Cambodia has had a history of illegal logging, which peaked during the civil war where forests were cut down with little regard to the environment. Following the change to civilian government in 1993, greater control has been established over illegal logging by powers given to the Department of Forestry and Wildlife (DFW). This has included the regularization of forest harvesting by the allocation of concessions to private operators and currently an annual off-take of 5,000 m³ is allowed from the only allocated concession in Siem Reap province. DFW responsibilities also include the management and monitoring of harvesting activities and issues permits for and monitors transport of forest products, including the ban on export of logs that has been in place since 1997. Illegal logging is further controlled by the allocation of 20,000 ha of community managed forests within the area, whereby communities enter into an agreement with DFW and in return for managing the area are allowed to harvest forest products and trees for their own use.

102. There is no forest within the ambit of NR5/NR6 while NR56 and NR68 only pass through degraded woodland areas. While the Project will improve access to the upper areas of Oddar Meanchey by the replacement of bridges it is not expected to increase any forest loss as there is no timber yielding forest in the area. The main areas of primary intact forest occur to the east of the area in Siem Reap province and are mainly contained within the limits of the forest concession. The

vegetation along NR56 and NR68 is open woodland with a grass under-storey and is used by the local community for woodfuel and basic housing materials with the knowledge of the government who have permitted the area to be occupied as many of these families were former refugees. Woodland species are too small to have any significant timber value. While access may be improved by the Project the harvesting of the woodland species may only slightly increase as there is unlikely to be any change in harvesting abilities of the local community from hand tools to machines while the marketing arrangements for woodfuel are expected to remain the same.

Mitigation: No program proposed at this stage. This is dependent on the outcome of the monitoring program.

Monitoring: MPWT/SEU will be in close consultation with MAFF/DFW on the matter. Based on the results of the on-going monitoring by the relevant organization, necessary mitigation measures will be taken which may include the establishment of fixed or random checkpoints.

viii. Accelerated loss of Wildlife (D1)

103. A further concern with increased access, is the possibility of an increase in illegal wildlife hunting and the consequent threats to endangered species. While there are no wildlife-protected areas within the ambit of NR6/NR5, there are two protected areas within the ambit of NR56 and NR68. These are; (i) the Banteay Chhmar Protected Landscape (BCPL) and (ii) the Ang Trapang Thmor Sarus Crane Conservation Area (SCCA). While the Banteay Chhmar Protected Landscape presently shares a common boundary with NR56, the provision of bridges is unlikely to accelerate illegal wildlife hunting as the area is already accessible, apart from about one month at the peak of the wet season. For the SCCA the only reliable access to this area is from NR6 at Prey Maon village about 22 km on the western side of Kralanh. While access is also available from NR56 at Svay Chek District and from NR68 at Srie Snam District, these tracks are presently in extremely poor condition. Furthermore the Stueng Sraeng (a major watercourse) separates the SCCA from NR68, which further limits any possible access to the SCCA. For the BCPL there are three checkpoints and 15 rangers while for the SCCA there are four checkpoints and four rangers, which have strengthened control in the area. Both organizations also support community education programs in their areas.

Mitigation: No program proposed at this stage. This is dependent on the outcome of the monitoring program.

Monitoring: MPWT/SEU will be in close consultation with MAFF/DFW on the matter. Based on the results of the on-going monitoring by the relevant organization, necessary mitigation measures will be taken which may include the establishment of fixed or random checkpoints.

5. Potential Environmental and Social Enhancement Impacts

i. Hiring of Local Communities (+D4)

104. The Project will promote a labor based pro-poor technology concept to increase the hiring of local labor wherever this is possible to replace some of the machinery activities. This will be incorporated as a component of the Project and be mainstreamed into the MPWT for future road development projects. This action will significantly benefit local communities by diverting part of the project funds directly to the local communities.

Monitoring: RE/SEU monthly.

ii. Reduced Transport Costs (+D3)

105. For NR6/NR5 the improvement of the road surface and new bridging will reduce travel time and transport costs. For NR56 and NR68 the new bridges will facilitate all-year access to and from Samrong, which will improve access to services, especially access to medical facilities.

Monitoring: not needed.

iii. Improved Public Access and Transport of Goods for Rural Communities (+D3)

106. The road will only provide a small incremental benefit in improving access to services for rural people as the road is already in existence. However, better roads will create easier access to government services while a flood free road will ensure that there is now unrestricted access to hospitals. Overall while access will be marginally improved access to services will be increased. Similarly the road will also provide better access of service providers into the rural areas by having a flood free road.

Monitoring: not needed.

iv. Tourism Benefits (+D3)

107. One of the major beneficiaries will be the tourism industry in Siem Reap who will benefit by having a good road link to the Thai border. This will promote easier and more comfortable access to and from Thailand. With a vastly improved road to Siem Reap and shorter connection times, tour bus operators would be expected to expand services into Cambodia and Vietnam via Poiphet. Table 6 shows that the tourist industry is growing at a very fast rate and arrivals are practically doubling each year. The Ministry of Tourism considers that lack of infrastructure especially roads is the single largest constraint to tourist growth in Siem Reap. The completion of the road from Siem Reap to Poiphet will enable this to be achieved. This will provide greater opportunities for employment of local people in the hotel and tourism service sector. Already tourism is a major employer in Siem Reap and will continue as the sector grows.

Monitoring: not needed.

iv. Decreased Flooding of Upstream Farm land (+D2)

108. NR5/NR6: The provision of additional drainage within the road embankment will allow water to be discharged faster from the upper areas providing a hydraulic gradient can be established between the road and the Tonle Sap which will allow the area to drain. Farmers complain about the flooding of areas above the road and areas may be inundated for up to 21 days, which can have a damaging effect on rice yields. A possible small beneficial impact has been identified for this item as the length of flood inundation may be slightly reduced.

Monitoring: not needed.

E. INSTITUTIONAL REQUIREMENTS AND ENVIRONMENTAL MONITORING PROGRAM

1. Legal Requirements

109. The Ministry of Environment (MoE) was established soon after the UN sponsored election of July 1993. The MoE is responsible for promoting environmental protection and developing sustainable natural resource management in the country. The MoE has the responsibility to oversee the initial environmental examination and environmental impact assessment process. Since its inception, the MoE has been developing and strengthening environmental policies, plans and legal instruments. The EIA Sub-decree has been adopted pursuant to the Law on Environmental Protection and Natural Resources Management. Two of the most relevant legal instruments are discussed below.

110. The Law on Environmental Protection and Natural Resources Management was enacted by the National Assembly in December 1966. This is an enabling law, providing a framework within which specific regulations need to be developed. Specific policies and regulations are left to subsequent legislation – Prakas or Sub-decrees. The Sub-decrees encompass environmental impact assessment, water pollution control and solid waste management. Others are under review with the Council of Ministers. The law provides opportunities for public participation in the environmental assessment process and mandates penalties for environmental pollution.

111. The Sub-decree on Environmental Impact Assessment Process. Article 6 of the Environmental Law requires that all public and private investment require an EIA prior to approval, according to the criteria and procedures that are stated in the Annex of the EIA Sub-decree. The Sub-decree is intended to:

- promote conservation, protection and appropriate use of natural resources to maintain sustainable economic development and enhance environmental quality;
- integrate environmental impact assessment within project planning and decision making, and;
- promote public participation in the decision making process.

112. The Sub-decree specifies which investments require Initial Environmental Impact Assessment (IEIA) and a full scale EIA according to: type or size of project and its location as specified in the Annex of the Sub-decree. All projects which are required by the Sub-decree must first conduct an IEIA and submit this to the MoE Environmental Impact Assessment Department (EIAD) for review and approval. Where the project has “no significant” impact or the impacts can be mitigated the EIAD will approve the project. On the other hand should the project have significant impacts an EIA will need to be undertaken. On completion the EIA is submitted to the EIAD for review and approval. Normally a decision should be made in 30 days.

113. With regard to the Sub-decree on environmental impact assessment process the only requirements that require an IEIA or an EIA are:

- National road construction with lengths of 100 km or more, and
- Construction of bridge-roads that are designed to carry more than 30 tonnes.

Under these regulations the Ministry of Public Works and Transport (MPWT) will not need to submit an IEIA for this Project to the MoE. Environmental approval will be by internal assessment within MPWT.

114. Other regulations that are of relevance to the Project include:

- Law on Cultural Heritage, 1996 – with regard to preservation and discovery of cultural relics
- Law on Forestry Management, 1988 – with regard to forest use and wildlife hunting

2. Institutions

115. Within the MPWT structure environmental matters are handled on an *ad hoc* basis as projects are implemented within the structure of a Project Implementation Unit (PIU) that is established for each project under the guidance of a Project Director. Implementation of environmental and social projects is normally the responsibility of a Consultant and or an NGO. Under such an arrangement, staff who have been trained in these specialized skills are not retained and return to previous positions at the completion of the project. This has prevented the development of any environmental skills being centralized within the existing MPWT structure. With increasing environmental responsibility being demanded of ministries, there is a need to strengthen environmental monitoring and compliance within MPWT. Under the Project, a specialized Social and Environmental Unit (SEU) is to be created within the Department of Planning (DOP) in MPWT to oversee environmental and social matters. The SEU would formalize the role of environmental and social analysis within the MPWT while also supporting project activities.

116. The newly created SEU within the DOP would have a variety of roles one of which would be overseeing the execution of the environmental components of road development projects as these are approved for implementation. To facilitate this an Environmental Specialist (ES) from the SEU will be attached to a specific PIU.

117. During Detailed Design, the SEU will have two main functions. There are:

- (i) Assisting the Design Team in reviewing the environmental components that have been identified within the IEE as requiring attention during this phase.
- (ii) Preparation of the detailed Environmental Management Plan (dEMP) that sets out monitoring requirements, responsibilities and reporting procedures. The SEU would develop the dEMP in association with the Ministry of Environment (MOE), Ministry of Water Resources and Meteorology (MWRM), Ministry of Agriculture Forestry and Fisheries (MAFF), and the Ministry of Culture and Fine Arts (MCFA). The dEMP will establish the Contractor's responsibilities and stipulates specifications that will meet the various ministerial requirements for; sediment release, re-vegetation of disturbed areas, acceptable solid waste disposal methods dust, noise, and vibration. Discovery of artifacts. Transport of forest products and wildlife. The dEMP will be attached to the Contract Documents and will form part of the Project Specifications. The Contractor will need to address the contents of the dEMP during the bid and this will be evaluated at the time of the bid.

3. Environmental Monitoring Program

118. Monitoring has several objectives. (i) To determine whether the impacts have been correctly predicted, (ii) to ensure that mitigation programs are in fact implemented and meet specified targets and (iii) to meet environmental compliance parameters such as releases to water, soil and air bodies. Monitoring will allow the actual situation to be compared to the required release standard or the predicted situation so as to allow corrections to be made to the intervention. The following

environmental programs and issues will need monitoring.

119. During Construction those environmental values that have been identified in the IEE that require monitoring will be detailed in the dEMP. The ES will monitor these with assistance from the RE. This will require the ES to work closely with the RE so as to establish appropriate approval procedures for verifying Contractor compliance with the Contract specifications. The RE having the closest established linkage to the Contractor and the requirement to be present on site on a daily basis would under the direction of the SEU be given the responsibility for the daily monitoring of the dEMP. To undertake this role the RE will need to be conversant with the dEMP monitoring requirements. The RE, while overseeing the Contractor's work, would also advise the Contractor on work required to meet the dEMP conditions. As the ES has a smaller time requirement the ES would visit the construction site on a monthly basis and together with the RE would inspect the work areas to ensure that these are complying with the dEMP. All monitoring would be of a qualitative nature and the only other cost associated with monitoring would be the attendance of a representative from both the TBSR and the BCPL to assist in monitoring the Contractor's performance along the Transition Zone of the TBSR and again along the BCPL perimeter. A small cost will need to be included in the dEMP to cover this contingency. The ES, together with the RE, would certify that the environmental compliance requirements that have been stipulated within the dEMP have been completed as required.

120. During Operation those issues that require monitoring include accident records, toxic spills, settlement along the RoW, monitoring of forest and wildlife losses from RN56 and RN68.

121. Progress Reports will need to be submitted by the ES on a quarterly basis to the Head of the SEU for forwarding to the General Director of MPWT. These reports will also be incorporated in the quarterly project progress reports submitted to ADB

F. PUBLIC INVOLVEMENT

122. There have been extensive consultations with a wide range of officials while the local communities along the road were surveyed for their attitudes. The following is a list of organizations contacted during the IEE.

Phnom Penh

1. Ministry of Public Works and Transport
2. Primary Roads Restoration Project, Ministry of Public Works and Transport
3. Mekong River Commission; Cambodian Freshwater Capture Fisheries Project
4. Ministry of Rural Development; N.W. Rural Development Project
5. Ministry of Agriculture, Forests and Fisheries: Department of Fisheries; GIS Section
6. Ministry of the Environment

Siem Reap Province

1. Department of Public Works and Transport
2. Department of Environment
3. Department of Planning and Statistics
4. Office of Forestry
5. Office of Fisheries
6. Department of Land Use, Urbanization and Construction
7. Department of Water Resources and Meteorology
8. Wildlife Conservation Society (WCS)
9. Department of Tourism
10. All Districts, Communes and most of the villages that are located along the road
11. Hotel and Guest House Association

Banteay Meanchey Province

1. Department of Public Works and Transport
2. Department of Environment
3. Department of Planning and Statistics
4. Office of Forestry
5. Department of Land Use, Urbanization and Construction
6. Department of Water Resources and Meteorology (Siem Reap & Banteay Meanchey)
7. All Districts, Communes and most of villages that are located along the road

G. FINDINGS AND RECOMMENDATIONS

123. An IEE has been undertaken concerning the environmental assessment of the two Project components. These include the rehabilitation of 147 km of pavement, bridges and culverts along NR6/NR5 and the provision of new bridges along NR56 and NR68. While IEEs are based on an assessment of existing information, it is considered that overall there was adequate information to form reliable opinions on all of the most critical concerns. These were related to the siting of NR6/NR5 along the Transition Zone of the Tonle Sap Biosphere Reserve and the proximity of NR56 and NR68 to the Banteay Chhmar Protected Landscape and the Ang Trapang Thmor Sarus Crane Conservation Area. It was difficult to assess the effect of NR56 and NR68 with regard to possible effects on wildlife poaching and possible increases in woodfuel harvesting. In this case a monitoring program has been recommended so as to address this uncertainty, the output of which will be evaluated so as to make a better-informed decision on this critical issue, especially with regard to the need for any further measures.

124. The IEE shows that major impacts were identified for the presence of two ancient bridges along NR56 and to a lesser extent with a small shrine at Andong Meas village on NR5. The ancient bridges will need to be further assessed by a detailed engineering study that will be carried out during Detailed Design as to whether the bridges can continue to be used. Realignment of NR5 at the shrine can be effected with few problems. Moderate impacts were identified with regard to; (i) loss of agricultural land arising from siting borrow pits on private land, (ii) dislocation of people within the RoW (iii) increase in accidents to people and livestock, (iv) accidental risk of toxic spills and (v) unplanned settlement attracted to the RoW. All of these impacts can be mitigated. Otherwise, all of the other impacts have been assessed as being of small magnitude only and can be relatively easily mitigated. A monitoring program has been proposed, together with responsibilities and frequency of reporting. This will be carried out by the SEU within the DOP of MPWT. The dEMP will be assisted by the MoE and additionally requires the assistance of the Tonle Sap Biosphere Reserve and the Department of Environment for the Banteay Chhmar Protected Landscape.

The following recommendations are carried over from the text:

- i. Further investigations are needed with regard to developing a suitable design for the borrow pits so that these may provide a range of multiple uses for the farmers whose land they will be excavated on.
- ii. During Detailed Design a decision is required from the Ministry of Culture and Fine Arts and the APSARA Authority, with regard to the status of the two ancient bridges on NR68.
- iii. The formation of a Social and Environmental Unit within a restructured Department of Planning as already agreed as part of the proposed Project between the ADB and MPWT.

H. CONCLUSIONS

125. The IEE has identified a range of potential impacts and determined suitable mitigation measures together with a monitoring program. Implementation of the proposed mitigation measures and the monitoring program will reduce the impacts to insignificant levels. Consequently, no detailed EIA study is warranted and the IEE is regarded as the final environmental assessment report for the Project.

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