Environmental Assessment Report

Summary Environmental Impact Assessment
Project Number: 40919
August 2007

Nepal: West Seti Hydroelectric Project

Prepared by West Seti Hydro Limited for the Asian Development Bank (ADB).

CURRENCY
(as of 30 June 2007)

Currency Unit	–	Nepalese rupee/s (NRe/NRs)
NRe1.00	=	$0.0153
$1.00	=	NRs65.3

ABBREVIATIONS

ADB	–	Asian Development Bank
EIA	–	environmental impact assessment
EMU	–	environmental management unit
EMAP	–	environmental management action plan
EMP	–	environmental management plan
FSL	–	full supply level
FWDR	–	Far-Western Development Region
GLOF	–	glacial lake outburst flood
HEP	–	hydroelectric project
IUCN	–	World Conservation Union (formerly International Union for the Conservation of Nature)
MOEST	–	Ministry of Environment, Science and Technology
MWDR	–	Mid-Western Development Region
PDB	–	plant design and build (contractor)
PGCIL	–	Power Grid Corporation of India (Limited)
ROW	–	right-of-way
SEIA	–	summary environmental impact assessment
VDC	–	village development committee
WSH	–	West Seti Hydro Limited

WEIGHTS AND MEASURES

^{o}C	–	degrees Celsius
GWh	–	gigawatt-hours
ha	–	hectare
km	–	kilometer
kV	–	kilovolt
m	–	meter
m^3	–	cubic meter
m^3/s	–	cubic meter per second
MW	–	megawatt

NOTE

In this report, “$” refers to US dollars.

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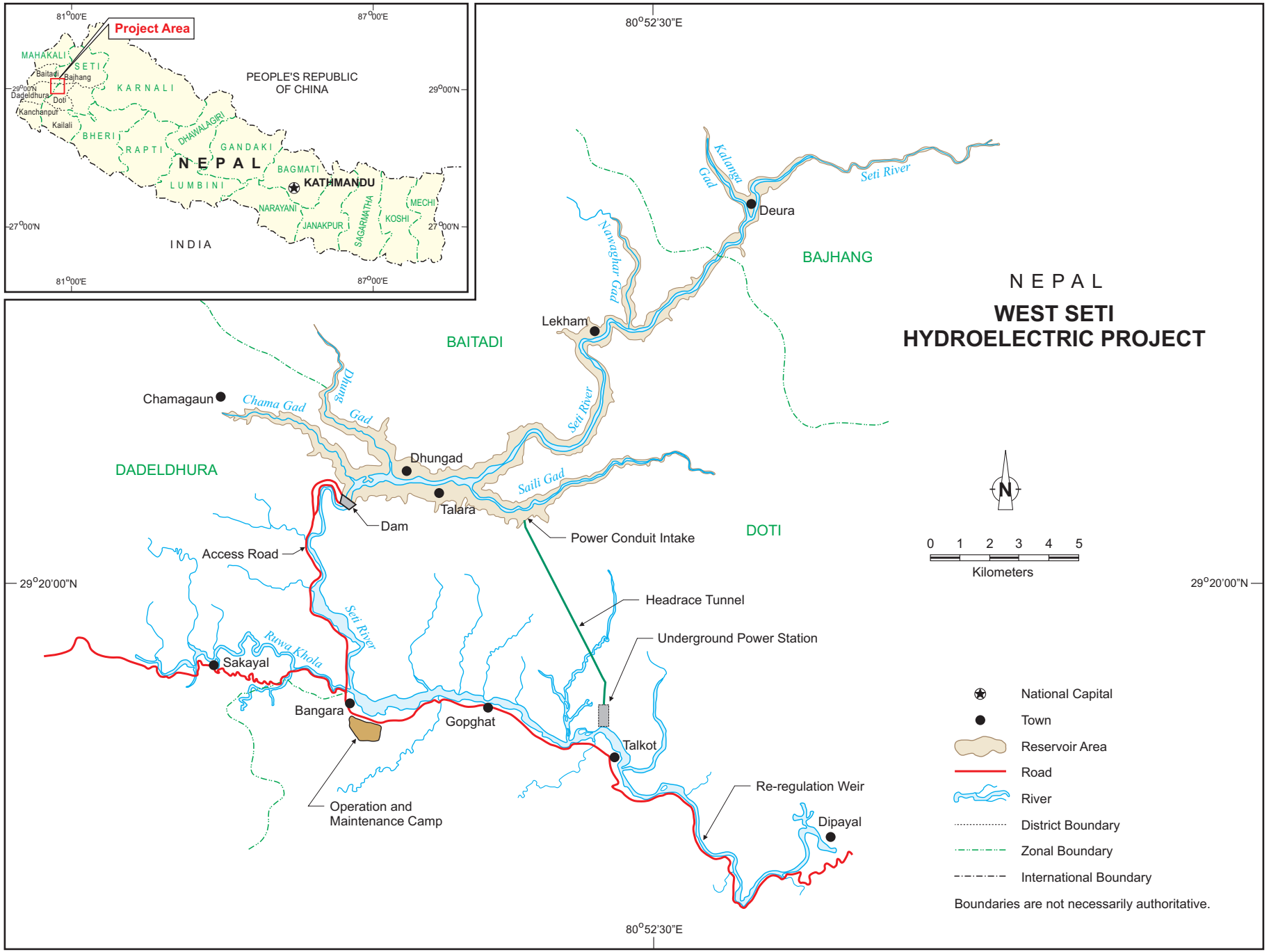

07-2491b RM

Map 1

NEPAL

WEST SETI HYDROELECTRIC PROJECT
TALKOT–MAHENDRANAGAR 400-kV TRANSMISSION LINE

07-2491c RM

Map 2

I. INTRODUCTION

1. The 750-megawatt (MW) West Seti Hydroelectric Project in Nepal's Far-Western Development Region (FWDR), proposed by West Seti Hydro Limited (WSH), is a storage scheme designed to generate and export large quantities of electrical energy to India. The Project will generate electrical energy throughout the year, storing excess wet season river flows in the reservoir, and using this water to generate energy during peak demand periods in the dry season.

2. SMEC International prepared a detailed environmental impact assessment (EIA) (seven volumes) for the Project, as required by the Government of Nepal to seek project approval.[1] The EIA was prepared between 1996 and 2000 in accordance with Government requirements by a team of in-house SMEC International specialists and local and international specialists. Planning requirements include the Environment Protection Regulation 1997 and the subsequent 1999 amendment to the regulation made under the provisions of the *Environment Protection Act* (1996). The EIA includes an environmental management action plan and resettlement action plan. In 2000, the Ministry of Population and Environment, now the Ministry of Environment, Science and Technology, approved the Project.

3. In 2007, an EIA was prepared for the project transmission line, the only component of the Project that had not been assessed in detail in the 2000 EIA. The 2007 EIA is about to be submitted to Government approval authorities. In 2006/07, a household census and sample socioeconomic survey were undertaken to update the resettlement action plan, while a vulnerable community development plan was prepared to focus on this group. In addition, a cumulative impact assessment and disaster management plan were prepared for the Project in 2007 and all costs were updated.

4. The Project is classified as ADB environment category A, primarily due to the magnitude of resettlement and the adverse impacts on land use and terrestrial and aquatic ecosystems. This summary environmental impact assessment (SEIA) is based on the project EIA (2000), transmission line EIA (2007), social update work, vulnerable community development plan (2007), cumulative impact assessment (2007) and disaster management plan (2007), with costs updated to 2007 prices and the main Seti River hydrological figures updated to include recent data.

II. DESCRIPTION OF THE PROJECT

5. Nepal has a large, untapped potential for hydropower development, one of the few major development options currently available to the country. The total potential for hydropower development is estimated to be 83,000 MW,[2] of which approximately 43,000 MW are considered economically viable but only 527.5 MW had been installed at the end of the 9th Plan (in 2002). During 2006/07, India faced a peak power deficit of 13.5% and power supply deficit of 9.9%; India's northern region had corresponding peak power deficit of 11.3% and power supply deficit of 10.9%.[3] These deficits are set to increase despite a significant increase in installed capacity in India over the last decade. These shortages make hydropower development in the

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1 SMEC International, 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

2 Shrestha, H.M.. 1966. *Cadastre of Potential Water Power Resources of Less Studied High Mountain Regions, with Special Reference to Nepal*. Ph. D. Thesis. Moscow Power Institute, USSR.

3 Central Electricity Authority. Available: http://www.cea.nic.in

Himalayan region, especially Nepal, an economically viable alternative to additional thermal power development.

6. The proposed 750 MW Project will generate and export large quantities of electrical energy to India under a power purchase agreement with PTC (India) Limited, which will in turn sell the power within the northern region of India. Under the terms of the 1997 project agreement between WSH and the Government of Nepal, the Government receives revenue from the sale of power through energy and capacity royalties. In addition, the project agreement incorporates an agreement whereby the Government could receive 10% of the output of the power station as free power or 10% of the revenue received under the terms of the power purchase agreement in lieu of free power. The Government chose the latter option. The Project will generate electrical energy throughout the year, storing excess wet season river flows and utilizing this water to generate energy during peak demand periods in the dry season.

7. The Project is a build-own-operate-transfer scheme, through which WSH has a 30-year generating license that will provide about 24.5 years of generation before full ownership of the Project is handed over to the Government. The power purchase agreement has a 25-year term from the date the Project starts commercial operation. The tariff will be on a take-or-pay basis and comprise (i) off-peak energy rate, (ii) peak energy rate, and (iii) excess energy rate. The average tariff will be $0.04.95/kilowatt-hour at the point of delivery on the Nepal-India border.

8. The Project is located on the Seti River in the FWDR. The dam site is located 82 kilometers (km) upstream of the confluence of the Seti and Karnali rivers, forming part of the Ganges basin. The project sites are located in the Middle Mountains, at elevations ranging from 550 to 920 meters (m) and spanning six districts. All project sites, excluding the reservoir area and transmission line corridor, are located in Doti and/or Dadeldhura districts. The reservoir is also located in Baitadi and Bajhang districts, and the transmission line corridor crosses Doti, Dadeldhura, Kailali, and Kanchanpur districts. The project area is accessed by road from the East–West Highway via the Mahakali Rajmarg (H14) and Seti Rajmarg (H15) National Highways, a distance of 139 km.

9. The Project consists of four Francis-type vertical-shaft turbines connected to four alternators, each with an output of 187.5 MW at the rated net head. This storage scheme is designed primarily to generate peaking power. The plant is expected to be operated to achieve a target minimum generation of 6 hours per day. The average annual electricity production will total about 3,636 gigawatt-hours (GWh). The main project features are a 195 m high concrete faced rock-fill dam, 2,060 hectare (ha) reservoir area, 6.7 km headrace tunnel, underground power station, 620 m tailrace tunnel, reregulation weir, switchyard, 20.3 km permanent access roads, and 132.5 km 400 kilovolt (kV) double-circuit transmission line in Nepal; as well as permanent accommodation for up to 200 operation and maintenance staff.

10. The Project will generate power from a head of 259 m, created by running the headrace tunnel across a river bend of the Seti River and thus diverting water around a 19.2 km river section. The reservoir will fill during the monsoon season (mid June to late September/early October), and then water will be drawn down to generate power at peak times each day during the dry season. The reservoir will inundate 25.1 km of the Seti River and a total of 28.0 km of five main tributaries (Chama Gad, Dhung Gad, Saili Gad, Nawaghar Gad, and Kalanga Gad). The reservoir will have a total storage capacity of 1,566 million cubic meters (m^3) (926 million m^3 of live storage and 640 million m^3 of dead storage) and a drawdown range of 59 m (from the full supply level to minimum operating level). The peak generation flow will be 330 m^3/s.

11. The daily and seasonal pattern of power generation will be dictated by market demand. Average power generation over the 7 months from November to May is likely to be over two periods per day to match peak power demand in India. These demand periods, and hence the likely daily periods of generation, based on a target of 8 hours generation per day, are 0600 to 1000 hours and 1800 to 2200 hours.

12. The reregulation weir will attenuate changes in river flows during starting and stopping of the generators, reducing the large and rapid daily power station discharges to a more even flow. The attenuated flow will rise over 4–5 hours, commencing soon after initiation of the power station release. A similar fall will occur after the shutdown of the station. The average flow below the reregulation weir will briefly drop to a minimum of 50 m^3/s if generation occurs only once a day during the 7 months of the year when average total generation is likely to occur for 7.4–9.0 hours per day.

13. Power will be transmitted from the Project via a 230.5 km 400 kV transmission line. The initial 132.5 km of this line will be located in Nepal, running south from the switchyard to Attariya then west to Mahendranagar, with the final 98 km heading southwest in India to join the Indian electricity transmission grid at Atamanda, 22 km north of Bareilly.

14. Project construction is targeted to commence in late 2007 and take 66 months (5.5 years) to complete. The construction workforce will peak at around 3,400. The total cost of the Project is estimated to be $1,200 million.

III. DESCRIPTION OF THE ENVIRONMENT

A. Physical Resources

15. The project catchment covers 4,250 square kilometers (km^2), comprising 57% of the total Seti River catchment (7,460 km^2), 9.5% of the Karnali River basin within Nepal and the People's Republic of China (42,500 km^2), 0.38% of the Ganges basin, and 2.7% of the total surface area of Nepal. The predominant land types in the catchment are rocks and snow (38.6%), and forests (35.1%). Secondary land uses include cultivation (13.3%) and grassland (10.7%). Accordingly, the main land use enterprises in the catchment are forestry, cereal cropping and grazing. Approximately 40% of the catchment lies above the tree line (above 4,000 m), where seasonal grazing up to 5,000 m is the only land use activity.

16. The climate in the catchment ranges from alpine in the high altitude upper catchment, to warm temperate, subtropical monsoon at the main project sites. Rainfall is primarily brought by the Indian southwest monsoon, generally between mid-June and the end of September, delivering 72%–80% of the annual rainfall.

17. The average annual Seti River discharge rate at Gopghat, located 14 km below the dam site, is 206 m^3/s; equivalent to a total annual flow of 6,519 million m^3. River flow rates are highly seasonal, with 86% of the annual flow occurring from May to October. The lowest flows occur during the dry season months of January to April, with a mean discharge in February, the driest month, of just 46 m^3/s. River discharge rates rapidly increase from late May, reaching a peak monthly mean discharge of 637 m^3/s in August. A daily variation in river flow generally occurs throughout the year due to increased snow melt during the daytime in the upper catchment. This variation peaks from May to August when the snow pack is melting, reaching a maximum daily water depth variation of 60–70 centimeters in June.

18. Seti River water temperatures at Gopghat range between a mean minimum of 10 degrees Celsius (°C) in January and a mean maximum of 19°C in August/September. Suspended sediments usually peak in August during the monsoon season, and then fall to a low in February/March. Recorded fecal coliform colonies per 100 milliliters range from 6 to above 600 (classified as "too numerous to count"), substantially exceeding raw drinking water criteria of 0 per 100 milliliters.[4]

19. The project area is located in the Lesser Himalayas tectonic zone, characterized by a broad belt of folded and faulted Precambrian to Tertiary rocks developing a number of thrusts and nappes. A large thrust sheet, known as the Karnali Klippe, occurs to the east of the project area. The stratigraphy of the Seti basin consists of three major groups: the Surkhet, Midland, and Dadeldhura groups.[5] Several large or great earthquakes exceeding modified Mercalli 8 have affected the FWDR during the past 1,000 years. Recent earthquake activity in the project area is dominated by events along the south boundary of the Himalayas; a regional seismicity study concludes that earthquake hazard in the area is high.[6]

20. Forests in the catchment are extensively grazed and harvested for fuelwood, timber, fodder, herbs, wild fruits, and vegetables. The majority of forests are government managed, although community forests are increasingly being established. Cultivation is the main form of household agricultural production. Cropping occurs up to 4,200 m, with irrigated land mainly located on valley floors and rain-fed land on hill slopes. Livestock, predominantly comprising cattle, buffalo, and goats, are grazed on communal grasslands and forests, and private land.

21. Land use on sites to be acquired by the Project (2,326 ha) is dominated by forests (34.6%) and cultivation land (28.3%), which comprises 466 ha of irrigated and 193 ha of rainfed land. Riverine features make up 17.6% of the area; grasslands 10.6%; shrubs 7.3%; and abandoned cultivation land, settlements, rocks, cliffs, and scree 1.6%.

B. Ecological Resources

22. Forest cover in the four catchment districts ranges from 29% in Bajhang district to 75% in Dadeldhura district.[7] Miscellaneous forest types predominate in all project catchment districts except Baitadi, where coniferous forests are dominant at higher elevations. Eight forest types were identified in the reservoir area: Sal, Sal-pine*, Aegle Marmelos*, mixed broad-leaved, Chiuri, Mallotus, pine, and Acacia. Most vegetation in and around the reservoir area is disturbed, with many forests being highly disturbed. Eleven forest types were identified within the transmission line ROW; all are common in Nepal and found in similar ecological zones of the central, western, and far-western regions.

23. Twelve plant species of conservation significance, listed under different categories of the World Conservation Union (IUCN),[8] were recorded in Seti valley project sites. One species, *Butea frondosa*, is classified as being endangered, two as vulnerable, five as rare, and four as

[4] Australian and New Zealand Environment and Conservation Council (ANZECC). 1992. *Australian Water Quality Guidelines for Fresh and Marine Waters*. National Water Quality Management Strategy Occasional Paper No 4, Canberra: Australian and New Zealand Environment and Conservation Council.

[5] SMEC International, 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

[6] Royal Melbourne Institute of Technology (RMIT). 1997. *Review of Seismicity – West Seti Hydroelectric Project*. Melbourne Seismology Research Centre. Melbourne.

[7] Water and Energy Commission Secretariat (WECS). 1988. *District, Regional and National Forest Cover Class Summaries of the Area, Fuelwood Yield and Wood Volume for the Kingdom of Nepal*. Kathmandu.

[8] World Conservation Union. 1986. *Plants in Danger*. Gland, Switzerland and Cambridge, United Kingdom.

commercially threatened. Five plant species of conservation significance as classified by IUCN occur within the transmission line ROW (one rare, two endangered, and two commercially threatened). *Michelia kisopa* and *Butea frondosa*, both endangered, were each only observed at one location. The rare species *Alstonia scholaris* was also observed at one site only.

24. A total of 140 bird species were observed in the Seti valley project area, including 11 species identified to be of conservation significance, but only the Yellow Cheeked tit (*Parus xanthogenys*) is listed as endangered (IUCN). Although this species is considered endangered, it is a common resident in Nepal between 915 and 2,300 m. Mammal diversity and distribution in the Seti valley project area is typical of the Middle Mountains, where human influence has been extensive. All identified species are common in Nepal, and most are common locally. No observed species are included in Nepal's Protected (Schedule 1) Species list.[9] Ten species of mammals and 56 species of birds native to the physiographic regions crossed by the transmission line route (excluding Shuklaphata Wildlife Reserve) were recorded either by direct observation or from secondary sources. Mammal and bird diversity is greater in the hills than the terai. None of these 10 mammal species are listed by IUCN, but six mammals are listed as susceptible in the *National Red Data Book* and under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), even though all of these species are considered common in the project area and elsewhere in Nepal.

25. Only two common herpetofauna species were observed in the project area: garden lizards and geckos. However, based on discussions with villagers, 34 species of herpetofauna are suspected to occur in the Seti valley project area. Two of these species are endemic to Nepal: *Scutiger nepalensis* (Khaptad Pelobatid toad) and *Paa ercepeae* (Bajhang frog). None of the three herpetofauna species listed as protected on the Protected (Schedule 1) Species list (footnote 9) are known to occur in the project area.

26. The snow-fed Seti River provides a cold water aquatic habitat, with numerous large boulders in this wide watercourse providing shelter for fish and potential spawning sites. Few aquatic plants were observed in the project area, probably due to high velocity and high turbidity in the Seti River and reservoir tributaries. Phytoplankton species recorded in all sampled watercourses included *Synedra ulna* and *Navicula spp*. The dominant zooplankton species was *Calanodia*. Thirteen fish species were identified in the project area. None of the identified species are protected under Government legislation or recorded on IUCN and CITES international lists. However based on the classification of Shrestha[10] one species is rare (*Glyptothorax telchitta*), five are vulnerable, one is common, one is fairly common, one is occasional, and four are insufficiently known. The dominant fish species in the Seti River and reservoir tributaries is the cold water species *Schizothorax plagiostomus*, locally known as Buche Asla. The migratory species Mahseer (*Tor putitora)* and Jalkapoor (*Clupisoma gaura*) were reported to be common during the monsoon.

27. Two protected areas are located in the project area: Shuklaphata Wildlife Reserve and Kaptad National Park. A 2.9 km section of Shuklaphata Wildlife Reserve will be crossed by the transmission line. The reserve was proclaimed to protect the last remaining herds of Swamp deer (*Cervus duvauceli*) in Nepal. Other wildlife species of note in the reserve are Bengal tiger, Asian elephant, Indian rhinoceros, Blue bull, and sloth bear. The section of the reserve to be crossed by the line, consisting of degraded forest and grassland, serves as a migratory corridor

[9] Ministry of Law and Justice, 1973. *National Parks and Wildlife Conservation Act 1973*. Kathmandu.
[10] Shrestha, J. 1995. *Enumeration of Fishes in Nepal*. Technical Publication No. 10. Kathmandu and Euroconsult Arnhem, The Netherlands.

for animals moving between the terai and hills, including occasional visits by Asian elephants, although wildlife diversity in this area is low. Kaptad National Park is located 8–14 km southeast and east of the reservoir area, generally above 2,500 m, with access difficult from the project area. Kaptad National Park was gazetted in 1984 to protect representative forests of the western middle hills. It covers an area of 225 km^2 and contains diverse habitats, including coniferous, hardwood and mixed forests; shrublands; and grasslands. A feature of the park is its grasslands, which include 22 major pastures.

C. Economic Development

28. Based on household surveys undertaken in the reservoir area (1997–1999, 2006) and along the transmission line ROW (2007), the prime occupation of the surveyed population 15 years and older is agriculture (68.1% in the reservoir area and 50.9% along the transmission line route), followed by business and services (11.3% and 14.3%), and wage labor (4.9% and 7.8%). Students comprise 10.7% of the population 15 years and older in the reservoir area and 15.6% along the transmission line ROW. Women in the terai districts have more mobility and access to nonagricultural livelihood earning activities than their counterparts in the hill districts. In the reservoir area, 82.0% of females in the 15 years and older age group are engaged in agriculture as their primary occupation, compared to 60.7% of women surveyed along the transmission line ROW. Overall, women's income-earning activities are essentially limited to the subsistence agriculture, while men have greater access to business, service, and wage labor opportunities.

29. Subsistence agriculture is the dominant economic activity in the FWDR and project area. Valley cultivation in the reservoir area is dominated by rice and wheat, with average crop yields higher than district averages. Paddy and wheat are also cultivated on irrigated hill slopes, while the dominant crops on rainfed hill slopes are upland rice, millet and/or maize, followed by wheat in winter. Paddy, wheat, potatoes, and maize are the main crops cultivated along the transmission line ROW. Secondary crops include millet and pulses. Crop yields in the terai are generally higher than in the hills due to higher soil fertility.[11]

30. Livestock raising (mainly cattle, water buffaloes, and goats) is an important subsistence farming activity. Livestock provide meat, milk, eggs, and a cash income. Large livestock are also an integral part of cropping activities, providing draught power and producing organic fertilizer. Livestock is grazed on private and communal land.

31. Land tenure is in the form of simple freehold (*raikar*); incidence of registered tenancy is low, although low castes groups such as the *Kami* (iron smith), *Damai* (tailor), and *Sarki* (shoemaker) often depend on landowners for their subsistence (e.g., grain payments or donations). Land-poor households sometimes rent cultivation land from larger landowners.

32. Landholdings are generally small, with the EIA household surveys recording average private holdings of 1.14 ha in the reservoir area and 0.76 ha along the transmission line ROW. In the reservoir area, just over 15% of households are recorded as landless, while 44.5% have landholdings of 1 ha or less. This latter category owns only 16.3% of the total reported landholdings. Households with landholdings between 1 and 2.5 ha constitute 42.8% of the affected households and own 49.4% of cultivation land, while owners of holdings larger than 2.5 ha constitute 12.7% of the affected households but own 34.3% of the land. Along the transmission line ROW, 54.4% of surveyed households are recorded as marginal landholders

[11] Central Bureau of Statistics. 2002. *Census of Agriculture 2001/02.* Kathmandu.

with holdings of 0.5 ha or less. These landholders own only 17.4% of the total reported private land. Nearly 80% of households have holdings of 1 ha or less.

33. People in the project areas engage in a range of enterprises to supplement crop production or generate a cash income. In the reservoir and downstream areas this includes the production of ghee (liquid butter) from Chiuri trees and bee-keeping. People also catch fish, mainly from the Seti River. Fishing is either undertaken on a part-time or professional basis to generate income and for household consumption, forming an important source of protein in the diet of people living near the Seti River, although only 0.3% of households in the downstream riparian area rely on fishing for their main source of income. Off-farm enterprises in both the reservoir area and along the transmission line include teashops, general stores, traditional trades such as metal work, and transport of goods by porters.

34. Seasonal (circular) and permanent labor migration is a common feature in the FWDR. Push/pull factors leading to migratory employment in India, from the hills to the terai, and to other areas of Nepal include lack of work in the mountain/hill zones during the slack agricultural season and low wage rates in the local off-farm economic sector. Migration from the hills to the terai also reflects people's desire to gain access to agricultural land, services, and trade; and employment opportunities in the lowlands.

35. The EIA household surveys show that the main sources of household income are agriculture, animal husbandry, and off-farm (non-agricultural) activities. Off-farm activities include professional services, petty trade, cottage industry, pensions, wage labor, sale of nontimber forest products, and remittances. Computed average annual household incomes (2006/07) ranged from NRs91,674 to NRs112,821, with off-farm sources contributing 40.2% to incomes in the reservoir area and 51.9% to incomes along the transmission line. Annual income differs by caste/ethnic group and gender of the household head, with Tharu, Dalit (socially excluded castes), and female-headed households earning the lowest incomes.

36. Since the beginning of the 8th Plan (1992–1997), poverty reduction has been a major development focus. Nevertheless, even though the incidence of poverty is gradually declining across all regions, substantial regional disparities remain. In fiscal year 2003/04, poverty incidence in the FWDR was 41.0%, substantially higher than the national average of 30.8%. By ecological region, poverty incidence is higher in the hill and mountain regions than the terai.[12]

37. Services, commercial activities, and industry in the four hill districts affected by the Project are restricted to government administration and services, and small-scale commercial retail and service activities in the larger settlement areas of Dipayal and Dadeldhura. No medium- or large-scale industry exists in the project area districts.

38. No major water resource developments such as irrigation schemes and hydropower development have been developed in the Seti River basin. The major use of river water in the Karnali basin is irrigation, supplying three areas on the Nepal terai and two areas in India. The irrigation diversions in Nepal are located approximately 170 km downstream of the project dam site (85–90 km below the Seti–Karnali confluence). Total demand for irrigation water from the three main Karnali River diversions in Nepal amounts to a mean annual rate of 54 m^3/s;[13]

[12] Central Bureau of Statistics. 2005. *Poverty Trends in Nepal (1995-96 and 2003-04)*. Kathmandu

[13] Himalayan Power Consultants. 1989. *Karnali (Chisapani) Multi-purpose Project*. Feasibility Study, Main Report. Kathmandu.

equivalent to 3.9% of the 1,370 m^3/s mean annual Karnali River flow into India.[14] In India, water is diverted from the Karnali River at Girijapur Barrage (located 20 km downstream of the Nepal–India border) into the Sarda Sahayak irrigation scheme, which has a 2 million ha command area, while the Saryu Nahar irrigation scheme currently under construction will irrigate 1.2 million ha. The combined annual water demand from these two projects is 10,000 million m^3 (317 m^3/s), equivalent to 23% of the mean annual Karnali River flow.

D. Social and Cultural Resources

39. All project components are located within the FWDR, considered to be one of the least developed regions of the country. The reservoir is located in parts of 15 village development committee (VDC) areas and the downstream project developments (power station, reregulation weir and construction camps) are located in another four VDCs. The transmission line crosses the four downstream VDCs as well as an additional 15 VDCs and two municipalities. The combined population of the 30 VDCs and the concerned wards of the two municipalities is estimated at 345,508 based on 2001 figures.[15]

40. Migration from the hill/mountain areas of Nepal to the terai is a common demographic feature and reflects the growing economic, social, and cultural links between the hill and terai zones. In 2001, 54.6% of the FWDR population was resident in the seven hill/mountain districts, down from 67.6% in 1981. In 2006, the share of the hill/mountain districts was estimated to have decreased to just over 53% of the FWDR population.

41. The Hindu caste groups (the high caste *Brahmin*, *Thakuri,* and *Chhetri;* the middle caste group; and the low caste group, including the Kami, Damai, and Sarki) generally dominate the area. Many of the low caste groups are marginal landholders, often dependent on the high caste groups for their livelihoods. In general, the VDCs and municipalities in the hills are ethnically less diverse than those on the terai, where communities of the Tharu indigenous group, in particular, are also present.[16]

42. Settlement patterns generally reflect the distribution of arable land and market areas, with the two municipalities exhibiting higher semiurban/urban land use patterns. In the reservoir area, many of the larger settlements (e.g., Dhungad) were established in proximity to valley cultivation land by rulers and high caste groups, while other settlements (e.g., Deura) developed as market areas along trade routes. Population concentrations in the reservoir area occur in the main valley at Dhungad, Talara, Lekham, Deura, and Chaudam, and along some of the tributaries, such as the Chama Gad and Nawaghar Gad. Numerous other scattered settlements or household clusters occur in the reservoir area, ranging in size from several houses to more than 30 houses. Some households have more than one residential house, situated in different settlements at different elevations (i.e., in valleys, on hill slopes, and/or on ridges), occupied at different times of the year according to agricultural activities.

43. The overall literacy rate of the FWDR population aged 6 years and older increased substantially from 32.2% for the 1991 census to 48.2% for the 2001 census, but was still some

[14] Sharma, 1977. A Treatise on Water Resources of Nepal. Kathmandu.

[15] Compiled from Central Bureau of Statistics. 2003. *Population Monograph of Nepal Volume 1.* Kathmandu: His Majesty's Government of Nepal; and Central Bureau of Statistics. 1997. *Statistical Year Book of Nepal*. Kathmandu.

[16] Central Bureau of Statistics. 2002. *Population Census of Nepal: Village Development Committees/Municipalities.* Kathmandu: His Majesty's Government of Nepal; Central Bureau of Statistics. 2003. *Population Census 2001; Caste/Ethnicity, Mother Tongue, Religion (District).* Kathmandu.

5.5% lower than the national average. The gender gap in literacy is large in the FWDR, with 64.1% of males aged 6 years and older classified as literate in 2001, compared to only 32.8% of females. Female literacy rates are lower in the hill districts than in terai districts. A survey of a sample of 230 households in the reservoir area (December 2006) recorded literacy rates of 67.2% for the population 6 years and older: 85.3% for males and 45.4% for females.

44. Twenty-two schools are located in and around the reservoir area and 11 in the riparian area between the dam and the tailrace outlet. Long walking distances to schools, poor classroom facilities, high teacher-student ratios, and domestic demands place constraints on education, with high student dropout rates.

45. The Seti River is used by local communities for religious festivals, ceremonies, fishing, washing, and recreation. Most communities use natural springs or side streams for drinking water; however some riparian villages use the river as a secondary potable source during the dry season.

46. Access in the Seti valley to agricultural land and communal forest and grassland resources located away from homes, and for trading, schooling, communication, and social purposes, is provided via foot trails. The main local destinations outside the reservoir area, Gopghat, Dipayal and Dadeldhura, where goods are traded or basic services accessed, are reached by three main access routes. Two tourist destinations are located in the region: the High Himalaya above Chainpur is occasionally visited by mountaineering teams and trekking groups; and Kaptad National Park, 8–14 km east of the reservoir, receives a small number of tourists annually.

IV. ALTERNATIVES

47. Different project options and design alternatives were considered as part of the project feasibility and design process. Alternatives were assessed on operational, economic, engineering, environmental, and/or safety aspects.

A. Without the Project

48. To forego developing the Project will result in the loss of significant export earnings from a major underdeveloped natural resource that Nepal has in abundance: water-based energy. This would result in the Government foregoing total annual payments (royalties, revenue share, and taxes) of $18 million in year 1 of operation, rising to $43 million in year 16, and totaling $991 million over the 30-year generation license, as well as total project revenues of around $170 million per year after this period. The significant regional economic development that the Project would create will not occur, comprising an estimated 1,000 local semiskilled and unskilled construction jobs and some 100 operations jobs, while regional flow-on economic benefits from the provision of goods and services would not occur. In addition, the resettlement of people from project sites to the terai has the potential to provide improved socioeconomic conditions and opportunities from additional cultivation production, market access, and access to social amenities.

49. The main benefit of not developing the Project is avoiding the range of associated environmental and social impacts. The main impacts that would be avoided are seasonal and daily changes to river hydrology, habitat loss, degradation/changes to aquatic ecology, cultivation land loss (659 ha), forest loss (851 ha cleared and up to 94 ha pruned), and population displacement and resettlement.

B. Alternative Forms of Generation

50. Alternative forms of large-scale generation include thermal (coal and gas), solar, wind, biomass, and nuclear power. Power from fossil fuel powered thermal plants (coal or gas) is not economically feasible in Nepal as all fuel would have to be imported at a high cost and the plant would be competing for electricity sales with plants in India located near the fuel source. In addition, the production of large volumes of greenhouse gases from thermal power plants is an undesirable environmental impact avoided by hydroelectricity, in line with Nepal's commitment to the Convention on Climate Change (1992).

51. Solar and wind power cannot generate on-demand peaking power due to the intermittent nature of generation and inability to store this volume of power economically. These forms of generation are not cost-effective due to less than ideal conditions for generation in Nepal (i.e., average wind speed, year-round solar radiation) and the relatively high cost of installation/operation in comparison to hydropower generation. Biomass generation cannot economically produce a large volume of energy from a single plant due to uneconomic cost increases once fuel transport distances exceed about 50 km. Nuclear energy is an expensive and complex form of generation that is untried in Nepal and has perceived safety issues, therefore it is deemed unsuitable.

C. Alternative Hydroelectric Projects and Locality

52. Other major potential hydroelectric developments in the west of Nepal are the Chisapani (Karnali) multipurpose scheme and the Upper Karnali scheme. Although the 10,800 MW Chisapani storage scheme would generate around 20,842 GWh,[17] more than 5.7 times the electricity to be generated by the Project, it would create a significantly greater magnitude of adverse impact. The Chisapani scheme will involve the resettlement of at least 60,000 (1989 estimate (footnote 13) in comparison to an estimated 12,914 people for the Project, it would directly impact Bardia National Park, and require agreements to be reached between Nepal and India on sensitive cross-border water issues. The 300 MW Upper Karnali run-of-river scheme will involve almost no resettlement and occupy very little land in comparison to the Project, but this scheme will only produce around 44% of the power produced by the Project (1,590 GWh per annum compared with 3,636 GWh per annum).

53. The project site is located in close proximity to the large northern Indian energy market, with a relatively short length of transmission line required to connect to the Indian grid. The Government wants to develop the western regions of the country where little development presently occurs. The construction and operation of a major hydroelectric facility in this region will provide significant economic benefits to this region, generate a significant number of jobs, and provide a local economic boost.

D. Alternative Project Designs

54. **Project Type**. A storage versus a run-of-river scheme was considered for the Project. In 1981, a 37 MW run-of-river scheme was proposed 8 km upstream of the current dam site based on preliminary studies conducted in 1980/81. Three alternative barrage designs were considered based on engineering criteria: (i) dam with overflow weir, (ii) barrage incorporating

[17] Bhattarai, D.. 2006. *Hydro-power Projects in Nepal*. Paper presented at USAID conference *Powering Nepal—Connecting Markets*. Kathmandu.

high gates, and (iii) barrage with double gates at medium height. The double-gated barrage arrangement, based on raising the gates for all river flows above 1,000 m^3/s to allow the passage of large boulders through the barrage and shutting down the power station, was selected because this design avoided the risk of damage to gate sills, deterioration of the stilling basin, and harm to turbines from grit and pond sedimentation.[18] This would result in the loss of energy generation during all high flows, with annual power generation from this scheme estimated to be 319 GWh. Resettlement and land take required was estimated to be less than 15% of that required for the Project, the predicted impact on river hydrology was substantially lower as seasonal river flows would not be altered, but the dewatered length of river would be 31 km (barrage to tailrace outlet) as opposed to 19.2 km for the Project.

55. During prefeasibility investigation in the 1980s, the current dam site was identified for a storage scheme. This site was deemed suitable because the valley narrows between suitable underlying geology, a headrace tunnel could be constructed that was not excessively long across a major bend in the Seti River, and the reservoir capacity was sufficiently large enough to retain a large volume of the annual river flow. Three alternative designs with different dam heights and installed capacities were compared to select the optimum storage scheme (Table 1), ranging between 147 and 187 m height and 210 and 360 MW (no higher dams were considered due to landform limits). A 360 MW scheme with a 187 m high dam capable of generating an estimated 2,402 GWh per annum was selected due to its higher economic internal rate of return (15.97%).

Table 1: Comparison of Initial Hydroelectric Storage Project Options

Feature	Dam Height		
	147 meters	177 meters	187 meters
Dam Crest Elevation (meters elevation)	1,240	1,270	1,280
Installed Capacity (megawatts)	210	325	360
Rated Discharge (cubic meters/second)	100	140	150
Economic Internal Rate of Return (%)	13.93	15.50	15.97

Source: Sogreah. 1987. *West Seti Hydroelectric Project, Feasibility Study, Final Report, Main Report*. Grenoble.

56. The annual energy generation of the 360 MW storage scheme was estimated to be 2,083 GWh greater than the 37 MW run-of-river scheme, a more than seven-fold increase representing a significantly more favorable option. The storage scheme was selected as it optimizes energy production and financial return without a corresponding increase in environmental impacts, and capitalizes on this storage site, a limited opportunity in the Himalayas.

57. **Project Design and Operation**. The main project design alternatives considered were dam type, dam height, and reservoir operating range. A concrete face rock-fill dam was selected over a concrete gravity dam and a concrete arch dam based on dam stability and cost. The concrete face rock-fill dam has proven earthquake resistant, can be constructed from locally available materials, and has the lowest cost. Dam height was primarily optimized based on project economics. A full supply level (FSL) of 1,284 m[19] was selected based on improving project economic viability as the dam height is increased up to the extent of hard rock on the western abutment of the site. A comparison was then made between the extent of resettlement and land take associated with this water level against a 40 m lower level (1,240 m) (Appendix

[18] Sogreah. 1987. *West Seti Hydroelectric Project, Feasibility Study, Final Report, Main Report*. Grenoble.
[19] The original design had a FSL of EL 1,280 m that was later raised by 4 m to EL 1,284 m by the addition of Hydroplus fuse gates.

1). While resettlement is reduced by 20.6% and land take by 32.5% with the lower FSL, the lower FSL reduces energy by 884 GWh per annum and the financial return by more than 2% to a level that threatens the Project's economic viability. This energy difference becomes more marked with a 750 MW capacity station, with the lower FSL rendering the Project economically unviable.

58. The reservoir minimum operating level was designed to maximize reservoir dead storage volume to accommodate sediment and hence maximize the life of the Project, without changing the minimum monthly target energy outputs in the dry season. A minimum project life of 50 years was sought. Minimal water level fluctuation (from FSL to minimum operating level) was also sought to reduce the drawdown-exposed foreshore area and the drawdown rate, thereby reducing foreshore erosion and landslip hazard. The initially selected drawdown range of 96 m was subsequently reduced to 59 m to achieve these objectives.

59. Alternative flow rates for the base environmental release from the dam to supply river water along the 19.2 km section of the Seti River between the dam and tailrace outlet were considered. A constant base flow is required to provide water suitable for existing non-potable uses such as stock water and washing, and to support an aquatic habitat between the dam and tailrace outlet, while minimizing the volume of water released to maximize the volume of water available for power generation. A base environmental flow of 4 m^3/s was selected to provide sufficient water of acceptable quality for essential non-potable uses and to support a substantially reduced and highly modified aquatic ecosystem, while minimizing the reduction in stored water available for generation in the main power station. This release will be used to generate electricity through an 8 MW power station to be installed on the riparian outlet at the dam. The base release flow rate was influenced by project economics, as each 1 m^3/s released (equivalent to 31.5 million m^3/s) is worth an estimated $644,000 in foregone generation (based on an estimated 30% energy recovery from the riparian power station in comparison to the main power station). The power generated from the riparian power station will be available for sale to the Nepal Electricity Authority (NEA) at a price comparable with that produced by the main power station, and will most likely be used to supply the local area, improving electricity reliability in the area.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

60. The four significant biophysical issues associated with the Project are hydrology, land resources, ecosystems, and natural and project-induced hazards (Table 2).

Table 2: Primary Biophysical Issues and Impacts

Primary Biophysical Issue	Impact / Benefit
Hydrology	• Creation of reservoir water body • Altered seasonal river flows • Changed river water quality • Riverbed degradation
Land Resources	• Loss of agricultural land • Loss of forest resources
Ecosystems: Terrestrial and Aquatic	• Loss of vegetation • Loss of habitat: terrestrial and aquatic • Habitat change: aquatic
Natural and Project-Induced Hazards	• Impact of floods • Reservoir foreshore landslides • Impact of glacial lake outburst floods • Impact of landslide dams • Seismic risk • Impact of sedimentation

Source: SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

A. Hydrology

61. Seti River hydrology will be altered by the seasonal impoundment and controlled release of water from the reservoir. During reservoir filling, water in the lower levels (below 140 m depth) will have a low dissolved oxygen concentration (below 4 mg/liter) unsuitable to support an aquatic ecosystem, while coliform bacteria will be present in reservoir water, making the water unsuitable for drinking. Medium- to long-term reservoir water quality will be similar except that temperatures will be lower and reservoir water will be mixed annually (in January each year) due to cold Seti River inflows in winter plunging to the bottom of the reservoir, thus raising the dissolved oxygen concentration in bottom waters. The reservoir will be oligotrophic (low in nutrients) due to inflows with low organic and nutrient loading, and the short average residence time of stored water (averaging 85 days) created by the annual inflow (6,519 million m^3) being more than four times the storage volume of the reservoir (1,566 million m^3) and the draining of live storage (59% of total storage volume) virtually every year.

62. River flows between the dam and tailrace outlet (19.2 km) will be substantially reduced due to the mean annual diversion of 86% of river water through the power station. Flows will consist of a base environmental release, dry season flushing flows, flood flows over the spillway, and intermediate catchment runoff, providing a mean total environmental flow of 13.6% of the annual mean Seti River flow (ranging between 3.2% and 30.9% of mean monthly river flow rates during the year). The continuous environmental release, equivalent to a 4 m^3/s surface flow immediately upstream of the Ruwa Khola (9.5 km below the dam), will meet all existing non-potable domestic water requirements (bathing, washing, etc.), stock water needs, and water for religious practices; and maintain a substantially reduced stream ecosystem. Three flushing flows will be released each dry season in late December, late February, and late April to remove accumulated nutrients and algal growth from the river. The effect of flushing flows will be monitored, and the volume and timing of flows will be adjusted accordingly. Flood flows during the monsoon will average 10.5% of the annual mean river flow.

63. River flows downstream of the tailrace outlet will be decreased from May–October and increased from November–April. The corresponding mean Karnali River flow at Chisapani will

be increased by 1%–18% from December to April, and decreased by 2%–15% from May to October. Seasonally regulated river flows will not detrimentally affect the supply of water to the three irrigation schemes that supply Bardia and Kailali districts in Nepal, as altered flows would only decrease the total Karnali River flow by 5% in the peak demand month (October) for the driest year on record (1966), with 67% of the river flow remaining once the irrigation demand is met.

64. Flow regulation will provide a potential irrigation benefit to India by increasing dry season firm minimum flows in the Karnali River at Girijapur Barrage (Katerniaghat), as indicated by an increase of 1%–27% from November to May for the driest recorded year (1966). But river flows may also be reduced late in the dry season if monsoon rains are delayed and generation occurs at a reduced rate, reducing the volume of water available for irrigation during this period.

65. Flows between the tailrace outlet and the reregulation weir will be substantially altered in all months of the year except when the reservoir spills occur, and during August and September when average power station discharges will occur for almost 24 hours a day. Flows downstream of the reregulation weir will be attenuated by the weir, but will still vary in rate across the day. This change will be greatest from November to May, with flows ranging from a peak of 243 m^3/s down to a minimum flow of 50 m^3/s over 24 hours if generation occurs over a single 8-hour period per day. The maximum and minimum flows will occur for a short duration (less than 10 minutes), with these extremes equating to a depth change of between 0.71 m and 1.30 m and a velocity change of between 0.72 m/s and 1.13 m/s in the Seti River below the weir.

66. Power station discharges will generally be warmer than existing Seti River flows from December to February (peaking at up to 4^oC–5^oC warmer in January); a similar temperature in March, October, and November; and cooler from April to September (up to 4^oC cooler in August and September). Automatic flood warning sirens will be activated between the tailrace outlet and the reregulation weir by power station discharges to warn of imminent power station discharges.

67. Dam operation will reduce the frequency and volume of downstream floods. The reservoir storage characteristics will reduce a 1 in 100-year flood from 5,100 m^3/s to 4,850 m^3/s, while flooding along the Seti River from the dam to the tailrace outlet will also be reduced by the diversion of up to 343 m^3/s of water through the power station when dam spills are occurring.

B. River Morphology

68. River bed degradation of 0–1.5 m depth is predicted to occur over the 60.2 km stretch of the Seti River from the dam site downstream to the confluence with the Budhi Ganga. Bed degradation will be caused by scour from clear water reservoir releases and reduced injection of sediment due to reservoir trapping. This may result in the erosion of 15%–20% of alluvial deposits at the confluences of tributaries over the initial 33 km of the river below the dam (up to Dipayal), including small areas of cultivated land. A river bed scour pond up to 30–40 m deep will be formed below the spillway due to flood spills, and vegetation and soil cover may be removed from the lower slopes of the left bank opposite the spillway due to scouring. A detailed study to identify tributaries with a high risk of erosion down to Dipayal will be undertaken prior to project operation; degradation will be monitored at high risk sites over the first 5 years of project operation.

C. Land Use

69. The permanent project features will require the acquisition of 2,326 ha of land; in addition 25 ha will be leased for temporary construction sites and 604 ha utilized for the transmission line ROW. The area to be permanently acquired includes 659 ha of cultivated land, comprising 466 ha of irrigated cultivation and 193 ha of rainfed cultivation (Table 3). This is equivalent to a loss of between 0.45% and 0.91% of each of the four main affected district's total area of cultivation. In addition, 806 ha of forest will be removed from permanent sites, with an additional 45 ha of forest cleared and up to 94 ha of forest pruned within the transmission line ROW. Forest removal from permanent project sites consists of hardwood (82.5%), coniferous (5.7%), and mixed wood (11.8%) forest types. These forests have crown cover densities of 10%–70%, with 70.5% of forests having 10%–40% crown density and the remaining 29.5% of forests having 40%–70% crown density. Also, 246 ha of grassland and 169 ha of shrubland will be lost from permanent project sites, equivalent to an annual grazing loss of approximately 246 livestock units.

Table 3: Land Use on Sites to be Permanently Acquired

	Land Use Type (ha)									**Total**
	Cultivation				**Grass**	**Aban-**	**Settle-**	**River.**	**Rock/**	**Area**
Project Site	**Irrigat.**	**Rainfed**	**Forest**	**Shrubs**	**-land**	**doned Land**	**ment**	**Feat.**	**Cliffs/ Screes**	(ha)
Reservoir	454	165	769	162	241	9	5	342	19	**2,166**
Dam and spillway		1	17		2			12	4	**36**
Power station area	8	1	5	3				3		**20**
Reregulation weir	3	2	1	3	1			52		**62**
Bangara camp	1	20								**21**
Access roads		2	10	1	2					**15**
Transmission line towers		2	4							**6**
Total	**466**	**193**	**806**	**169**	**246**	**9**	**5**	**409**	**23**	**2,326**

ha = hectare.
Source: Adapted from SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

70. The total land area permanently required for the Project has been minimized in the project design by limiting the number and length of project roads, locating the power station underground, minimizing the size of permanent ancillary sites, and leasing temporarily required sites. In addition, lower value production land will be utilized for project facilities in preference to higher value land where options exist. Land degradation will be minimized by locating temporary facilities on permanent project sites, preventing the degradation of temporary sites during construction by stockpiling site topsoil and re-using it for site rehabilitation, and strictly controlling potentially polluting activities. Vegetation clearance will be minimized by manual or cross-bow pay out of the pilot cable to string the transmission line conductor; no transmission line ROW clearance in deep valleys where adequate clearance exists between conductors and the forest canopy; stepped clearance/pruning across the transmission line ROW; road ROW clearance restricted to the minimum width required for access; marking out all areas to be cleared/pruned prior to these activities; and strictly controlling these activities within the marked areas.

D. Ecosystems

71. The Project will remove up to 1,042 ha of vegetation, comprising 851 ha of forest and 169 ha of shrubs. Up to an additional 94 ha of forest will be pruned along the transmission line

ROW. Vegetation degradation near project sites may also result from illegal harvesting by the project workforce and private businesses and as a consequence of improved local access. All vegetation communities to be removed are representative of middle mountain, Siwalik, and terai types in western Nepal, with most of the affected areas significantly disturbed by human activity. Most vegetation loss will occur in the reservoir area (931 ha), dominated by Acacia forest, Chiuri forest, and *Aegle marmelos* forest, and within the transmission line ROW (45 ha of forest cleared and up to 94 ha of forest pruned).

72. Twelve plant species of conservation significance (footnote 8) occur on project sites in the Seti valley, including *Butea frondosa,* which is classified as endangered. Despite the identified significance of these species, they are all widely distributed across Nepal, except for *Pistacia chinensis*. *Dalbergia latifolia* will most likely be removed from the reservoir area section of the Seti valley. Degradation of *Lillium wallichiana, Pistachia chinensis,* and *Wallichia densiflora* populations may result in a marked reduction in the distribution of these species in western Nepal.

73. Species of conservation significance in the transmission line ROW include *Michelia kisopa*, *Butea frondosa*, *Alstonia scholaris*, *Acacia catechu,* and *Discorea deltoidea*. The impact on *Michelia kisopa* and *Butea frondosa* will be low as each species was only observed in one location within the ROW, and their frequency and density was very low. The rare species *Alstonia scholaris* was also observed at only one site within the ROW, in highly degraded forest with low frequency and density. Only a small number of trees of the commercially threatened species *Acacia catechu* will be cleared, while another commercially threatened species, *Discorea deltoidea*, will not be affected as it will not be cleared.

74. A propagation and planting program will be undertaken for species of conservation significance that will be cleared from or inundated on project sites, with emphasis on *Butea frondosa*, *Pistacia chinensis, Dalbergia latifolia*, *Lillium wallichiana,* and *Wallichia densiflora*. Project sites will be progressively revegetated following the completion of construction using native species propagated from local seed sources. Planted sites will be maintained until the plants are well established. The potential indirect impacts on vegetation from increased local demand and improved access will be mitigated by allowing the controlled harvesting of vegetation in the reservoir area prior to inundation, prohibiting the project construction and operation workforces from harvesting or trading in vegetation, and providing alternative fuel supplies at workforce camps. The establishment of community forests in the region of influence will be supported and several major riparian area villages will be connected to electricity.

75. Approximately 2,463 ha of potential existing fauna habitat will be removed from permanent project sites and along the transmission line ROW, comprising 1,546 ha of higher value areas (up to 945 ha of forest, 169 ha of shrubland; 409 ha of riverine features; 23 ha of rocks, cliffs, and scree) and 917 ha of other types. Much of this lost habitat will be converted to reservoir water body (1,989 ha) that will provide an aquatic habitat. The forest and shrubland habitat cleared/pruned along the transmission line ROW (up to 139 ha) will be converted to low growing shrubs, grasses, and pruned trees. The Project may also indirectly cause the degradation of fauna habitat and reduction in animal numbers within the region of influence due to illegal harvesting by the project workforce, harvesting to meet project-induced enterprise demands, or from improved local access.

76. A 2.9 km section of the transmission line will cross Shuklaphata Wildlife Reserve, with land cover in this 12.0 ha section of ROW consisting of degraded forest (5.5 ha), open grassland (6.6 ha), and riverine features (1.2 ha). This section of ROW does not contain

significant conservation habitat or vegetation species, but it serves as an occasional migratory route for significant wildlife that includes Asian elephants. The transmission line conductors will be strung above the forest canopy within the reserve to avoid the need to clear a strip of vegetation along the length of the ROW. Forest clearance will be limited to the clearance of a total of 0.52 ha at tower sites (4 x 0.13 ha) for safety purposes. No other protected areas are likely to be affected by the Project.

77. Habitat of the endangered Yellow Cheeked tit will be inundated by the reservoir, but its survival is not expected to be jeopardized due to its broad distribution across Nepal. It is a common resident at 915–2,300 m, from Ilam in the east to Dhorpatan in the west, including the project area. All 47 avian species observed associated with water bodies will benefit from the creation of the reservoir; this waterbody may be used as a major resting area by long-distance migratory species. Most mammals in the area are generalists and occur in a wide range of habitat types; therefore they are unlikely to be significantly affected by reservoir inundation. The Common otter (*Lutra lutra*), the only mammal species of conservation significance recorded in the area, main gain habitat from the reservoir if it can adapt to the annual water level fluctuation.

78. The Project will divide the existing aquatic ecosystem into five distinct habitat types with different flow conditions. Migratory fish species that move past the dam site will be removed from the upper Seti River and tributaries above the reservoir due to the prevention of migration past the dam wall. Long distance migratory species (Mahseer, Eel, and Jalkapoor) and mid-distance migratory species (Buche Asla, Chuche Asla, Katle, and Termassa) will be prevented from reaching upstream spawning grounds. Water quality in the reservoir will be suitable to support an aquatic ecosystem, except for the bottom waters (below 140 m depth). Reservoir conditions will favor lentic and broad-ranging fish species, while lotic species will survive in smaller numbers or be absent. Omnivorous and planktivous species such as Katle are likely to be dominant after impoundment, while the population of cold water asla species is likely to decline or disappear.

79. The Seti River between the dam and the tailrace outlet (19.2 km) will be a stream for 8–11 months of the year when spill flows do not occur, supporting substantially reduced fish numbers during these periods, with many existing spawning grounds becoming dry. Daily flow fluctuations from power station discharges over approximately 9 months of the year are likely to reduce fish numbers in the downstream stretch of the Seti River below the tailrace outlet, but the operation of the reregulation to maintain a permanent riverine water body of at least 50 m^3/s will substantially mitigate this impact.

80. Project workers will be prohibited from harvesting or trading in fauna and fish. The habitat and behavior of the Common otter in the reservoir area will be researched, with a focus on the effect of annual water level fluctuation and the abundance of prey fish species. An active conservation management strategy will be developed and implemented for the otter if required, covering habitat protection and community awareness. A fish hatchery will be established in the reservoir, breeding native fish fry to stock the reservoir and upstream tributaries, thereby maintaining genetic diversity. Interspecific hybridization will be avoided by using broods from wild stocks. The hatchery will also trial caged fish culture. Fish screens will be installed to prevent fish movement into the penstock and the power conduit intake.

E. Natural and Project-Induced Hazards

81. Natural hazards in the reservoir catchment and at project sites can affect the Project and in turn cause site and downstream impacts. Natural hazards that currently exist in the project

catchment include flooding from runoff, glacial lake outburst floods (GLOFs), landslides and landslide dam floods, and seismic activity. Reservoir storage characteristics and dam operation will reduce flooding, with a 1 in 100-year flood reduced from 5,100 m^3/s to 4,850 m^3/s. Flooding along the Seti River from the dam to the tailrace outlet will also be reduced by the diversion of up to 343 m^3/s of water through the power station when dam spills are occurring.

82. The dam spillway is designed to safely release the probable maximum flood flow. The ungated spillway eliminates the risk of human error and mechanical failure involved with the operation of gates. The Project will not affect the frequency or volume of GLOF events above the dam, while the dam will be able to resist GLOF surge waves. A GLOF warning system will be installed to minimize potential loss of human life arising from an event during project construction and operation. Emergency response procedures will be developed prior to the commencement of construction, and retreating glaciers in the reservoir catchment will be monitored for the appearance of new lakes. Once the dam is constructed, the risk of GLOF damage to riverine communities and land downstream of the dam will be substantially reduced as the dam will generally control GLOF surges.

83. Landslide dam floods in the upper catchment will generally be contained in the reservoir when storage capacity exists, reducing the adverse impacts of these floods downstream. The dam is designed for a maximum design earthquake with an annual exceedance probability of 1 in 10,000, and an operating basis earthquake with an annual exceedance probability of 1 in 200. A maximum design earthquake, the most extreme event possible in the region, may cause substantial but repairable damage to the dam, but not total failure. An operating basis earthquake should not interrupt operation of the Project.

84. The raised water level involved in reservoir operation is likely to increase the existing risk of slope instability around the foreshore, but the extent of instability cannot be accurately predicted. Reservoir foreshore slopes that are too steep will erode due to wave action on slope deposits, which may cause slope slumping. All habitation will be prohibited around the reservoir foreshore up to FSL+96 m and land use restrictions will apply up to 6 m above FSL. A comprehensive dam safety surveillance program will be developed.

F. Social Impacts

85. The primary social issues associated with the Project are land acquisition, population displacement, changes to socioeconomic conditions and practices, and social impacts during construction (Table 4).

Table 4: Primary Social Issues and Impacts

Primary Social Issue	Impact / Benefit
Land Acquisition	• Permanent and temporary land loss • Loss of private assets/property on land acquired by the Project • Impacts on livelihoods
Population Displacement	• Out-of-area resettlement • Local resettlement
Changes to Socioeconomic Conditions and Practices	• Cultural practices • Subsistence and local economic activities • Access • Services • Institutions • Traditional use of the Seti River • Impact on host communities
Social Impacts during Construction	• Local employment and income generation • Local authorities and services • Labor force impacts

Source: SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

86. Approximately 18,269 individuals (2,421 households) will be directly affected by the Project (Table 5). Most will be affected by the reservoir (14,378, 78.7%) and transmission line (2,048, 11.2%). Of the people affected by the reservoir, an estimated 4,410 (490 households) live in nearby settlements above the reservoir no-habitation zone.

Table 5: Directly Affected Households

Project Component	Affected Households	Households Requiring Resettlement
Reservoir and Dam Site:		
- below FSL+6 m	933	933
- between FLS+6 m and FSL+96 m	257	257
- above FSL+96 m	490	122
Dam Access Road (estimate)	40	0
Power Station Site and Access Road	35	21
Work Areas (estimate)	20	0
Workforce Camps/Offices (estimate)	200	30
Reregulation Weir (estimate)	150	30
Transmission Line	296	186
Total	**2,421**	**1,579**

FSL = full supply level, m = meters.
Sources: SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 3 Resettlement Action Plan. Cooma; and Shah Consult. 2007. *Talkot-Mahendranagar Transmission Line Environmental Impact Assessment.* Kathmandu.

87. An additional 11,160 people in the downstream riparian zone between the dam site and the reregulation weir site may be affected to varying degrees by a permanent reduction in the

flow of the Seti River as well as rapid increases and decreases in river flow due to unregulated discharges from the power station.

88. Resettlement plans have been prepared for the reservoir area/ancillary sites and the transmission line. They include detailed entitlement matrices designed to ensure fair and prompt compensation for losses attributed to the Project. The matrices address loss of land and other private assets, adverse impacts on subsistence/livelihood or income-earning capacity, and collective adverse impacts on vulnerable groups and social categories.

G. Land Acquisition and Property Losses

89. A total area of 2,326 ha, comprising private and Government land, will be permanently acquired for the Project; an additional 26 ha will be temporarily leased for construction facilities (Table 6). The permanently required land area encompasses the reservoir area to be flooded (2,060 ha) plus a 6 m high flood zone (FSL to FSL+6 m) to cover the probable maximum flood level (106 ha), and other infrastructure/facility sites (160 ha). A total of 659 ha of private cultivation land will be acquired at permanent project sites, consisting of 619 ha in the reservoir area (FSL+6 m) and 40 ha at other sites. Reservoir area land comprises irrigated cultivation (72.3%), rain-fed cultivation (26.3%), and abandoned (fallow) land (1.4%). Land temporarily required during construction will be leased under a standard occupancy contract, including temporary workforce camp areas and work areas.

Table 6: Project Land Area

Project Component	**Permanent Acquisition** (ha)	**Temporary Acquisition** (leasing) (ha)
Reservoir (FSL 1,284 m), excluding dam and spillway sites	2,060	–
Reservoir flood zone (1,284–1,290 m)	106	–
Dam and spillway sites	36	–
Power station area (surface developments)	20	–
Reregulation weir (including inundation area)	62	–
Access roads to spillway and dam site	15	–
Transmission line tower sites	6	–
Temporary transmission line construction areas		15
Workforce camp	21	6
Work area[a]		5
Total	**2,326**	**26**

FSL = full supply level, ha = hectare, m = meter.

[a] Excluding camps, offices and work areas within the reservoir area.

Sources: SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 3, Resettlement Action Plan. Cooma; and Shah Consult. 2007. *Talkot-Mahendranagar Transmission Line Environmental Impact Assessment*. Kathmandu.

90. A total of 224.5 ha of private agricultural and residential land within the transmission line ROW will be affected by the line. Approximately 1.5 ha of this land will be permanently acquired for 105 tower sites. Residences and business structures, currently occupying an estimated 4.7 ha of residential land within the ROW, will be relocated to outside the ROW, but the respective owners will retain title over the land. Landowners will be compensated at replacement cost for the affected land. Land use restrictions will apply to all private land in the ROW, preventing the construction of houses and other structures, and the growing of vegetation more than 3 m high.

91. All private land losses will be compensated at full replacement cost, or in the case of households (mainly from the reservoir area) who are resettled to sites in the terai, through the provision of replacement land of equal productivity. Households will receive additional compensation representing 20% of the value of their acquired land, and in the case of households resettling to project sites in the terai, additional cultivation land if their land entitlement is below the terai subsistence landholding. These households will also receive land-based compensation for the loss of access to natural resources in the Seti valley.

92. Land use restrictions will be placed on land in the ROW not acquired by the Project. The cultivation of cereal crops and other vegetation less than 3 m high will be allowed, but no residential or business structures. Titled owners of this land will receive compensation of 10% of the value of the affected portion for the application of these land use restrictions. Compensation for land use restrictions will not be applicable to land currently utilized for residential or business purposes, since the concerned owners will receive full compensation for these residential/business plots.

93. Houses and structures to be acquired for project implementation include 1,861 houses/homestead structures, 117 business structures (mainly tea shops), 29 temples, 34 water mills, eight schools, and five hostels/offices. All affected structures will be compensated at full replacement cost in cash or through the provision of replacement structures. Owners will have the right to salvage materials and the value of these materials will not be deducted from the final compensation.

94. Compensation will be paid for the permanent loss of trees based on 5 years of annual net production. Privately owned trees cleared or pruned by the Project will remain the property of the owner.

H. Population Displacement and Resettlement

95. An estimated 1,579 households (12,914 people) will be resettled from project sites, with the majority of these (1,190 households or 75.4%) requiring resettlement from the reservoir flood zone and no-habitation zone (Table 5). Households displaced from the reservoir area or downstream ancillary sites will be resettled to project relocation sites in the terai if their agricultural production is severely affected, or locally if production is only marginally affected. The terai resettlement sites will be developed on cultivation land purchased from larger landowners.

96. Approximately 1,202 (91.6%) of the 1,312 reservoir area households qualifying for resettlement are expected to be relocated to project relocation sites in the terai due to excessive land losses, while the remainder will resettle locally to continue using their unaffected cultivation land. Households relocated from the transmission line ROW will resettle in the vicinity, either on their current landholdings or on newly acquired sites, as most will only have small portions of their landholdings acquired or have land use restrictions applied.

97. In addition to compensation for asset losses, resettlement and the restoration of livelihoods will be supported through the payment of various allowances. These include an evacuation/shifting allowance, household and business displacement allowances, cultivation disruption allowance for non-displaced households, rehabilitation allowance for vulnerable households, and rental stipend for tenant households. A significant project livelihood improvement benefit will be the allocation of additional land to an estimated 38% of the

households that are resettled to project relocation sites in the terai who have land entitlements less than the defined minimum subsistence landholding.

98. Project resettlement is outlined in the 2000 project resettlement action plan approved by the Government as part of the EIA. This plan was updated in accordance with ADB's *Involuntary Resettlement Policy* (1995) to form the revised resettlement plan (2007). The revised resettlement plan and the transmission line resettlement plan will be disclosed to those affected and posted on the ADB website. The Project will provide compensation for all affected household assets, and community resources and buildings, based on compensating for losses at replacement cost. Living standards and livelihoods of all those affected will be restored or improved, with resettled households to receive a direct economic benefit from the Project.

I. Changes to Socioeconomic Conditions and Practices

99. The project-affected downstream riparian population between the dam and the reregulation weir is estimated to total 1,537 households (11,160 people) based on general village reconnaissance, a sample survey of 10% of affected households, and a survey of village heads. These people reside in 32 villages and some use the Seti River for a secondary water source (mainly in the dry season), for religious ceremonies and practices, stock water, fishing, transport, and recreation. The estimated 8,581 people that use the Seti River between the dam and tailrace outlet will be subjected to a 4 m^3 Seti River flow at all times of the year except when the dam spills, flushing flows are released, and intermediate catchment runoff occurs. The main potential social impacts of a substantially reduced river flow are reduced river water quality, increased pressure on existing non-river water supply systems (particularly late in the dry season when use of the Seti River is greatest), potable water shortages for those who use the river as a secondary source, substantial decline in fishing, insufficient river flows to remove the remains of cremated bodies, and reduced recreational amenity of the river. Secure potable water will be supplied to all affected riparian area villages between the dam and reregulation weir by improving existing village-based systems and/or constructing new facilities. A sanitation program will be implemented in these villages to improve public health. A flood warning system consisting of riverside signs and sirens activated by reservoir releases will be installed between the dam and the Karnali River confluence to warn of dam releases.

100. The population residing in the riparian area between the tailrace outlet and the reregulation weir will be subject to rapid increases and decreases in river flow due to unregulated discharges from the power station. This will create a safety hazard for people and stock that will be mitigated by a minimum 30-minute start-up and slowdown for each generating unit, with units likely to be started successively once the previous unit is fully generating, to avoid a surge flow and rapid rise in river water. Other measures will include the installation of warning signs along both riverbanks, automatic sirens that will be activated by power station releases, and a regular public awareness campaign.

101. Downstream of the reregulation weir the main impact on river users will be the creation of a safety hazard from fluctuating regulated river flows (albeit at a substantially lower rate of change over time compared to the tailrace to reregulation weir section) and other reservoir discharges (spills, flushing flows, and emergency releases). Population density along the initial 12 km of river valley from the reregulation weir downstream to 4 km below Dipayal (excluding Dipayal) is similar to the section of valley above the reregulation weir up to the Ruwa Khola. Along the 48.7 km of river below Dipayal up to the Karnali River confluence, the population is sparse due to limited riverside agriculture land. The extent of impacts will decrease downstream as tributary flows enter the Seti River and the natural configuration of river reaches reduces flow

level changes. The Budhi Ganga, entering the Seti River 35.0 km downstream of the reregulation weir site, will attenuate regulated project flows as it contributes around 23% of total Seti River flow. A similar but greater attenuation effect will occur once the Seti River enters the Karnali River, with river level fluctuations from reregulated generation flows reduced. In addition, some privately owned riverside cultivation land may be eroded at tributary confluences between the dam and Dipayal. The owners of this land will be compensated at replacement cost.

102. The local economy will experience a rapid increase in business and population activity during construction. People whose income-earning capacities are severely affected by project activities (e.g., porters) will be registered for preferential project employment. Health impacts of the Project may include an increased incidence of disease due to the influx of carriers in the project workforce. Project health facilities will be provided for the workforce, while existing community health facilities will be supported by the Project.

103. Fishing will be substantially reduced between the dam and reregulation weir, reducing the income of fisherfolk and reducing the protein intake of fish consumers. A mitigation program to cover the economic loss to full-time fisherfolk will be implemented (including consideration of the potential impact on full-time fisherfolk down to the Budhi Ganga). A nutrition program will be developed to ensure that community nutrition is not adversely affected.

104. Seti valley access will be restricted by the creation of the reservoir, with the inundation of eight permanent footbridges, two temporary footbridges, two cable slides, and the main valley trail. Cross-river access will be improved between the dam and the tailrace outlet due to reduced river flows, and at Talkot due to construction of the power station bridge. Access around the reservoir will be restored by constructing six suspension bridges at the extremities of the reservoir, improving walking tracks, constructing new link tracks, and providing boat access in the reservoir. The inundated section of the Chainpur road at Deura will be relocated to a higher elevation.

105. The displacement of stores, teashops, and other services by the Project will be mitigated through full replacement of these assets in areas agreed to by the affected owners. Existing facilities at resettlement sites will be upgraded and extended to benefit resettled and host communities.

J. Socioeconomic Impacts during Construction

106. Project construction activities are likely to lead to a range of adverse and beneficial socioeconomic impacts. These include access to construction employment opportunities, potential social and health impacts associated with the presence of a large construction workforce, impacts on local institutions and services, and safety and health impacts associated with construction activities. Adverse impacts will be mitigated and beneficial impacts enhanced through appropriate plans and measures, including a preferential employment policy and skill training program to increase construction employment in unskilled and semiskilled job categories; provision of international standard workforce accommodation and facilities; health awareness campaigns, including HIV/AIDs programs; standard measures to minimize impacts (e.g., dust, noise, vehicular, and safety impacts) associated with construction activities; and a structured consultation program to ensure that all construction-related issues are promptly addressed.

VI. ENVIRONMENTAL AND SOCIAL ASSESSMENT OF THE INDIAN TRANSMISSION LINE

107. WSH is responsible for constructing the 132.5 km 400 kV double-circuit transmission line from the project switchyard to the Nepal-India border near Mahendranagar. Power Grid Corporation of India (PGCIL), a national government enterprise, will be responsible for connecting this line to the Indian grid via an additional 98 km of line from the border to a new substation at Atamanda, 22 km north of Bareilly.

108. The Indian section of the transmission line will require approximately 280 towers, at an average spacing of 350 m on the plains. A 46 m wide transmission line easement (23 m on either side of the centerline) will be established as per Indian Standard (IS):5613 and Indian Ministry of Environment and Forests guidelines. WSH commissioned PGCIL to carry out load-flow studies, identify line route options, and prepare an initial environmental and social assessment for the line.

109. Environmental clearance must be obtained from the Indian government for certain types of new developments or the expansion of existing developments as specified in the Notification of Environmental Impact Assessment (1994) and subsequent amendments under the Environment (Protection) Act 1986. Under the 1994 notification of EIA, environmental clearance for a transmission line is not required as it is not a listed development in Schedule I. Forest clearance is required under the Forest (Conservation) Act 1980 for a transmission line if it traverses any forest land. The preliminary route identified by PGCIL crosses the Lalkua Reserve Forest, therefore forest clearance is required.

110. The main environmental issue associated with the transmission line is vegetation/habitat clearance. Vegetation will be cleared within the ROW to permanently provide a minimum clearance of 6 m between trees and conductors, with 2 x 3 m wide strips cleared beneath the conductors to facilitate line stringing. Regrowth will be allowed to a height of 3 m along one of the strips, with the other maintained at 30 centimeters height to provide line access during operation.

111. The main social issues associated with the preliminary Indian route are crop disturbance and land use restrictions within the ROW. The ROW, including tower sites, will remain the property of existing landowners as per the provisions of the Indian Electricity Act 2003. PGCIL has already acquired land for the Atamanda substation. A detailed line survey will only be undertaken once the line has received all necessary government clearances. PGCIL will manage transmission line planning, construction, and operation in accordance with government requirements and PGCIL environmental and social management procedures.

VII. CUMULATIVE IMPACT ASSESSMENT

112. The cumulative impact of all likely major development in the Karnali basin, incorporating part of the FWDR and Mid-Western Development Region (MWDR) of Nepal, was assessed to predict the likely contribution and influence of the Project to this impact over time. This assessment evaluates the existing basin/region condition, identifies recent development trends and likely development scenarios across all major development sectors over the next 5 years (to 2013) and 20 years (to 2028), and predicts the cumulative impact of these developments on the basin.

113. The spatial coverage of the cumulative impact assessment is the Karnali River basin down to the Nepal-India border, with major river developments noted on the Karnali River in India. The main development sectors considered are hydropower, irrigation, water supply and sanitation, urban and industrial development, agriculture and forestry, conservation (biodiversity issues), and social development. The principal environmental and social features likely affected by development are river flows, water quality, land resources, and social factors.

A. Basin Profile and Trends

114. The Karnali basin incorporates 20 districts, either fully or partially. The basin is home to 18% of Nepal's population and has an annual population growth rate of 2.2%. Population density across the basin is 242/km^2 on the terai, 76/km^2 in the hills, and 16/km^2 in the mountains. The urban population in the basin continues to increase in an unplanned manner, rising from 1.6% in 1971 to 7.4% in 2001. This increase has predominantly occurred on the terai, partly due to migration from the hills to the lowland districts where more services and job opportunities exist. Migration is also occurring out of the basin to other countries on a temporary basis, predominantly to India for employment, with 5.8% of the economically active population recorded as absent from basin districts in the 2001 census.[20]

115. The basin is the least developed area of Nepal with few of the prerequisites for development, in particular having a general lack of roads, power supply, and communications. Basin residents are highly reliant on agriculture, with more than 50% of nominal household income derived from farms in the FWDR and MWDR.[21] More than half of the households in the basin experience a food deficit, while the percentage of the population living below the poverty line is between 25% and 60%, with all but two districts falling in the 35%–54% bracket.[22]

116. Industrial development in the basin is mostly small scale, limited to cottage industries, although some larger industry exists on the terai (e.g., sugar refining). No major hydropower projects exist in the Karnali basin. Existing large water resource developments in the basin are limited to three small- to medium-sized irrigation schemes on the lower section of the Karnali River in Nepal and a single large scheme in India. The three small and medium-sized irrigation schemes in Nepal service two areas in Bardia district (2,320 ha and 18,340 ha) and a single area in Kailali district (13,925 ha). The large scheme operating in India is Sarda Sahayak irrigation scheme (2 million ha); while an additional large scheme, the Saryu Nahar irrigation scheme (1.4 million ha), is under construction. Both Indian schemes are fed from Girijapur Barrage, located 20 km downstream of the Nepal-India border. These two schemes will have a combined estimated annual demand of 10,000 million m^3 of water once the Saryu Nahar scheme is operating, equivalent to 23% of the mean annual Karnali River flow. Other water and river uses in the basin are domestic water supply, micro-hydropower generation, and religious and sanitation uses.

117. Land cover and use in the Nepal area of the basin is dominated by forest (39.9%), bare land (20.8%), snow (18.6%), agricultural/grassland (15.4%), and shrubland (5.0%).[23] The terai is the most intensively cropped area in the basin due to higher soil fertility and flat land. The pressure on forests is increasing primarily due to lack of diversification of livelihoods and high reliance on natural resource use. Forest cover in basin districts is estimated to be decreasing at

[20] Central Bureau of Statistics. 2001. *Population Census of Nepal*. Kathmandu.
[21] Central Bureau of Statistics. 2004. *National Sample Census of Agriculture, Nepal, 2001/02, District Summary.* Kathmandu.
[22] Central Bureau of Statistics. 2006. *Four Monthly Statistical Bulletin, 2063/64*. Kathmandu: Government of Nepal.
[23] Central Bureau of Statistics. 2005. *Environment Statistics of Nepal*. Kathmandu: Government of Nepal.

2.7% per annum, although community forest management of approximately 18% of the basin forest area aims to ensure sustainable management of this resource.

118. Protected areas cover almost 14% of the basin, incorporating Bardia, Khaptad, Rara and Shey Phoksundo national parks; Shuklaphata Wildlife Reserve; and Dhorpatan Hunting Reserve. Wildlife of conservation significance in the basin include Royal Bengal tiger, One Horned rhinoceros, Swamp deer, Black buck, Red panda, Snow leopard, and Musk deer.

119. The FWDR and MWDR receive the lowest development budgets of the five regions in Nepal. The estimated annual average Government development budget spent in basin districts ($58.3 million)[24] is mainly allocated to road construction and local development activities (35%), irrigation (16.0%), and education (14.4%); with basic services that include water supply, health, and electricity receiving less than 5%.

B. Development Scenarios

120. Four hydropower projects are predicted to be operating in the Karnali basin by 2028: the 750 MW West Seti Hydroelectric Project (HEP); 300 MW Upper Karnali HEP; 48 MW Bheri-Babai Multipurpose Project; and 58 MW Lohore Khola HEP (Table 7). The 10,800 MW Karnali Chisapani Multipurpose Project has been proposed in the lower basin since the 1960s, but the major obstacles of an agreement on cross-border water benefits and the major environmental and social impacts that will result from this project are likely to prevent development within the next 20 years.

Table 7: Likely Major Hydropower Development in the Karnali Basin by 2028

Project	Installed Capacity (MW)	Type	Irrigation Diversion	Likely Year of Commissioning
West Seti	750	Storage	0	2012
Upper Karnali	300	Run-of-river	0	2013
Bheri-Babai	48	Run-of-river	40 m^3/s	2020
Lohore Khola	58	Storage	0	2020

m^3/s = cubic meters per second, MW = megawatt.
Source: Canadian International Water and Energy Consultants (CIWEC). 1997. *Upper Karnali Hydroelectric Project Environmental Impact Assessment*. Kathmandu. Japan International Cooperation Agency (JICA). 1993. *Master Plan Study for Water Resources Development of the Upper Karnali River and Mahakali River Basins*. Kathmandu.SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1 – Main Report. Cooma.

121. Substantial cultivation land has been identified in the FWDR and MWDR as having future irrigation potential (344,600 ha),[25] mainly on the terai and in river valleys. Six large-scale irrigation projects have been identified in the basin, including the Bheri-Babai and Chisapani multipurpose schemes, as well as 74 small-scale schemes. The irrigation of large areas of land in the basin will require considerable investment in major diversions, but given the small budget currently allocated to irrigation development the rate of development is likely to be slow. Despite this limitation, irrigation demand is estimated to rise from 5% of the mean annual Karnali River flow at Chisapani to 11% by 2025,[26] primarily from implementation of the Bheri-Babai scheme.

[24] National Planning Commission. 1998, 1999, 2000, 2001,2002,2003,2004,2005,2006. *Development Programmes and Budget Allocation to Districts*. Fiscal Years 1997/98 to 2005/06. Kathmandu.
[25] Japan International Cooperation Agency (JICA). 1993. *Master Plan Study for Water Resources Development of the Upper Karnali River and Mahakali River Basins*. Kathmandu.
[26] Tahal Consulting Engineers. 2002. *Institutional Development of the Department of Hydrology and Meteorology – Final Report*. Kathmandu.

The water supply requirement to meet drinking water, other domestic uses, and livestock needs in the basin is predicted to increase from an estimated 0.34 m^3/s (2006) to 0.51 m^3/s by 2026 (footnote 18) as the population and livestock numbers increase (Appendix 2).

122. Urban development is predicted to continue to increase in basin districts, with the highest rate of urbanization expected on the terai. Industrial development is likely to increase in the basin over the longer term, but it will be reliant on the presence of basic infrastructure, services, and facilities, particularly adequate and reliable electricity supply, year-round trafficable roads, and reliable communications. The terai has a greater potential for urban and industrial development due to the presence of better infrastructure, access, and services; but development in these sectors is likely to lag major centers elsewhere in the country.

123. Road improvement and new road construction in the basin is expected to accelerate over the next 5–20 years under the Government's 10th Five-Year Plan, which aims to connect all district headquarters by road, and the Department of Roads' Sector-Wide Road Program and Priority Investment Plan, with 14 roads planned/under construction in the FWDR and MWDR. The potential exists for agricultural and horticultural diversification in the basin, but this is likely to only be stimulated by substantial road development over the next 20 years, particularly in the hills, to provide ready access to markets. Irrigation development is set to increase cropping intensity in limited areas over the next 20 years, while improved forest management may occur in community forests under the stewardship of user groups. Tourism, currently minimal in the FWDR and MWDR due to lack of infrastructure, is expected to steadily grow over the next 20 years as total visitor numbers increase in Nepal; and transport, accommodation, and communication facilities improve.

C. Cumulative Impacts

124. The cumulative impact of development in the Karnali basin over the next 20 years is mainly predicted to affect river hydrology, riverine ecosystems, and social development. Karnali River flows are predicted to increase in the dry season by up to 12.8% (February) and decrease in the monsoon season by up to 10.1% (July), primarily due to the storage of monsoon flows by the West Seti and Lohore Khola HEPs, but also affected by the interbasin transfer of 40 m^3/s out of the basin by the Bheri-Babai scheme (Appendix 2).

125. Aquatic habitat will be fragmented by the flooding of river sections and downstream dewatering by the HEPs on the Karnali, Seti, Bheri, and Lohore rivers within the basin; but this impact will mainly be felt at the subbasin level. The HEP impoundments will convert a combined total of 55 km of shallow, fast-flowing main river water bodies to deep and relatively still water. Mid- to long-range migratory fish species will be prevented from migrating past the West Seti, Lohore Khola, and Bheri-Babai dams due to the physical obstruction that these structures will create. Deepwater fish species will dominate the reservoirs, while riverine habitat areas will be degraded to different degrees along a combined total of 109 km of river between the dams and tailrace outlets, reducing fish spawning and rearing areas. Downstream water quality will also be altered by stored and regulated hydropower releases, with changes to temperature, reduction in coarse and suspended sediments, and reduction in woody debris moving down the river.

126. The total permanent loss of all land use types, excluding forest and shrubland, likely to be caused by the four likely HEPs is 2,086 ha, while an estimated 1,525 ha of forest and shrub cover will also be permanently removed/pruned from HEP sites. The majority of these losses will come from the Project (64.8% of all land uses excluding forest and shrubland, and 62.0% of permanent forest and shrub loss). While the loss of these areas is not beneficial, this impact is

put into perspective by comparing it to the estimated rate of forest removal in the four terai basin districts (unrelated to HEPs) over the past decade of 2.69%, equating to over 1,100 ha per annum.[27]

127. The cumulative impact of development on terrestrial biodiversity is predicted to relate to increasing forest resource demand by the general population versus increased protected area management. The development of the four predicted HEPs in the basin may increase pressure on forests by increasing population density on the terai, but only the Bheri-Babai project will directly impact a protected area as the dam, powerhouse, and access road sites are located within Bardia National Park.

128. The net cumulative impact of development on socioeconomic conditions in the Karnali basin over the next 20 years is predicted to be positive, primarily resulting from construction wages and the provision of services and materials by local businesses. Environmental and social enhancement measures implemented by the HEPs should improve the quality of life of affected people. People directly affected by these projects from resettlement or land leasing should also benefit as the Government's draft policy on land acquisition, compensation and resettlement requires that the pre-project income and livelihood sources of affected people are at least restored.

129. Overall, the Project will contribute a significant proportion of project-related adverse impacts and benefits in the basin as it is the largest development predicted to be implemented in the catchment up to 2028. The project impact on hydrology and aquatic ecology will be largely restricted to the Seti River as the project catchment forms only 57% of the total Seti watershed and 9.5% of the total Karnali basin up to the Nepal-India border. Likewise, the creation of an estimated 1,000 jobs for local people will provide a major boost to the local economy, primarily during construction but also over the entire operating period.

VIII. ECONOMIC ASSESSMENT

A. Project Costs

130. The cost of the Project is estimated to be $1,200 million, consisting of all construction costs, including the cost of environmental mitigation and improvement measures, and capitalized interest during construction. The total estimated cost of environmental and social mitigation and improvement measures is $147.03 million, including the cost of the reregulation weir (but not including standard construction mitigation measures), constituting 12.25% of the total project development cost (Table 8). The budget for resettlement and compensation is based on measures contained in the two project resettlement plans. The cost of water supply and sanitation improvement for downstream riparian communities is based on the most expensive option of supplying a reliable water source to these affected villages. The other main mitigation measures are costed as least-cost options.

[27] Central Bureau of Statistics. 2005. *Environment Statistics of Nepal*. Kathmandu.

Table 8: Summary of Social and Environmental Budget Commitments

Mitigation and Improvement Measures	Budget Commitment ($ million)
Social Measures	
Resettlement, compensation, management	85.64
Potential additional foreshore resettlement	0.50
Community development initiative in Seti valley	1.58
Environmental Measures	
Reregulation weir	20.00
Water supply and sanitation improvement (riparian area)	6.70
Fish hatchery	1.71
Community forestry	0.13
Forest compensation	1.71
Otter conservation	0.08
GLOF/spillway warning system	0.26
Management	3.20
Contingency	12.15
Contractors' Margin	13.37
Total	**147.03**

GLOF = glacial lake outburst flood.
Source: revised from SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

B. Economic Benefits

131. The direct economic benefit that will accrue to the Government from royalties and revenue share during the 30-year generation license is estimated to total $991 million, equivalent to an average annual benefit of $33 million. Once the full ownership of the Project is transferred to the Government following the private generation period, the Government will operate the power station and receive full revenues of approximately $170 million per annum from electricity sales to India (based on the current power purchase agreement price). This revenue is projected to last for a minimum of 25 years after ownership transfer, based on estimated reservoir sedimentation rates. Nepal will also receive important secondary economic benefits from linkage industries established to support project construction and operation. This combined contribution to the economy from the local supply of materials and services is estimated to exceed $19 million during the 5 years of construction, and $64 million during the operating period (including salaries).

132. Economic benefits that will accrue to people directly affected by the Project will include the provision of a 20% additional land entitlement to all titled landowning households suffering permanent land losses, valued at $4.1 million; and the provision of a subsistence landholding to the 38% of landowning households resettled to the terai, valued at $1.3 million. Project benefits that have not been valued include

(i) water supply and sanitation improvement in riparian villages between the dam and regulation weir;
(ii) benefits from Seti valley community development initiatives and livelihood improvement/diversification programs;
(iii) fish production from the reservoir, likely to generate an estimated open water catch of 63,000 kilograms per annum, with the potential for greater production from cage fish culture;

(iv) more reliable local electricity supply that will occur if the Nepal Electricity Authority purchases project electricity generated by the 8 MW riparian outlet unit; and
(v) future irrigation benefits that could be derived from increased dry season flows in the Karnali River.

C. Economic Losses

133. Project establishment will involve the loss of private land permanently required for the Project. This land, comprising irrigated and rainfed cultivation land, is valued at $4.31 million based on the approximate price of land in the project area districts. The value of agricultural production that will be lost from this acquired land is estimated to be $1.55 million per annum. Project losses that have not been valued include the following:

(i) inundation or removal of communal forest, shrubland, and grassland resources on Government land; this production loss will be directly offset by the provision of a land-based communal resource entitlement to all households resettling to project sites in the terai;
(ii) loss or substantial reduction of the current fish catch from the Seti River between the rear of the reservoir and the reregulation weir (to be at least be partly offset by fish production in the reservoir); and possible reduction in fish catch between the reregulation weir and the Budhi Ganga; and
(iii) degradation of the aquatic ecosystem downstream of the dam.

IX. SOCIAL AND ENVIRONMENTAL MANAGEMENT PLANS

A. Introduction

134. Project social and environmental impacts will be mitigated in accordance with measures described in the two resettlement plans and environmental management plans (EMPs). The project EIA (2000) contained a resettlement action plan and EMAP that addressed all project components except the transmission line (footnote 1). The resettlement action plan was revised in 2007 and this SEIA contains revisions to the EMAP. In addition, the transmission line EIA prepared in 2007 contains a resettlement plan and EMP specifically for this component of the development. The content and objectives of each of these plans are summarized in Table 9, and the environmental management measures to be implemented in Appendix 3.

Table 9: Summary of Environmental and Social Management Plans

Plan	Objective	Content
Resettlement plan (2000 and 2007)	To develop resettlement and compensation principles and plans to ensure successful reestablishment/rehabilitation of households	• Household and community resources affected by the Project (land, houses, infrastructure, etc.) and replacement resources required for effective household reestablishment • Likely number of households affected by the Project and the number of households facing resettlement • Organizational and institutional requirements for resettlement implementation • Implementation schedules and key milestones • Proposals for monitoring resettlement activities • Compensation and resettlement costs
Resettlement plan, for the transmission line (2007)	To develop resettlement and compensation principles and plans to ensure successful reestablishment/rehabilitation of households	• Household and community resources affected by the Project (land, houses, infrastructure, etc.) and replacement resources required for effective household reestablishment • Likely number of households affected by the Project and the number of households facing resettlement • Organizational and institutional requirements for resettlement implementation • Implementation schedules and key milestones • Proposals for monitoring resettlement activities • Compensation and resettlement costs
EMAP (2000)	To define environmental management principles and guidelines; establish roles and responsibilities; describe mitigation measures; and establish a supervision, monitoring, auditing, and reporting framework	• Implementation responsibilities and program • Description of mitigation measures covering design, construction, and operation phases • Auditing and monitoring activities and program
EMP for the transmission line (2007)		

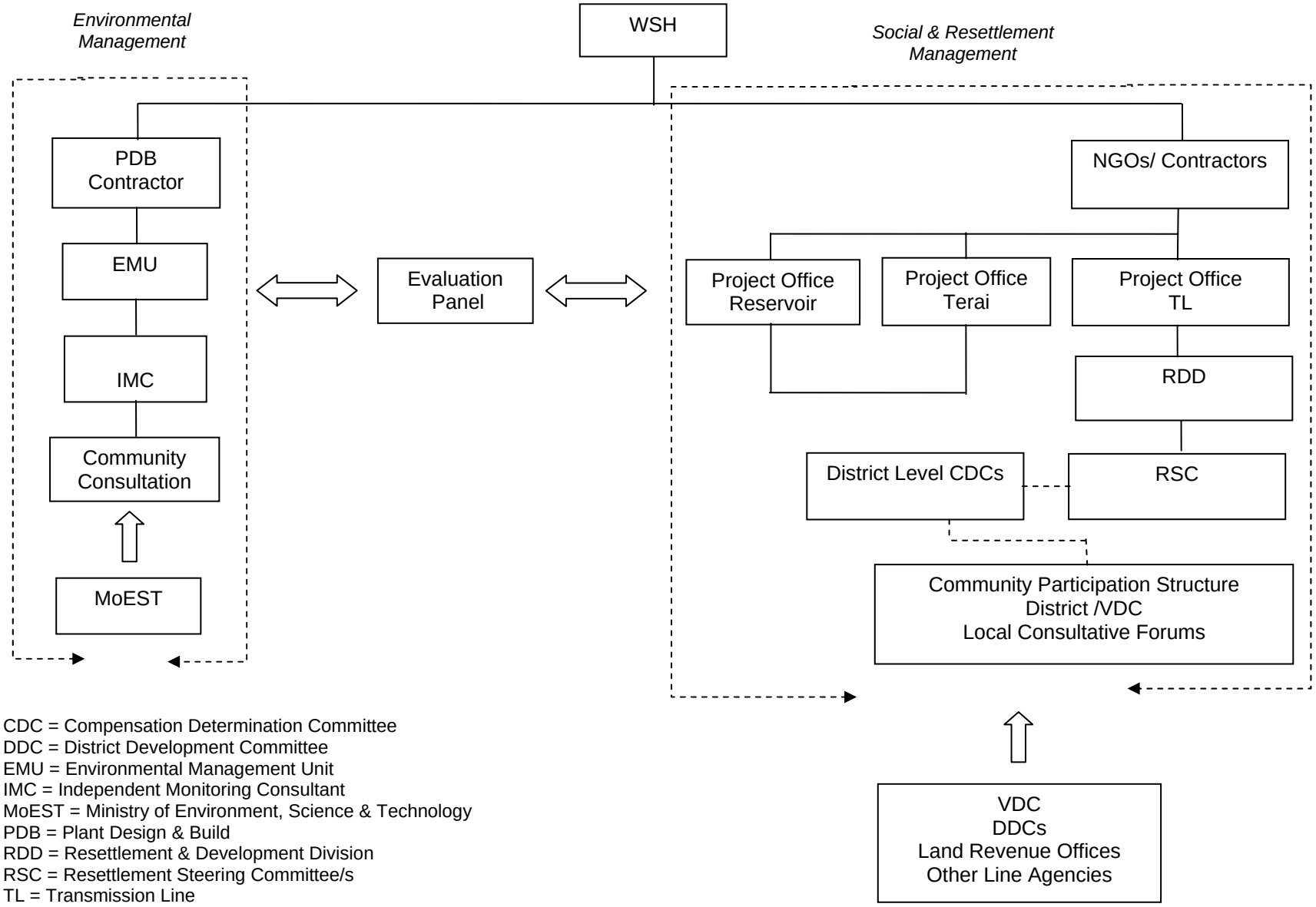
EMP/EMAP = environmental management (action) plan.
Source: SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 2, Environmental Management Action Plan, and Vol. 3, Resettlement Action Plan. Cooma; and Shah Consult. 2007. *Talkot-Mahendranagar Transmission Line Environmental Impact Assessment*. Kathmandu.

135. Additional social and environmental management plans to be prepared and approved during implementation include preferential employment policy, skills training program, community development plan, host community plan, erosion and sediment control plan, spoil management plan, and incident management and emergency response procedures.

B. Institutional Responsibilities

136. The framework for social and environmental management implementation is illustrated in Figure 3.

Figure 3: Overview of Social and Environmental Implementation Responsibilities



CDC = Compensation Determination Committee
DDC = District Development Committee
EMU = Environmental Management Unit
IMC = Independent Monitoring Consultant
MoEST = Ministry of Environment, Science & Technology
PDB = Plant Design & Build
RDD = Resettlement & Development Division
RSC = Resettlement Steering Committee/s
TL = Transmission Line
VDC = Village Development Committee
Source: Shah Consult, 2007. Talkot-Mahendranagar 400 kV Transmission Line EIA. Kathmandu.

1. Key Responsibilities for Resettlement Implementation

137. **Resettlement and Development Division**. The division, a component of the management and administration contractor appointed by WSH, will have overall responsibility for the resettlement program, and ensure prompt implementation of all resettlement-related activities. Headed by a resettlement and development manager with full administrative powers and a separate budget line, the division will have a number of dedicated sections to provide support to three field managers and field offices (reservoir area, terai resettlement sites, and transmission line) with aspects such as land acquisition, compensation, livelihood restoration, consultation and participation, and information systems/geographic information system.

138. **Resettlement Steering Committee**. The committee will ensure proper coordination of resettlement activities. Apart from WSH (which will act as secretariat), the resettlement steering committee is expected to comprise members from district government, VDCs, community institutions, and other local stakeholders.

139. **Compensation Determination Committees**. As a private sector initiative, the management and administration contractor appointed by WSH will oversee the resettlement program and coordinate all negotiations for land and asset acquisition. Negotiations will be coordinated by district compensation and determination committees. The principal role of these structures will be to assist in the negotiation process between WSH and affected communities, promote transparency of procedures, and ensure compliance with Government legislation.

140. **Local Consultative Forums**. The forums will represent the residents of villages/settlement areas in each ward; advise them of project-related matters (e.g., resettlement schedules and compensation issues); participate in the finalization of resettlement sites; assist with the identification/confirmation of vulnerable households that may require additional transitional support; act as the first point of call for the resolution of grievances and disputes; and assist with the planning and coordination of participatory monitoring and evaluation exercises in their areas of operation.

141. **Grievance Redress Committees**. Responsibility for matters relating to grievance and dispute resolution within WSH will rest with the Liaison and Participation Section of the Resettlement and Development Division, local consultative forums, and grievance redress committees; the latter established as subcommittees of the resettlement steering committee. Grievances and disputes that cannot be resolved through project-related mechanisms or mutually acceptable mediation channels will have recourse to national law through the judiciary.

2. Key Responsibilities for EMAP Implementation

142. **Environmental Management Unit**. An environmental management unit (EMU), to be managed by the management and administration contractor appointed by WSH, will be the primary body responsible for supervising and monitoring project environmental management during construction, as well as implementing environmental management measures during project operation. EMU duties will include approving specific project environmental management plans; ensuring that all EMAP design recommendations are included in the final project design; acquiring all necessary permits and approvals for project construction and operation; monitoring implementation of environmental measures by the contractors; and conducting internal audits of contractor compliance with EMAP conditions, other project approval conditions, and statutory requirements. The EMU will also oversee the hiring and actions of the independent monitoring contractor and liaise with the Ministry of Environment, Science, and Technology (MOEST)

regarding its oversight role and requirements for access to environmental documentation and personnel.

143. **Plant Design and Build Contractors**. The plant design and build contractors will primarily be responsible for the implementation and internal monitoring of all environmental management measures associated with project design and construction. These measures are set out in the EMAP and include measures contained in specific project environmental plans developed by these contractors and the EMU, as well as additional measures required to meet project approval conditions and statutory requirements. The contractors will also implement corrective actions as directed by the EMU or MOEST. The plant design and build contractors will be required to maintain an environmental management system in full compliance with International Organization of Standardization 14001.

144. **Independent Monitoring Contractor**. The EMU will commission an independent monitoring contactor to monitor key physical environmental parameters at project sites. The monitoring will include river water quality immediately downstream of the dam, power station and camp sewerage treatment plant discharge point on the Seti River, air quality near the dam and power station sites and underground excavation areas, and noise levels near the dam and power station sites.

145. **MOEST**. MOEST will externally monitor project compliance with approval and license conditions and Government statutory standards.

3. Evaluation Panel

146. A social and environmental evaluation panel will be appointed to provide guidance to the Resettlement and Development Division and EMU. The panel will comprise three specialists with significant expertise in resettlement and development process and practise, and one environment specialist. It will undertake overall evaluations of the resettlement and livelihood restoration work and environmental management being undertaken by the Project. The panel will be appointed early in the preconstruction phase. Panel visits will occur every 6 months during project start-up, and then annually. The scope of work of the panel will include

(i) examining internal monitoring reports, and quantitative and qualitative socioeconomic monitoring reports;
(ii) visiting resettlement sites and consulting resettler and host communities to verify the success of the resettlement program;
(iii) evaluating project institutions, including capacity and operating constraints;
(iv) analyzing budgets and expenditure in relation to milestones and site realities;
(v) advising on any emerging issues and providing recommendations on how to address issues and improve the resettlement program; and
(vi) assessing the adequacy of, and providing advice to improve, the environmental management system, contractor performance, environmental supervision, monitoring and auditing, and effectiveness of remedial actions.

4. Institutional Capacity

147. The primary government ministries and departments that will be involved in the Project's social and environmental management monitoring and other project tasks are MOEST, land revenue offices, and Department of Electricity Development. The Project will undertake general capacity building and provide institutional support where required to ensure that these institutions are in a position to undertake their monitoring tasks. The Project will also directly

fund any Government staff seconded to project tasks (e.g., land title verification) and meet any associated costs.

C. Financing

148. WSH will bear the cost of all social and environmental mitigation measures set out in the project resettlement plans and EMPs, apart from the contractual and statutory obligations of the construction and EMUs, and the statutory role of Government authorities. WSH has allocated $147.03 million to cover all social and environmental management costs, as summarized in Table 8.

D. Monitoring

1. Social Monitoring

149. Although the Government will be involved in project development, WSH will hold overall responsibility for the implementation of compensation, resettlement, and other mitigation measures, and for monitoring the resettlement program. The Project's socioeconomic monitoring and evaluation program, detailed in the resettlement plan, will be coordinated by the WSH Monitoring and Evaluation Section of the Resettlement and Development Division, and involve consultation structures such as the local consultative forums and the resettlement steering committee, as well as external agencies. The duration of the program will be determined in consultation with the affected community and other stakeholders.

150. The main functions of the Monitoring and Evaluation Section will be to (i) record and assess project inputs, outputs, and outcomes; (ii) provide an ongoing assessment of the efficacy of compensation and resettlement initiatives, identifying problems and successes as early as possible so that timely adjustments of implementation arrangements can be made; and (iii) confirm that former livelihoods and living standards have been reestablished.

151. The Monitoring and Evaluation Section will be established at an early stage to undertake preparatory activities for implementation of the monitoring and evaluation program. This will include the establishment of a monitoring management system, incorporating a monitoring database linked to existing databases, and early training/capacity-building programs among affected communities to prepare them for participation in the program.

152. The overall aim of the program will be to measure the extent that the goals of the resettlement plan have been achieved. WSH will establish indicators and targets in consultation with the resettlement steering committee and local consultative forums. While indicators will be established for the resettlement and livelihood restoration process as a whole, they will be disaggregated to ensure that social variables are properly accounted for, such as for vulnerable groups.

153. The monitoring and evaluation program will entail performance and impact monitoring, as well as the appointment of an evaluation panel. A completion audit will be undertaken after a suitable period following completion of the resettlement program.

2. Environmental Monitoring

154. Environmental monitoring will be undertaken during project construction and operation to provide baseline environmental data; detect adverse environmental impacts or noncompliance with project approval conditions and management plans during implementation; and

design/modify mitigation measures to prevent/manage environmental impacts. Internal project monitoring will be the responsibility of the plant design and build contractor and EMU during their respective periods of project management, as well as the WSH EMU during construction and initial 25 years of project operation. External monitoring will be undertaken by WSH's independent monitoring consultant and by MOEST as part of its compliance duties.

155. Internal environmental monitoring during construction will mainly comprise daily (vegetation clearance, excavation activities, stockpiling, and spoil disposal), weekly (drainage works, erosion and sediment controls, tunneling, chemical, fuel and explosive storage, oil separators, refueling areas, and site rehabilitation) and monthly (all workforce camps and work sites in use over the preceding month) inspections of activities and features by the plant design and build contractor (Appendix 4). The plant design and build contractor will adopt an International Organization for Standardization 14001 (ISO 14001) quality management system for environmental management. The EMU will review the plant design and build contractor's environmental management system and site activities at least once a month. Likewise, the EMU will adopt an ISO 14001 environmental management system and monitor environmental aspects of the Project as per the frequency summarized in Appendix 4.

156. The independent monitoring contactor will monitor key environment parameters at project sites, and report to WSH. All monitoring data will also be made available to MOEST. MOEST will monitor project activities and environmental features affected by the Project as per its statutory duties.

X. PUBLIC CONSULTATION AND DISCLOSURE

A. Overview

157. Public consultation has been an integral part of EIA and resettlement plan preparation since 1996, in recognition that the Project will affect the lives of many people and affect ecosystem conditions over a large area. All types of stakeholders have been consulted about the Project, including affected people, local communities, government ministries and departments, non government organizations, and other interested parties.

B. Public Consultation Activities

158. Public consultation was undertaken during preparation of the project EIA (2000) and in 2006-2007 during the updating of this EIA and preparation of the transmission line EIA. This involved affected communities and households, relevant government departments, non-government organizations, and other organizations. WSH consultation commenced in 1996 with informal discussions with affected people in the project area regarding issues and concerns, followed by a scoping meeting with relevant government departments and non-government organizations to establish the EIA terms of reference.

159. Consultation with affected communities at the project site was initially conducted over 21 months (1997–1999) and provided affected people with the opportunity to comment on the proposed development, proposed/required mitigation measures, and findings of the draft EIA. The form of consultations included: ad hoc and formal meetings with communities elected local consultative forum representatives; a comprehensive socioeconomic survey of directly affected households supplemented with additional qualitative research (participatory rural appraisal); discussions with landholders, district officials, and other stakeholders in the potential resettlement areas (host communities); a three-day field inspection of potential resettlement areas by community representatives; distribution of information sheets; and two public hearings

undertaken in accordance with Government requirements to conclude the EIA consultation process. These are summarized in Table 10. Many issues raised and mitigation measures proposed by affected people were incorporated in the project design.

Table 10: Summary of Local Consultation, Social Survey Fieldwork and Information Disclosure (1997–1999)

Date	Activity
24 Oct 1997	Meetings with chief district officers of Doti and Dadeldhura districts
25 Oct–2 Nov 1997	First round of meetings and informal discussions in Dhungad, Talara and Deura
5–12 Nov 1997	Discussions with officials in Doti and Dadeldhura districts (land revenue office, etc.)
Nov 97–Feb 98	Socioeconomic survey of reservoir-affected households
30 Nov–1 Dec 1997	Meetings with acting chief district officer and local development officer , Bajhang district
20 Dec 1997	Distribution of information sheet #3 (100 copies)
28 Dec 1997–3 Jan 1998	Meetings with government officials and other stakeholders in Kailali and Kanchanpur districts
7 Jan 1998	Community meeting in Dhungad
8 Jan 1998	Community meeting in Talara
11 Jan 1998	Community meeting in Deura
14–16 Jan 1998	Meetings with selected village development committee chairmen in Kailali district
9 Feb 1998	Discussions with households affected by power station area developments
10–11 Feb 1998	Establishment of local consultative forum (LCF), Deura
12–13 Feb 1998	Establishment of LCF, Moribagar
14–15 Feb 1998	Establishment of LCF, Dhungad/Talara
18–26 Feb 1998	Meetings with landowners and district development committee officials in Kailali district regarding availability of land
28 Feb 1998	Distribution of information sheet #4 (300 copies)
10 Mar 1998	Discussion on land availability in Kailali (Lamki)
13 Mar 1998	Meeting with LCF, Moribagar; distribution of sheet on land investigations in Kailali (38)
15 Mar 1998	Meeting with LCF, Dhungad/Talara; distribution of sheet on land investigations in Kailali (46)
17 Mar 1998	Establishment of LCF, Gopghat (construction areas/camps, work sites, power station)
18 Mar 1998	Meeting with LCF, Gopghat
19–24 Mar 1998	Discussions with landowners in Kailali district regarding the availability of resettlement land
20 Apr 1998	Meeting with coordinating LCF in Dipayal
21–23 Apr 1998	Inspection of potential replacement land in Kailali district by community representatives
17–30 Mar 1999	Sample survey of water use in downstream communities
10 Apr 1998	Distribution of information sheet #5 (250 copies)
19 Apr 1999	Meeting with coordinating LCF in Dipayal to present and discuss final resettlement proposals
31 May 1999	Distribution of resettlement proposals and information sheet # 6 (200 copies)
2–9 Jul 1999	EIA team members notify affected communities of public hearings
3 Jul 1999	Public notice of proposed public hearings published in Nepali and English national newspapers
17 Jul 1999	Public hearing at Gopghat for main project area, advice and recommendations requested
18 Jul 1999	Public hearing at Budar for transmission line area, advice and recommendations requested

EIA = environmental impact assessment; LCF = local consultative forum
Source: SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

160. Two formal public hearings were conducted in the presence of government officials after the initial draft of the EIA had been prepared and prior to EIA submission, in accordance with amendments to the April 1999 *Environmental Protection Regulations* requiring a public hearing to be held in the affected areas to "collect advices and recommendations" during the course of EIA preparation. A public hearing was held on 17 July 1999 in Gopghat to address issues

relating to the main project area, and another on 18 July 1999 in Budar to address issues relating to the transmission line (attendees listed in Appendix 5). Notification of the public hearings involved placing public notices in two English and two Nepali national newspapers over three days advising of the hearings and requesting written “recommendations and advices” 2 weeks before the hearings; posting public notices on all VDC notice boards in the affected areas; discussing the Project, EIA, and public hearings with all VDC chairpersons; and advising officials from the Electricity Development Centre (now Department of Electricity Development), Ministry of Water Resources, and Ministry of Population and Environment (now MOEST) of the hearings. The recommendations and advice received at the public hearings were consistent with previous advice; those issues were addressed in the EIA.

161. Consultation recommenced in 2006-2007 when the project EIA and resettlement plan were updated and the transmission line EIA was prepared, conducted over 9 months (Table 11). In the reservoir and downstream areas, this involved five community meetings (four in the reservoir area, and one in the downstream area) in November 2006, and four community meetings (three in the reservoir area and one in the downstream area) in April 2007. The aim of the first round of meetings was to reintroduce the Project and inform communities about the upcoming socioeconomic fieldwork to update the EIA. The meetings in April 2007 explained the pre-implementation work to be initiated during the course of 2007 and reiterated the Project’s compensation and resettlement proposals and plans. These meetings confirmed the communities’ overall acceptance of the Project, and clarified the compensation and resettlement demands of affected communities and reaffirmed the need for a negotiation structure (representing WSH; affected communities; and relevant regional, district, and/or national government officials) to finalize compensation and resettlement entitlements. Socioeconomic survey work conducted during this period comprised: a questionnaire survey of a sample of 230 households located in the reservoir area; a survey of 274 vulnerable households (socially disadvantaged castes and female-headed households) in the reservoir and downstream areas; 19 group discussions with men, women and vulnerable households in the reservoir and downstream areas; and a count of households in the reservoir area to update baseline data.

Table 11: Summary of Local Consultation, Social Survey Fieldwork and Information Disclosure (2006-07)

Date	Activity
Reservoir Area	
6-15/11/06	Distribution of information sheet #8 (300 copies)
20/11/06	Community meeting in Deura for Rayal, Dangaji, Sunkuda, Koiralakot and Parakatne VDCs
22/11/06	Community meeting in Moribagar for Thalakanda, Shivaling, Girichauka and Chhapli VDCs
24/11/06	Community meeting in Dhungad for Dhungad, Sigas and Belapur VDCs
25/11/06	Community meeting in Talara for Lamikhal, Mahadevsthan and Dahakalikatshan VDCs
27/11/06	Community meeting in Gopghat for Barpata, Banlekh, Pachnali and Latamandu VDCs
28/11 – 15/12/06	Household questionnaire survey – 504 households
28/11 – 15/12/06	Focus group discussions – 19
16/4/07	Community meeting in Deura for Rayal, Dangaji, Sunkuda, Parakatne and Koiralakot VDCs
17/04/07	Community meeting in Moribagar for Thalakanda, Shivaling, Girichauka and Chhapli VDCs
18/04/07	Community meeting in Dhungad for Dhungad, Sigas, Belapur, Lamikhal, Girichauka, Dahakalikatshan and Mahadevsthan VDCs
20/04/07	Community meeting in Gogphat for Barpatta, Banlekh, Latamandu, Pachnali and Belapur VDCs
16-20/04/07	Distribution of information sheet #9 (300 copies)
Transmission Line	
10-19/1/07	VDC-level group meetings - 17
6-19/2/07	Socio-economic survey of 399 households living within/near the transmission line RoW
6-19/2/07	VDC-level focus group meetings with men, women and vulnerable households – 45
6-19/2/07	Distribution of transmission line information sheet #1 (500 copies) on Project status, the proposed route, line design and on-going studies
6-19/2/07	Meetings with government officials and other stakeholders in Kailali and Kanchanpur districts
26/7/07	Public Hearing at Dadeldhura for transmission line EIA
28/7/07	Public Hearing at Mahendranagar for transmission line EIA

Sources: Shah Consult. 2007. *Talkot-Mahendranagar Transmission Line Environmental Impact Assessment.* Kathmandu; and WSH project records.

162. Public consultation during the preparation of the transmission line EIA commenced during the scoping of issues and preparation of the EIA terms of reference in late 2006 when group discussions were held in the affected districts. Group meetings and checklist surveys at VDC and Ward level were then held in January 2007 to introduce the project and EIA process. A second round of meetings was held in February 2007 to collect the views of local people, political representatives, NGOs and other concerned stakeholders. A comprehensive socio-economic survey of 399 households living within or near the proposed transmission line ROW was undertaken in February 2007, and an Information Sheet was distributed to each surveyed household providing information on the status of Project development, the proposed transmission line route, line design features and on-going studies. A workshop was held with government agencies in Kathmandu in April 2007 to scope issues and finalize the EIA terms of reference.

163. Two formal public hearings were conducted in affected areas in the presence of government officials after the initial draft of the transmission line EIA had been prepared, prior to EIA submission, to inform local people, NGOs, line agencies and other stakeholders about the project and EIA findings, and provide a forum for public comment, which in turn was used to finalise the EIA. A public hearing was held on 26 July 2007 in Dadeldhura and another on 28 July 2007 in Mahendranagar to address issues relating to transmission line construction and

operation (attendees listed in Appendix 5). An information booklet in Nepali was distributed at the public hearings, describing the Project, baseline environmental conditions in the area, potential impacts, proposed mitigation measures and a summary of the EIA findings. Notification of the public hearings involved placing public notices in one English and one Nepali national newspaper on 16 July 2007, as well as notices in three local papers. Invitation letters were sent to concerned Government ministries/departments, affected VDCs and Municipalities, requesting their representation at the meetings. In addition, a Project three-member team posted public notices and met government officials before the hearings, inviting them to participate in the hearing. The recommendations and advice received at the public hearings were consistent with previous advice, and these issues were addressed in the EIA.

164. Local support for the Project increased during the field work and local consultation, largely due to the production benefits designed in the resettlement and relocation package, as well as recognition of the indirect benefits gained from living on the terai, including better access to jobs, health services, and education facilities. Migration to the terai from the project area has occurred over the past 30–40 years, with many affected people having close relatives in Kailali and Kanchanpur districts. Another factor influencing support for the Project was the major Seti River flood in May 2000. The flood damaged large areas of riverside cultivation land and destroyed some houses, effectively increasing the overall benefits of resettlement to households that lost land, especially as land title will be recognized.

165. Ongoing consultation and community participation will occur during implementation of resettlement activities through a community participation structure consisting of resettlement steering committees, local consultative forums, and deployment of community liaison assistants to ensure effective information dissemination and exchange at the household level.

C. Public Disclosure

166. During project planning and impact assessment, information about the Project was disclosed to stakeholders by a variety of means. In addition to disclosure during the extensive consultation activities and public hearings, disclosure involved the periodic distribution of information sheets to affected communities (seven between 1997 and 2000 and two in 2006/07); community meetings and informal discussions with locally affected people during EIA field work; and discussions with district officials.

167. SEIA disclosure will involve making the SEIA available to the public through the depository library system and posting on the ADB website no later than 120 days prior to ADB Board consideration. The SEIA, in Nepali, will be distributed to affected communities. The full EIA is available to interested parties at selected public libraries district development committees, offices of the Chief District Officers of the districts concerned, and WSH offices in Nepal.

D. Project Planning Based on the Provision of Benefits to Affected People

168. In addition to compensation according to international best practice, the main additional measures incorporated to provide benefits to affected people and communities are

(i) provision of a 20% additional land entitlement to all titled landowning households suffering permanent land losses,
(ii) provision of at least a subsistence landholding to all landowning households resettled to project sites in the terai,
(iii) provision of a land-based communal resource entitlement to all households resettling to project sites in the terai,

(iv) water supply and sanitation improvement in riparian villages between the dam and reregulation weir,
(v) Seti valley community development initiatives,
(vi) livelihood improvement/diversification programs, and
(vii) preferential employment to local people in unskilled construction jobs.

XI. CONCLUSIONS

169. **Project Benefits**. The Project will generate 3,636 GWh of electricity per annum for export to India, and provide significant economic and development benefits to Nepal. The direct economic benefit from annual payments by the Project to the Government is estimated to total $991 million during the 30-year generation license, equivalent to an average annual payment of $33 million. Once full project ownership is transferred to the Government, the Government will receive full revenues of around $170 million per annum from electricity sales (based on 2007 prices), projected over a minimum of 25 years. Other significant project benefits include the creation of jobs (up to 6,000 construction positions and 200 permanent positions), provision of an additional 20% of land (based on productivity) to all project-affected landholders being resettled, lifting of the living standard of 38% of people being resettled from the main project area to subsistence level, provision of community development initiatives near the reservoir and in the downstream area, and provision of a significant economic boost to the FWDR.

170. **Adverse Impacts**. The main adverse impacts of the Project are altered river hydrology, ecosystem loss/degradation (aquatic and terrestrial), land take (agricultural and forestland), and resettlement/relocation of affected people. The impact on Seti River hydrology and the aquatic ecosystem will be mitigated by the release of a base environmental flow and dry season flushing flows, as well as the operation of the reregulation weir. Resettlement and compensation for land and other losses will be managed by the implementation of the resettlement plan, which includes land-for-land exchange and net benefits to affected people, particularly those currently living below the subsistence level.

171. **Adequacy of the EIA**. The EIA was recently updated with the incorporation of an EIA for the section of transmission line in Nepal, an initial environmental and social examination (2006) for the Indian section of the line, disaster management plan, initial decommissioning plan, cumulative impact assessment, recent public consultation, and updated project data including costs. The EIA provides an adequate assessment for the purpose of project evaluation.

172. Environmental monitoring during project operation will mainly be conducted in relation to the main impact areas of river hydrology, village water supply in the riparian zone, downstream riverbed degradation, reservoir foreshore stability, water quality, aquatic ecology, and hazards at daily to annual frequencies depending upon the feature being monitored.

COMPARISON OF LAND LOSS AND RESETTLEMENT AT ALTERNATIVE RESERVOIR FULL SUPPLY LEVELS

Table A1.1: Land Types by Area at Alternative Full Supply Levels

	Land Area (ha)		
Land Type	**FSL 1,240 m +10 m**[a]	**FSL 1,284 m +6 m**[b]	**Land Between 1,240 m +10 m – 1,284 m +6 m**
Cultivation	460	628	168
Forest	458	769	311
Shrubland	91	162	71
Grassland	143	241	98
Settlement	4	5	1
Riverine Feature	300	342	42
Rock, Cliff, Scree	7	19	12
Total	**1,463**	**2,166**	**703**

FSL = full supply level; ha = hectare; m = meter.
[a] Total FSL land area includes a plus 10 m flood zone.
[b] Total FSL land area includes a plus 6 m flood zone.
Source: Adapted from SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

Table A1.2: Estimated Resettlement at Alternative Full Supply Levels

Component	**Households**[a]		
	FSL 1,240 m[b]	**FSL 1,284 m**	**Difference**
Resettlement	917	1,155	238

m = meter.
[a] Households estimates include flood zones.
[b] Resettlement for FSL 1,240 m was estimated by excluding Bajhang district.
Source: Adapted from SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

PREDICTED CUMULATIVE IMPACT OF HYDROELECTRIC PROJECTS IN THE KARNALI RIVER BASIN BY 2028

Month	Existing Flow (m^3/s)	Flow Change (m^3/s)			Modified Flow (m^3/s)	Change (%)
		Bheri-Babai	Lohore Khola	WSHEP		
January	369	(40)	12.4	58	399	8.2
February	331	(40)	13.3	69	373	12.8
March	343	(40)	13.5	68	385	12.1
April	445	(40)	12.2	32	449	0.9
May	732	(40)	8.7	(10)	691	(5.6)
June	1,454	(40)	(3.2)	(5)	1406	(3.3)
July	3,112	(40)	(44.0)	(230)	2798	(10.1)
August	4,139	(40)	(29.3)	(123)	3947	(4.6)
September	2,868	(40)	0.0	(14)	2814	(1.9)
October	1,246	(40)	0.0	(8)	1198	(3.9)
November	631	(40)	7.2	22	620	(1.7)
December	451	(40)	10.9	69	491	8.9

m^3/s = cubic meters per second; % = percentage.

Source: Japan International Cooperation Agency (JICA). 1993. *Master Plan Study for Water Resource Development Karnali and Mahakali River Basin.* Volume 1. Kathmandu; and SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

ENVIRONMENTAL MANAGEMENT ACTIVITIES

Environmental Issue	Action	Responsibility
Project Site Layout	• Incorporate the following principles in site layout: - Set construction sites, work sites, and workforce camps back from the crest of riverbanks by a minimum of 15 m, where possible. - Locate workforce camps at least 100 m from existing villages and construction and work sites. - Locate stockpile sites on flood-free sites and at least 15 m from watercourses or drainage lines where possible. - Set permanent spoil disposal areas back at least 15 m from watercourses and away from workforce camps. - Locate construction materials storage areas close to the point of use to avoid excessive handling and transportation. - Locate noisy activities at construction and ancillary sites together, where practical, and as far away as possible from dwellings, schools, offices, and businesses. - Locate refueling and equipment maintenance areas on the low side of project sites to avoid contamination of the sites in the event of spillage.	PDB contractor
Erosion and Sediment Control	• Prepare an erosion and sediment control concept plan. • Incorporate the following design principles in site drainage: - minimize land reshaping, - use existing flow paths where possible, and - limit flow velocities and encourage particulate precipitation. • Review, and approve if acceptable, the erosion and sediment control concept plan.	PDB contractor PDB contractor WSH
Permits and Approvals	• Obtain all necessary permits/approvals prior to commencing any related works. • Provide a copy of all permits and approvals to the supervising engineer and PDB contractor. • Adhere to all permit and approval terms and conditions. • Obtain written permission from private landholders to conduct activities on their land prior to commencing these activities, and provide copies to the PDB contractor.	WSH WSH PDB contractor Supervising engineer
Survey, Peg, and Fence Project Sites	• In accordance with detailed design, survey and peg the boundary of all construction sites, work areas, and workforce camps at intervals of 25 m or less. • Botanist to identify any endangered/threatened flora species in pegged areas. • Install temporary fencing around endangered/threatened species not directly impacted by construction in project areas. • Archaeologist to identify any archaeological, religious, or cultural sites within pegged areas. • With assistance from village heads arrange for relocation of identified archaeological, religious, or cultural sites affected by the Project. • Where an archaeological, religious, or cultural item/site is located on a project site, move the project site where possible, or fence out or relocate the identified site with the permission and	PDB contractor Supervising engineer PDB contractor Supervising engineer WSH PDB contractor

Environmental Issue	Action	Responsibility
	assistance of the VDC chairperson. • Identify and document all trails and services within pegged sites. • Identify trees/vegetation to be retained within each site and fence them off. • Peg the proposed location of spoil disposal areas, crushing plants, batching plants, waste disposal areas, and fuel/chemical storage areas at 10 m intervals or less. • Count the number of trees to be felled and complete the application/s for a permit to fell trees. • Jointly inspect all pegged sites. • Approve, if correct, all pegged areas and proposed location of activities. • Seek approval from supervising engineer to commence work at each project site.	PDB contractor PDB contractor PDB contractor PDB contractor Supervising engineer and PDB contractor Supervising engineer PDB contractor
Plant Propagation	• Propagate endangered/threatened flora identified at project sites.	PDB contractor
Land and Building Acquisition and Leasing	• Acquire all necessary land and buildings prior to the commencement of any related works, adhering to all acquisition procedures. • Provide copies of land acquisition procedures to the supervising engineer and PDB contractor. • Provide a list of affected property owners to the supervising engineer and PDB contractor.	WSH WSH WSH
Resettlement/ Relocation	• Implement the resettlement action plan.	WSH
Employment	• Establish and implement a preferential employment strategy, specifying recruitment eligibility, age requirements, and recruitment and selection procedures. • Adhere to the preferential employment strategy.	WSH WSH, supervising engineer, PDB contractor and subcontractors
Training	• Conduct an EMAP workshop to be attended by key PDB contractor representatives. • Conduct environmental management workshops to be attended by all staff.	Supervising engineer PDB contractor
Local Services	• Identify and document the location of local services. • Confirm location of local services during inspection of pegged areas. • Liaise with affected landowners and villages regarding services to be maintained, timing of cuts, and reinstatements. • Provide a list of all services that may be temporarily or permanently cut during project construction and services that must be reinstated as soon as possible, to the PDB contractor.	PDB contractor Supervising engineer Supervising engineer Supervising engineer
Erosion and Sediment Control	• Develop a detailed erosion and sediment control plan. • Review and approve the detailed erosion and sediment control plan.	PDB contractor Supervising engineer
Hazards	• Develop incident management and emergency response procedures. • Review and approve procedures.	PDB contractor Supervising engineer

Environmental Issue	Action	Responsibility
Vegetation Clearance	• Seek approval for clearing from the supervising engineer at least 2 weeks prior to any proposed clearing. • Instruct all construction workers to restrict clearing to the marked areas and not to harvest any forest products for personal consumption. • Undertake vegetation clearance in Government or community forests only when a permit and forest user group permission to clear are obtained. • Progressively clear vegetation at construction sites. • Protect identified vegetation within site boundaries. • Establish and maintain a nursery for site rehabilitation.	PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor
Drains, Erosion, and Sediment Control Measures	• Implement the approved erosion and sediment control plan. • Survey and peg all designed drainage works prior to construction. • Jointly inspect the pegged drainage works. • Install appropriately sized sediment basins at tunnel outlets, batching plants, spoil disposal sites, and all construction sites and other drainage structures. • Inspect all construction sites, work sites, and workforce camps for drainage and erosion problems daily and after each major storm event during construction. • Repair all failed drains, desilt sediment basins, and take other appropriate action as directed by the supervising engineer. • Inspect all drainage structures during weekly site inspections.	PDB contractor PDB contractor Supervising engineer and PDB contractor PDB contractor PDB contractor PDB contractor
Topsoil Saving	• Strip and save all available topsoil from disturbed sites and reuse it in progressive site rehabilitation. • Stockpile topsoil away from drainage lines at sites approved by the supervising engineer. • Cover or seed topsoil stockpiles if retained for more than 1 month.	Supervising engineer PDB contractor PDB contractor PDB contractor PDB contractor
Excavation	• Construct required retaining walls prior to excavation of hill slopes. • Rehabilitate all disturbed areas as soon as possible. • Form stable batter slopes.	PDB contractor PDB contractor PDB contractor
Spoil Disposal	• Reuse spoil on project sites where possible. • Dispose of excess spoil at designated fill sites approved by the supervising engineer. • Instruct the construction workforce on approved fill disposal sites and strictly supervise the correct placement of fill at these sites. • Construct gabions to contain spoil at approved sites if deemed necessary by the supervising engineer. • Inspect spoil disposal placement each day. • Shape spoil fill to form stable landforms. • Inspect and approve final land shaping at each fill site.	PDB contractor PDB contractor PDB contractor PDB contractor Supervising engineer PDB contractor Supervising engineer
Water Quality	• Treat all wastewater prior to being discharged to watercourses. • Regularly sample and test water from sediment basins and settling ponds.	PDB contractor PDB contractor

Environmental Issue	Action	Responsibility
	• Install grease traps at maintenance workshops and regularly clean them. • Undertake field maintenance in areas approved by the supervising engineer. • Install oil separators to treat generator cooling water. • Store fuel and chemicals in secure sheds or in bunded areas. • Undertake monthly monitoring of water quality in the Seti River.	PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor
Waste Management	• Reuse or recycle waste materials on-site wherever possible. • Provide waste disposal containers at all project sites. • Collect waste oils, fuels, and chemicals for recycling on-site or transport to recycling facility. • Burn wastes where feasible. • Cover landfills with soil at the end of each day to reduce odors and prevent scavenging. • Inspect waste management procedures at each site during the weekly site inspection.	PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor Supervising engineer
General Hazards Hazardous Material	• Provide safety training to each employee at the commencement of employment and conduct refresher workshops as required. • Provide relevant safety equipment and clothing to each employee and fire-fighting equipment and first-aid facilities at each project site. • Construct security fencing around all Project sites and designate walkways around and through Project sites. • Install a GLOF warning system and audible warning devices (e.g. sirens) at appropriate locations along the Seti River. • Conduct regular safety audits at all project sites. • Store hazardous material in secure sheds or bunded areas and in accordance with manufacture's specifications. • Store explosives in police-guarded bunkers and in strict accordance with Government regulations. • Immediately contain and mop up chemical spills with saw dust. • Seek directions from the supervising engineer for the disposal of hazardous materials. • Provide disposal directions to the PDB contractor when requested.	PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor Supervising engineer
Workforce Management and Safety	• Ensure workers act in a responsible manner to local people and do not harvest or take personal resources, forest products, or wildlife. • Establish and enforce rules prohibiting the consumption of alcohol, employment of underage workers, and urination in open areas and waterways. • Provide alternative fuels for wood for all workforce cooking, lighting, and heating needs. • Provide and maintain proper drinking water, sewerage, waste disposal, and health care facilities at workforce camps.	PDB contractor PDB contractor PDB contractor PDB contractor
Noise and Vibration	• Inform local villages of construction schedules, likely commencement and completion dates at each site, and dates and times when blasting and drilling will occur.	Supervising engineer

Environmental Issue	Action	Responsibility
	• Locate stationary plant (e.g., generators) as far away as possible from local villages and workforce camp sites. • Fit mufflers on road vehicles and construction equipment. • Provide ear muffs to workers operating high decibel construction equipment, as well as workers in close proximity to this equipment. • Prohibit the use of air horns in settled areas. • Seek approval for blasting from the supervising engineer. • Inspect proposed blasting site prior to granting approval. • Undertake controlled blasting. • Inspect blasting operations during weekly site inspections.	PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor Supervising engineer PDB contractor Supervising engineer
Air Pollution	• Provide ventilation for employees working in confined locations e.g., tunnels and power station. • Provide breathing masks for employees where required. • Monitor air quality in construction tunnels and at the power station on a daily basis. • Spray water on disturbed areas to suppress dust. • Cover or seed stockpiles left for more than 2 months (or immediately during the monsoon). • Gravel temporary roads that have heavy traffic. • Conduct weekly visual inspections of vehicle and equipment emissions, dust control measures.	PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor Supervising engineer
Traffic and Access	• Clearly define and provide signage for trafficable areas. • Establish speed limits on project roads. • Implement and enforce speed limits on project roads. • Construct speed bumps on internal project roads.	PDB contractor Supervising engineer PDB contractor PDB contractor
Archaeology	• Report any archaeological, cultural, or religious sites discovered during project construction immediately to the supervising engineer. • Issue an immediate stop work demand at that particular site until a plan of action is determined. • Seek the assistance of village head leaders to decide on the necessary plan of action. • Advise the PDB contractor to resume work.	PDB contractor Supervising engineer Supervising engineer Supervising engineer
Demobilization	• Approve the commencement of site demobilization. • Remove all temporary buildings, mitigation measures, refuse, stockpiles, and excess construction materials from project sites. • Recycle demolished materials where possible, or otherwise burn on-site or landfill.	Supervising engineer PDB contractor PDB contractor
Site Rehabilitation	• Rehabilitate/revegetate disturbed areas within 1 month of final site use. • Evenly spread stockpiled topsoil and plant a cover crop and/or indigenous tree species. • Regularly monitor the effectiveness of rehabilitation/revegetation measures during weekly site inspections.	PDB contractor PDB contractor Supervising engineer

Environmental Issue	Action	Responsibility
Reinstatement of Services	• Progressively reinstate or repair all interrupted services not compensated with permanent alternatives, to the previous capacity. • Inspect and certify the adequate reinstatement of services.	PDB contractor Supervising engineer
Training	• All employees will attend an EMAP induction and training workshop at the commencement of employment.	EMU
Hydrology	• Monitor riparian releases and discharges from the tailrace outlet on a daily basis. • Fund water supply schemes in the riparian area. • Monitor effectiveness of water supply schemes in first 2 years of project operation.	EMU WSH EMU
River Bed Degradation	• Monitor erosion of the Seti River bed during first 5 years of project operation.	EMU
Reservoir Foreshore Stability	• Prohibit habitation between FSL – FSL+96 m. • Prohibit removal of trees between FSL – FSL+96 m. • Conduct 6-monthly investigations of slope stability around the reservoir for the first 5 years of project operation. • Check and remove any logs or large stags accumulating in the reservoir.	EMU EMU EMU EMU
Water Quality	• Collect and analyse water samples monthly.	EMU
Aquatic Ecology	• Establish a fish hatchery. • Regularly stock the reservoir and waters downstream of the tailrace outlet with fish fry. • Monitor impact on aquatic ecology in first 5 years of project operation.	WSH EMU EMU
Hazards Natural Hazards Project Hazards	• Develop incident management and emergency response procedures. • Approve incident management and emergency procedures. • Implement incident management and emergency procedures. • Regularly check and maintain GLOF early warning system and audible warning devices. • Annually monitor glacial lakes in upper catchment area via aerial photography interpretation or periodic field inspection. • Monitor landslides in reservoir area and upper catchment area. • Develop and implement an ongoing public education program (addressing dangers of electricity and changed hydrological conditions in the project area). • Erect warning signs at regular intervals along the Seti River warning of fluctuating river flows. • Fence off and prohibit public access to dam wall, power station, tailrace outlet, switching yard, and transmission towers. • Undertake safety audits of all project structures and sites every 6 months.	EMU WSH EMU EMU EMU EMU EMU EMU EMU EMU

EMAP = environmental management plan; EMU = Environmental Management Unit; FSL = full supply level; GLOF = glacial lake outburst flood; m = meter; PDB = Plant Design and Build; VDC = village development committee; WSH = West Seti Hydro Limited.

Source: SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Vol. 1, Main Report. Cooma.

ENVIRONMENTAL MONITORING REQUIREMENTS

Feature/Issue	Parameter/s Monitored	Location	Responsibility	Frequency
A. Preconstruction Phase				
Climate	• Rainfall, evaporation, temperature, wind speed and direction, etc	Dam site	Supervising engineer	Daily
Building Survey	• Condition of buildings - to verify impacts caused by the Project (e.g., from blasting)	Immediate catchment area	RDD	Once
B. Construction Phase				
Statutory Responsibilities	• Compliance with license and permit conditions	All project sites	PDB contractor	Weekly
Climate	• Rainfall, evaporation, temperature, wind speed and direction, etc	Dam site	PDB contractor	Daily
Glacial lakes	• Glacial lake development - from aerial photos and/or site visits	Upper catchment	EMU	Annually (during summer)
Landslides	• Catchment stability	Dam catchment	EMU	Annually (after monsoon)
Vegetation Clearance	• Progressive vegetation clearance within pegged sites	All project sites	PDB contractor	Daily
Erosion and Sedimentation	• Effectiveness of controls - presence of erosion and off-site sedimentation • Regular maintenance of sediment basins/traps • Topsoil stripped and covered or seeded if stockpiled for longer than 1 month or during the monsoon • Batter stability	All project sites All project sites All project sites All project sites	PDB contractor PDB contractor PDB contractor PDB contractor	Weekly/after storms Weekly/after storms Weekly Daily
Spoil Disposal	• Reuse of spoil within project areas where possible • Correct disposal of surplus spoil in designated areas	All project sites Spoil disposal areas	PDB contractor PDB contractor	Daily Daily
Hydrology	• River flow volumes	Seti River at Gopghat	PDB contractor	Daily
Water Quality	• Wastewater treated prior to river discharge • Temperature, dissolved oxygen, pH, conductivity, turbidity, reactive silica, total phosphorous, inorganic phosphorous, total nitrogen, ammonia nitrogen, nitrogen oxides, biochemical oxygen demand, chlorophyll-a, and fecal coliforms	All construction sites and camps Seti River, upstream of all construction sites, downstream of the dam, and downstream of the tailrace outlet	PDB contractor PDB contractor and IMC	Weekly Ongoing

Feature / Issue	Parameter/s Monitored	Location	Responsibility	Frequency
Waste Management	• Waste materials reused or recycled on-site where possible • Non-recyclable wastes disposed of appropriately	All project sites All project sites	PDB contractor PDB contractor	Daily Weekly
Hazards/Risk	• Workers provided with appropriate safety equipment and regular safety training • Maintenance of GLOF warning system • Maintenance of tailrace to reregulation weir warning signs and sirens • Storage of hazardous goods in bunded areas or in secure sheds • Explosives stored in guarded bunkers • Use of hazardous goods according to manufacturers' specifications	All project sites Dam catchment Construction sites Construction sites All project sites All project sites	PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor PDB contractor	Weekly Every 6 months Weekly Weekly Weekly Weekly
Workforce Management and Safety	• Enforcement of workforce rules and regulations • Provision of alternative fuels for cooking, heating, and light • Provision of adequate and well-maintained services and facilities	All project sites Workforce camps All project sites	PDB contractor PDB contractor PDB contractor	Weekly Weekly Monthly
Aquatic Ecology	• Fish and macro-invertebrate species and populations	Seti River - above dam site and immediately below tailrace outlet	PDB contractor and IMC	Every 3 months
Flora	• Direct observation of surrounding vegetation • Presence and health of any rare/threatened species	Within 1,000 m of all project sites Within 1,000 m of all project sites	PDB contractor PDB contractor	Monthly Monthly
Noise and Vibration	• Maintenance of equipment in accordance with manufacturers' specifications • Controlled blasting	All project sites Construction sites	PDB contractor PDB contractor	Weekly Daily
Air Quality	• Air quality in confined areas • Water sprayed regularly to minimize dust generation • Exhaust emissions from machinery - visual inspection	Tunnels and power station cavern All project sites All project sites	PDB contractor and IMC PDB contractor PDB contractor	Daily Daily Weekly
Traffic/Access	• Enforcement of speed limits on project roads	All project roads	PDB contractor	Weekly
Complaints	• Replies to all complaints	All project sites	Supervising engineer	Weekly
Post-Construction Phase				
Rehabilitation	• Erosion and sedimentation, ground cover, tree and shrub establishment rates	All project sites	PDB contractor	Monthly

Feature / Issue	Parameter/s Monitored	Location	Responsibility	Frequency
Operation Phase				
Statutory Responsibilities	• Compliance with license and permit conditions	All project sites	EMU	Every 6 months
Climate	• Rainfall, temperature, wind speed and direction	Established catchment monitoring stations	EMU	Daily
Hydrology	• River flow volume	Immediately below spillway, immediately above the Seti River-Ruwa Khola confluence, below the tailrace outlet, and below the re-regulation weir	EMU	Daily
Village Water Supply	• Effectiveness of water supply schemes	Riparian area villages	EMU	Monthly
Riverbed Degradation	• Riverbed degradation	Seti River bed from dam to Dipayal	EMU (qualified geologist)	Every 3 months (first 5 years)
Reservoir Foreshore Stability	• Landslides and slope stability	Reservoir foreshore	EMU	Every 6 months (first 5 years)
Water Quality	• Temperature, dissolved oxygen, pH, conductivity, turbidity, reactive silica, total phosphorous, inorganic phosphorous, total nitrogen, ammonia nitrogen, nitrogen oxides, biochemical oxygen demand, chlorophyll-a, and fecal coliforms	Seti River	EMU	Monthly
Aquatic Ecology	• Habitat availability and seasonal fish species and populations	In reservoir and in the Seti River at tailrace outlet	EMU	Every 3 months (first 5 years)
Hazards	• Monitor landslides • Structural soundness • Check and maintain GLOF warning system and sirens • Monitor glacial lakes from aerial photos and/or site visits	Upper catchment Project structures Along Seti River Upper catchment	EMU EMU EMU EMU	Annually Every 6 months Every 3 months Annually (during summer)

EMAP = environmental management plan; EMU = Environmental Management Unit; GLOF = glacial lake outburst flood; IMC = Independent Monitoring Contractor; m = meter; PDB = Plant Design and Build; RDD = Resettlement and Development Division.
Source: SMEC International. 2000. *West Seti Hydroelectric Project Environmental Impact Assessment.* Volume 1, Main Report. Cooma.

PUBLIC HEARING ATTENDEES

Table A5.1: Public Hearing Gopghat, 17 July 1999

SN	Attendee	Position	Location of Residence
1	Dambar Bahadur Bista	Ward chairman	Belapur VDC- 2
2	Khadak Bahadur Shahi	Social worker	Banlekh VDC – 6
3	Tilak Bahadur Shahi		Banlekh VDC – 7
4	Laxmi Datta Ojha	Member	Mahadevsthan – 9
5	Padam Bahadur Bista	VDC chairman	Belapur VDC
6	Prem Singh Kathayat	VDC chairman	Latamandu VDC
7	Sambhu Koirala	Chief district officer	District Administration Office, Doti
8	Lal Bahadur Bista	VDC chairman	Mahadevsthan VDC, Doti
9	Mukti Nath Sharma	Head teacher	Prabhat Higher Secondary School, Dehimandu, Doti
10	Chet Raj Pant	VDC secretary	Barbata VDC
11	Rai Singh Bhul	Teacher	Lamikhal VDC
12	Dilli Raj Joshi	Principal	Soojung School, Dipayal
13	Purna Bahadur Shrestha	Inspector	District Police Office, Doti
14	Lok Raj Awasthi	Businessman	Dhungad
15	Nar Bahadur Bista	District development committee member	District Development Committee, Dadeldhura
16	Megh Raj Rosyara	Head Teacher	Jijodamandu VDC, Doti
17	Indra Mani Awasthi		Belapur
18	Ravindra Pratap Singh		Lamikhal-5, Talara
19	Lal Bahadur Kathayat	Teacher	Latamandu
20	Indra Bahadur Balayar	Chairman	Banlekh
21	Jaya Bahadur Saud		Belapur - 4
22	Khagendra Singh Dhami	Chairman	Sigas
23	Dev Singh Dhami		Sigas
24	Karna Bahadur Dhami		Lamikhal VDC
25	Mandev Dhami	Vice chairman	Banlekh VDC
26	Tek Bahadur Deuba	Social worker	Ashigram VDC
27	Hari Singh Dhami	Social worker	Banlekh VDC
28	Sita Ram Awasthi	Social worker	Barbata
29	Tek Bahadur Rokaya		Barbata
30	Muralidhar Bhatta	Teacher	Latamandu - 9
31	Prem Bahadur Balayar	Teacher	Barbata
32	Karna Bahadur Saud	Teacher	Shivaling VDC, Baitadi
33	Laxman Singh Saud	Teacher	Thalakanda - 6, Baitadi
34	Prem Raj Joshi	Teacher	Dangaji - 4, Bajhang

Source: Source: West Seti Hydro Limited records, 1999.

Table A5.2: Public Hearing Budar, 18 July 1999

SN	Attendee	Position	Location of Residence
1	Hari Bhakta Bhandari	Chairman, school management committee	Chhatiwan VDC-4
2	Gaja Bahadur Bista	Resource person	Chhatiwan VDC-4
3	Hem Raj Ojha	Resource person	Chhatiwan VDC-4
4	Hikmat Bahadur Malla	Ward chairman	Chhatiwan VDC-2
5	Bishnu Raj Ojha	Teacher	Rampur Ma. Vi.
6	Gita Prashad Khanal	Chief district officer	Dadeldhura
7	Padam Bahadur Deuba	Chairman	Ashigram VDC
8	Tej Bahadur Bohara	Ward chairman	
9	Tek Bahadur Shahi		
10	Jeet Bahadur Bista	Chairman	Chhatiwan VDC
11	Padam Raj Ojha	General public	Chhatiwan VDC
12	Gopal Bahdur BK	General public	Ghanteshwor VDC
13	Nar Bahadur BK	Member	Ghanteshwor VDC-1
14	Hem Bahadur Yir	Ward chairman	Chhatiwan VDC
15	Mohan Bahdur Malla	Ward chairman	Ghanteshwor VDC
16	Tek Raj Bhandari	Teacher	Chhatiwan VDC-4
17	Chitra Bahadur Khatri		Chhatiwan VDC-7
18	Birendra Prashad Pant	VDC secretary	Chhatiwan VDC
19	Tilak bahadur Malla	Vice chairman	Ghanteshwor VDC
20	Harka Bahadur Malla	Ward chairman	Ghanteshwor VDC
21	Harka Bahadur Khatri	Ward member	Chhatiwan VDC
22	Ram Chandra Ojha		Chhatiwan VDC – 4
23	Bir Bahadur Yir		Chhatiwan VDC – 3
24	Bir Bahadur BK		Chhatiwan VDC – 3
25	Tek Bahadur Jethara		Chhatiwan VDC – 3
26	Khem Bahadur Yir		Chhatiwan VDC – 6
27	Basanta Bahadur Malla	Secretary, Nepal Tarun Dal, Village Unit Committee	Chhatiwan VDC- 2
28	Ganesh Bahadur Bista	Chairman, Nepal Tarun Dal, Village Unit Committee	Chhatiwan VDC – 1
29	Udhhav Bahadur Yir		Chhatiwan VDC – 3
30	Liladhar Jethara		Chhatiwan VDC – 3
31	Dhanjit BK		Chhatiwan VDC – 3
32	Dal Bahadur BK		Chhatiwan VDC – 3
33	Ganesh Datta Bhattarai		Chhatiwan VDC – 3
34	Man Bahadur		Chhatiwan VDC – 3
35	Tirtha Bahadur BK		Chhatiwan VDC – 3
36	Shayam Bahadur Lama		Chhatiwan VDC – 3
37	Suresh Bahadur BK		Chhatiwan VDC – 3
38	Chandra Bahadur BK		Chhatiwan VDC – 3
39	Man Bahadur Thapa		Chhatiwan VDC – 3
40	Kamal Singh Kadal		Chhatiwan VDC – 3
41	Rana Bahadur Kadal		Chhatiwan VDC – 7
42	Bajir Singh Saud		Chhatiwan VDC – 8
43	Dal Bahadur Saud		Chhatiwan VDC – 8
44	Bal Bahadur Saud		Chhatiwan VDC – 3
45	Karna Malla		Chhatiwan VDC – 1
46	Nar Bahadur Deuba		Ashigram VDC
47	Bijaya Bahadur Deuba		Ashigram VDC
48	Ram Bahadur Oli	Chairman	Ghanteshor DVC
49	Dambar Bahadur Khadka		Gangkhet VDC
50	Lal Bahadur BK	Ward chairman	Ghanteshor VDC-1

SN	Attendee	Position	Location of Residence
51	Bhav Bahadur Kadal		Ghanteshor VDC-7
52	Karna Bahadur Malla		Ghanteshor VDC-8
53	Bhakta Bahadur Aale	Teacher	Ghanteshwor VDC-1
54	Yogendra Malla	Unemployed	Chhatiwan-2
55	Prem Bahadur Oli	Ward chairman	Chhatiwan VDC
56	Dev Bahadur Kadal	Head teacher	Chhatiwan VDC-7
57	Lal Bahadur Khatri	Ward member	Chhatiwan VDC-7
58	Kamal Singh Oli	Ward member	Chhatiwan VDC-7
59	Tej Bahadur Khatri	Social worker	Chhatiwan VDC-7
60	Kishor Kumar Malla	Social worker	Ghanteshwor VDC
61	Sidhha Bahadur Bohara	Social worker	Laxminagar VDC
62	Sher Bahadur Malla	Social worker	Chhatiwan VDC
63	Dan Bahadur Bogati	Student	
64	Nar Bahadur Rana		
65	Ram Bahadur Malla	Driver	Ghanteshwor VDC
66	Khadak Bahadur Rawat	Social worker	Aalital VDC
67	Dal Bahadur Bohara	Social worker	Aalital VDC
68	Yanai Bahadur Simseli	Social worker	Barchhain VDC
69	Lachhi Ram Palli	Social worker	Chhatiwan VDC
70	Tej Bahadur Palli	Social worker	Chhatiwan VDC
71	Chandra Bahadur Gharti	Social worker	Chhatiwan VDC
72	Sher Bahadur Kuwor	Police constable	Chhatiwan VDC
73	Dal Bahadur BK	Social worker	Chhatiwan VDC
74	Dhan Bahadur BK	Social worker	Chhatiwan VDC
75	Khagendra Bohara	Social worker	Aalital VDC
76	Bal Bahadur Gurung	Chairman	Gangkhet VDC
77	Dan Bahadur Bogati	Social worker	Gangkhet VDC
78	Bhaskar Dutta Bhatta	Social worker	Ghanteshwor VDC

VDC = village development committee.
Source: West Seti Hydro Limited records, 1999.

Table A5.3: Public Hearing Dadeldhura, 26 July, 2007

SN	Attendee	Occupation/Position	Location of Residence
1	Budhi Rijal	Service	Dadeldhura
2	Krishna Dutta Bhatta	Agriculture	Bhageshwor, Chatiwan, Doti
3	Yagya Raj Bhandari	Agriculture/Chairman	Bhageshwor, Chatiwan, Doti
4	Dev Raj Bhatta	Agriculture/Treasurer	Bhageshwor, Chatiwan, Doti
5	Padma Singh Bam	Agriculture/Chairman of Nepali Congress, Doti	Doti
6	Yagya Raj Bhatta	Service	DDC, Dadeldhura
7	Soman Singh Bali	Chairman, Public Forest	Ghanteshwor-1, Gohanpani
8	Surat Bam Malla	Agriculture	Ghanteshwor-8, TilaChaur
9	Mohan Singh Deuwa	Social Service	Asigram-1, Saukham
10	Chetraj Bhatta	Social Service	Asigram-5
11	Ram Bahadur Dhami	Agriculture	Asigram-5
12	Kali Man Khattri	Secretary	Ghanteshwor-2/3, Gaira, Doti
13	Gambhir Singh Bohara	Consumer Advisor, Public Forest	Ghankhet-8, Dadeldhura
14	Tek Raj Bhatta	Secretary, Public Forest	Ghanteshwor-2, Gaira, Doti
15	Ghan Shyam Jethara	Member, Public Forest	Chhatiwan-6, Ritha
16	Jang Bahadur Rawal	Member, Public Forest	Chhatiwan-5, Ritha
17	Siddha Bahadur Jethara	Treasurer, Public Forest	Chhatiwan-6, Ritha
18	Prakash Bhatta	Reporter, Radio Mahakali	Dadeldhura
19	Shiva Oli	News Reporter	Ghanteshwor, Public Forest
20	Kashi Ram Thapa	Service	Dhangadi-14
21	Ram Dutta Bhattaari	Agriculture	Chhatiwan-1, Doti
22	Tek Bahadur Rawal	Agriculture	Chhatiwan-5, Doti
23	Rajan Kadel	Service	Kathmandu
24	Awadh Narayan Yadav	Project Official	West Seti Hydro Ltd., Kathmandu
25	Shekhar Sharma	Service	West Seti Hydro Ltd.
26	Dilip Sadaula	Service	Department of Electricity Development
27	Pradeep Raj Aryal	Service	Ministry of Water Resources
28	Arun Rijal	Consultant	West Seti Hydro Ltd.,, Kathmandu
29	Sailendra Kurmi	Consultant	West Seti Hydro Ltd.,, Kathmandu
30	Ganesh Bahadur Malla	Agriculture	Pachnali-6, Doti
31	Dev Raj Bhatta	Agriculture	Chhatiwan-8, Dharapani
32	Kamala Bishta	Service	Samaiji-8
33	Bam Bahadur Sawad	Agriculture	Chhatiwan-8, Budar, Doti
34	Harka Bahadur B. K.	Agriculture	Chhatiwan-8, Budar, Doti
35	Yogendra Kadal	Service	Chhatiwan-8, Budar, Doti
36	Bhajan Singh Malla	Agriculture	Ghanteshwor-8, Doti
37	Tek Bahadur Malla	Agriculture	Ghanteshwor-8, Doti
38	Del Bahadur Rakmi	Agriculture	Ghanteshwor-1, Doti
39	Birendra Prasad	-	-
40	Chandra Bahadur Bhandari	Teacher	Chhatiwan-4, Budar, Doti
41	Brij Bahadur Gagh	Teacher	Chhatiwan-4, Budar, Doti
42	Pradeep Kumar Ojha	Teacher	Chhatiwan-4, Budar, Doti
43	Lokendra Bahadur Rana	Agriculture	Chhatiwan-9, Doti
44	Lok Bahadur Sijali	Agriculture	Chhatiwan-9, Doti
45	Bijay Bhandari	Agriculture	Chhatiwan-9, Doti
46	Khem Raj Pandey	Service	DDC, Dadeldhura
47	Bhoj Raj Ojha	Businessman	Attaria-5
48	Sher Bahadur Deuwa	-	Mastamandu-4
49	Bhim Balayar	Student	Latamandu-8, Gopghat
50	Man Balayar	Student	Latamandu-8, Gopghat
51	Kulpati Thagunna	Agriculture	Mastamandu-4

SN	Attendee	Occupation/Position	Location of Residence
52	Kamala Bahadur Balayar	Student	Latamandu-8, Gopghat
53	Dal Bahadur Balayar	Agriculture	Warpata-7, Simar
54	Bir Bahadur Balayar	Student	Latamandu-8, Gopghat
55	Bhim Bahadur Thagunna	Student	Mastamandu-4, Seldada
56	Sher Bahadur Deuwa	Agriculture	Mastamandu-4, Seldada
57	Lal Bahadur Bhul	Agriculture	Mastamandu-4, Sajana
58	Hari B. K.	Agriculture	Mastamandu-4, Seldada
59	Bharat Bahadur Bohara	Agriculture	Pachnali-6, Talkot
60	Karna Bahadur Deuwa	Agriculture	Mastamandu-4, Seldada
61	Naulashi Thagunna	Agriculture	Mastamandu-4, Seldada
62	Lal Bahadur Deuwa	Agriculture	Mastamandu-4, Seldada
63	Puran Shrestha	Service	Suklaphat Conservation
64	Dambar Deu Bhatta	Chairperson, Business	Asigram-7, Bhatkada
65	Pari Damai	Agriculture	Pachnali-6, Talkot
66	Dami Manahare Saud	Agriculture	Pachnali-4, Talkot
67	Anil Sundar Malla	Businessman	Pachnali-6, Talkot
68	Bhakta Bahadur Balayar	Service	Latamandu V.D.C-9, Doti
69	Tej Bahdur Balayar	Agriculture	Latamandu V.D.C-9, Doti
70	Dhauli Devi Balaya	Agriculture	Latamandu V.D.C-9, Doti
71	Mohan Singh Rawal	Agriculture	Latamandu V.D.C-9, Doti
72	Harka Bahadur Balayar	Agriculture	Latamandu V.D.C-9, Doti
73	Murali Dhar Bhatta	Teacher	Latamandu V.D.C-9, Doti
74	Nara Bahadur Bista	Agriculture	Mastamandu V.D.C-8
75	Prem Bahadur Balayar	Agriculture	Barwata V.D.C-1, Doti
76	Kabindra Raj Bhatta	Assistance Officer	Amargadhi Municipality-5, Dhadeldhuda
77	Chandra Bahadur Chand	Service	Conservation Office, Kanchanpur
78	Sranti Devi Aera	Member	Bhumiraj Public Forest
79	Umesh Bhatta	Politics	Nekapa Mawobadi
80	Hemraj Chataut	Secretary	Nepali Congress
81	Gunakar Chataut	Treasurer	Nepali Congress
82	Padam Bahadur Mahata	President	Janaki Public Forest, Asigram
83	Dan Bahadur Bista	Service	Malpot Office Dadeldhura
84	Indra Prakash Paneru	Student	Nepal Student Union
85	Bhoj Bahadur Malla	Student	Ghanteswor-6, Doti
86	Ram Chandra Ojha	Agriculture	Barpata V/DC-1,Doti
87	Surat Singh Madai	Service	Malpot Office , Dadeldhura
88	Sobhan Singh Madai	Student	Laxminagar-3, Doti
89	Dilliraj Joshi	Agriculture	Amarghadi Municipality-2
90	Kalu Singh Pal	Agriculture	Dewal -7, Dadeldhura
91	Shankar Paneru	Business	Bhattapur-6, Dhadeldhura
92	Bir Bahadur Mallla	Agriculture	Bhageswor-7, Lamikade
93	Rajendra Prasad Pant	-	District Aa.ka.Se Community
94	Raghu Nath Bista	Forest Office	District Forest Office
95	Lal Bhadur Sunar	District Police Office	District Police Office
96	Birendra Prasad Pant	Service	Chhatiban V.D.C
97	Ram Dutta Bhattarai	Agriculture	Chhatiban V.D.C
98	Ganesh Bahadur Malla	Agriculture	Chhatiban V.D.C
99	Prakash Subba	Agriculture	Chhatiban V.D.C
100	Harka Bahadur Khatri	Agriculture	Chhatiban V.D.C, Durga Public
101	Bom Bahadur Mohara	Agriculture	Chhatiban V.D.C, Durga Public
102	Sher Bahadur Sharki	Agriculture	Deupal Public Forest
103	Padam Bahadur Aera	Agriculture	Amar Ghadi Municipality, Dhadeldhuda
104	Lal Mani Ojha	Agriculture	Dadeldhuda
105	Chetraj Panta	Service	Warbata V.D.C
106	Ganesh Bahadur Deuwa	Student	Asigram-1 V.D.C, Dadeldhura
107	Min Bahadur Hamal	Student	Ghanteswor V.D.C

SN	Attendee	Occupation/Position	Location of Residence
108	Gajendra Shahi	Politics	Nekapa Aemale District Community
109	Kishor Kumar Shrestha	Head Research	National Research Office, Dadeldhura
110	Jung Bahadur Balayar	Agriculture	Banlek V.D.C
111	Siddha Bahadur Balayar	Business	Latamandu V.D.C
112	Karna Balayar	Student	Banlek V.D.C ,Doti
113	Harka Bahadur Rokaya	Teacher	Banlek V.D.C-1, Doti
114	Karna Bahadur Saud	Teacher	Banlek V.D.C-8, Doti
115	Dil Bahadur Balayar	Student	Banlek V.D.C-2, Doti
116	Bhan Bahadur Dhami	Teacher	Banlek V.D.C, Doti
117	Dirgha Bahadur Mohara	Agriculture	Banlek V.D.C, Doti
118	Dhan Bahadur Saud	Teacher	Banlek V.D.C, Doti
119	Bhim Bahadur Dhami	Agriculture	Banlek V.D.C, Doti
120	Yagya Bahadur Saud	Agriculture	Banlek V.D.C, Doti
121	Prabha Hamal	Service	Fish Devlopment Office, Dadeldhura
122	Karna Bahadur Mali	Agriculture	Ganeshpur V.D.C, Dadeldhura
123	Keshav Balayar	Agriculture	Latamandu V.D.C-8

Source: West Seti Hydro Limited records, 2007.

Table A5.4: Public Hearing Mahendranagar, 28 July 2007

SN	Attendee	Occupation / Position	Location of Residence
1	Rajendra Rawal	Community Party of Nepal (UML), District Committee Secretary	Bhimnagar-6
2	Bhoj Raj Bohara	Nepali Congress, Secretary	Kanchanpur
3	Arjun Karki	Chairman, Community Forest	Kanchanpur
4	Surendra Singh Karki	Service	Mahendranagar Municipality Office
5	Bhupendra Singh Rawal	Agriculture	Mahendranagar Municipality Ward – 6
6	Rabi Dhami	Reporter, Annapurna Post Daily	Mahendranagar
7	Trilok Chand	Leader, National Democratic Party	Mahendranagar
8	Jay Bahadur Malla	Leader, Rastriya Janamorcha	Kanchanpur
9	C.N. Bhandari	Businessman	Mahendranagar Municipality – 18
10	Birbal	Agriculture	Mahendranagar Municipality – 2
11	Bir Bahadur Buddhayar	Businessman	Suda VDC – 5
12	Chandra Bahadur Chand	Service	Bhumla Phaant
13	Laxmi Data Bhatta	Service	District Police Office , Kanchanpur
14	Chandra Dev Bhatta	Service	Mahendranagar, Paittaina
15	Parmananda Joshi	Service	District Police Office, Kanchanpur
16	Puran Shrestha	Service	Sukla phata Wildlife Preserve
17	Megh Nath Pandey	Agriculture	Krishnapur VDC – 2
18	Bir Bahadur Chand	Agriculture	Krishnapur VDC – 2
19	Nanu Raj Panta	Leader, Nepali Congress (Democratic)	Kanchanpur
20	Rajan Kandel	Employee	Kathmandu
21	Shekhar Sharma	Social Officier	Dhangadhi
22	Shailendra Kurmi	Employee	Kathmandu
23	Ram Bahadur Lama	Employee	Dhangadhi - 1
24	Hikmat Kathayat	Agriculture	Dhangadhi – 4
25	Khem Naath	Police service	District Police Office, Kanchanpur
26	Hari Dhatta Bhatta	Agriculture	Gowaria
27	Devi Datta Chokari	Agriculture	Mahendranagar Municipality - 6
28	Kashi Ram Thapa	Service	Dhangadhi – 14
29	Chetendra Prakash Bhatta	Service	Mahendranagar Municipality – 7
30	Jaya Dev Bhatta	Agriculture	Suda VDC – 6
31	Dipendra Joshi	Agriculture	Hakukhal – 6
32	Gopal Datta Bhatta	Agriculture	Hakukhal – 6
33	Krishna Saaud	Journalist	Kanchanpur
34	Dharma Nanda Bhatta	Secretary	Suda VDC
35	Daan Singh Bista	Secretary	Daigi VDC
36	Indra Bahadur Malla	Secretary	Krishna pur VDC
37	Cheet Raj Bhatta	Secretary	Sahajpur VDC
38	Tharijir Singh Aair	Technical Assistant	Jhalari VDC
39	Gauri Prasad Joshi		Mahendranagar Municipality - 7
40	Gagan Singh Bohara	Agriculture	Simlaphata
41	Krishna Bahadur Singh	Agriculture	Mahendranagar Municipality – 8
42	Devi Sing Khawala	Agriculture	Simalcas
43	Rama Singh Makaid	Agriculture	Suda VDC – 6
44	Bir Bahadur Bam	Agriculture	Wanka
45	Sher Bahadur Bam	Agriculture	Suda VDC – 6
46	Dhana Bahadur Bam	Agriculture	Suda VDC – 6

SN	Attendee	Occupation / Position	Location of Residence
47	Hem Raj Lekhak	Agriculture	Suda VDC – 6
48	Shiva Lal Rana	Agriculture	Krishnapur – 6
49	Khem Raj Bhatta	Agriculture	Suda VDC – 6
50	Keshav Datta Joshi	Agriculture	Mahendranagar Municipality – 6
51	Shiva Raj Rana	Agriculture	Krishnapur – 2
52	Jay Bahadur Bohare	Agriculture	Daigi - 4
53	Kanthe Wod	Agriculture	Daigi – 4
54	Gamara	Agriculture	Daigi – 6
55	Rajendra Shah	Engineer	Road Dept, Mahendranagar
56	Bhuvan Sing Saud	Agriculture	Daigi – 3
57	Ram Bahadur Wod	Agriculture	Daigi
58	Nagendra Karki	Agriculture	Mahendranagar Municipality – 6
59	Kamala Pati Bhatta	Agriculture	Mahendranagar Municipality
60	Shanti Joshi	Agriculture	Mahendranagar Municipality
61	Kamalapati Bhatta	Agriculture	Mahendranagar Municipality – 6
62	Lato Bhoot	Agriculture	Daigi
63	Govinda Singh	Agriculture	Jhallari
64	Suka Dhanuwa	Agriculture	Daigi
65	Mangle Dhanuk		Daigi
66	Chakra Bahadur Bohara		Daigi
67	Bir Bahadur Chand		Krishna pur – 2
68	Jayanti Devi Khatri		Daigi
69	Manoraath Bhatta		Daigi
70	Anka Bahadur Kuchhecha		Yeathpur – 6
71	Dil Bahadur Bohara	Agriculture	Mahendranagar Municipality – 6
72	Nanda Singh Bhatta		Yeathpur – 6
73	Tekendra Bhatta Bikram	Politician	Pipaladi
74	Man Singh Bhandari	Agriculture	Jhallari
75	Lal Bahadur Singh	Agriculture	Jhallari
76	Karna Jit Singh	Agriculture	Jhallari
77	Tika Ram Bhatta	Agriculture	Yeathpur
78	Bikash Bam		Bank, krishnapur
79	Lav Bahadur Pal		Dipendra Smriti Community Forest, Bank
80	Bal Bahadur Bohara		Dipendra Smriti Community Forest, Bank
81	Lokendra Bahadur Bam		Bank
82	Tumal pandey		Shree Birendra Community Forest
83	Kamala Devi Rokaya		Bank
84	Jaya dev Bhatta		Suda – 6
85	Gopal Datta Bhatta		Mahendranagar Municipality – 6
86	Dipendra Joshi		Mahendranagar Municipality – 6
87	Jayaram Sarki		Daigi, Baitadi
88	Chimada Bhull		Daigi, Baitadi
89	Ranawa Bhull		Daigi, Baitadi
90	Dinesh Aier		Jhallari – 2
91	Jograj Rana		Suda – 2
92	Manorath Bhatta		Daigi, Baitadi
93	Kabira Rana		Krishnapur - 2
94	Bhoj Raj Bhatta		Suda – 7
95	Dev Raj paneru		Suda, Musapani
96	Prakash Bahadur Singh		Jhallari – 2
97	Jaya Raj Bhatta		Aithpur, Mahendranagar Municipality – 3
98	Prakash Rawal		Aithpur, Mahendranagar Municipality – 6
99	Mehar Singh Rawal		Aithpur, Mahendranagar Municipality – 6
100	Johari Lal Chaudhary		Mahendranagar Municipality – 18
101	Lok Raj Bhatta		Krishnapur VDC
102	Laxmi Dutt Paneru		Musepani, Suda VDC

SN	Attendee	Occupation / Position	Location of Residence
103	Shiva Raj Paneru		Musepani, Suda VDC
104	Laxman Prasad Bogati		Mahendranagar Municipality – 6
105	Jaya Bahadur Malla	Chairman, Rastriya Janamorcha	
106	Janak Kuwar		Jhalari VDC
107	Ammar Bahadur KC		Mahendranagar Municipality – 6
108	Hari Bahadur KC		Mahendranagar Municipality – 6
109	Mukti Nath Chaudhary		Aithpur, Mahendranagar Municipality – 6
110	Khem Kani Chaudhary		Aithpur, Mahendranagar Municipality – 6
111	Rana Bahadur Bista		Mahendranagar Municipality – 6
112	Arjun Bahadur Rawal		Suda VDC – 4
113	Puran Shrestha	Service	Shuklaphata Wildlife Reserve
114	Chandra Bahadur Chand	Service	Shuklaphata Wildlife Reserve
115	Anand Lal Bishwakarma	Service	Shuklaphata Wildlife Reserve
116	Mahabir Rana		Krishnapur VDC
117	Roop Bahadur Rawal	Service	Mahendranagar Municipality – 6
118	Man Bahadur Dhami	Agriculture	Jhalari VDC – 2
119	Rajendra Singh Rawal	Agriculture / Secretary, District Committee, Communist Party of Nepal (UML)	Mahendranagar Municipality – 6
120	Bhagrathi Chand	Agriculture	Jhalari VDC – 2
121	Jai Singh Dhami	Agriculture	Jhalari VDC – 2
122	Pushkar Singh Dhami	Agriculture	Jhalari VDC
123	Bajir Singh Dhami	Technical Assistant	Jhalari VDC – 2
124	Bharat Raj Bhatta	Agriculture	Mahendranagar Municipality – 6
125	Gagan Singh Bhandari	Agriculture	Mahendranagar Municipality – 6
126	Bishnu Hari Acharya	Service	District Forest Office
127	Lava Bahadur Bista	Mahakali Seti Bus Management Committee	
128	Arvind Yadav	Service	Shuklaphata Wildlife Reserve
129	Ganesh Bahadur BK	Nepal Dalit Mukti Morcha Samiti	
130	Ramesh Damai	Teacher	Baitadi
131	Hira Singh Bista		Mahendranagar Municipality – 10
132	Keshav Singh Bista		Mahendranagar Municipality – 10
133	Pramod Sharma		Mahendranagar Municipality – 4
134	Yuvraj Ghimire	Journalist	
135	Jag Bahadur Bohara	Agriculture	Simalphata – 2
136	Jahari Bhatta	Agriculture	Juda – 2
137	Githe Damai	Agriculture	Simalphata
138	Bijwa Thagunwa	Agriculture	Juda – 2
139	Ammar Singh Dhami	Agriculture	Juda – 2
140	Kalawati Dhami	Agriculture	Juda – 2
141	Dan Singh Aair	Agriculture	Simalphata
142	Man Singh Bohara	Agriculture	Simalphata – 2
143	Datt Ram Padaal	Agriculture	Simalphata – 2
144	Gaumati Rawal	Agriculture	Simalphata – 2
145	Jagadish Awasthi	Agriculture	Simalphata – 2
146	Madan Raj Joshi	Agriculture	Jhalari, Ammarpur
147	Dil Bahadur Buda	Agriculture	Jhalari, Ammarpur
148	Devi Datt Bokati	Agricuture	Aithpur, Mahendranagar Municipality – 6
149	Gambhir Mahata		Mahendranagar Municipality – 6
150	Dambar Bahadur Bista		Mahendranagar Municipality – 7
151	Nanda Kishore C. K.	Politician	Raikuwar, Bichhuwa - 7
152	Bacchu Bishwakarma	Journalist	Mahendranagar Municipality – 4
153	Rajendra Bista	Journalist	Mahendranagar Municipality – 18

SN	Attendee	Occupation / Position	Location of Residence
154	Rani Bibas	Journalist	Mahendranagar Municipality – 6
155	Dil Bahadur Singh		Gularia
156	Kalu Singh Bohara		Mahendranagar Municipality – 6
157	Bhoj Raj Bohara	Secretary, Nepali Congress	Kanchanpur
158	Dipendra Sing Rawal		Mahendranagar Municipality – 6
159	Madan Raj Bhatta		Nava Durga
160	Hem Raj Joshi		Mahendranagar Municipality – 10
161	Bikram Bohara		Mahendranagar Municipality – 6
162	Arjun Singh Bohara		Mahendranagar Municipality – 10
163	Tej Singh Karki		Mahendranagar Municipality – 10
164	Damber Bhandari		Mahendranagar Municipality – 6
165	Suresh Dhami	Journalist	Mahendranagar Municipality – 4
166	Dharmananda Bhatta	Secretary	Suda VDC
167	Dil Bahadur Kunwar		Mahendranagar Municipality – 6
168	Jay Dev Bhatta		Jhallari – 2
169	Lila Devi Bhandari		Mahendranagar Municipality – 6
170	Bhag Rathi Bhandari		Mahendranagar Municipality – 6
171	Hari Krishna Pandey	Agriculture	BhajPura
172	Kabindra Bhandari	Journalist	Mahendranagar Municipality – 18
173	Dhan Bahadur Saud	Agriculture	Krishna pur -1
174	Shyam Bhatta	Business	AmarGhadi Nagar Municipality – 5
175	Jay Raj Bohara	Agriculture	Jhanpura – 6
176	Lokendra Bokari	Agriculture	Aaithpur
177	Chuda Mani Bhatta	Agriculture	Aaithpur
178	Dev Raj Bhatta	Agriculture	Aaithpur
179	Ishwori Datta pandey	Service, District Development Committee	Basanta pur
180	Mer Shit Rawt	Agriculture	Aaithpur
181	Shekhar Sharma	Service, West Seti Hydro P. Ltd	
182	Rajan Singh Kadel	Service	Shah Consult International (P.) Ltd.
183	Shailendra Kurmi	Service	Shah Consult International (P.) Ltd.
184	Dilip Kumar Sadaula	Service	Department of Electricity Development
185	Prabin Raj Aryal	Service	Ministry of Water Resources
186	Keshav Raj Joshi		Mahendranagar Municipality – 19
187	Yem Kala Pandey	Journalist	Mahendranagar Municipality – 18
188	Nima Kafle	Journalist	Mahendranagar Municipality – 18
189	Awadh Narayan Yadav	Representative	West Seti Hydro P. Ltd.
190	Arun Rijal	Consultant	West seti Hydro P. Ltd.
191	Kabindra Bhandari	Journalist	Mahendranagar Municipality – 18

Source: West Seti Hydro Limited records, 2007.