Environmental Addendum
Updated from July 2012 version

Project Number: 43281-NEP
December 2012

NEP: Tanahu (Upper Seti) Hydropower Project

Prepared by Nepal Electricity Authority/Tanahu Hydropower Limited for the Asian Development Bank

CURRENCY EQUIVALENTS

(as of 1 October 2012)

Currency Unit – Nepali rupees (NRs)
NR 1.00 = $0.01185
$1.00 = NRs 84.39

ABBREVIATIONS

AP	Affected People
DFO	District Forest Office
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESCP	Erosion and Sediment Control Plan
ESMU	Environmental and Social Management Unit (in THL)
ESSD	Environmental and Social Studies Department (in NEA)
ESU	Environmental Sub-Unit (under THL-ESMU)
FSL	Full Supply Level
GoN	Government of Nepal
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism
IEE	Initial Environmental Examination
IUCN	International Union for Conservation of Nature
MoE	Ministry of Energy
MoEST	Ministry of Environment, Science and Technology
MoFSC	Ministry of the Forests and Soil Conservation
NARA	Nepal Association of Rafting Agents
NARC	National Agricultural Research Council
NEA	Nepal Electricity Authority
NGO	Non-Governmental Organization
PIC	Public Information Center
PMO	Project Management Office
ROW	Right-of-Way
RP	Resettlement Plan
THL	Tanahu Hydropower Limited
THP	Tanahu Hydropower Project
USHEP	Upper Seti Hydropower Project
VDC	Village Development Committee

WEIGHTS AND MEASURES

gal	unit of acceleration, cm/s2
GWh	gigawatt hour
ha	hectare
km	kilometer
kV	kilovolt (1,000 volts)

kWh	kilowatt hour
m	meter
m^3	cubic meter
m^3/s	cubic meter per second
masl	meter above sea level
MCM	million cubic meter
MW	megawatt

PREFACE

The Tanahu Hydropower Project (Nepal) has been in development since at least 2009, at which time a detailed Environmental Impact Assessment (EIA) was prepared for the dam and reservoir on the Seti River in the Western Region. In 2010, an Initial Environmental Examination was also completed for the Transmission Line component of the project (by the Nepal Electricity Authority). Since some technical details and environmental considerations were still unclear in 2010, more detailed surveys and technical assessments were undertaken, with ADB support, in 2011 and 2012. As a result of this consolidating activity, there is now a need to update both the EIA and the Environmental Management Plans (EMPs) that were prepared as part of the original work in 2009 and 2010. These volumes have been prepared, and include the following:

- Volume 1: Updated Tanahu Hydropower Project **Addendum to EIA 2009 and IEE 2010** (for both the dam/reservoir component and the transmission line);
- Volume 2a: Updated **Environmental Management Plan** for the **Dam/Reservoir** Component; and,
- Volume 2b: Updated **Environmental Management Plan** for the **Transmission Line** Component.

VOLUME 1 – UPDATED ENVIRONMENTAL ADDENDUM FOR EIA 2009 AND IEE 2010 (DAM/RESERVOIR COMPONENT AND TRANSMISSION LINE)

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

A. EXECUTIVE SUMMARY

A.1 Introduction

1. Nepal is currently suffering from a severe power shortage, particularly during the winter dry season from November to April. Due to a power shortfall, Kathmandu suffers from lack of electricity for up to 18 hours every day during the winter season. The total installed power generation capacity of Nepal is 706 MW, representing only about 1.5% of its theoretical hydropower potential.

2. To address the power crisis in Nepal, there is a great need to harness the hydropower potential of the existing river systems and to promote medium-sized hydropower projects that can be implemented in the earliest possible time and in an environmentally-sustainable manner. Of the various potential hydropower projects in Nepal, the Government has given high priority to the development of the Tanahu Hydropower Project ("the Project")[1] as a "project of national pride". The 140 MW project is located about 150 km west of Kathmandu, with associated 220 kV transmission line of about 36.9 km, and rural electrification to provide electricity to approximately 17,636 households.

3. The Government of Nepal (GoN) has requested the Asian Development Bank (ADB) to finance the Project. According to ADB's Safeguard Policy Statement 2009 (SPS, 2009), the Project is a "Category A", which requires the preparation of an Environmental Impact Assessment (EIA).

4. An EIA for the Upper Seti Storage Hydroelectric Project was prepared by the Environmental & Social Studies Department (ESSD) of Nepal Electricity Authority (NEA) and in July 2009, the EIA was approved by the Ministry of Environment, Science and Technology (MoEST). An Initial Environmental Examination (IEE) was also prepared by ESSD for the associated transmission line, Damauli-Bharatpur 220 kV, and was approved by the MoEST in April 2010.

5. The previous generation capacity of the Project quoted in EIA 2009 was 127 MW and it was upgraded to 140 MW in 2012 during the detailed engineering study. The capacity increase did not change fundamental design features but it enhanced operational efficiency of the plant and resultant maximization of power supply. Therefore overall environmental impacts pertaining to reservoir area, length, water level, gross storage capacity, dam height, tail water level are unchanged.

6. In September 2010, ADB provided a grant to the GoN to conduct the detailed engineering study of the Project and to undertake a technical assistance to complete the required due diligence.[2] To meet the requirements of SPS 2009, the environmental due diligence reports for the Project include the Government-approved EIA (2009), the Government-approved IEE of the associated transmission line (2010), the IEE for the rural electrification component, and this environmental addendum, which provides additional information and an

[1] The original name of the project was Upper Seti Storage Hydroelectric Project, but was changed to the Tanahu Hydropower Project on 15 May 2012, to prevent confusion with the proposed West Seti Hydroelectric Project. The name of the project comes from the Tanahu District, where most of the structures for the proposed project are located.

[2] ADB. 2010. Technical Assistance to Nepal for *Preparing Hydropower Development for Energy Crisis (TA 7590)* and Grant for *Detailed Engineering Study for the Upper Seti Hydropower Project (Grant 0215)*.

update on the baseline environmental conditions where appropriate, impacts and mitigation measures, building on the information in the previous Government-approved EIA (2009) and IEE (2010). The environmental addendum is supported by six additional surveys and special studies conducted after the government approval of the EIA and IEE in 2009-10. These include a water quality survey (2011), groundwater sources survey (2011), fisheries survey (2011), forestry-botany survey from Damauli to Bhimad in the Seti River Basin (2011), terrestrial fauna survey in the Seti River Basin (2011), and the land stability and erosion mapping in the Seti Watershed (2012). Therefore, this Environmental Addendum needs to be read conjointly with the EIA (2009) and the IEE (2010). As noted in the Preface, this Environmental Addendum comprises two volumes, including the **updated addendum to EIA 2009 and IEE 2010** (this document: Volume 1), the **EMP for the Dam/Reservoir Component** (Volume 2a, in a separate document), and the **EMP for the Transmission Line** (Volume 2b, also separate).

A.2 Project Design, Cost and Implementation

7. The main features of the Project include the following:

- **Dam gates**: The dam gate and spillway design has been modified, based on hydraulic modeling. Gate design has been reduced from six gates to three gates to reduce the distance between the retaining walls (i.e., to prevent overtopping) at the base of the spillway.

- **Headrace intake**: The headrace intake has been set at 362 meters above sea level (masl), which is 16 m below the minimum operating level (MOL) of 378 masl.

- **Middle outlet**: Two middle outlets have been included in the dam to enable the reservoir level to be lowered from the MOL to a height that allows the sediment flushing gates to be opened. An additional design consideration is the reduction in the possible impact of rapid flow releases on downstream areas.

- **Sediment flushing facilities**: These facilities consist of two sets of inlets through the base of the dam wall, in the middle of the river cross-section, with a sill elevation of 319.4 masl.

- **Road alignments**: The proposed road alignments have been improved to reduce the environmental and social impacts of these structures.

- **Transmission line alignment**: The location of the alignment near the power plant has been moved by up to 300m and changed very slightly at other locations to account for local topography.

8. The Tanahu Hydropower Limited (THL) will be the executing agency (EA) for the hydropower component, while the NEA will be the EA for the transmission and rural electrification components. To conduct ongoing safeguard and community development activities, THL will establish an Environmental and Social Management Unit (ESMU) and Project Information Centers (PICs) for regular communication with Affected Persons (APs) at the project sites. THL will also employ a project supervision firm (including an environmental consultant) to manage the overall project development, from construction through to the initial five-year operation phase following commissioning.

9. During project implementation, an independent panel of experts (PoE) will be responsible for assessing the environmental and social safeguards, including dam safety(structural safety and seismic design) and power generation operating procedures. To promote the environmental mitigation activities, the Project will provide, with the ADB-financed component, consulting services for six specific plans. These plans are: (i) the Fish Conservation Management Plan (for the dam/reservoir); (ii) a Wildlife Conservation and Awareness Management Plan (one each for the dam/reservoir and the transmission line); (iii) a Watershed/Forest Management Plan (one each for the dam/reservoir and the transmission line); and, (iv) the Water Release/River Safety Management Plan (these are described in detail in Volume 2).

10. The total project cost is estimated at $505 million, including $35 million for NEA's transmission line and rural electrification components. Of the Project costs, the total environmental safeguards-related costs are estimated to be $23.29 million (GoN will fund $20.77 million, and ADB will fund the related consultancies; $2.52 million, including monitoring of the consultancies).

A.3 Environmental condition, impact assessment and management measures

11. **Project generation and river hydrology.** The Project will generate base-load power (24 hours per day) from early July to September. Peaking power will be generated from October to early June, between 6 and 20 hours per day. Daily peaking generation releases will range from a maximum of 127.1 m^3/s down to 117.8 m^3/s.

12. Reservoir operation over the initial 10 years of Project operation will consist of: (i) monsoon season generation in the July-to-September period; (ii) dry season generation, December to early June; (iii) reservoir draining in mid-June; (iv) sediment flushing in late June; and, (v) reservoir filling in early July. After the initial 10 years, the reservoir operation will be slightly different, due to an extension of the sediment flushing period to 40 days. This is intended to achieve greater sediment removal, given the estimation that sediment which will have entered the western end of the reservoir over the previous decade will be distributed along the length of the reservoir down to the dam wall. To comply with the requirements of the GoN, a 2.4 m^3/s minimum "environmental" release will be made from the dam throughout the year, except when this is not required during the reservoir draining and sediment flushing.

13. The main flow change in the Seti River downstream of the tailrace will result from the peaking power generation ranging from 6 to 20 hours per day between October and May. Based on the results of flow modeling in the existing river channel, the river water level below the tailrace outlet will rise by a maximum of 1.66 m above the existing natural levels during the peaking power generation cycle. The other flow changes in the Seti River will occur over 10 days in June, when up to 1,000 m^3/s will be released from the dam to drain the reservoir at or immediately prior to the start of the monsoon season. This release could increase the natural water level in Seti River by a maximum of 4.3 m, depending on monsoon flows at the time.

14. Some impact on water quality could come from the temperature difference between water drained from the reservoir when it is emptied in early June and the temperature in downstream river water. This temperature difference will be monitored at strategic locations downstream of the tailrace to determine if thermal shock to aquatic organisms could occur. However, given the design of the dam operation (run-over rate is 12 times/year, emptying once

a year) and power generation, the occurrence of thermal stratification (with colder water at the bottom) may be unlikely anyhow.

15. **River safety.** Generation releases of up to 127.4 m^3/s, periodic dam spill flows during the monsoon season, and draining of the reservoir in mid-June (releasing up to 1,000 m^3/s) could create a hazard to downstream river users due to the potential rapid rise in the levels of the Seti River, unless these are predicted and disseminated in advance. Public safety downstream of the Seti River will be ensured by a combination of a danger/warning system and public education and awareness programs. On the other hand, river regulation associated with the operation of the dam will be such that it will eventually result in a more regular and predictable discharge and will contribute to flood control during flash floods. A review of the dam operating procedures to enhance downstream river safety will be further evaluated by the PoE, as appropriate. Consulting services for the purpose of further assessment of river safety needs and implementation of a warning system will be provided by ADB during project implementation.

16. **Groundwater.** A mapping of groundwater sources used for domestic water supply within the Project area was conducted in 2011. Nineteen sources, of a total of 35 sources identified, could be affected by the project construction sites and the reservoir area. An alternative water supply will be provided to the groundwater users directly affected by the Project. An additional four springs on the hillside above the tailrace tunnel may be indirectly affected by the construction of the headrace and related tunnelling. The flow rate of the four springs identified will be measured and monitored. If a perceptible decrease in the flow rate of any of the springs occurs, then a solution to reinstate the water supply will be developed in consultation with the affected households.

17. **Aquatic ecology.** An additional fish population survey was conducted in 2011, during which six long-distance migratory species, six short- to mid-range migratory species, and 35 resident species were identified. One of the long-distance migratory species, the Golden mahseer, or Sahar (*Tor putitora)*, is listed as "endangered", and the Asla (*Schizothorax richardsonii)* is listed as "vulnerable" in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. *Tor putitora* can also be found in many other rivers in Nepal, including the Kosi, Sun Kosi, Tamar, and Arun in the Kosi drainage, the Sakayel and Karnal in the Karnali drainage, as well as rivers in the Kali Gandaki, Narayani, Tadi and Trisuli (in the Gandaki drainage). *Tor putitora* is also present in the Pokhara Lakes (Phewa, Begnas and Rupa); thus, the fish is quite common, in distribution, but is classified as endangered because of its recent temporal trend of evidently declining numbers. *Schizothorax richardsonii* is known to inhabit the river systems of Karnali and Kali Gandaki and is also found in the Indrasarobar Reservoir. These two fish species are treated as game fish in Nepal.

18. To cushion the Project impacts on the aquatic ecosystem and avoid the possibility of local extinction of endangered species, restocking will be done from a fish hatchery (located nearby), combined with a fish habitat management program supported by the Project, and other fish transfer measures (see below). The fish hatchery will produce fish fingerlings of *Tor putitora, Schizothorax richardsonii* and at least three other species on the IUCN Red List. The Fish Conservation Management Plan will also include monitoring and research on fish populations in the Seti River and Madi River. In addition to the proposed population enhancement with the fish hatchery initiative, it is proposed to institute a "catch-and-haul program, to move mature fish into the reservoir area, and to examine the technical feasibility of a "switchback" fish pass, to possibly handle the gradient of about 140 meters. These various measures will constitute a

multi-pronged approach to fish conservation to address all possible concerns regarding migrating fish in the Seti River system. Technical consulting services for the Fish Conservation Management Plan (and related awareness-raising) will be financed by ADB and implemented in collaboration with IUCN during Project construction and implementation. Collaboration with relevant government agencies, fish experts, and organizations like the IUCN will continue throughout the project cycle, to ensure that it is implemented in a sustainable manner that may provide an example for future hydropower projects in Nepal.

19. **Terrestrial ecology.** All project sites are located outside Government-designated protected areas. The nearest protected area is the Annapurna Conservation Area, which is located 30 km north of the proposed reservoir area. The Chitwan National Park is located about 15 km to the south of the substation that will be associated with the Bharatpur 220 kV transmission line.

20. An additional flora survey was conducted in 2011 at eight sampling stations. The survey indicated that there are no rare, threatened, or endangered plant species (according to the IUCN Red List of Threatened Species) that may be affected by the Project, but an estimated 422.6 hectares (ha) of forest area, containing approximately 162,000 trees will be cleared. According to the Forest Guidelines 2006 (Guidelines to Avail Forest Land for Other Development Purpose, 2063), the Project is classified as a commercial venture and should replace the affected trees at a ratio of 1:25 (the latter being seedlings). Following the provisions in the Forest Guidelines, THL and NEA, in consultation with the Ministry of Energy (MOE) and the District Forest Office (DFO), will develop a nursery and afforestation program for both the reservoir area and the transmission line right-of way. To ensure the sustainable implementation of these schemes, consulting services will be financed by ADB and implemented in collaboration with IUCN during Project implementation.

21. An additional survey of terrestrial fauna was also undertaken in 2011. In the EIA (2009), local people had reported the presence of 27 mammalian species in the project area, including apparent sightings of the Royal Bengal tiger (*Panthera tigris*). However, recent habitat information and consultation with specialists suggests the absence of tigers within the Project area; they are more likely to be encountered near Chitwan National Park, which is south of the terminus of the transmission line. However, given concerns about the mobility of the tiger, and the status of this animal, vegetation clearance within the right-of-way (ROW) of the proposed transmission line will be managed to avoid any lasting impacts on tiger movements (vegetation will be allowed to re-grow to 3 meters, which will provide cover for tigers, if they occur in the area). To promote wildlife awareness and ongoing conservation, ADB will finance consulting services to this effect; these will be implemented in collaboration with the World Wildlife Fund (WWF).

22. **Reservoir foreshore stability.** A landslide and soil stability/erosion mapping study of the reservoir foreshore was completed in 2012. This identified that the main instability near project sites will occur in the upper reaches of the proposed reservoir area, especially between Bhimad and Rising Patan. The steep cliffs of soft sand and gravel composing both banks of the Seti River, as well as the Jyagdi Khola, Wanteng Khola, and Phedi Khola, are highly vulnerable to failure. Another source of instability is the highly weathered colluvium located on the steep banks of various streams and gullies adjacent to the Seti River. To minimize erosion, protection works will be constructed along the toe of identified high risk slopes that are at or below the full supply level (415 m) and above the minimum operating level (MOL) of 378 meters above sea level (masl), prior to reservoir filling, to allow these areas to stabilize over time.

23. **Spoil disposal and project facilities.** An estimated 1.36 million m^3 (MCM) excess spoil materials (rock, gravel) will require disposal. Five disposal areas, with a total capacity of 2.4 MCM, have been identified in relatively close proximity to the Project sites. Modeling of the upstream river depth increases has been done, to determine the appropriate spoil disposal sites that will not result in a potential rise in the river water level (which could cause downstream riverbank erosion or flood). The spoil disposal site planning will be finalized during the Project pre-construction phase, when a detailed plan will have been prepared, showing the agreed boundary of each disposal site, the proposed cross-sections, temporary and permanent drainage and sediment control works, permanent retaining structures, and the final land profile and topsoil stockpile areas.

24. **Air quality.** Dust will be generated by construction activities which would affect ambient air quality in the immediate vicinity. Dust suppression measures, such as spraying water on unpaved or cut areas, covering of stockpiled soils and trucks hauling loose construction materials, etc., will be implemented during construction. The Contractor will be required to have all construction vehicles properly maintained to minimize exhaust emissions. The use of generator sets by Contractors will be required to meet the environmental standards of GoN and be located at an appropriate distance from work and camp areas.

25. **Greenhouse gas emissions.** The annual CO_2 emissions that will be avoided by the generation of renewable energy from the Project during the initial 10 years (587.7 GWh), and from the 11th year onwards (489.9 GWh), are 97,581 tons of CO_2 and 83,038 tons of CO_2, respectively.

26. **Rafting.** The current number of rafting companies that use the Seti River is not known, but an estimated minimum of 200 persons use the Seti River each day for rafting during the rafting season from September to May, and this is expected to increase over time. Flow changes resulting from the Project along the Seti River from Damauli to the confluence of Seti River and Trisuli River may potentially reduce the months available per year for rafting. To ensure that the impact on rafting is adequately addressed, a Water Release and River Safety Management Plan has been prepared which provides provisions for a detailed survey of rafting operators along the Seti River at Damauli during the rafting season, prior to the operation of the Project. Further consultations will be held with the surveyed operators and the Nepal Association of Rafting Agents (NARA) to understand their concerns, discuss the possible impacts due to Project-altered river flows, and to develop mitigation measures, as required.

27. **Access and Infrastructure.** Reservoir inundation will affect a range of community infrastructure, including motorable roads, suspension bridges, foot trails, irrigation canals, and electricity distribution lines. The Project will reinstate access to settled areas that will be cut off by the reservoir, with a combination of new footbridges, foot trails, and motorable truss bridges.

28. **Occupational health and safety.** The concerns regarding occupational health and safety that may be associated with the Project have been recognized and discussed in various sections of the EIA (2009), including water supply, sanitation and health, influx of workers during construction, and accidents and occupational health. Given the duration of the construction phase and the number of workers, a construction and camp management plan will be required from the Contractors and reviewed by THL/NEA to ensure that there is clear guidance on issues such as security, maintenance and sanitation of camp facilities, safety training, and workers' conduct both in the construction areas and nearby communities.

29. **Community health and safety.** Concerns regarding community health and safety have been discussed in the EIA (2009) in several sections pertaining to health, water supply and sanitation, safety and occupational health, noise and vibrations, and accidents and occupational health. In addition to the mitigation measures identified in the EIA (2009), addressing community health and safety issues, THL will recruit the Panel of Experts to review the dam safety (design of dam, structural safety and seismic design) and power generation operating procedures, to ensure the safety of settlements living downstream of the powerhouse. Moreover, the potential for an increase in water-borne diseases (such as malaria) will be monitored during the operation of the Project, to prevent and/or contain its occurrence within the Project area.

30. **Physical cultural resources.** Physical cultural resources, such as cremation sites and temples, which may be affected by the Project, were identified in the EIA (2009). Consultations among the users of the affected community structures, relevant government authorities, and local communities will be conducted prior to construction, to determine if there are any additional concerns. A working procedure (Appendix 3) to handle new archaeological findings during Project construction has been prepared to ensure that Contractors are properly guided, if they encounter cultural resources.

31. **Cumulative river basin impact.** The potential cumulative environmental impacts in the areas downstream from the dam will depend on water quality changes (dissolved oxygen and suspended sediments) and variations in discharge rates, these being most noticeable in the rivers before the confluence with the Trisuli River, and mainly due to the proposed annual reservoir flushing. Beyond the confluence of the Seti-Madi River and the Trisuli, the river discharges from other catchments will obscure both the water level changes associated with the dam operation and the water quality (dilution occurring with collectively larger inflows as one goes downstream).

32. **Social impact update summary.** The Project will affect about 758 households in the reservoir area, with 86 households that will have to be physically displaced, while the remaining 672 households will lose their agricultural land. Measures to mitigate the associated social impacts have been included in the Resettlement and Indigenous Peoples Plan for the Project. With regards to the transmission line, exact number of affected people and assets will be determined during preparation of a resettlement plan, prior to setting the exact alignment of the right-of-way.

33. **Grievance redress mechanism.** A grievance redress mechanism (GRM) will be established to ensure that any residual environmental and social concerns, complaints, and grievances from project stakeholders are received and dealt with properly and in the shortest time possible. The GRM will have three levels with time-bound schedules in managing the issue. The affected stakeholder will be able to seek redress of their grievance at three levels: public information center (PIC) at the village development committee (VDC) level;, the Safeguards Unit of THL; and, the Grievance Redress Committee (a multipartite group consisting of NGOs, Project Director, VDC representative, etc). If none of these measures work, the affected person can seek legal redress of the grievance in the appropriate courts, which is the formal legal court system.

34. **Consultation.** Additional stakeholders' consultations were undertaken on 8-9 June 2011, 1-5 September 2011, 11 November 2011, 16 May 2012, and 19-26 June 2012. Stakeholders who were consulted included project-affected people, Department of Forest,

District Forest officers, management of the existing fish hatcheries, the Federation of Community Forest Users Nepal, Directorate of Fishery Development, Nepal Association of Rafting Agents, the Nepal River Conservation Trust, IUCN Nepal, and the World Wildlife Fund (WWF) Nepal. Some of the concerns raised include: equal distribution of project returns; natural and environmental justice; social, economic and cultural preservation; and equity of employment of local people, based on capability and socioeconomic conditions. These various positions were recognized and addressed as much as possible within the plans and documents dealing with the social impacts and resettlement protocols.

B. PROJECT DESCRIPTION

35. Chapter 2 of the EIA (2009) describes the project components, electromechanical equipment involved, the associated transmission line, the construction camps and related planning, borrow areas, and the construction supply and its source. After the EIA (2009) was completed, some modifications in the design were incorporated as a result of additional detailed engineering studies (for both the hydropower facility and the transmission line). These are presented in **Tables B.1** and **B.2, and Figures B.1** and **B.2**, which show the project location and the lay-out, respectively.

Table B.1 Summary of Major Updates of Technical Components from the EIA (2009).

Comparison of Salient Features			
Particulars	**Approved EIA (2009)**	**Updates in 2012**	**Remarks**
Reservoir			
Reservoir Area	7.26 km^2	7.26 km^2	No change
Reservoir Length	18 km	18 km	No change
Full supply Level	415 m	415 m	No change
Minimum Operating Level	387.2m	378m	MOL lowered by about 9 m
Gross storage capacity	295.1 MCM	295.1 MCM	No change
Effective storage capacity	167 MCM	192.8 MCM first 10 year and 181.7 after 10 years	Increased due to lowering MOL
Available Surcharge	27.8 m	37 m	Changed by about 9 m due to lowering MOL
Diversion Tunnel			
Design Flood	994.6 m^3/s (2-year return period)	994.6 m^3/s (2-year return period)	No change
Length	No. 1 712.m No. 2 881 m	No. 1 556.m No. 2 622 m	Changed due to change of location of inlet and outlet
Diameter	6.6 m	6.6 m	No change
Dam			
Type	Concrete Gravity	Concrete Gravity	No change
Length at crest level	170 m	175 m	Changed by 5 m
Height	140 m	140 m	No change
Volume	870,000 m^3	806,000 m^3	Slight change
Upstream/downstream Slope	u/s: 1: 0.10 d/s: 1: 0.80	u/s: 1: 0.10 d/s: 1: 0.80	No change
Crest Elevation	420 masl	420 masl	No change
Crest width	6.6m	10.0 m	Changed to consider construction method of spillway gates
Spillway			
Type	Chute Type Gated Spillway with ski-jump type energy dissipater	Chute Type Gated Spillway with roller bucket type energy dissipater	Change of energy dissipater type based on the hydraulic model test results
Design Flood	7,377 m^3/s (PMF)	7,377 m^3/s (PMF)	No change
No of radial gates	6	3	Changed to improve discharge
Gate Size (width x height)	12.5 m x 12.5 m	16.5 m x 18.1 m	No change
Width of the overflow crest	75m	49.5m	Changed to improve discharge
Middle Outlet (Water level Lowering Equipment)	No	Yes	Installed for safely discharging to lower the reservoir water level
Gate Size (width x height)	-	3.8 m x 3.8 m	

Comparison of Salient Features			
Particulars	**Approved EIA (2009)**	**Updates in 2012**	**Remarks**
Sill Elevation	-	338.0 masl	before flushing operation
Sediment Flushing Facilities			
Gate Size (width x height)	5.0 m x 5.0 m	5.0 m x 5.0 m	No change
Sill Elevation	320.0 masl	319.40 masl	Slight change
Intake			
	A single Surface intake, invert elevation 371.6 masl	A single Tower type intake, invert elevation 362.0 masl	Change of type, based on optimization study
Headrace Tunnel			
Length	927 m	1,162m	Changed, due to change of powerhouse location
Diameter	7.8m	7.4 m	Changed to optimize the size
Headrace Surge Tank			
Type	Restricted Orifice type	Restricted Orifice type	No Change
Diameter of Orifice	3.7 m	3.6 m	Minor change
Diameter of Chamber	17.0 m	18.0 m	Minor change
Penstock			
Length	195m	175m	Changed, due to change of powerhouse location
Diameter	7.8 m to 3.1 m	7.4 to 3.1 m	Changed, due to diameter of headrace tunnel
Powerhouse			
Type	Underground	Underground	No Change of type (location is changed due to geotechnical reasons)
Length	90m	97m	Slight Change
Height	42m	46m	Slight Change
Width	22m	27m	Slight Change
Draft Tunnel			
Length	86.5 m	85.8 m	Slight change
Tailrace Surge Tank			
Length	40.0 m	-	Tailrace surge tank has been omitted, in consideration of length of tailrace tunnel
Height	32.5 m	-	
Width	15.0 m	-	
Tailrace Tunnel			
Length	320m	117m	Changed, due to change of powerhouse location
Diameter	8.2 m	7.4m	Optimized
Tail water Level	289.2 masl	289.2 masl	No change
Turbine			
Design discharge	127.4 m^3/s	131.2 m3/s	Changed due to increase in turbine output
Effective Head	113 m	121.55 m	Changed due to increase in output
Type	Vertical Axis Francis	Vertical Axis Francis	No change
Number of Units	2	2	No change
Output	64.1 MW	71.8 MW	Changed due to increase in turbine output

Comparison of Salient Features			
Particulars	**Approved EIA (2009)**	**Updates in 2012**	**Remarks**
Specific Speed	208 m-kW	189 m-kW	Slight change
Installed Capacity (2 units)	127 MW	140MW	Changed due to increase in turbine output
Center Elevation	280 masl	280 masl	No change
Generator			
Type	Three-phase Synchronous	Three-phase Synchronous	No change
Number of Units	2	2	No change
Output	74,700 kVA	74,700 kVA	No change
Revolving Speed	300 rpm	300 rpm	No change
Frequency	50 Hz	50 Hz	No change
Voltage	13.2 kV	13.2 kV	No change
Power factor	0.85 lag	0.85 lag	No change
Main Transformer			
Type	Indoor three phase, forced oil air type	Indoor, special three-phase, forced-oil-circulated and forced-water-cooled	Changed to optimize
Number of Units	2	2	No change
Capacity	74,700 kVA	82,300 kVA	Changed due to increase in turbine output
Voltage	Primary; 13.2 kV Secondary: 220 kV	Primary; 13.2 kV Secondary: 220 kV	No change
Switchyard			
Type	Gas Insulated Switchyard (GIS)	GIS	No change
Bus System	Single Bus	Single Bus	No change
Voltage	220 kV	220 kV	No change
Transmission Line			
Length	40 km	36.9 km	Changed due to minor change of location of substation
Number of Circuit	2	2	No change
Conductor Type	380 mm^2 x ACSR (Bison)	380 mm^2 x ACSR (Bison)	No change
Access Road (Permanent)			
Dam Left Bank	3 km	3 km	No change
Dam Right Bank	3.8 km	4.3 km	Slight change
Total Energy	469.4 GWh	First 10 years-585.7 GWh, After 10 years-489.9 GWh	Changed, because of setting-up of maximum capacity and lowering of MOL
Energy Generation from Environmental Flow			
Installed Capacity	1.9 MW	1.5 MW	Changed, due to change of powerhouse location
Total Energy	15 GWh	First 10 years-13 GWh, After 10 years-12.3 GWh	Slight reduction

Table B.2 Summary of Major Updates of Technical Components from the IEE (2010) for the Transmission Line

Comparison of Salient Features			
Description	**Government-Approved IEE (2010)**	**Updates in 2012**	**Remarks**
Location			
District	Tanahu and Chitwan	Tanahu and Chitwan	No change
VDCs/ Municipality	Kahun, Shivapur, Pokhari, Bhanjyang, Keshavtar, Dharampani, Chhipchippe, Devghat, Kabilas & Bharatpur Municipality	Kahun, Shivapur, Pokhari, Bhanjyang, Keshavtar, Dharampani, Chhipchippe, Devghat, Kabilas & Bharatpur Municipality	No change
Source of Power	Tanahu Hydropower Project	Tanahu Hydropower Project	No change
Voltage	220 kV	220 kV	No change
Length of Line	38.42 km	36.9 km	Shortened, due to change of location of substation
Alignment			
Nominal Span	300 m	350 m	Changed to optimize capacity
No. of Angle Points	23	19	Slight reduction
Number of Towers	Approximately 130	Approximately 110	Changed, due to increase of nominal span
Right of Way	30 m	30 m	No change
Tower			
Type	Steel Lattice Structure	Steel Lattice Structure	No change
Height of Tower	16 - 22 m (from top of foundation to lowest cross arm)	16 - 22 m (from top of foundation to lowest cross arm)	No change
Conductor			
Number of Circuit	Double	Double	No change
Size	380 mm^2 x ACSR (Bison)	380 mm^2 x ACSR (Bison)	No change
Earth Wire	EHS 7/3.35	GSW 7/3.35, OPGW	Changed, due to NEA's request
Foundation			
Type	Pad and Chimney isolated	Pad and Chimney type, Pile type, Anchor type	Changed, due to actual alignment conditions
Foundation Area	12.50 m x 12.50 m (approx. average per foundation)	12.50 m x 12.50 m (approx. average per foundation)	No change
Bay Extension	One at Kahu Shivpur substation and another at Bharatpur substation	One at Kahu Shivpur substation and another at Bharatpur substation	No change
Permanent Land Requirement			
For tower foundation	5.2 ha	4.4 ha	Change due to decrease in number of towers
Land use restriction under ROW	93.4 ha	90 ha	Slight change

Figure B.1 Project Location

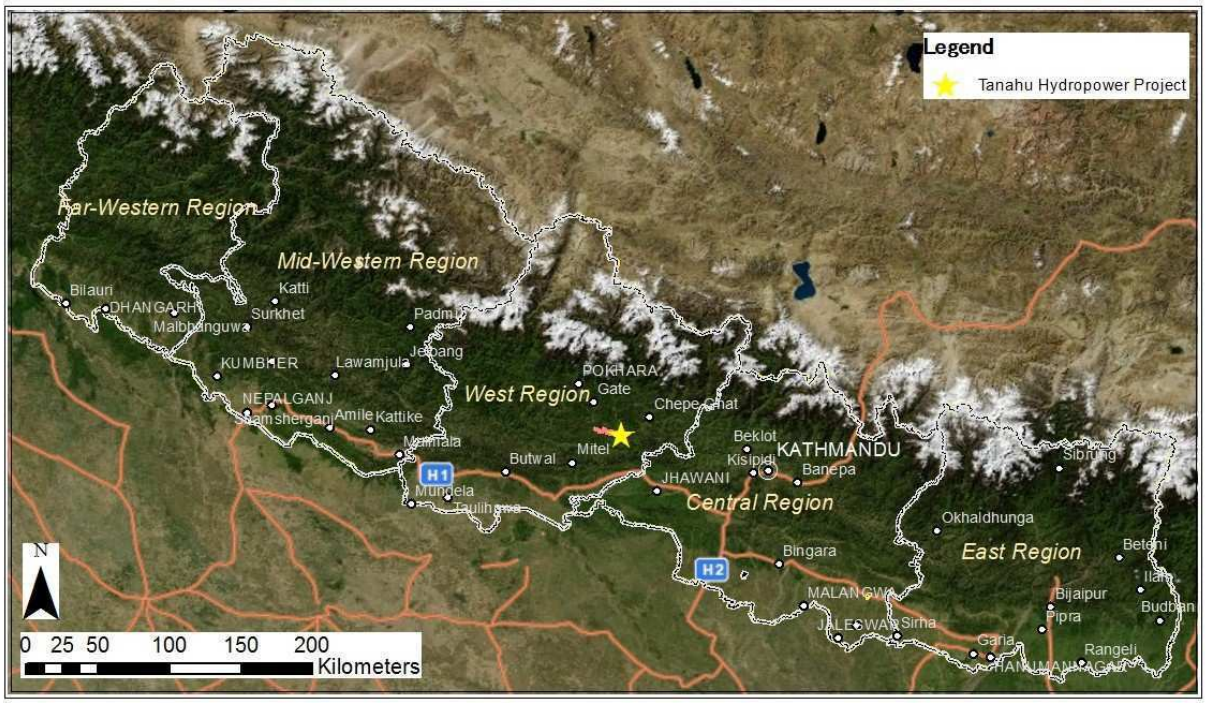


Figure B.2 Project Layout

36. The Tanahu Hydropower Limited (THL) will be the executing agency (EA) for the hydropower component, while the NEA will be the EA for the transmission and rural electrification components. To conduct safeguard and community development activities, THL will establish its Environmental and Social Management Unit (ESMU) and Project Information Centers (PICs) for communication with Affected Persons (APs) in the project sites. THL will also employ a project supervision firm (including an environmental consultant) to manage overall project development, from construction through to the initial five-year operation phase following commissioning.

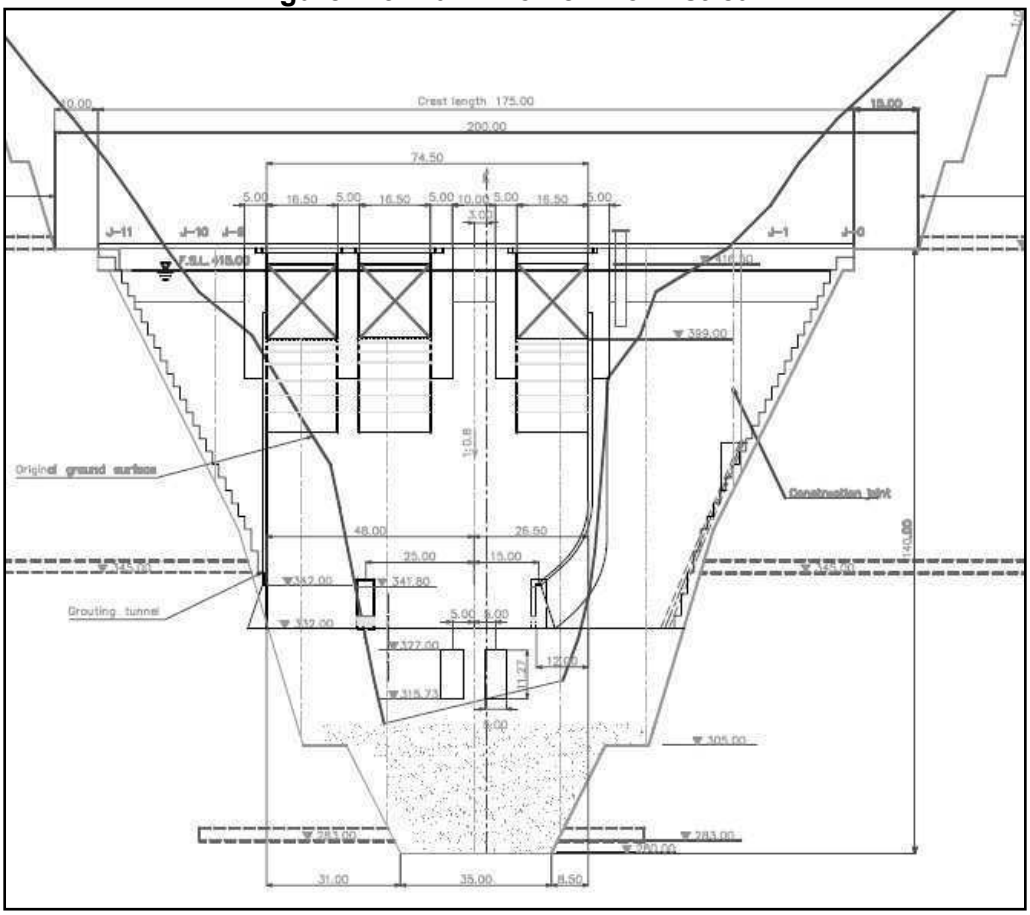
37. During project implementation, an independent Panel of Experts (PoE) will be responsible for assessing the environmental and social safeguards, including dam safety(design of dam, structural safety and seismic design) and power generation operating procedures. To promote the environmental mitigation activities, the Project will provide, with the ADB-financed component, consulting services for specific mitigation programs. These programs are: (i) the Fish Conservation Management Plan (for the dam/reservoir); (ii) a Wildlife Awareness and Conservation Management Plan (one each for the dam/reservoir and the transmission line); (iii) a Watershed/Forestry Management Plan (one each for the dam/reservoir and the transmission line); and, (iv) the Water Release/River Safety Plan (these are described in detail in Volume 2).

B.1 Project design modification

38. The major features of the Project design have not been altered since the EIA (2009) and the IEE (2010), as indicated in **Tables B.1** and **B.2**, but additional information is available on some features of the dam, the reservoir operating regime, and the resulting downstream river hydrology; described below.

39. **Dam gates:** The dam gate and spillway design has been modified, based on hydraulic modeling. Gate design now reflects the reduction from six gates to three gates, to reduce the distance between the retaining walls (i.e., to prevent overtopping) at the base of the spillway, with each gate increased in size to 16.5 m width by 18.1 m height. One gate is located on the left bank side and two on the right bank side as shown in **Figure B.3**.

Figure B.3 Dam Profile - Downstream



40. **Reservoir:** A reservoir with a total surface area of 7.26 km^2 at full supply level (elevation 415 m) will be created. The reservoir will have a MOL at elevation 378 m, providing a 37 m available drawdown (fluctuation zone) between MOL and full supply level (FSL). The total storage volume of the reservoir at FSL will be 295.1 million m^3 (MCM), with 192.8 MCM (or 65.3%) effective storage during the first 10 years of operation and 181.7 MCM (or 62%) from the 11th year onwards.

41. **Headrace, Penstock and Tailrace:** A 7.4 m diameter headrace tunnel, 1,162 m long, will be constructed on the right bank. The headrace intake has been set at 362 meters above sea level (masl), 16 m below MOL. This will connect to a 175 m long penstock that divides into two (going from 7.4 m in diameter to 2 x 3.1 m in diameter) near its end. A 117 m long tailrace tunnel will be constructed to discharge the flow used for power generation back into the Seti River.

42. **Powerhouse:** An underground powerhouse will be constructed 6 km downstream of the dam (beyond the confluence with the Madi River). Two units of vertical axis Francis turbines, three phase synchronous generator and transformer will be installed. The powerhouse dimensions are 27 m wide by 46 m high by 97 m long. Surface facilities will include an outgoing terminal and administrative buildings.

43. **Middle outlet:** Two middle outlets have been included in the dam to enable the reservoir level to be lowered from MOL (378 masl) to a height that allows the sediment flushing gates to be opened. The sediment flushing gates can only be opened when the maximum operating head is 25.0 m, equivalent to a reservoir level of 345 masl; therefore, the middle outlet is required to reduce the water level to this height. An additional design consideration is the reduction in the possible impacts of rapid flow releases on downstream areas.

44. Each middle outlet will consist of a conduit through the dam wall with an intake gate 3.8 m by 3.8 m, with a top invert level of 341.8 masl. The combined discharge rate of the middle outlets is summarized in **Table B.3** for various reservoir water levels from FSL down to 345 masl. Given that the reservoir is expected to be at MOL (378 masl) in most years when the middle outlet is opened, it is likely that the middle outlet discharge rate will be 710 m^3/s or less through this outlet.

Table B.3 Middle Outlet Discharge Rates

Reservoir Water Level (masl)	Height Above Sill (m)	Discharge Rate (Q) (m^3/s)
415	77	988
399	61	879
385	47	772
380	42	729
370	32	637
360	22	528
350	12	390
345	7	298

45. **Sediment flushing facilities:** These facilities will consist of two sets of inlets through the base of the dam wall, in the middle of the river cross-section, with a sill level of 320 masl. Three gates will be installed in a conduit that will be fully opened when in operation, once the reservoir level is at 345 masl or lower. Gate size is likely to be 5 m by 5 m which is the largest gate that can be readily manufactured for this purpose. The facilities will be designed to discharge 400 m^3/s under open channel flow conditions (**Table B.4**), adequate to handle the peak monsoon river flow, 70% of the time.

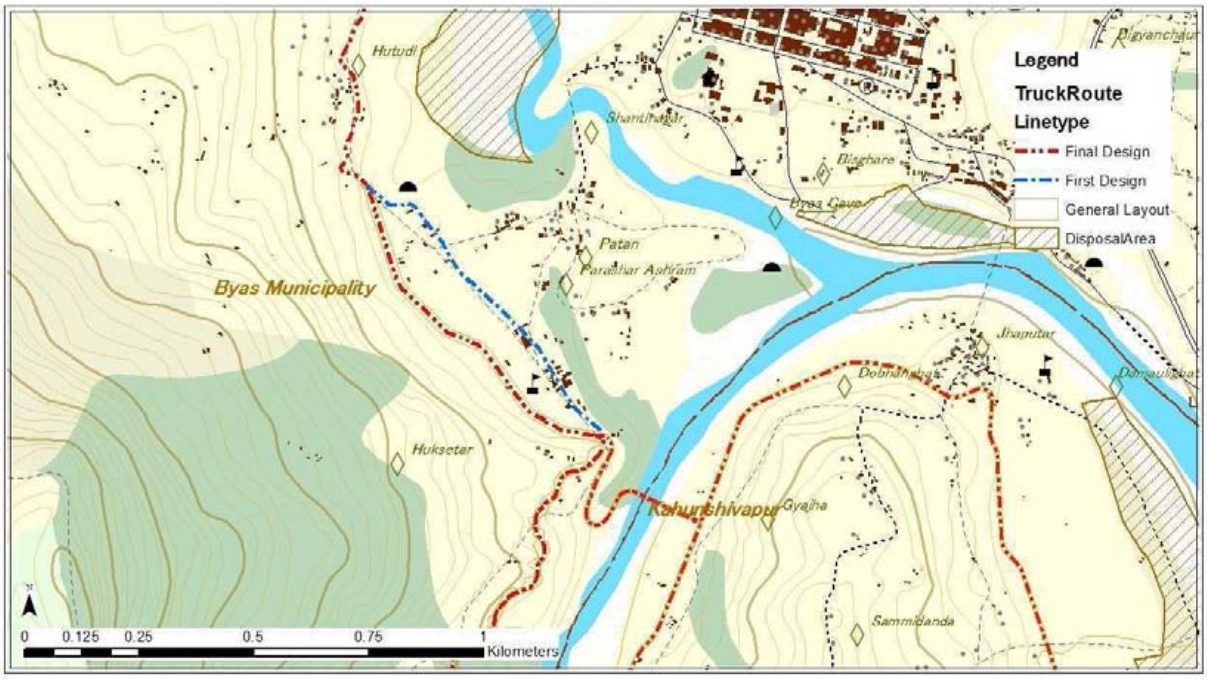
Table B.4 Sediment Flushing Discharge Rates

Reservoir Water Level (masl)	Height Above Sill (m)	Discharge Rate (Q) (m^3/s)
345	25	1,026
340	20	918
338	18	871
336	16	821
334	14	768
332	12	711
330	10	649
325	5	459

46. **Road alignments:** The proposed road alignments have been improved, to reduce the environmental and social impacts of these structures. The initial access road alignments incorporated existing village roads that ran through the middle of settlements. To avoid noise and dust impacts on adjacent houses and other sensitive sites that included a school in *Byas* village, a new access road alignment was planned at the rear of several settlements on the toe

of hillside slopes (**Figure B.4**). This involved setting the road back as far as possible from these features, including avoiding the existing road through the centre of *Byas* village.

Figure B.4 Revised Access Road Alignment



47. The Project will pave the existing main village access roads as a community development initiative, even though these structures will not be used by the Project.

48. **Transmission line alignment:** The transmission line will have a length of 36.9 km. The proposed location of the alignment near the power plant has been moved by up to 300 m and changed slightly at other locations, to account for local topography and terrain, which results in a shorter route (i.e., from 40 km to 36.9 km). These changes reduce the number of turning points along the line from 23 to 19, as illustrated in **Appendix 1**.

B.2 Dam safety

49. Dam safety was discussed in the 2009 EIA, in relation to seismicity, safety, and occupational health. This section includes the results from simulations of flood levels, in the event of a total dam failure.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	• Sect. 4.1.6 Seismicity	• No change
Impacts	•Sect. 5.1.9 Seismicity Risk	• No change in seismicity risk analysis • Simulation of flood level at dam failure was estimated at 330 masl (at the confluence of Seti River and Madi River) and a flood of 47,500 m^3/s at full supply level would occur for about 90 minutes
Mitigation	• Sect. 7.1.9 Seismicity • Sect. 7.3.4 Safety and Occupational Health	• No change in seismicity • Identified 55 stations to install warning signs from the dam site to the Trisuli River • Recruitment of Panel of Experts consultants to review

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
		design of dam, including structural safety and seismic design • Emergency inspection procedures of dam in the event of a severe earthquake • Disaster and Emergency Response Plan incorporating evacuation plan and procedures (see Volume 2A Dam/Reservoir EMP)Lower reservoir water level after notifying downstream communities, if damage due to earthquake is identified

50. THL will recruit an independent Panel of Experts (PoE) who will be responsible for evaluating dam safety (design of dam, structural safety and seismic design), and the PSC will review the dam design, including the structural safety and seismic design.

51. There are three factors that may cause dam failure, including possible impacts caused by climate change:

(i) **Flood damage caused by precipitation:** The capacity of the spillway is designed to cope with the probable maximum flood (PMF), which is the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the catchment. The PMF has been estimated at between 7,377 and 8,306 m^3/s. The dam spillway has been designed to safely discharge this flow; therefore, the possibility that the dam will overtop due to catchment runoff is remote.

(ii) **Flood damage caused by a glacier lake outburst flood:** According to the *Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods (2001)* by the International Centre for Integrated Mountain Development (ICIMOD), there are10 glacial lakes in the headwaters of the Seti River basin and none of these lakes is potentially dangerous. ICIMOD more recently reported that the number of glacial lakes had decreased from ten to six.[3] Based on this information, there is no possibility that a glacial lake outburst flood (GLOF) could cause the dam wall to fail.

(iii) **Earthquake damage:** According to the *Seismic Hazard Map of Nepal*, the maximum acceleration at the project site is evaluated as 230 Gal (Gal is equivalent to 1 cm/s^2) and the horizontal seismic coefficient is estimated at 0.15. The dam has been designed by pseudo-static seismic analysis under these conditions. Pseudotatic analysis is a simple approach in earthquake engineering to analyze the seismic response of soil embankments and slopes. For the estimated earthquake, the dam should have the following safety factors:

- the dam foundation should have the minimum safety factor of 4.0 against shear force caused by seismic acceleration; and,
- the tensile force should not act at the upstream side of the dam body against seismic acceleration.

52. A concrete gravity dam, designed in accordance with modern technical requirements, will not immediately collapse due to the severest earthquake, even if cracks develop in the dam

[3]ICIMOD. March 2011. Glacial Lakes and Glacial Lake Outburst Floods in Nepal. Kathmandu.

wall. Accordingly, there is no possibility that a probable earthquake will cause complete failure of the dam.

53. Immediately after the occurrence of a severe earthquake, THL would conduct an emergency inspection of the dam involving:

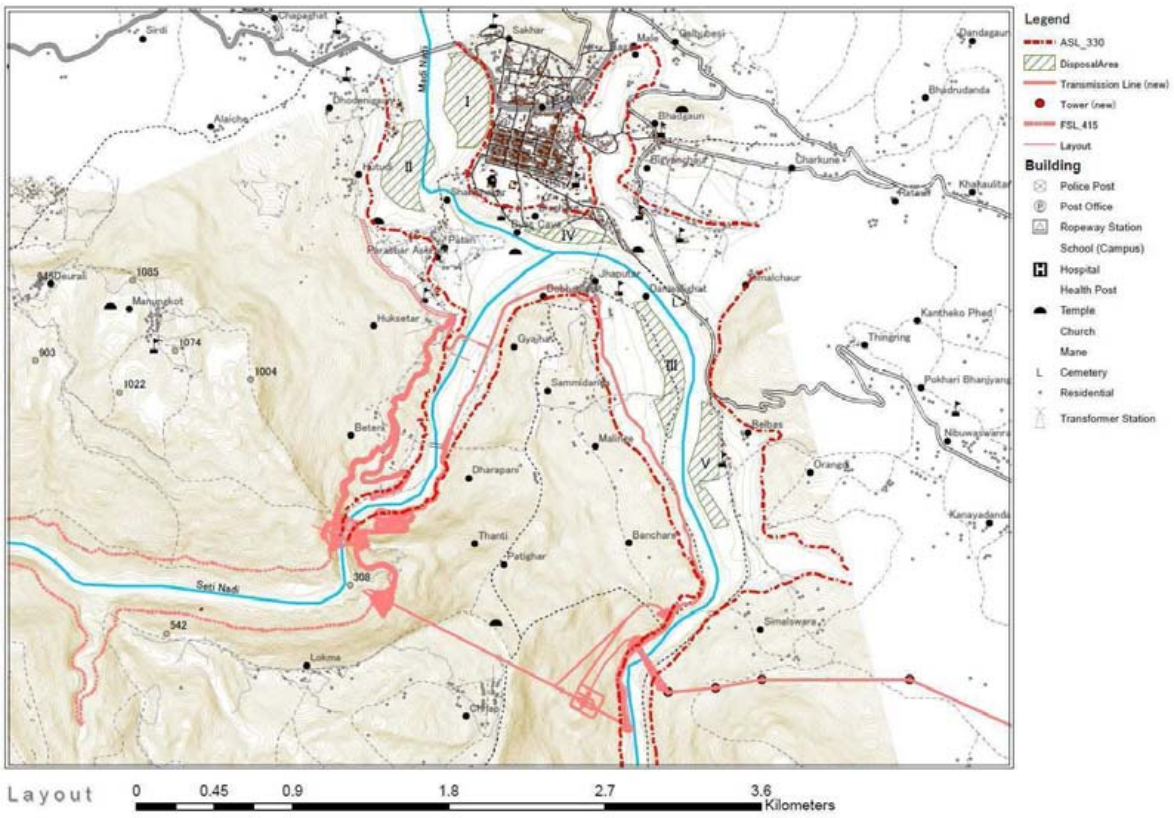
- Inspection of the outside appearance of the dam body to determine whether conspicuous cracks have been induced by earthquake or not;
- Inspection of displacement of the dam body to determine whether conspicuous changes in displacement of the dam body can be observed or not; and,
- Inspection in the galleries as to whether or not water leakage from joints and/or drainage holes has increased, uplift has changed or not, and any other significant changes in measured values of instruments installed in the dam body.

54. If damage that may lead to a dam failure is identified, THL will lower the reservoir water level after notifying downstream communities of increase in the river water level and will issue an evacuation advisory to riverine communities.

55. Assuming that the Tanahu dam could disappear instantaneously, and stored water with the full supply level flows down the Seti River, it is estimated that a flood of 47,500 m^3/s would occur for about 90 minutes. In this scenario, the maximum water level at the confluence of Seti River and Madi River is estimated at 330 masl. **Figure B.5** shows the maximum flood level, if there were an instantaneous dam failure.

56. In the event of a catastrophic total dam failure, people living close to the Seti River near Damauli District will be able to take safe refuge on land above 330 masl. A Disaster and Emergency Response Plan will be prepared by THL during project pre-construction that will incorporate an evacuation plan in the event of dam failure (see paragraph 121 of Volume 2A – Dam/Reservoir EMP).

Figure B.5 Maximum Flood Level from Dam Failure



B.3 Project cost

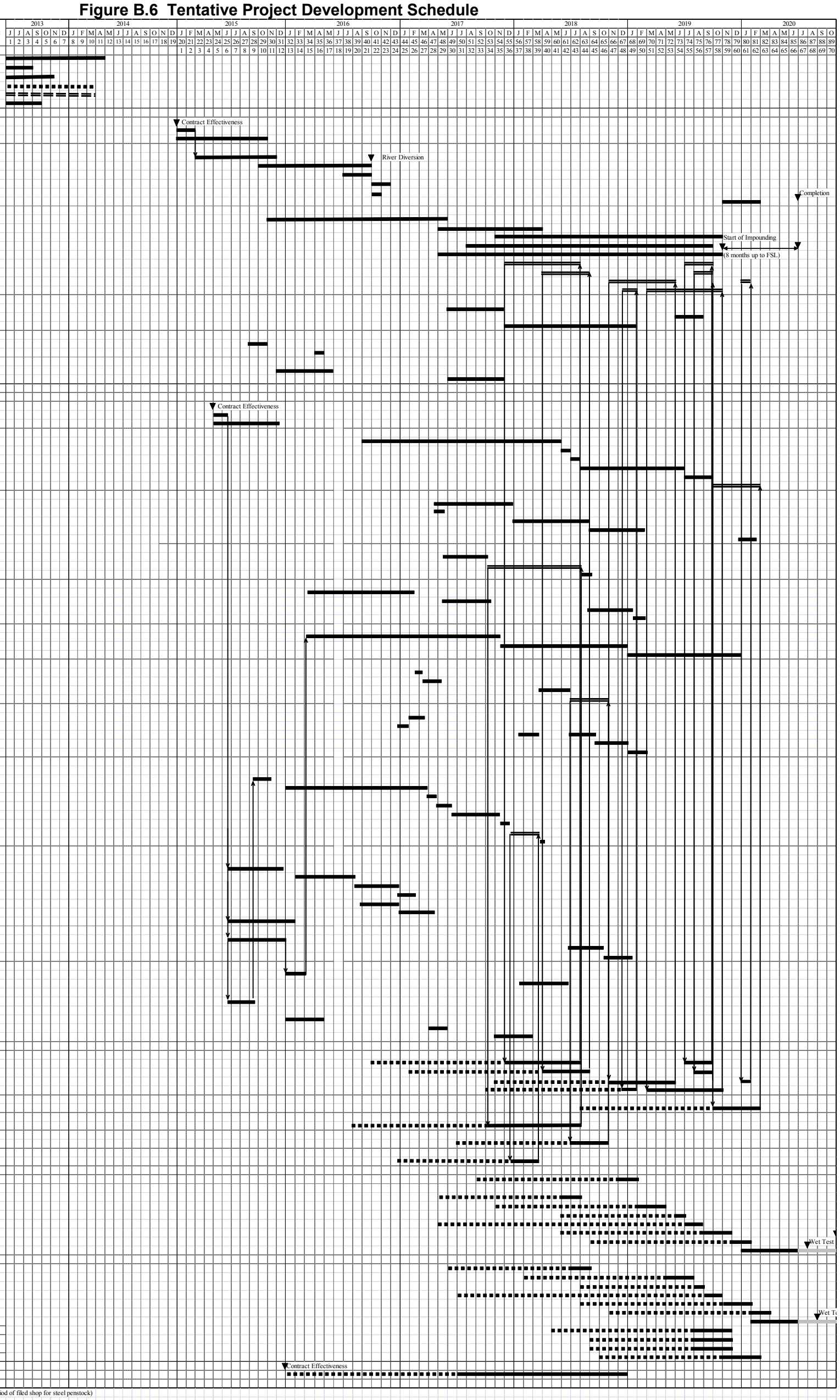
57. The total project cost is estimated at $505 million, including $35 million for NEA's transmission line and rural electrification components. Of the Project costs, the total environmental safeguards-related costs are estimated to be $23.29 million (GoN will fund $20.77 million, and ADB will fund the related consultancies; $2.52 million, including monitoring of the consultancies).

B.4 Implementation schedule

58. The revised Project implementation schedule is provided in **Figure B.6**, based on current conditions. Year 1 is expected to commence in April 2013.

Figure B.6 Tentative Project Development Schedule

		Description	Quantity	Unit
1		**THL's Preparatory Works**		
		Permanent Bridge		
		Access Road on Dam Right Bank		
		Access Road on Dam Left Bank		
		THL's Camp		
		Land Acquisition for main works		
		Power Supply System for Construction		
2		**Package-1 Civil Works of Headworks**		
	2.0	Mobilization & Preparation		
		Mobilization		
		Design and Access to Work Fronts		
	2.1	Diversion Tunnel		
		(1) Tunnel Excavation	1,178	m
		(2) Concrete Lining	1,178	m
		(3) Grouting Work	1	LS
		(4) Upstream Coffer Dam	1	LS
		(5) Downstream Coffer Dam	1	LS
		(6) Plug Concrete	1	LS
	2.2	Dam & Spillway		
		(1) Excavation	1,169,300	m^3
		(2) Grout Tunnel Excavation	732	m
		(3) Curtain Grouting	54,619	m
		(4) Consolidation Grouting	14,347	m
		(5) Dam & Spillway Concrete	846,290	m^3
		(6) Sediment Flushing Equipment Installation	1	LS
		(7) Water Level Lowering Equipment Installation	1	LS
		(8) Environmental Flow Equipment Installation	1	LS
		(9) Spillway Gate Installation	1	LS
	2.3	Reservoir Slope Protection		
		(1) Surface Excavation	136,438	m^3
		(2) Backfilling	24,273	m^3
		(3) Gabion Mat	158,723	m^3
	2.4	Access Road		
		(1) Access Road on dam Left Bank	750	m
		(2) Access Road on dam Right Bank	450	m
	2.5	Disposal Area		
		(1) Disposal Area I	115,000	m^2
		(2) Disposal Area II	110,000	m^2
3		**Package-2 Waterway, Powerhouse and Related Equipment**		
	3.1	**Civil Works**		
	3.1.0	Mobilization/Preparation		
		Mobilization		
		Design and Access to Work Fronts		
	3.1.1	Intake		
		(1) Open Excavation	366,300	m^3
		(2) Tunnel Excavation	1	LS
		(3) Tunnel Lining and grouting	1	LS
		(4) Intake Tower Concrete	28,380	m^3
		(5) Intake Bridge	1	LS
		(6) Gate & Screen Installation	1	LS
	3.1.2	Headrace Tunnel		
		(1) Tunnel Excavation (Ascend)	1,108	m
		(2) Tunnel Excavation (Descend)	95	m
		(3) Tunnel Lining	1,203	m
		(4) Grouting	1,203	m
		(5) Plug Concrete	1	LS
	3.1.3	Penstock		
		(1) Tunnel and Shaft Excavation	259	m
		(2) Steel Liner (with Backfill Concrete)	259	m
		(3) Contact Grouting	1	LS
	3.1.4	Headrace Surge Tank		
		(1) Arch Excavation	43	m
		(2) Shaft Excavation	67	m
		(3) Concrete Lining	67	m
		(4) Grouting	67	m
	3.1.5	Powerhouse		
		(1) Excavation	81,700	m^3
		(2) Concrete	21,500	m^3
		(3) Architectural Work	1	LS
	3.1.6	Draft Gate Chamber		
		(1) Tunnel Excavation	38	m
		(2) Shaft Excavation	48	m
		(3) Concrete	48	m
		(4) Draft Gate Installation	1	LS
	3.1.7	Tailrace Tunnel (including Draft Tunnel)		
		(1) Tunnel Excavation (Tailrace Tunnel)	190	m
		(2) Tunnel Excavation (Draft Tunnel)	147	m
		(3) Concrete Lining	337	m
		(4) Grouting	337	m
		(5) Plug Concrete	1	LS
	3.1.8	Tailrace Outlet and Draft Pond		
		(1) Access Road	1	LS
		(2) Coffering	1	LS
		(3) Open Excavation	39,400	m^3
		(4) Tunnel Excavation	32	m
		(5) Concrete Lining	32	m
		(6) Tailrace Outlet Concrete	147	m
		(7) Grouting	1	LS
		(8) Gate Installation	1	LS
		(9) Removable of Coffer	1	LS
	3.1.9	Access Tunnel and Access Adit		
		(1) Main Access Tunnel		
		Open Excavation, Portal	34,040	m^3
		Tunnel Excavation	837	m
		Invert Concrete & Lining	837	m
		(2) Draft Gate Access Tunnel	241	m
		(3) Work Tunnel for Penstock	572	m
		(4) Work Tunnel for Headrace Tunnel	522	m
		(5) Work Tunnel for Surge Tank Arch Heading	232	m
	3.1.10	Outgoing Terminal		
		(1) Excavation	52,500	m^3
		(2) Concrete Work of Control Building	1,050	m^3
		(3) Architectural Work of Control Building	1	LS
	3.1.11	Cable Tunnel		
		(1) Tunnel Excavation	458	m
		(2) Concrete Lining	458	m
	3.1.12	Access Road		
		(1) Access Road on dam Right Bank to Outlet	880	m
	3.1.13	Disposal Area		
		(1) Disposal Area III	80,000	m^2
		(2) Disposal Area IV	24,000	m^2
		(3) Disposal Area V	60,000	m^2
	3.2	**Hydromechanical Equipment**		
	3.2.1	Dam & Spillway		
		(1) Sediment Flushing Equipment Installation	1	LS
		(2) Water Level Lowering Equipment Installation	1	LS
		(3) Environmental Flow Equipment Installation	1	LS
		(4) Spillway Gate Installation	1	LS
	3.2.2	Intake		
		Gate & Screen Installation	1	LS
	3.2.3	Penstock		
		Steel Liner (with Backfill Concrete)	1	LS
	3.2.4	Draft Gate		
		Gate Installation	1	LS
	3.2.5	Tailrace Outlet		
		Gate Installation	1	LS
	3.3	**Electromechanical Equipment**		
	3.3.1	Overhead Traveling Crane	1	LS
	3.3.2	#1 Unit		
		(1) Draft tube	1	LS
		(2) Spiral casing	1	LS
		(3) Inlet Valve	1	LS
		(4) Runner	1	LS
		(5) Stator	1	LS
		(6) Rotor	1	LS
		(7) Whole Assembly, Dry and Wet Tests	1	LS
	3.3.3	#2 Unit		
		(1) Draft tube	1	LS
		(2) Spiral casing	1	LS
		(3) Inlet Valve	1	LS
		(4) Runner	1	LS
		(5) Stator	1	LS
		(6) Rotor	1	LS
		(7) Whole Assembly, Dry and Wet Tests	1	LS
	3.3.4	Power Plant Equipment	1	LS
	3.3.5	Main Transformer	1	LS
	3.3.6	Switchyard Equipment	1	LS
	3.3.7	Environmental Flow Generation Facility	1	LS
4		**Package 3 Transmission line and Rural Electrificat**		
			1	LS
			1	LS



Note:
- Design, Manufacturing and Transportation (including erection period of filed shop for steel penstock)
- Installation, Assembly
- Installation and/or assembly period of Hydromechanical Equipment indicated in 2.2 and 3.1 Civil Works (Same bars are shown in 3.2 Hydromechanical Equipment)
- Land Acquisition

C. ENVIRONMENTAL CONDITION, IMPACT ASSESSMENT AND MANAGEMENT MEASURES

59. Most of the information on the existing environmental conditions, impacts, and mitigation measures have been discussed and presented in the EIA (2009) for the dam and reservoir and in the IEE (2010) for the transmission line. **Table C.1** presents a comparison of the EIA (2009), IEE (2010), and the issues/information updated and added in this Environmental Addendum (2012), based on the recent surveys and the clarification of technical specifications of the project.

Table C.1 Summary of Major Updates (Additional Information) Compared to the EIA (2009) and IEE (2010)

EIA(2009)	IEE (2010)	Environmental Addendum (2012)	Remarks
Existing Environmental Conditions			
A. Physical Environment			
4.1.1. Watershed Conditions (p4-1)	5.1.1 Watershed condition (p5-1)	No change	-
4.1.2 Topography and Land Use (p4-3)	5.1.3 Topography (p5-2) 5.1.4 Land use and land take (p5-2)	No change	-
4.1.3 Climate, Meteorology and Air Quality (p4-5)	5.1.5 Climate (p5-3) 5.1.6 Air and Water Quality and Noise Levels (p5-3)	No change	-
4.1.4 River Hydrology and Morphology (p4-10)	5.1.7 Drainage and Hydrology (p5-4)	C.1.2 River Flows	• Updated hydrological data from the Seti River and Madi River: average monthly flow (Table C.3 and Table C.4) • Comparison of existing average monthly flow from the Seti River and flow during Project operation
4.1.5 Geology and Soil (p4-11)	5.1.2 Geology and Soil (p5-1)	No change	-
4.1.6 Seismicity (p4-13)	-	No change	-
4.1.7 Water Quality (p4-14)	5.1.6 Air and Water Quality and Noise Levels (p5-3)	C.1.3 Reservoir and Downstream Water Quality	Additional water quality sampling was done in April, July, September, and December 2011 (nine sampling stations)
4.1.8 Noise Quality (p4-15)	5.1.6 Air and Water Quality and Noise Levels (p5-3)	No change	-
4.4.3.2 Water Resource Use (p4-62)	-	C.3 Ground water	Survey was done from May to July 2011, to map the

EIA(2009)	IEE (2010)	Environmental Addendum (2012)	Remarks
			groundwater sources within the Project area
B. Biological Environment			
4.2.1 Vegetation (p4-17) Appendix D	5.2.1 Vegetation/Forest Resources (p5-4) 5.2.2 Plant Resource Use Pattern (p5-7) 5.2.3 Forest Management (p5-8) 5.2.4 Forest Land Requirement (p5-8)	C.5.1 Flora	Additional flora survey done in July 2011 (eight sampling stations)
4.2.2 Wildlife (p4-22)	5.2.5 Wildlife (p5-10)	C.5.2 Mammals	• Eight sampling stations for additional fauna survey in July 2011 • Additional information on wildlife and wildlife habitat status through field surveys and consultations with local people
4.2.3 Fish and Aquatic life (p4-24) Appendix E	-	C.4 Aquatic Ecology	• Additional fish survey done in April and September 2011 • Nine sampling stations were established
C. Socio-economic and Cultural Environment			
4.3.1 Tanahu District (p4-29)	-	No change	-
4.3.2 Education (p4-30)	-		
4.3.3 Health (p4-31)	-		
4.3.4 Water Supply and Sanitation (p4-32)	-		
4.3.5 Energy Use (p4-33)	-		
4.3.6 Economic Activities (p4-33)	-		
4.3.7 Cultural, Aesthetic and Archaeological Value (p4-37)	-		
4.4.1 Affected VDCs and Municipality (p4-38)	5.3.1 Profile of Affected VDCs/Municipality (p5-11)		
4.4.2 Project Affected Persons/ Households (p4-47)	5.3.2 Profile of the Sampled Households (p5-18)		
4.4.3 Community Resources and Properties (p4-61)	-		
Impact Assessment			
A. Physical Environment			
5.1.1 Watershed Condition (p5-1)	6.1.1 Watershed Condition (p6-1)	No change	-
5.1.1.1 Construction Phase (p5-1)	6.1.1.1 Construction Phase (p6-1)	No change	-

EIA(2009)	IEE (2010)	Environmental Addendum (2012)	Remarks
5.1.1.2 Operation Phase (p5-2)	6.1.1.2 Operation Phase (p6-1)	No change	-
5.1.2 Topography, Land Take and Land Use (p5-3)	6.1.2 Topography, Land Use and Land Take (p5-3)	No change	-
5.1.2.1 Construction Phase (p5-3)	6.1.2.2 Construction Phase (p6-2)	C.6 Reservoir Foreshore Stability C.7 Spoil Disposal and Project Facilities	• Identified high risk land slide areas • Identified Project-induced processes that will potentially cause foreshore erosion
5.1.2.2 Operation Phase (p5-4)	6.1.2.3 Operation Phase (p6-2)	No change	-
5.1.3 Air Quality (p5-4)	6.1.3 Air Quality (p6-3)	No change	-
5.1.3.1 Construction Phase (p5-4)	6.1.3.1 Construction Phase (p6-3)	C.8 Air Quality	Dust impact areas were identified
5.1.3.2 Operation Phase (p5-5)	6.1.3.2 Operation Phase (p6-3)	No change	-
5.1.4 Microclimate (p5-5)	-	No change	-
5.1.4.1 Construction Phase (p5-5)	-	No change	-
5.1.4.2 Operation Phase (p5-5)	-	No change	-
5.1.5 Noise and Vibration (p5-5)	6.1.4 Noise Quality (p6-3)	No change	-
5.1.5.1 Construction Phase (p5-5)	6.1.4.1 Construction Phase (p6-3)	No change	-
5.1.5.2 Operation Phase (p5-6)	6.1.4.2 Operation Phase (p6-3)	No change	-
5.1.6 Surface Hydrology (p5-6)	6.1.5 Water Quality (p6-3)	C.1 Project Generation and River Hydrology	• Estimated power generation hours • Average reservoir operating level during initial 10 years of operation and after 10 years
5.1.6.1 Construction Phase (p5-6)	6.1.5.1 Construction Phase (p6-3)	No change	-
5.1.6.2 Operation Phase (p5-6)	6.1.5.2 Operation Phase (p6-4)	C.1 Project Generation and River Hydrology C.1.2 River flows C.2 River Safety C.10 Rafting	• Monthly water level fluctuations after tailrace due to peaking power generation • Water level during operation (including reservoir draining for 10 days) at Seti River, based on simulations • Analysis of water level changes due to power generation • Detailed water level simulation was conducted on cross-

EIA(2009)	IEE (2010)	Environmental Addendum (2012)	Remarks
			section measurements and operation plan • Rafting operations may be affected by regulated river flows
5.1.7 Sedimentation and River Morphology (p5-8)	-	No change	-
5.1.7.1 Construction Phase (p5-8)	-	No change	-
5.1.7.2 Operation Phase (p5-8)	-	C.6 Reservoir Foreshore Stability	• Identified high risk land slide areas • Identified Project-induced processes that will potentially cause foreshore erosion
5.1.8 Water Quality (p5-9)	-	No change	-
5.1.8.1 Construction Phase (p5-9)	-	No change	-
5.1.8.2 Operation Phase (p5-9)	-	C.1.3 Reservoir and Downstream Water Quality	• Suspended sediment concentration in water discharged during annual sediment flushing predicted by mathematical modeling • Analysis of downstream impacts of turbid water was conducted
5.1.9 Seismicity risks (p5-13)	-	No change	-
5.1.9.1 Construction Phase (p5-13)	-	No change	-
5.1.9.2 Operation Phase (p5-13)	-	B.2 Dam Safety	• No change in seismicity risk analysis • Simulation of flood level at dam failure was estimated at 330 masl (at the confluence of Seti River and Madi River) and a flood of 47,500 m^3/s at full supply level
5.1.10 Change in Water Table (p5-14)	-	No change	-
5.1.10.1 Construction Phase (p5-14)	-	C.5 Ground water	• 35 groundwater sources identified and 19 of these could be affected by the Project

EIA(2009)	IEE (2010)	Environmental Addendum (2012)	Remarks
			• Four sources, out of the 19 sources identified, will be indirectly affected by tunneling
5.1.10.2 Operation Phase (p5-14)	-	No change	-
5.1.11 Spoil Handling and Disposal (p5-14)	-	No change	-
5.1.11.1 Construction Phase (p5-14)	-	C.7 Spoil Disposal and Project Facilities	• Volume of spoil was revised and disposal areas were changed • Potential to increase river levels due to spoil disposal was assessed by modeling • Established 36 river sections at Seti River and Madi River to determine impacts of disposal in areas upstream • Upstream and downstream influence of using the disposal sites to river water level was evaluated
5.1.11.2 Operation Phase (p5-14)	-	No change	-
B. Biological Environment			
5.2.1 Vegetation and Forest Resources (p5-15)	6.2.1 Forest and Vegetation (p6-4)	No change	• No change with number of trees to be cleared (about 162,000)
5.2.1.1 Construction Phase (p5-15)	6.2.1.1 Construction Phase (p6-5)	C.5.1 Flora	• 422.6 ha of forest land affected by reservoir and project facilities compared to 422 ha in EIA (2009) • Three plant species listed by GoN as under conservation • Six species (including four orchids) listed by Convention on International Trade in Endangered Species (CITES) and two listed by IUCN • Plants of

EIA(2009)	IEE (2010)	Environmental Addendum (2012)	Remarks
			conservation significance in the indirect impact area have been identified
5.2.1.2 Operation Phase (p5-15)	6.2.1.2 Operation Phase (p6-5)	No change	-
5.2.2 Wildlife (p5-20)	6.2.2 Wildlife (p6-6)	No change	-
5.2.2.1 Construction Phase (p5-20)	6.2.2.1 Construction Phase (p6-5)	C.5.2 Mammals	Confirmed the absence of tigers in the reservoir and project facilities areas
5.2.2.2 Operation Phase (p5-21)	6.2.2.2 Operation Phase (p6-6)	No change	-
5.2.3 Fish and Aquatic life (p5-21)	-	No change	-
5.2.3.1 Construction Phase (p5-21)	-	-	-
5.2.3.2 Operation Phase (p5-22)	-	C.4 Aquatic Ecology	• Inclusion of annual draining of reservoir and sediment flushing • Potential impacts on six fish species included in the IUCN Red List (updated and addressed in mitigation measures)
C. Socioeconomic and Cultural Environment			
5.3.1 Loss of land and Property (p5-26)	6.3.1 Acquisition of land (p6-7) 6.3.2 Loss of Standing Crop (p6-7) 6.3.11 Infrastructure and Communal Resources (p6-11)	C.16 Social Impact Update Summary C.11 Access and Infrastructure	Data based on socioeconomic survey in 2011-2012 and the draft Project Resettlement Plan August 2012
5.3.2 Direct Impacts to the Households (p5-28)	6.3.3 Acquisition of Houses and other Structures (p6-8)		
5.3.3 Affected Structure Owners of the Project (p-5-30)	-		
5.3.4 Residential Structure Affected Owner (p-5-31)	-		
5.3.5 Residential Structure Affected Owner without Legal Holdings (p5-32)	-		
5.3.6 Seriously Project Affected Families and Project Affected Families (p-5-32)	-		
5.3.7 Socio-economic and Cultural Impacts during Construction Phase (p5-34)	6.3.4 Health and Sanitation (p6-9) 6.3.5 Occupational	C.11 Access and Infrastructure C.12 Occupational Health	Included the occurrence of malaria in Nepal based on

EIA(2009)	IEE (2010)	Environmental Addendum (2012)	Remarks
	Hazards and Safety (p6-9) 6.3.6 Electric and Magnetic Field Effect (p6-10) 6.3.7 Interference (p6-10) 6.3.8 Gender and Vulnerable Group (p6-10) 6.3.9 Economic Activities (p6-11) 6.3.10 Historical and Archeological Sites (p6-11) 6.3.11 Social and Cultural Practices (p6-12) 6.3.13 Law and Order (p6-12) 6.3.14 Impacts of Aesthetics (p6-12)	and Safety C.13 Community Health and Safety C.14 Physical Cultural Resources	2010 World Health Organization Health Data
5.3.8 Beneficial Impacts (p-5-40)	6.4 Beneficial Impacts (6-13)	C.9 Greenhouse Gas Emissions	Estimated the CO_2 emissions reduction from the use of hydropower
-	-	D. Grievance Redress Mechanism	Included a process to address complaints from Project stakeholders
8.0 Consultation	-	E. Consultation	Additional consultations were done in 2011 (June, September, November) and in 2012 (May and June)

C.1 Project Generation and River Hydrology

60. The EIA (2009) briefly addressed fluctuation characteristics and downstream impacts during Project operation. After the EIA was completed, a detailed engineering study was undertaken; the results are discussed in this section, including power generation and reservoir operation and their environmental implications.[4]

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Impacts	•Sect. 5.1.6 Surface Hydrology (c) Fluctuation Characteristics	• Estimated power generation hours • Average reservoir operating level during initial 10 years of operation and after 10 years
Mitigation	• Sect. 7.1.6 Downstream impacts (7.1.6.2 Operation Phase)	• Sediment flushing • Reservoir draining

[4] ADB. 2010. Grant to Nepal for *Detailed Engineering Study for the Upper Seti Hydropower Project*. Manila.

C.1.1 Project Generation and Reservoir Operation

61. The Project will generate base-load power (24 hours per day) from early June to September (four months). Peaking power will be generated from October to early June (about eight months) for between 6 and 20 hours per day, as indicated in **Table C.2**. The daily times when peaking generation will occur between October and early June has yet to be finalized, but the estimated hours are also shown in **Table C.2**, corresponding to the higher demand periods of the day. Daily peaking generation releases will range from a maximum of 127.1 m^3/s down to 117.8 m^3/s.

Table C.2 Estimated Generation Hours

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Jan																									6
Feb																									6
Mar																									8
Apr																									14
May																									19
Jun																									24
Jul																									24
Aug																									24
Sep																									24
Oct																									20
Nov																									18
Dec																									9

Generation
No Generation
Peak hours

Note: table commences at 1 am (left side) and runs to 1 am (right side).

62. Reservoir operation over the initial 10 years of Project operation, illustrated in **Figure C.1**, will consist of:

- **Monsoon season generation July to September** – the reservoir will be maintained at FSL when around 127 m^3/s generation flow is released for 24 hours per day. Spill flows will occur from the dam when the reservoir is full (at various times, mainly during July-September) when river inflows exceed 129.4 m^3/s (generation flow plus environmental release).

- **Dry season generation December to early June** – the reservoir level will gradually decrease from FSL to MOL as 6-20 hours per day peaking generation occurs, using a release of between 118 m^3/s and 127 m^3/s;

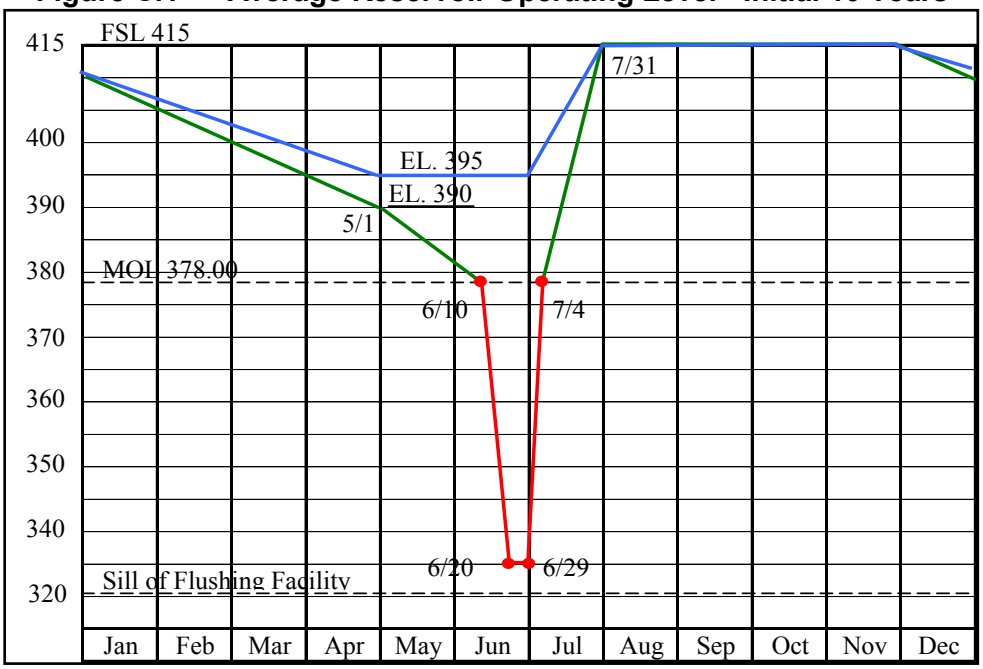
- **Reservoir draining mid-June** – up to 1,000 m^3/s will be released from the reservoir to drain it over a 10 day period from MOL down to empty (at 319.4 masl);

- **Sediment flushing late June** – the entire natural river flow will be allowed to flow unimpeded through the sediment flushing facilities over a 10 day period to promote sediment removal;

- **Reservoir filling early July** – the reservoir will fill over a four-day period, with generation commencing once the reservoir level reaches MOL.

63. The *Hydropower Development Policy* of the Ministry of Water Resources (approved on 15 October 2001) provides for an environmental flow requirement equivalent to 10% of the average monthly flow rate to be released during hydropower generation. To comply with this requirement, an environmental flow of 2.4 m^3/s will be made from the dam throughout the year, except when this is not required during reservoir draining and sediment flushing. An environmental flow is "an allocation of water with a prescribed distribution in space and time, and of a specific quality, that is deliberately left in a river, or released into it, to manage river health and the integrity of ecosystems and communities sustained by river flows." [5] Environmental flow requirements usually cover three major hydrological variables: water quality, minimum flows, and managed flood releases. These requirements are balanced with sound reservoir operating rules.

Figure C.1 Average Reservoir Operating Level - Initial 10 Years

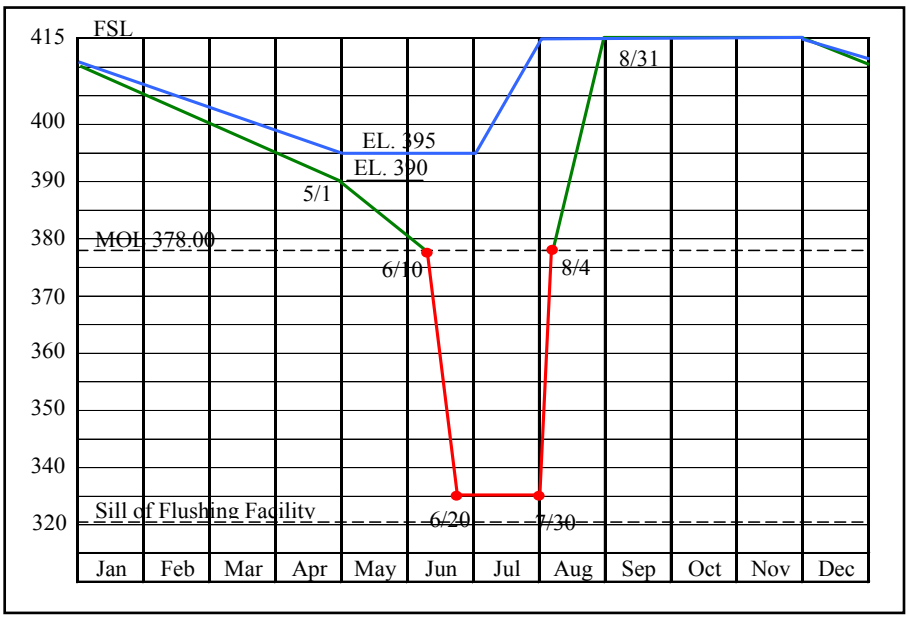


Note: green and red lines indicate reservoir levels under proposed operation that includes reservoir draining. Blue line indicates reservoir levels without draining.

64. Reservoir operation will be slightly different after the initial 10 years of operation, due to an extension of the sediment flushing period to 40 days, as illustrated in **Figure C.2**. This will reduce the post-filling base-load generation period to two months (August and September). This is designed to achieve greater sediment removal, given the estimation that sediments which enter the western end of the reservoir over the first ten years will be distributed along the length of the reservoir down to the dam wall.

Figure C.2 Average Reservoir Operating Level - After 10 Years

[5] Watson, P. 2006. *Manage the river as well as the dam: assessing environmental flow requirements—lessons learned from the Lesotho Highlands Water Project.* World Bank Directions in Development Series. World Bank, Washington, D.C., USA.



65. The impoundment of water in the reservoir (late July to early June) and sediment flushing operations in June/July will affect sedimentation in the reservoir and downstream. Most coarse sediments will drop out of river flows at the apical (inlet) end of the reservoir, whereas fine sediments will drop out of suspension across the reservoir.

66. Sediment deposited at the reservoir inlet will form a fan and alter localized riverbed morphology. The riverbed level immediately upstream of the reservoir is likely to rise, forcing the river to migrate laterally on the deposited fan material. Fan deposits will progressively move downstream with the daily and seasonal fluctuation of the reservoir water level between FSL and MOL. The likely impact, over time, will be lateral undercutting of the toe of adjacent terraces that support agricultural land and settlement areas, when the river course meanders in this direction. To minimize this impact, deposited sediment will be bulldozed annually to re-form a central channel and promote sediment transport further into the reservoir. Sediments may also be bulldozed to the sides to provide some additional toe protection, while sand may be extracted for construction material.

67. Reservoir flushing will erode the sediments deposited at the inlet end of the reservoir, transporting this material further downstream and eventually out of the reservoir. The combined flushing discharge from the dam and the Madi River flow will potentially transport finer sediments and these will be deposited in the downstream section at the confluence of the Seti River and Madi River, which could change the river bed morphological characteristics and aquatic habitat conditions. However, the sediment flushing period will coincide with high monsoon river flows, when the river naturally transports high sediment loads. Therefore, the expected sediment discharge from the reservoir during this period will represent only a small fraction of the sediment transported by the Seti River and Madi River during the monsoon season; thus, the envisaged impacts of downstream sedimentation are considered to be insignificant. To determine the most likely impacts, modeling will be conducted during operation and monitoring of strategic locations downstream.

C.1.2 River flows

68. The EIA (2009) describes the physical characteristics of the river morphology and hydrology of the Seti River basin, river flow changes, and the need for installation of warning signs downstream to alert communities of river water fluctuations. After the EIA was completed, additional hydrological data were used to study the Seti River flows in relation to project operation; details are included in this section.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	• Sect. 4.1.4 River Hydrology and Morphology	• Updated hydrological data from the Seti River and Madi River on average monthly flow (Table C.3 and Table C.4) • Comparison of existing average monthly flow from Seti River and that of during Project operation • River cross section survey at 13 points below the tailrace outlet (See 'Downstream Impact Assessment Report (2012)")
Impacts	•Sect. 5.1.6 Surface Hydrology	• Monthly water level fluctuations after tailrace due to peaking power generation • Water level during operation (including reservoir draining for 10 days) at Seti River based on simulations • Analysis of water level changes due to power generation • Downstream cumulative effects of regulated river discharges
Mitigation	• Sect. 7.1.6 Downstream impacts	• No change, but identified 55 stations for warning signs, from dam site to Trisuli River

69. The existing average monthly flow rate in the Seti River at the tailrace outlet (downstream of the Madi River confluence) ranges between 199 m^3/s and 598 m^3/s during the wet season (June to October) and 43 m^3/ to 95 m^3/s during the dry season (November to May); see **Table C.3**. These natural flows will be altered by the Project primarily by:

- storage of monsoon season flows; and,
- use of the stored water to generate power during the dry season.

Table C.3 Average Monthly Flow Rate at the Seti River and Madi River: Existing and Project Operation

Month	Existing Flow Rate (m^3/s)			Project Operation Flow Rate (m^3/s)					
	Seti River	Madi River	Total	Spill Flow	Generation Release	Environmental Release	Total	While Generating	Not Generating
Jan	26.2	23.0	**49.2**	0	127.1	2.4	**129.5**	152.6	25.4
Feb	22.9	20.1	**43.0**	0	125.4	2.4	**127.8**	147.9	22.5
Mar	22.9	20.5	**43.4**	0	122.6	2.4	**125.0**	145.5	22.9
Apr	26.1	24.0	**50.1**	0	117.8	2.4	**120.2**	144.1	26.4
May	41.6	38.5	**80.1**	0	119.2	2.4	**121.6**	160.1	40.9
Jun	119.5	102.7	**222.2**	123.6	120.0	2.4	**246.0**	348.8	228.8
Jul	290.3	259.9	**550.2**	287.9	0	2.4	**290.3**	550.2	550.2
Aug	319.5	278.6	**598.1**	122.8	119.5	2.4	**244.7**	523.3	403.8

Month	Existing Flow Rate (m^3/s)			Project Operation Flow Rate (m^3/s)					
	Seti River	Madi River	Total	Spill Flow	Generation Release	Environmental Release	Total	While Generating	Not Generating
Sept	227.1	168.4	**395.5**	97.1	127.4	2.4	**226.9**	395.3	267.9
Oct	110.6	88.5	**199.1**	8.6	127.4	2.4	**138.4**	226.9	99.5
Nov	51.9	43.9	**95.8**	0	127.4	2.4	**129.8**	173.7	46.3
Dec	33.5	29.4	**62.9**	0	127.4	2.4	**129.8**	159.1	31.8

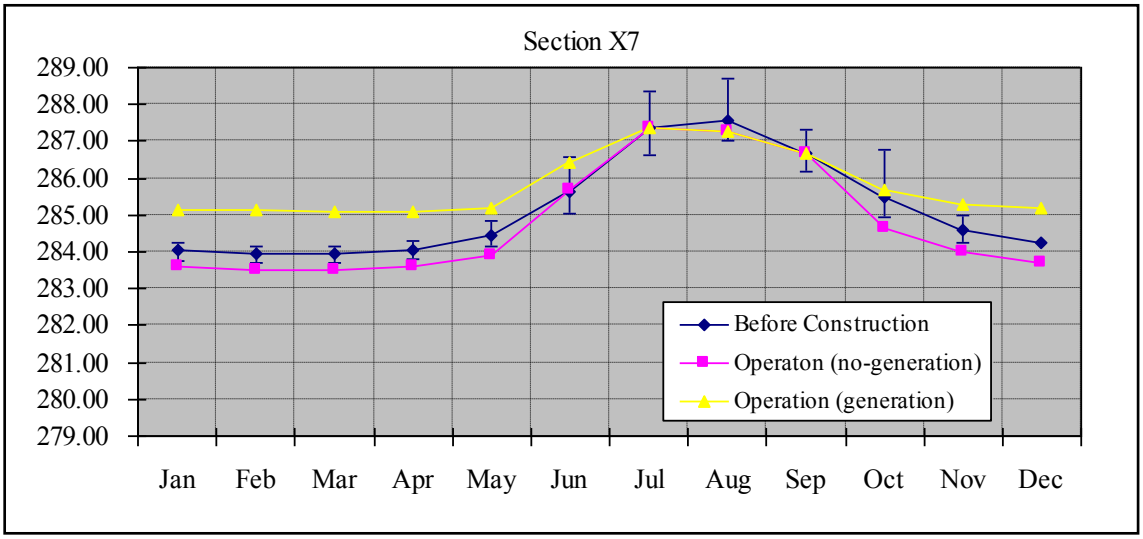
70. The average monthly flow rate in the Seti River immediately below the tailrace outlet will be altered to rates between 228 m^3/s and 550 m^3/s in the wet season (June to September), with minimum non-generation flows of between 23 m^3/s and 100 m^3/s in the dry season (October to May). The maximum river flow changes will occur in February, when a 244% increase will occur during generation and a 51.7% reduction will occur during non-generation (**Table C.4**). River flow changes during the monsoon will be relatively minor, ranging between 0 and 12.5% (reduction) between July and September.

Table C.4 Average Monthly Seti River Flow Rate Change: Existing and Project Operation

Month	Existing Flow (m^3/s)	Generation Flow		Non-Generation Flow	
		m^3/s	% of Existing Flow	m^3/s	% of Existing Flow
January	49.2	152.6	**310.2**	25.4	**51.6**
February	43.0	147.9	**344.0**	22.5	**52.3**
March	43.4	145.5	**335.3**	22.9	**52.8**
April	50.1	144.1	**287.6**	26.4	**52.7**
May	80.1	160.1	**199.9**	40.9	**51.1**
June	222.2	348.8	**157.0**	228.8	**103.0**
July	550.2	550.2	**100.0**	550.2	**100.0**
August	598.1	523.3	**87.5**	403.8	**67.5**
September	395.5	395.3	**99.9**	267.9	**67.7**
October	199.1	226.9	**114.0**	99.5	**50.0**
November	95.8	173.7	**181.3**	46.3	**48.3**
December	62.9	159.1	**252.9**	31.8	**50.6**

71. The main flow change will be a daily variation in Seti River flows below the tailrace outlet, created by peaking power generation for between 6 and 20 hours per day between October and May. The maximum number of hours of generation per day in October, November and May will be between 18 and 20 hours, with the non-generation period commencing late at night; therefore, the potential impact on river activities and general community safety will be low. The river water level below the tailrace outlet will rise by a maximum of 1.66 m during peak generation (in February) above existing natural levels, based on flow modeling of the existing river channel (**Figure C.3** and **Appendix 2**).

Figure C.3 Water Level Fluctuations Within 1 km Downstream of the Tailrace Outlet



72. Another flow rate change in the Seti River will occur over 10 days in June, when up to 1,000 m^3/s will be released from the dam to drain the reservoir at or immediately prior to the start of the monsoon season. This release could increase the natural water level in the Seti River by a maximum of 4.3 m.

73. **Cumulative Downstream River Discharge Effects:** Storage and release of water from the Tanahu reservoir will create an added variation to the current hydrological regime in the downstream areas of the Seti River, the Seti River (before the confluence with the Trisuli River), and then in the collective downstream reaches of the Trisuli River. Beyond every subsequent confluence downstream from the reservoir, the measurable effect of discharge and water level variations, due solely to the operation of the Tanahu dam/reservoir, will diminish, as other conjoining rivers continue to influence downstream areas in the Nepal river system. This creates a "diluting" effect the further away one gets from the dam. This has been modeled, to clarify these downstream impacts and their possible effects down to the Trisuli River. The catchment of the Trisuli River is considerably larger than those of the Seti and Madi combined, and therefore exerts the most influence in downstream reaches. For example, the Seti catchment makes up only 7.9% of the total catchment of the Seti-Madi-Trisuli combined, whereas the Trisuli River makes up 85% of this combined catchment (see **Table C.5**). This relationship (respective catchment areas) in turn determines the extent to which changes in Seti River flows (due to the operation of the dam) can influence overall river discharges and water levels in downstream areas. This is described below.

Table C.5 Collective Catchment areas downstream from the Tanahu dam

River	Area of Catchment (km^2)	% of Combined Seti-Madi-Trisuli Catchment
Seti (before confluence with Madi)	1,502	7.9
Madi (before confluence with Seti)	1,102	5.8
Seti-Madi River combined	2,604	13.7
Seti River to confluence with Trisuli*	2,843	15.0
Trisuli River before confluence with Seti*	16,134	85.0
Seti-Madi-Trisuli catchment (combined *)	18,977	100

74. The modeling indicates that the greatest variation in the discharge in the downstream areas (of the Trisuli), due to the dam operation, would occur during generation periods in January to April (dry season), with discharge rates up to 131% of those currently experienced in this period. Even then, the maximum discharge rates (in January) due to dam operation would only be 9% of the maximum discharge rate currently experienced during monsoon period (in August) in the Gandaki river system. In other words, the discharge increases that might be experienced in January-April (due to the Tanahu dam) are well within the discharge variations currently experienced on an annual basis within the lower reaches of the river system, and therefore should not be a concern. The river morphology currently handles discharge variations that are ten times larger than those which will be due to the operation of the Tanahu dam. More important, the actual water level variation in the lower reaches of the river system, that might be expected due to the operation of the Tanahu dam, would be in the range of 20-30 cm (only in November-April). This small water level variation is due to the increasingly larger cross-sections of the lower reaches of the river, compared to upstream areas, which allows absorption of river discharge increases with minimal water level increases. In fact, the dam operation will have a smoothing, or buffering, effect on river level variations, with provision of some flood control in the monsoon, and virtually no reduction in river discharge rates in the lower reaches of the river at any time of the year.

C.1.3 Reservoir and Downstream Water Quality

75. Four water quality sampling stations were identified in the EIA (2009). These sampling stations are: the reservoir and the dam site area, powerhouse site, at the end of the dam in Bhimad Bazaar, and the Madi River. Additional water quality measurements were conducted in April, July, September and December 2011, at nine sampling stations along the Seti River, to supplement the water quality data from the EIA (see **Figure C.4**).

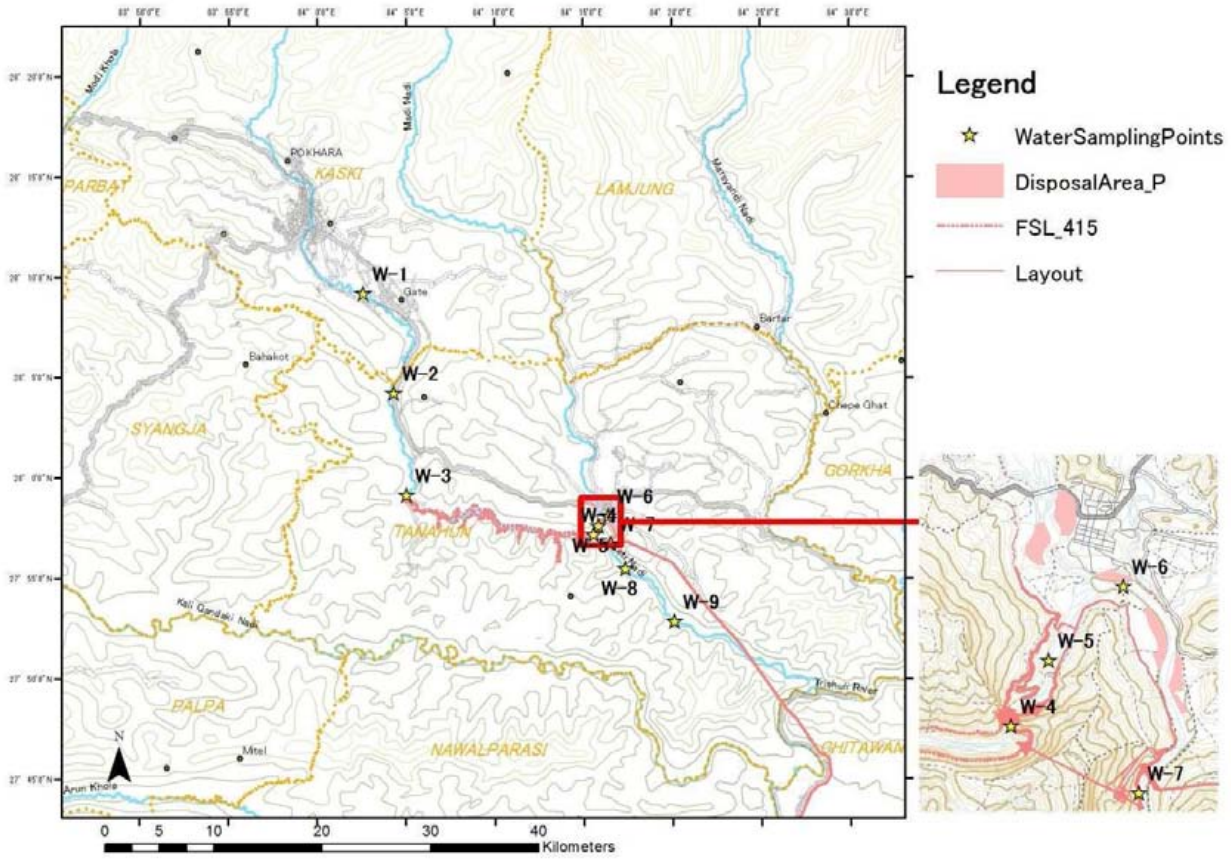
Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	• Sect. 4.1.7 Water Quality	• Includes a section on 'Reservoir and Downstream Water Quality' • Nine water sampling stations were identified at Seti River in 2011 • Water quality measurements in 2011 (April, July, September, December) of 14 parameters (i.e., temperature, pH, conductivity, total suspended solids, total phosphorus, total Kjeldahl nitrogen, ammoniacal nitrogen, nitrate nitrogen, nitrite nitrogen, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, sulfate, and fecal coliform)
Impacts	•Sect. 5.1.8 Water Quality	• No change for construction and operation *Additional information* • Suspended sediment concentration of water discharged during annual sediment flushing predicted by mathematical modeling • Quality of water released when reservoir is drained (10 days)
Mitigation	• Sect. 7.1.8 Water Quality	• No change during construction phase and operation phase *Additional measures* • Adaptive management plan during the start of reservoir flushing (i.e., implementation of flushing be raised gradually to minimize environmental impacts) • Monthly monitoring of water quality of water released from the power house and dam during the first 5 years of operation

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
		• Will consider installation of mixing apparatus at the intake, if significant change in water quality is identified • Examination of technical feasibility of a boulder field just below the dam to increase aeration of reservoir water during June release, and maintain sediments in suspension. • Pre-filling reservoir management to minimize downstream water quality impacts (see Watershed/Forest Management Plan)

Water Quality Sampling in 2011

76. Water quality in the Project reservoir will be affected by the quality of the river inflow and reservoir operation. Based on additional water quality measurements in the Seti River in 2011, it is clear that its water quality is seasonally variable, ranging from highly turbid during the monsoon season, and relatively clear during the remainder of the year, apart from stormwater runoff that is usually turbid. Water temperature ranges from 15^{o}C in winter to a high of around 24^{o}C-27^{o}C in the hot late dry season in May. The water is slightly alkaline (pH up to 9), while values of biological oxygen demand (ranging from less than 1 mg/l to 35 mg/l) and chemical oxygen demand (from 1 mg/l to 28 mg/l) reflect relatively clean water that is not overloaded with organic and chemical pollutants. Dissolved oxygen values at all the nine stations during April, July, September and December were above the 5 mg/l level required to sustain aquatic life in the Seti River. The sulfate level is highest (at 224 mg/l) in April at the sampling station east of Bhimad Bazaar, while total phosphorus is highest at 2.53 mg/l in September, downstream of the confluence of the Seti and Madi Rivers. Total nitrogen ranges from less than 1 mg/l to 24 mg/l. Total nitrogen value was highest in July at the sampling station upstream of dam. The Seti River is positive for fecal coliform at all the nine sampling stations and in all four sampling periods, indicating animal and human fecal contamination. Total suspended solids (TSS) range from as low as 4 mg/l in December to as high as 13,200 mg/l in July (reflecting large discharges during the monsoon). The highest TSS was recorded at the NEA hydrological station, south of Betini Byas 7. Aside from settlements, some activities noted during the water quality surveys in 2011 include agriculture and animal grazing, occasional excavation of boulders and pebbles, and aggregate mining and crushing.

Figure C.4 Water Quality Sampling Stations, 2011



Downstream water quality during annual sediment flushing

77. The suspended sediment (SS) concentration of water discharged during annual reservoir sediment flushing has been predicted using a mathematical simulation model, as described below.

i. Simulation case and condition

Simulation Case:

(1) Case for Basic Pattern
(2) Case for Alternative Pattern

*Simulation Period: 135 years (from 1964 to 2008, 45 years * 3 cycles)*
Inflow Concentration

The concentration of the inflowing SS load is calculated by using two formulas;

$$C = 0.0369 \cdot Q^{2.0686} \quad (Q < 200 m^3/s)$$
$$C = 5.939 \cdot Q^{0.8607} \quad (Q \geq 200 m^3/s)$$

Formula (1-1)

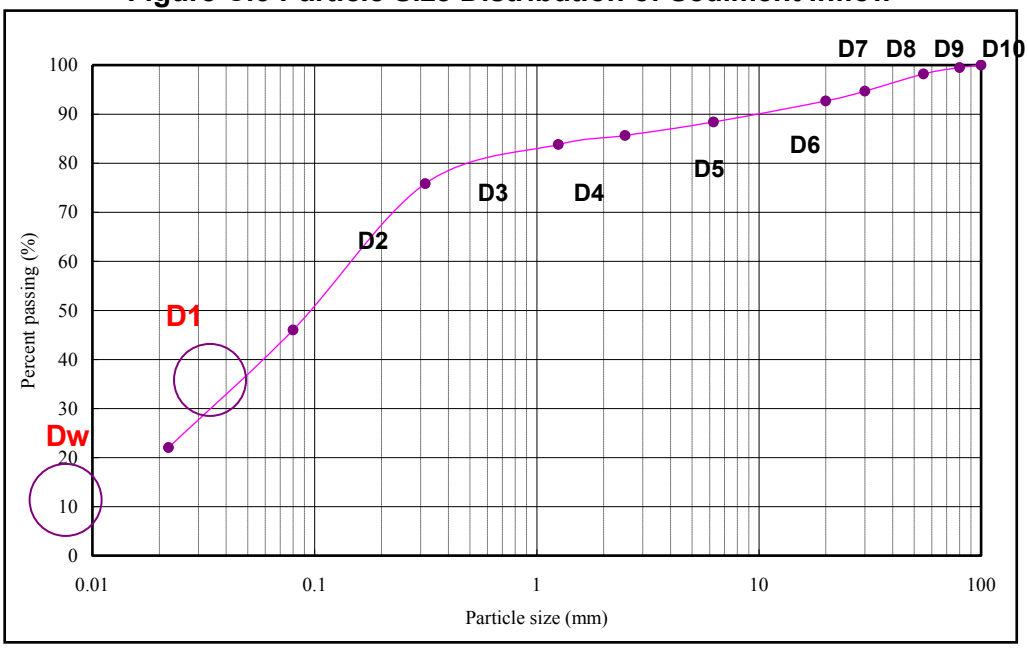
C : SS (mg/l)
Q : River flow (m^3/s)

78. **Formula (1-1)** is set up with regression analysis on observed SS load data so that the bed-load component with a larger particle size is not included. Therefore, 1.2 times the amount calculated by formula (1-1) is applied to the simulation as total inflowing sediment.

Particle size distribution

79. The particle size distribution applied for the simulation is shown in **Figure C.5**. In the simulation, particles having size Dw, and from D1 to D10 (11 sizes), are inputs into the model as representative particle sizes. In this regard, Dw and D1 are subject to forecasted suspended solid concentration, because particle sizes under 0.074 mm are categorized as "clay and silt" from an engineering viewpoint. Therefore, outflow sediments having other particle sizes, from D2 to D10 are not considered in the forecasted SS concentration.

Figure C.5 Particle Size Distribution of Sediment Inflow



ii. Simulation results

80. **Figures C.6** and **C.7** show forecasted monthly average SS concentrations discharged downstream of the dam in June and July, respectively. In these figures, "Original" indicates the SS concentration inflowing into the reservoir, calculated by formula (1-1). "FLUSH Basic" and "FLUSH Alt" refer to the discharged SS concentration by the "Basic Flushing Operation."

81. According to **Figures C.6** and **C.7**, the discharged SS concentration will be tens of times greater than the inflowing concentration in June; however, the discharged SS concentration in July will be almost the same as the inflow concentration (due to the monsoon effect). The fine sediment component deposited in the reservoir between August and May the following year,

when no flushing operation is scheduled, will be ejected at the earlier stage of flushing and will be balanced to the inflowing SS concentration during the later period of flushing.

82. **Figure C.6** indicates that there are no significant differences between the discharged SS concentration of the Basic flushing pattern (Figure C.2) and Alternative B (Figure C.1) flushing pattern, with both likely to decrease gradually over time.

Figure C.6 Forecast Monthly Average SS Concentration by Flushing – June

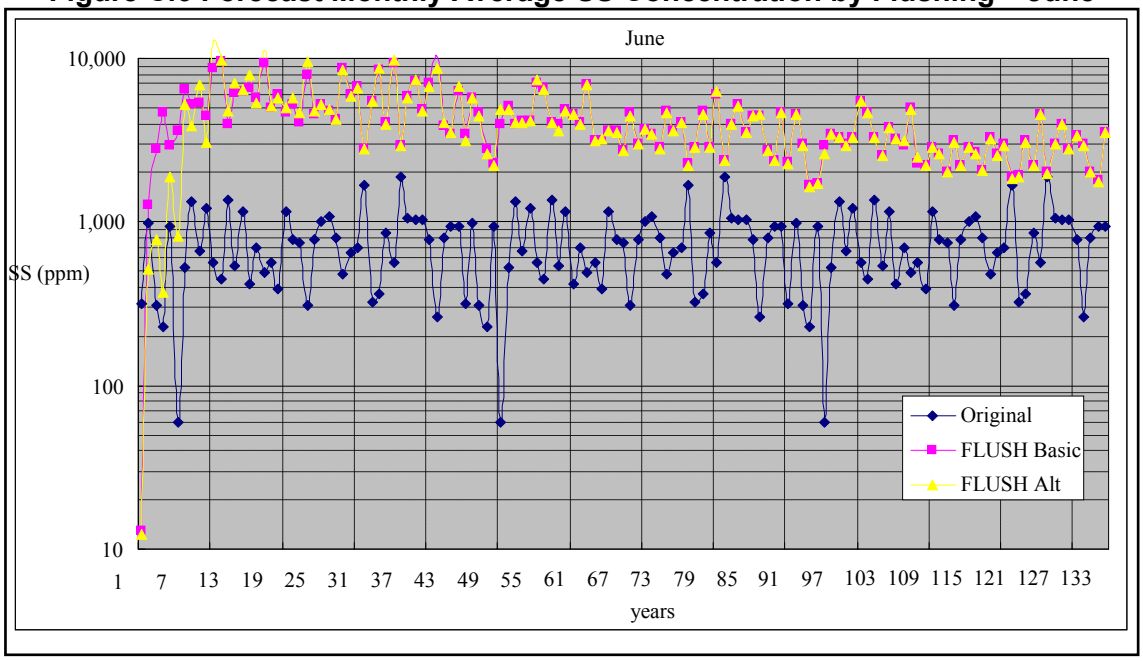
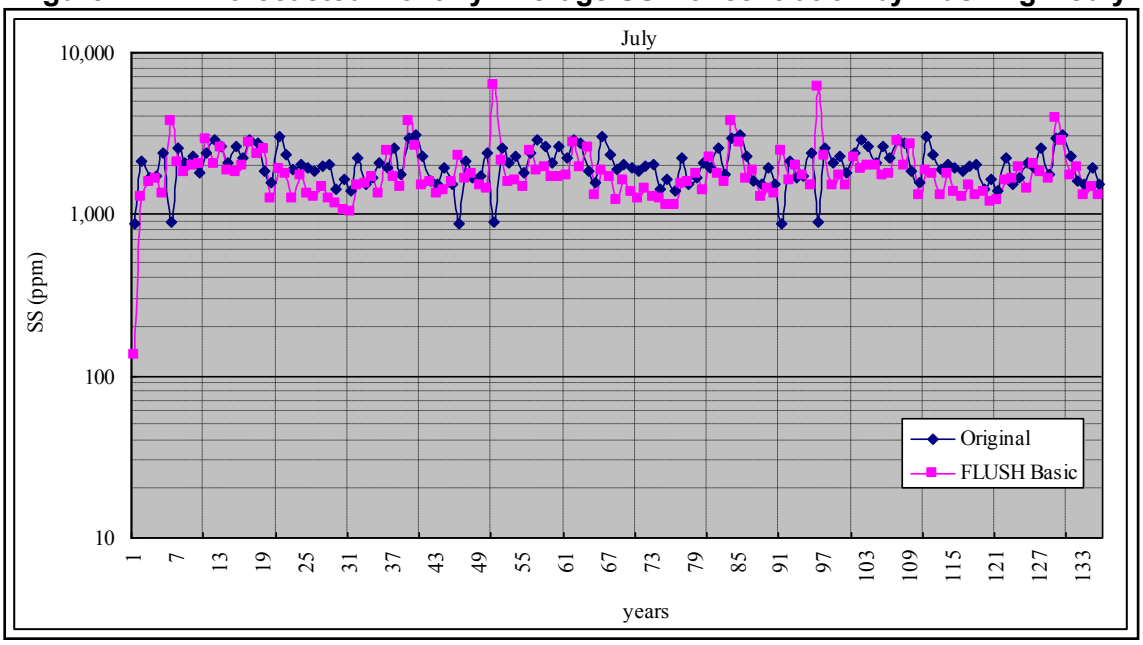


Figure C.7 Forecasted Monthly Average SS Concentration by Flushing – July



84. **Figure C.8** shows the forecasted SS concentration by the flushing operation over the initial 10 years of reservoir operation. Comparing "FLUSH Basic" and "FLUSH Alt", it shows that the SS concentration with the basic flushing operation pattern will be greater than that of the inflow from the third year onwards. On the other hand, the SS concentration with Alternative 3 would not be greater than the inflow in the initial five years; however, it would become progressively greater and finally become almost the same concentration as that indicated with the basic flushing pattern in 10 years. This calculation indicates that the discharged SS concentration can be mitigated over the initial few years with a shorter flushing operation period.

Figure C.8 Forecasted SS Concentration by Flushing - June (monthly average over the initial 10 years)

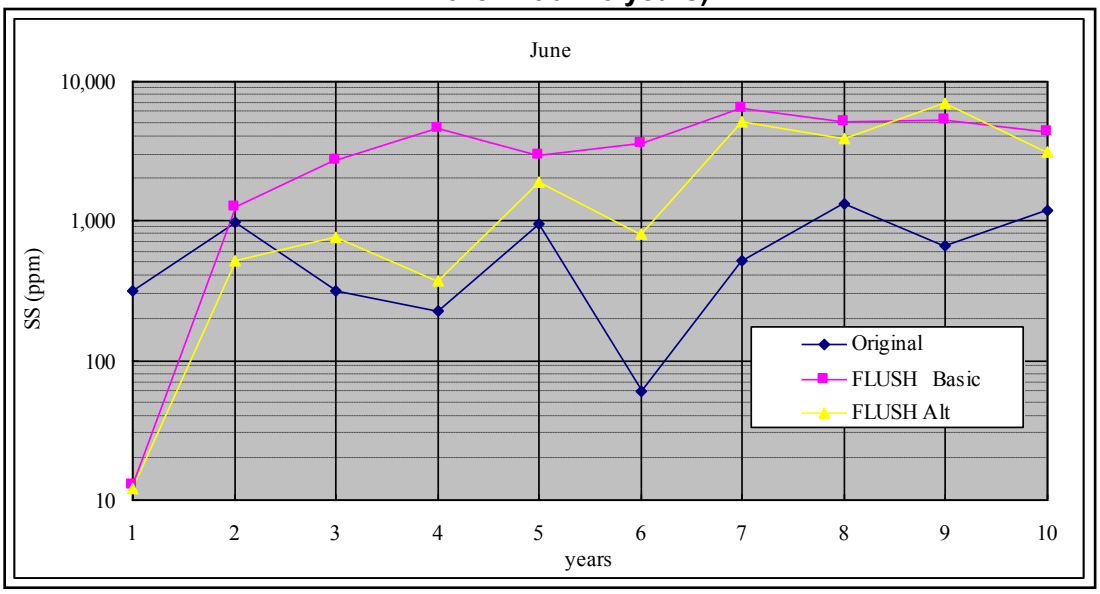
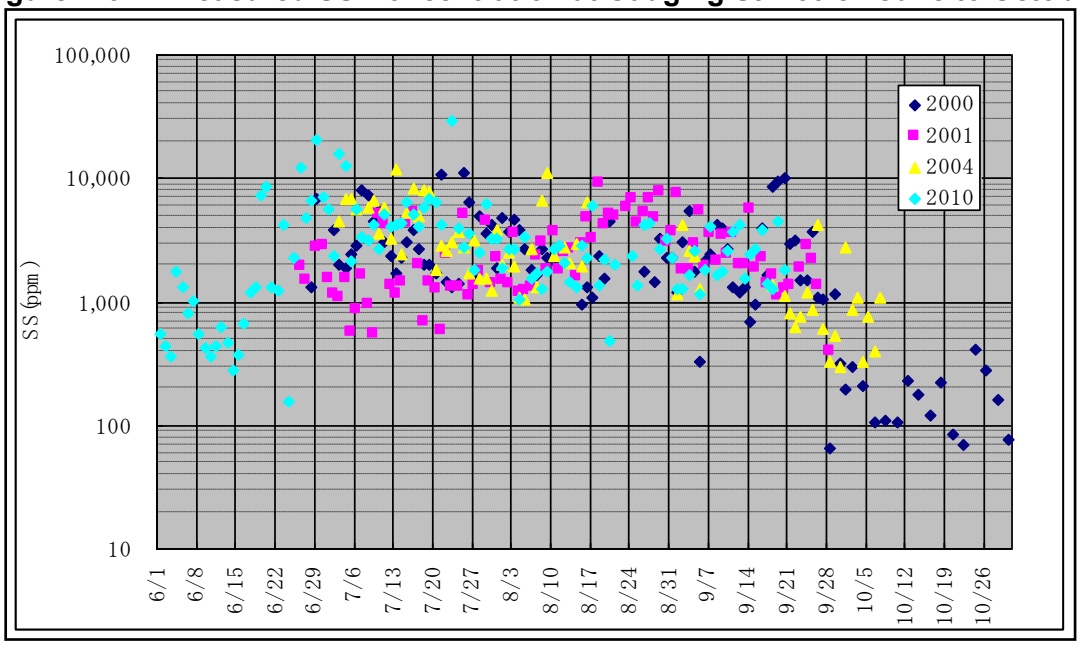


Figure C.9 Measured SS Concentration at Gauging St. 430.5 - June to October



85. The SS concentration measured at Gauging Station 430.5 is shown in **Figure C.9**. The actual SS concentration in the monsoon season, from mid-June to the end of September, ranges from 1,000 to 10,000 mg/l, which is not so different from the forecasted SS concentration during the initial stage of the flushing operation.

Downstream water quality impacts and mitigation measures

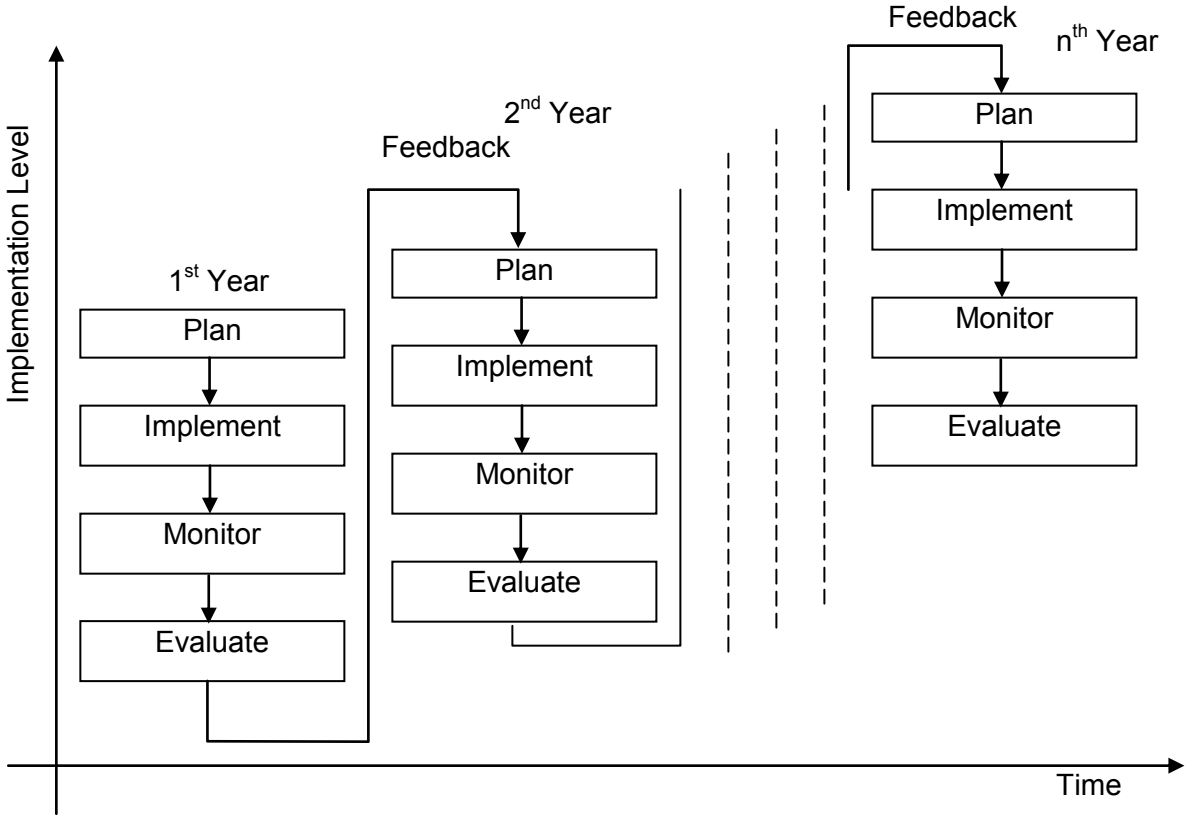
86. Simulation results of reservoir flushing suggest the following for SS concentrations downstream:

- The discharged SS concentration will be higher than the inflowing SS concentration at the earlier stage of flushing. It is likely that the fine components of sediments deposited when there is no flushing (from August to May in the previous year), will be ejected intensively during the early phase of flushing.
- In the later stage of flushing, the discharged SS concentration will be almost the same as the inflowing concentration, which could indicate that the inflowing fine components will pass directly through the reservoir. Therefore, during the later stage of flushing, the SS concentration will be similar to the natural concentrations prior to dam construction.
- Over the initial few years of dam operation, the discharged SS concentration can be controlled (mitigated) by flushing for a shorter period. Note, however, that higher suspended sediment concentrations during flushing will join the higher suspended sediment loads in the other river systems, which reflect soil erosion and turbidity associated with the monsoon.

87. Aside from the SS concentration, other altered parameters of the discharge water, such as temperature and dissolved oxygen level, have the potential to affect the fish population downstream of the river section, although this will occur at a time when the rivers are in flux with high discharge rates due to the monsoon, and water quality parameters tend to reflect much higher river discharges anyhow. As a result, it is very difficult to forecast impacts precisely, incorporating the various factors mentioned, due to the limitation of forecasting tools. Therefore, there are a number of uncertainties (note that it is also difficult to accurately predict *natural* water quality parameters during each monsoon, as these vary from year-to-year, and the monsoon is a period of extreme variations, in any case). In addition, the “armor coat phenomenon”, that is, when the riverbed is covered by large-sized stones and/or a rock surface, as often occurs in the downstream river when the sand/gravel supply is terminated due to dam construction, can be improved by reservoir flushing, providing better conditions for fish spawning, etc., as smaller particle sizes can then be re-introduced to the downstream reaches, increasing the range of particle size distribution, which in turn is likely to increase the spawning habitat options for various fish species.

88. Given the uncertainty, it is proposed that, at the commencement stage of reservoir flushing, adaptive management will be implemented. **Figure C.10** shows the concept of adaptive management, with cycles composed of "plan", "implement", "monitor", and "evaluate" applied over the initial years of project operation, with each year’s findings fed back into the management cycle the following year. Thus, it is recommended that the implementation of flushing be adjusted gradually to establish an effective operation pattern that minimizes the adverse impact on the downstream river ecosystem as much as possible. **Table C.6** provides examples of adaptive management activities for each step in the cycle.

Figure C.10 Adaptive Management Approach



89. The use of adaptive management has been encouraged as a paradigm for ecological restoration situations and has been increasingly put forward in the context of rivers.[6]

Table C.6 Examples of Adaptive Management Activities

Step	Activities
Plan	Establishing: 1) Flushing operation plan, including forecasting performance of sediment ejection by the mathematical model. 2) Auxiliary measures planning, such as partial mechanical sediment removal. 3) Monitoring plan. 4) Facilities maintenance plan; etc.
Implement	Annual flushing operation as per the plan.
Monitor	1) Data collection on environmental impacts: physical - particle size distribution of riverbed, SS concentration, water temperature, dissolved oxygen, etc; and biological - fish, benthic organism, aquatic plant, etc; in the reservoir and downstream river. 2) Sedimentation survey (at fixed cross-sections) in the reservoir. 3) Degradation (abrasion) of facilities.

[6]Acreman, Mike and Michael J Dunbar. 2004. "Defining environmental river flow requirements - a review". *Hydrology and Earth Systems Sciences*. 8(5), 861-876.

Step	Activities
Evaluate	Evaluating: 1) Performance of sediment ejection from the reservoir compared to the forecasted rate, and review of the mathematical model. 2) Determination of positive and negative environmental impacts caused by flushing operation. 3) Soundness of facilities after flushing operation. 4) Backwater risk, based on the sedimentation survey data; etc.
Feedback/Adjust	The flushing operation plan for the flowing year is based on the results of the evaluation.

90. One water quality issue that was not directly described in the EIA (2009) was the possible quality of water released when the reservoir is drained. Draining of the entire reservoir over 10 days will release water that is possibly cooler and may have lower dissolved oxygen levels than the natural Seti River flows in mid-June (generally between 20°C-24°C), and may contain higher levels of phosphorus, etc.

91. As previously predicted in the EIA, weak thermal stratification may occur in the reservoir, although its intensity may be weak, due to the expected short retention time of water in the reservoir. This phenomenon will be limited by: (i) annual reservoir draining for 10 days; and, (ii) the large total annual run-off from Seti River into the reservoir (3,382 MCM compared with the gross reservoir capacity of 295 MCM). As the reservoir water level will be at MOL (378 masl) at the start of reservoir draining, the initial draining release from the middle outlet (with a top invert height of 341.8 masl) will be at the depth of 37 m and, hence, will likely be cooler than the temperature in the natural flows or in the recent generation releases. The inflows from the Madi River at the confluence of Seti River ranging from 20.1 m^3/s in February up to 278.6 m^3/s in August will contribute to mixing and turbulence (aeration), thus minimizing any significant changes in water quality (see **Table C.2**). The most significant changes would therefore likely only occur in the few kilometers just below the dam, before the confluence with the Madi River.

92. In any case, the temperature difference will be monitored to see if thermal shock to aquatic organisms is a possibility. Water quality will be monitored at the same sampling stations for aquatic ecology (fish survey) monitoring identified as: (i) upstream of the reservoir, (ii) in the reservoir, (iii) in the dewatered reach of the Seti River from the dam to the powerhouse, (iv) downstream from the tailrace prior to the confluence with Madi River, and (v) downstream of the confluence of the Seti River and Madi River. Aside from these stations, three more stations downstream of the powerhouse-tailrace will be established in conjunction with gauging stations, or water level stations, to relate water quality results with the changes in the river flow and/or water level, with temperature, dissolved oxygen, total suspended solids and conductivity being the critical parameters to be monitored. In the event that water quality in the reservoir and downstream of the tailrace does not meet the environmental standards of the GoN, mitigation measures, such as installing an aeration device in the reservoir, changes in dam operating rules, and installation of aeration weirs in the tailrace (or a boulder field immediately below the dam) for the June reservoir flushing, will be considered and implemented, as appropriate.

93. Other factors are also defining water quality in the Project area. Development within the Pokhara and Lekha Nath Municipalities of Kaski District is rapid. Based on further urban development and an increased use of agricultural fertilizer in the watershed over time, the phosphorus loading in the Seti River is expected to increase. The highest phosphorus level in the Seti River, recorded during the additional water sampling in 2011, was 2.53 mg/l in

September, east of Dhobla, in the Brimdi Pul downstream, and at Pokhari Bhanjyang - 9. The reservoir could possibly become eutrophic, based on the current phosphorus levels in the Seti River flows (Sect. 5.1.8 Water Quality, Operation Phase), but annual flushing will ensure that nutrients accumulated in the reservoir over the year are purged downstream (a fraction fence may also be considered, to push incoming nutrients below the photic zone in the reservoir). The concentration of suspended sediments in the reservoir will also be controlled by annual draining of the reservoir and sediment flushing.

94. Diligent clearing of vegetative material in the area to be flooded by the reservoir will significantly reduce the future risk of decomposition of organic matter, and subsequent degradation of water quality in the deeper parts of the reservoir (including risk of anoxic surficial sediments and a low-oxygen deep-water layer in the reservoir, methane and carbon dioxide production, and hydrogen sulphide generation). This pre-filling management of the reservoir area will therefore reduce possible future impacts of poor water quality on the turbines and on downstream reaches of the Seti River, as well as reducing emissions of significant GHGs. The vegetation clearing will follow the protocol set for tree identification and cutting (which will occur over three years; see the Watershed/Forest Management Plan), and then will involve cutting (with smaller equipment), collection, drying, removal, and burial/mulching offsite (or burning, if the former is not practical) of brush, smaller branches, leaves, and organic litter that will be raked from the cleared land. This process should be completed about three-six months before filling of the reservoir, to prevent significant re-growth of vegetation in the area to be flooded, and the whole cleared area will be inspected prior to flooding, to ensure that comprehensive vegetation clearing has occurred.

95. Mapping of areas or zones downstream of the tailrace that may be susceptible to erosion will be undertaken using a hand-held global positioning system (GPS) unit before dam operation. These mapped areas will then be examined in conjunction with monitoring of aquatic ecology (see **Section. C.4**). During power generation, any impact of river water releases on areas identified as vulnerable during the mapping (if any), will be rehabilitated as appropriate, while potential sedimentation downstream of the tailrace will be monitored to determine if there is any deposition that could restrict the river flow (i.e., combined Madi River and Seti River). If needed, THL will use available computer models such as HEC-6 (Scour and Deposition in Rivers and Reservoirs) developed by the U.S. Army Corps of Engineers to determine if the designed dam operating rules will cause any significant impacts.[7]

C.2 River safety

96. Additional engineering study was undertaken following EIA 2009 to specifically determine water levels and its implications in the Seti River during dam operation. This is described below.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	•No discussion	• No discussion
Impacts	•Sect. 5.1.6 Surface Hydrology	• Identified water levels in the Seti River during generation flows and reservoir draining
Mitigation	• Sect. 7.3.4 Safety and Occupational Health	• No change, but identified 55 locations where warning signs will be installed from the dam site to the Trisuli River • Additional 14 sirens will be installed in

[7] Hydrologic Engineering Center. U.S. Corps of Engineers. http://www.hec.usace.army.mil/software/legacysoftware/hec6/hec6.htm. (Accessed on 7 November 2012)

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
		villages downstream • Organize community consultations with settlements to disseminate information on the impacts to downstream river users • Conduct detailed survey and continuous consultation of downstream communities prior to operation of the Project

97. Generation releases (up to 127.4 m^3/s), periodic dam spill overflows during the monsoon season, and draining of the reservoir in mid-June (releasing up to 1,000 m^3/s) could create a hazard for downstream river users due to potential rapid and unexpected rises in river water levels. The safety of people using the Seti River downstream of the dam site will therefore be protected by a combination of a warning system and public education.

98. Generation flows will be released at a rate that ensures that the downstream increase in river water level is no greater than 0.7-1.6 m over 30 minutes. The release of water to drain the reservoir will be restricted to a maximum flow water level increase rate of 0.3 m per 30 minutes. The regulation pond was considered but not found to be feasible because of these reasons:

(i) Regulation pond will be easily filled up with sedimentation flashed from the flashing gate. Then it will not work soon.
(ii) The regulation pond will block the migration fish not only to Seti river but also Madi river.
(iii) Regulation pond will increase the risk of flood of Damauri.

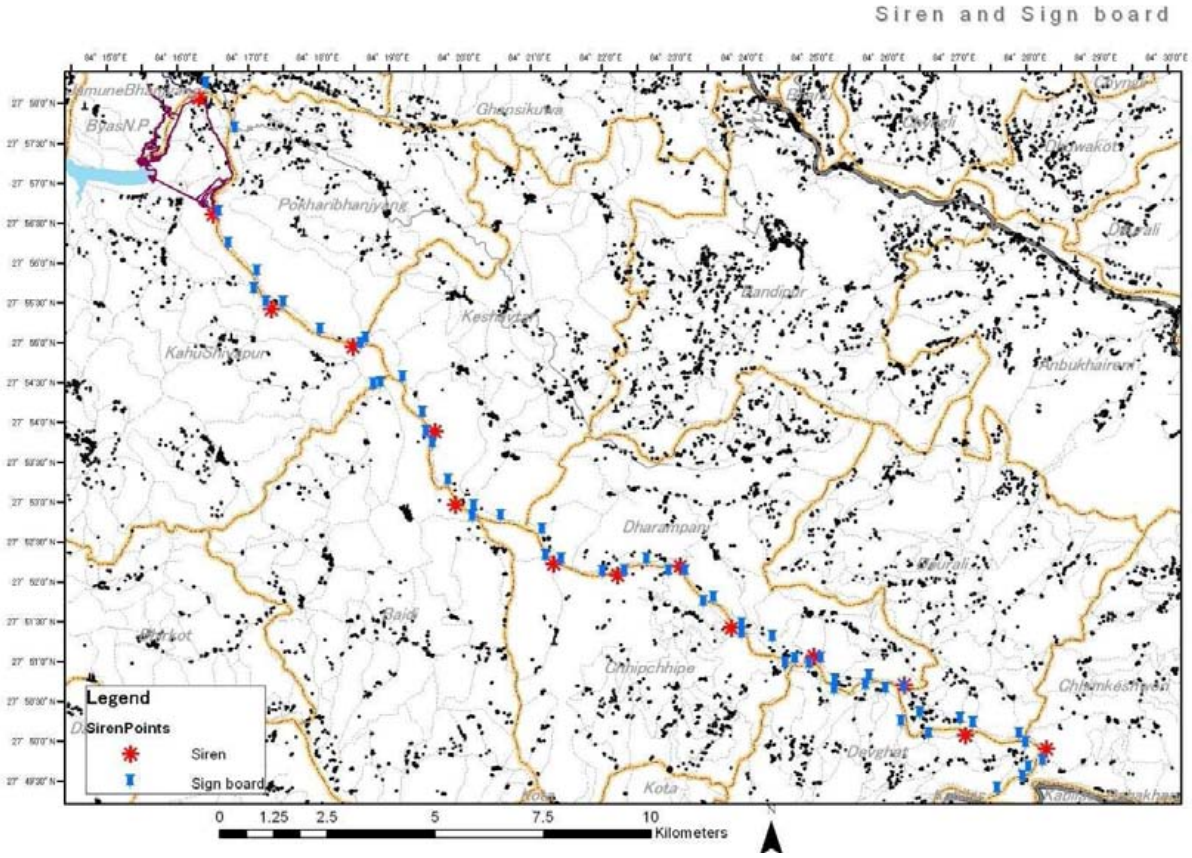
99. Signs will be installed at 55 locations between the dam site and the Trisuli River, to indicate a warning of potential sudden changes in river flows (**Figure C.11**). In addition, a system of sirens will be installed in each of the 14 villages that may be affected by the river fluctuations. Each siren will have mains power supply, as well as a battery and inverter in a secure fenced area. Sirens will be sounded 30 minutes, 15 minutes and 5 minutes prior to the release of water from the dam and tailrace outlet. The sounding of sirens will be restricted to the daily hours of 6 am to 10 pm for generation flows, to avoid disrupting people at night, but flood flows will be sounded at any time of the day, given the potentially far greater and more sudden increase in downstream river flows and the related increased safety hazard of these events. Given that the timing of spill flows over the spillway is unknown, sirens will be sounded immediately prior to the spill or once it commences. Light posts will also be installed in the siren locations to indicate a risk of water releases, in case people are still adjacent to the river at night, after the siren time period has passed.

100. During construction, the Seti River will be temporarily diverted around the dam site via an upstream coffer dam and two 6.6 m diameter diversion tunnels, with a total capacity of 996.6 m^3/s. In the unlikely event that the coffer dam breaches due to high flood flows, prior to the base of the dam wall being constructed (Year 1), a warning of a possible flood between the dam and tailrace outlet will be broadcast on local radio, when the hazard is identified, and project staff will notify nearby villages of this hazard. A similar broadcast will also be made during project operation each time a release is likely.

101. From the dam to the Seti-Trishuli confluence, there are 10 VDCs that has settlements along the river side valley of Seti. Based on the additional river cross section measurement and

planned discharge water, any potential risks (e.g., bathing, fishing, washing) to settlements during peak generation and flushing operation period are assessed and mitigation measures are planned including siren, and awareness programs at community level and through local community FM radio. THP plans to organize community consultation sessions at the settlement level to disseminate the information on the likely nature of impact as well as the mitigation measures to seek additional information from the river side communities to strengthen the mitigation options before construction starts. In addition to this, a detailed survey and continuous consultation of the downstream communities is planned before the operation of the project.

Figure C.11 Location of River Warning Signs and Sirens



C.3 Groundwater

102. The discussion on groundwater sources and potential Project impacts to these water sources is included in the EIA (2009), in the section on water supply and sanitation, and in the socioeconomic impacts during construction. Following the EIA, an additional groundwater survey was done (in 2011), the results of which, and the potential related project impacts, are discussed below.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	•Sect. 4.3.4 Water Supply and Sanitation (Table 4.23) • Sect. 4.4.1 Affected VDCs/Municipality (Table 4.43)	• Groundwater survey conducted from 27 May-19 July 2011 from the dam site to the powerhouse • Identified 35 sources of groundwater

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
	•Sect. 4.4.2 Project Affected Persons/Households (Table 4.59) •Sect. 4.4.3 Community Resources and Properties (Table 4.82 and Table 4.83) •Sect. 4.4.3.2 Water Resources Use	for drinking, household use, cattle feeding, and agricultural purposes
Impacts	•Sect. 5.1.10 Changes in Water Table •Sect. 5.3.7(VI) Socioeconomic and Cultural Impact during the Construction Phase (Table 5.25 and Table 5.27)	• Lowering of water table due to associated project tunneling • Four springs used for domestic purposes located above the headrace and tailrace may be dried up
Mitigation	• Sect. 7.3.1 Acquisition of Land and Property •Sect. 7.1.10	• Monitoring of flow rate of the four springs every quarter per year before tunneling and three years after tunneling • Provision of pipeline water supply, in case the springs dry up

C.3.1 Existing Groundwater Sources

103. Based on the groundwater survey in 2011, a total of 35 groundwater sources have been identified. These groundwater sources are used by settlements for drinking, various household uses, cattle feeding, irrigation, and other agricultural purposes. Of these 35 groundwater sources, 19 consist of springs or spring-fed watercourses that could be affected by project construction sites and the reservoir area. An additional four springs on the hillside above the tailrace tunnel may be indirectly affected by headrace and related tunneling.

C.3.2 Impacts of Tunneling

104. The water table above the headrace tunnel, tailrace tunnel and other associated tunnels may fall due to Project-induced changes in subsurface rock conditions, but the likelihood of this occurring is difficult to predict. Four existing springs used for domestic water supply (for an estimated 236 households) are located above the headrace and tailrace as noted in **Table C.7** and shown in **Figure C.12**. One of these four springs is close to the alignment of the tailrace tunnel, while the other three springs are offset at least 250 m from the headrace tunnel alignment. These springs consist of small masonry (concrete and rock) collection ponds. Water is extracted from the ponds by dipping a container into the pool.

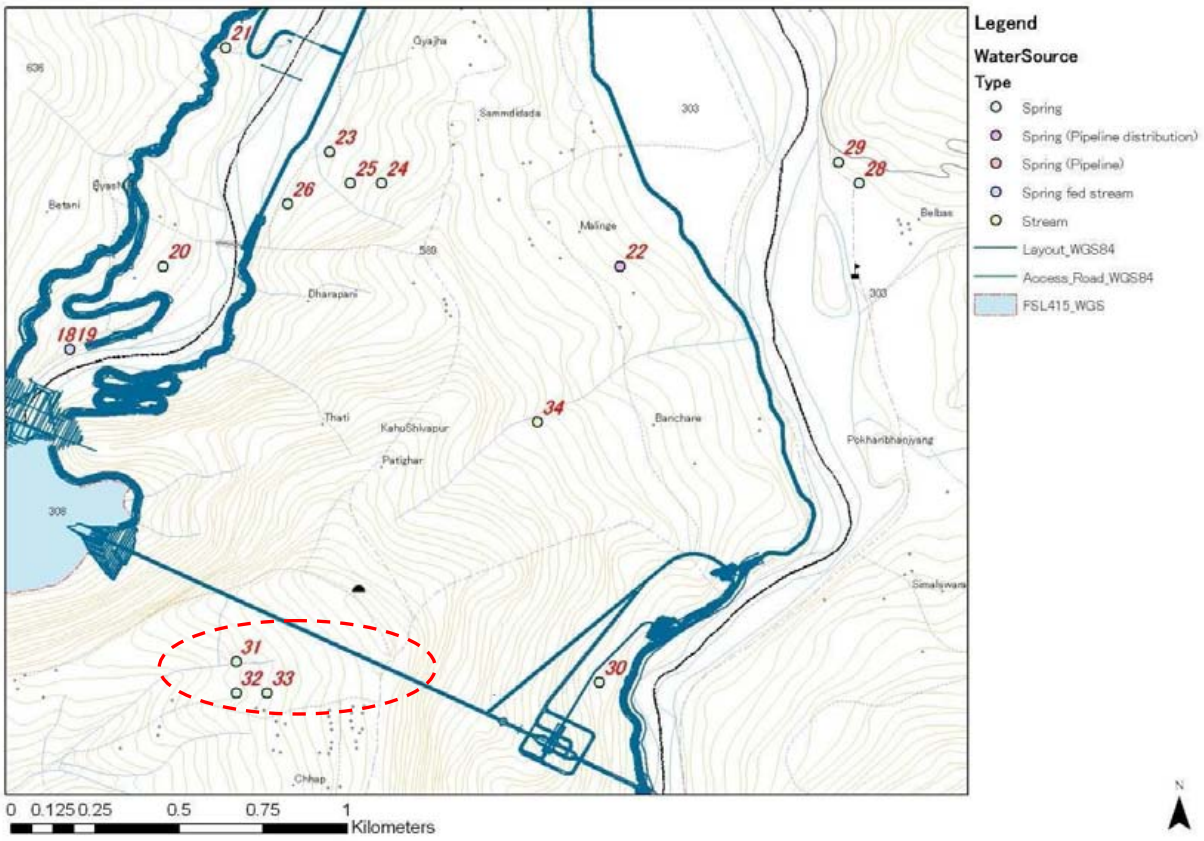
Table C.7 High Risk Springs

Well No.	Name of Water Source/ Supply System	Type of Water Source	Owner	Use	Beneficiary Households	Discharge Rate (liter/min)
30	Mukurluk Khanepani Muhan	Spring	Jhaputar village	Household purpose only	152	31
31	Hulmadi Khanepani Muhan	Spring	Chhap and Jikhabari villages	Household purpose only	30	12
32	Jhirudi Khanepani Muhan	Spring	Lokma village	Household purpose only	10	16
33	Simaldi Khanepani Muhan	Spring	Chhap and Jikhabari villages	Household purpose only	24	13

C.3.3 Mitigation Measures

105. The flow rate of the four springs that are at risk of being affected by Project tunneling will be measured every quarter, for one year prior to tunneling, and for three years following tunneling. If a perceptible decrease in the flow rate of any of the springs occurs, water supply will be provided in consultation with the affected households. Options that will be considered include: (i) gravity reticulation of water from an upslope source using a polyethylene pipeline; and, (ii) trucking of water. The cost of the installation of a water supply pipeline is estimated at NRs 500,000.

Figure C.12 Location of High Risk Springs



C.4 Aquatic Ecology

106. The EIA (2009) provided baseline information on the aquatic ecology in the Project area, from upstream of Changthand-Bhimad, in the reservoir area and dam site, in the dewatered zone (i.e., dam site to the powerhouse), at the confluence of the Seti and Madi Rivers and downstream area, and up to 5 km downstream from the powerhouse. The EIA also considered the impacts of the Project on aquatic ecology and the corresponding mitigation measures to be implemented. Appendix E (Study on Fisheries) of the EIA provided the details on aquatic flora, invertebrates, fisheries, food links, migration and spawning grounds, and fish with economic importance and conservation status, and included the required mitigation measures, such as establishment of a hatchery, fish trapping and hauling, a trash rack, and support to NARC Fisheries Research Center at Begnas and Pokhara.

107. Following the completion of the EIA, additional fisheries surveys were undertaken, in April and September 2011 at nine sampling stations. The results of the additional aquatic survey are discussed in this section.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	•Sect. 4.2.3 Fish and Aquatic Life •Appendix E Study on Fisheries	• Fisheries survey conducted in April and September 2011 • Update on conservation status and distribution of six fish species

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Impacts	•Sect. 5.2.3 Fish and Aquatic Life •Appendix E Study on Fisheries	• Inclusion of annual draining of reservoir and sediment flushing • Potential impacts on six fish species included in the IUCN Red List (update)
Mitigation	•Sect. 7.2.3 Aquatic and Fisheries •Appendix E Study on Fisheries	• EMP revised to include the proposed Fish Conservation Management Plan

108. The Seti River is one of the major tributaries of the Trisuli River, which in turn drains the central and eastern parts of the greater Gandaki River basin of the Nepal Himalaya. The Seti River comprises approximately 14% of the Gandaki basin area and around 11% of the total volume of basin river runoff. The Seti River is an important part of the drainage network that provides habitat conditions suitable for aquatic life, particularly migrating fish species of the Gandaki River system.

109. The Seti River supports both warm and cold water fish, similar to other drainage networks of the Gandaki basin (Trisuli, Marsyangdi, Mardi, Madi, Kaligandaki). Warm water fish species migrate upstream from the Narayani River into the Trisuli, Seti and other rivers to spawn at the onset of the monsoon, leaving the eggs and fingerlings in the upstream stretches of these river networks. Cold water fish, however, are confined to the upstream stretches of these rivers, only moving locally upstream and downstream over a limited range, depending upon the rise and fall of water temperatures and flows.

110. The aquatic ecosystem values of the Seti River are similar to other rivers of the Gandaki basin system, in terms of species diversity and ecological status. In recent years, however, with the rapid expansion of Pokhara, Lekhanath, Bhimad, and Damauli townships in the middle and upstream sections of the Seti River, the ecological status of the river for fish species has been greatly compromised due to urban activities, particularly from the discharge of untreated sewage and solid waste. In this regard, the middle and upstream sections of the Seti River apparently no longer provide a pristine fish habitat. The Madi River on the other hand, joining the Seti River about 2 km downstream of the dam site, has a catchment free of large urban areas and hence, provides better quality habitat for aquatic life found in this river basin.

C.4.1 Aquatic Survey

111. The additional fish survey was conducted in 2011 to provide more information and updates about the fish species within the Project area. The survey was carried out from 21 to 29 April and 11 to 20 September 2011, involving sampling at nine stations (see **Figure C.13**) and discussions with local people. **Table C.8** describes the sampling stations.

112. During the survey in April 2011, a total of 45 species were reported by local fishers, but only 28 species were actually collected from the nine sampling stations. In the September survey, 46 species were reported, but only 24 species were actually collected by the survey team from the nine sampling stations. Altogether, the collected fish species during this survey accounted for 34 species of the total of 49 fish species reported at various times from 1986 to 2011 in the Seti River project area of influence.

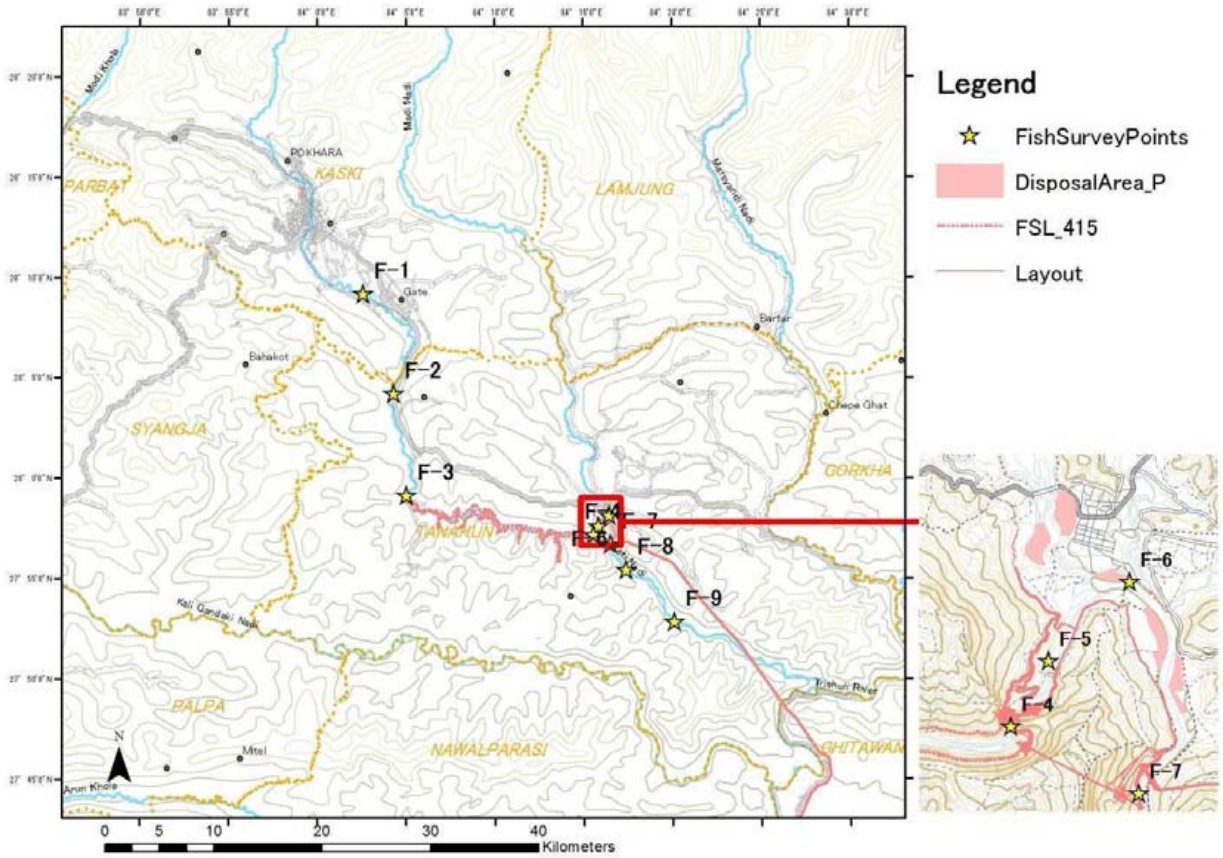
113. The most dominant fish species in the Seti River are Copper Mahseer or Katle (*Neolissochielus hexagonolepis),* Torrent minnows or Faketa (*Barilius bendilisis),* Asla

(*Schizothorax richardsonii),* Stone roller or Nakatuwa *(Garra annandalei*), Rewa (*Labeo pangusia),* Stone roller or Buduna (*Garra goytla*), and Golden mahseer or Sahar (*Tor putitora)*.

Table C.8 Description of Fish Sampling Stations (2011)

Station	Coordinates		Location	District	VDC	Ward No.	Village	River Bank
	Northing	Easting						
F1	28°08.054'	84°04.338'	Far upstream of dam site	Kaski	Lekhnath MPC	1	Sainik Basti	Left
F2	28°03.705'	84°04.123'	Upstream of Dam site	Tanahun	Dulegauda	7	Gachepani	Left
F3	27°55.196'	84°05.043'	Near upstream of dam site	Tanahun	Chhang	9	Phulbari	Left
F4	27°57.118'	84°15.522'	Dam site	Tanahun	Byas MPC	7	Dule	Left
F5	27°57.829'	84°15.928'	Dewatered Zone	Tanahun	Byas MPC	7	Betini	Left
F6	27°58.145'	84°16.326'	Confluence of Seti River and Madi River	Tanahun	Byas MPC	10	Bisghare	Left
F7	27°56.837'	84°16.532'	Powerhouse site	Tanahun	Pokhari Bhanjhyang	9	Neugoghari	Left
F8	27°55.383'	84°17.532'	Downstream of powerhouse site	Tanahun	Shivapur	8	Koidimghat	Right
F9	27°54.987'	84°18.646'	Far downstream of powerhouse site	Tanahun	Pokhari bhanjhyang	8	Sude Pul	Left

Figure C.13 Fish Sampling Stations, 2011



114. Six long distance migratory species were identified, including the Torrent catfish or Bidur (*Amblyceps mangois*), Freshwater eel *or* Rajbam (*Anguilla bengalensis),* Giant catfish or Goonch *(Bagarius yarrelli),* Jalkapoor (*Clupisoma garua),* Golden mahseer or Sahar (*Tor putitora)* and Mahseer or Pahelo Sahar (*Tor tor).* Six short- to mid-range distance migratory species were also identified, including Minor carp or Handey (*Labeo angra)*, Minor carp or Gardi (*Labeo dero*), Copper mahseer or Katle (*Neolissochielus hexagonolepis*), Point nosed snow trout or Chuchche Asla (*Schizothoraichthys progastus),* Snow trout or Buchche Asla (*Schizothorax plagiostomus),* and *Asla (Schizothorax richardsonii).*Only 35 species are known to be resident species.

115. Of the 49 species identified, six species are included in the IUCN Red List, even though they are also key fish species in other rivers in the Gandaki River Basin, and also comprise the dominant species in the Sapta Koshi River system in eastern Nepal and the Karnali River system in mid to far western Nepal (see **Table C.9**).

Table C.9 Confirmed IUCN Red List Fish Species

Scientific Name	Nepali Name	Reported by John 1986	NEA Survey 2001	EIA Upgrade Survey 2006	PPTA Survey 2011	Migratory Status	IUCN Red List Category
Tor putitora	Sahar	-	*	*	*	LD	EN
Schizothorax richardsonii	Asla	-	-	*	*	MD	VU

Scientific Name	Nepali Name	Reported by John 1986	NEA Survey 2001	EIA Upgrade Survey 2006	PPTA Survey 2011	Migratory Status	IUCN Red List Category
Bagarius yarrelli	Goonch	-	-	-	*	LD	NT
Neolissochielus hexagonolepis	Katle	*	*	*	*	MD	NT
Tor tor	Pahelo Sahar	-	*	*	*	LD	NT
Labeo pangusia	Rewa	-	-	-	*	R	NT

LD - long distance migratory species; MD -mid distance migratory species; R - locally resident species.
EN (Endangered) - a taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.VU (Vulnerable) - a taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild. NT (Near Threatened) - a taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
(Source: IUCN Standards and Petitions Subcommittee. 2010. Guidelines for Using the IUCN Red List Categories and Criteria. Version 8.1. Prepared by the Standards and Petitions Subcommittee in March 2010. Downloadable from http://intranet.iucn.org/webfiles/doc/SSC/RedList/RedListGuidelines.pdf.).
Source: Fisheries Survey - Tanahu Hydroelectric Project (2011).

117. Most migratory species migrate upstream at the start of monsoon (May through June) and migrate downstream towards the end of the monsoon (September through November). River hydrology (flow regime) and temperature are the basic factors that influence fish migration which coincides with the general spawning season of the long distance migratory fish. Immediately after upstream migration, most fish species spawn in the clean, oxygenated waters of tributaries then migrate downstream as river/stream flows reduce in the late monsoon. Mid-distance migratory fish also spawn in the monsoon season; however, some species, particularly *Schizothorax* species, spawn in the pre-monsoon as early as March-April, as snow from high altitudes begins to melt.

C.4.2 Project Impacts on Fish

118. The predicted impacts on water flow and volumes, which in turn might affect fish, are shown in **Table C.10** and **Figure C.14**, **Figure C.15**, and **Figure C.16**. In this regard, the key project impacts on aquatic ecosystems will be:

- the creation of a barrier preventing upstream and downstream fish migration throughout the year, except over the 10-40 day period when natural river flows will occur in late June (during reservoir flushing); migration barriers could result in long term effects on fish populations and species diversity;
- annual draining of the reservoir, that will reduce downstream water temperature over 10-40 days each year;
- replacement of lotic fish species (river dwelling) by lentic fish species (lake dwelling) in the reservoir stretch (18 km) of the Seti River;
- a potential reduction of the fish population between the dam and Seti River-Madi River confluence; and,
- possible downstream water quality changes (primarily a reduction in temperature, during flushing, and a reduction in long-term suspended sediment levels, except during annual flushing) due to reservoir operation. This also includes a reduction in the nutrient base supplying downstream river sections, due to reservoir trapping of organic matter, with possible implications for fish populations and species diversity.

Table C.10 Predicted Impacts on Water Flow

Area	Current Water Flow	Water flow during operation		
		Dry Season (Nov to May)	Wet season (Jun to Sep)	Sediment flushing period (Jun to Aug)
Upstream of the Reservoir	Low volume (22-50 m^3) and low SS in dry season and high volume (110-320 m^3) and high SS in wet season	No change	No change	No change
In the reservoir stretch (18 km)	Low volume (22-50 m^3) and low SS in dry season and high volume (110-320 m^3) and high SS in wet season	Water condition will be changed to lentic environment.	Water condition will be changed to lentic environment.	Water level will decrease 45 m in half month, recover lotic condition half/one month and rise up 45m in a week.
Dam – Madi River (2km)	Low volume (22-50 m^3) and low SS in dry season and high volume (110-320 m^3) and high SS in wet season	Water volume will decrease to 2.4 m^3 (10% of current flow). SS may be higher and water quality and temperature may change. (Figure C.14)	Water volume will recover up to 100-290 m^3. SS might be same as before. Water quality would be worse.	Water up to 1,000 m^3 will flow over 10 days. The water temperature might be lowered.
Madi River – Tailrace (3km)	Low volume (43-95 m^3) and low SS in dry season and high volume (119-598 m^3) and high SS in wet season	Water volume will decrease to 22.0– 45 m^3. (Figure C.15)	Water volume will recover up to 227 – 548 m^3.	Water up to 1,000 m^3 will flow over 10 days. The water temperature might be lowered.
Tailrace – Trisuli River (27km)	Low volume (43-95 m^3) and low SS in dry season and high volume (119-598 m^3) and high SS in wet season	Water volume will be 144-173 m^3 during generation and 22-46 m^3 during no-generation. (Figure C.16)	Water volume will be 226-550 m^3 during generation and 99-550 m^3 during no-generation.	Water up to 1,000 m^3 will flow over 10 days. The water temperature might be lowered.

Figure C.14 Change in Water Volume from the Dam to Madi River

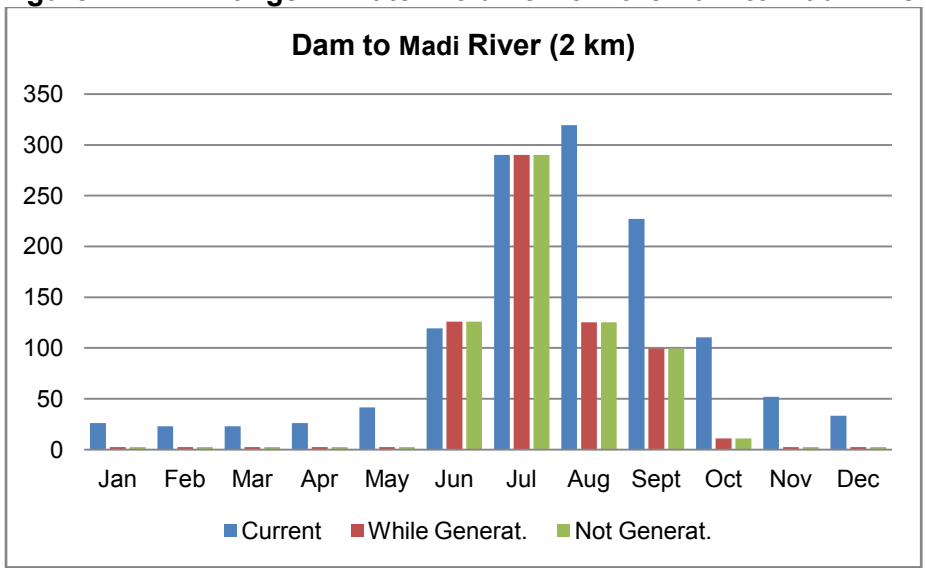


Figure C.15 Change in Water Volume from Madi River to Tailrace

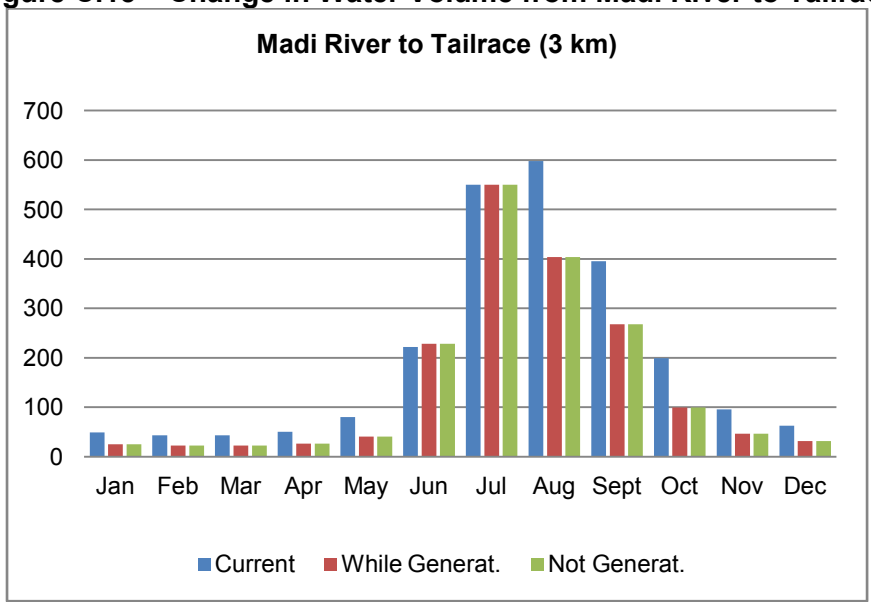
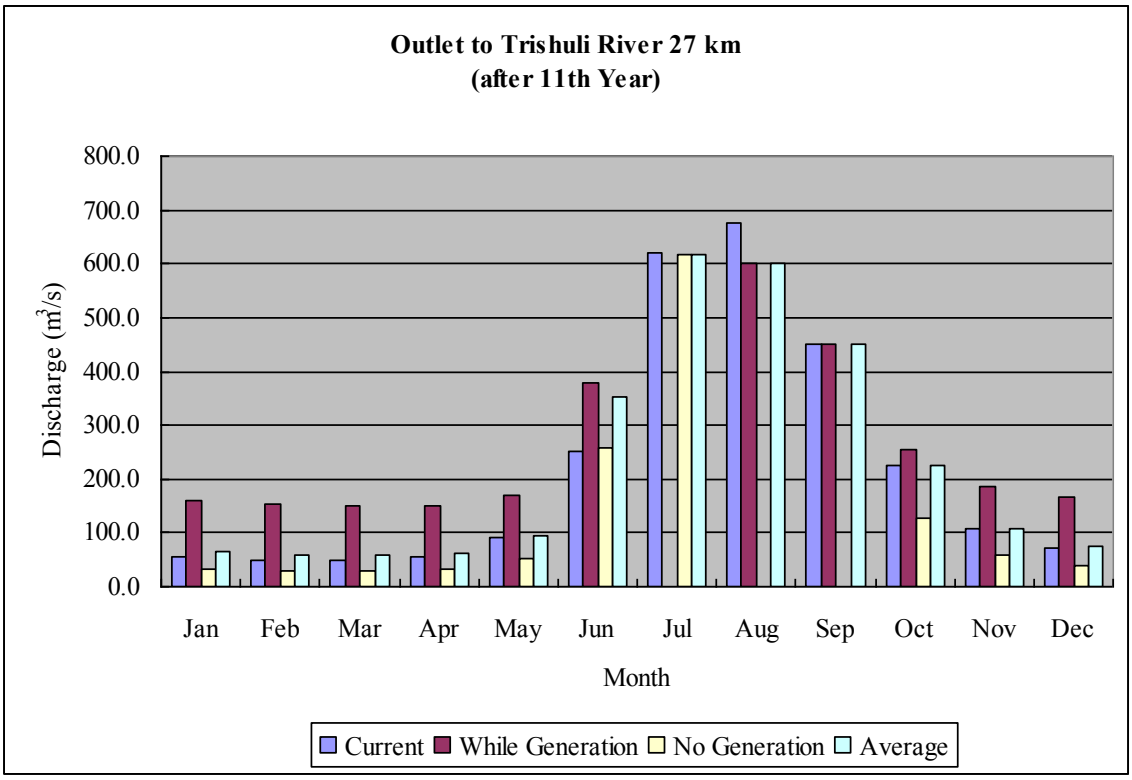


Figure C.16 Change in water volume from tailrace to Trisuli River



119. The main changes in project-altered hydrology, compared to those discussed in the 2009 EIA, which have the potential to affect aquatic ecology, are:

(i) full opening of the lower level outlet to allow natural river flows to pass for a period of 10 days during late June for the first 10 years of project operation, and to pass for 40 days for the remaining project life; and,
(ii) draining of the reservoir annually – the prolonged downstream flow of water (equivalent to a long period flood flow) may affect aquatic life in the immediate section of the river near the dam.

120. Reservoir draining, releasing between 298 m^3/s and 1,048 m^3/s over a 10 day period via the middle and sediment flushing outlets (**Tables B.3** and **B.4**) will release colder water with possibly lower dissolved oxygen levels downstream. However, re-oxygenation of the water will occur rapidly due to the velocity of water releases (and a boulder field to enhance aeration is also proposed), and the temperature should not be too low, due to mixing and turbulence, such that a thermal shock can probably be avoided. These effects will be further mitigated by the mixing with water from the Madi River, after the confluence, and then additionally along the 27 km stretch to the confluence with the Trisuli River, which adds more water again to mitigate reservoir water effects.

Likely impact on significant fish species

121. The likely project impact on the six IUCN Red List species is described below and summarized in **Table C.11**. The project impact on *Neolissochielus hexagonolepis* and *Schizothorax richardsonii* is not expected to be serious, because these species are mainly distributed upstream of the reservoir where the habitat will remain relatively unchanged. The migration and upstream access to spawning grounds by *Tor putitora* and *Tor tor*, two long-range migratory species, will be disrupted above the dam due to the barrier created by this structure,

122. The endangered species, *Tor putitora,* reportedly migrates to upstream areas of the Seti River to spawn. The migration range of this species is reported up to the Pokhara in upstream area and to Tribani in the downstream area (Sect. 4.3.5, Appendix E of EIA 2009). Five major spawning sites were identified in the Project area (see Sect. 4.2.3.1 Fish Fauna item ii, of EIA 2009 and Sect. 4.3.7, Figure 3 and Figure 4 of Appendix E of EIA 2009). The construction of the dam will block two spawning sites upstream in Bhimad, but the other three spawning sites from the dam site to the confluence of Seti River and Madi River until about 3 km downstream will provide alternative spawning sites. Spawning of *Tor putitora* normally takes place at the confluences of the tributaries with the main stream, where water is well-oxygenated with moderate velocity and water depths of 1-2 m (Sect. 4.3.5, Appendix E of EIA 2009). *Tor putitora* is known to spawn from June to September.[13] These months correspond to the power generation when the Seti River flow changes are almost the same as the current flow rates (it was estimated to fluctuate by only 0-12%; thus, impacts, if any, will be relatively minor).

123. The Seti River is not the only habitat for the endangered species, *Tor putitor.* It is also found in the Kosi, Sun Kosi, Tamar and Arun Rivers in the Kosi drainage, and in the Sakayel and Karnal in the Karnali drainage, as well as the Kali Gandaki, Narayani, Tadi and Trisuli in the

[13]Shresta, Jiwan. *Coldwater Fish and Fisheries in Nepal*. http://www.fao.org/docrep/003/x2614e03.htm. (Accessed on 30 October 2012)

Gandaki drainage.[14] Both the *Tor tor* and *Tor putitora* are also found in the Pokhara Lakes (Phewa, Begnas and Rupa).[15] One of the best known spawning spots of *Tor putitora* is Harpan Khola, a perennial stream of Lake Phewa, while the main breeding ground is Syangkhudi Khola, also a perennial stream leading to Lake Begnas.[16] *Tor tor* and *Tor putitora* can tolerate a wide range of water temperature and as a consequence, are important food and sport fishes in Nepal.[17] The absence of *Tor putitora* in the Seti River near the Pokhara-Baglung Highway and Phulbari area was noted from February 2003 until January 2004.[18] *Schizothorax richardsonii* is known to inhabit the river systems of Karnali and Kali Gandaki and is also found in the Indrasarobar Reservoir.

124. The population of *Tor putitora* may potentially decrease due to blocking of its migration routes along the Seti River by the dam, but this cannot be estimated at this stage. However, it is also possible that migrating *Tor putitora* may adapt to the changed migration routes along Seti River from the confluence of Seti River and Madi River to upstream of the Madi River. According to Gurung *et al*. (2001), *Tor putitora* could spawn up to nine months when the water temperature reaches 19°C to 33°C. However, they were also successful in breeding *Tor putitora* in waters that exceeded 37°C in summer "without any apparent negative effects", suggesting their "high acclimatization capabilities."

125. To monitor the impacts on fish populations, a fish survey (using backpack electro-fishing as a sampling method) will be conducted twice a year during the initial 5 years of dam operation at the following stations: (i) upstream of the reservoir; (ii) in the reservoir; (iii) dewatered reach of the Seti River from the dam to the powerhouse; (iv) downstream from the tailrace prior to the confluence with Madi River; and, (v) downstream of the confluence of the Seti River and Madi River.

Table C.11 Predicted Impact on the IUCN Red List Fish Species

Location	Water Condition	Impact on Habitat	*Bagarius yarrelli*	*Labeo pangusia*	*Neolissochielus hexagonolepis*	*Schizothorax richardsonii*	*Tor putitora*	*Tor tor*
F-1 • 21 km upstream of reservoir	No change	No change	?	→	→	→	↘	↘
F-2 • 10 km upstream of reservoir	No change	No change	?	→	→	→	↘	↘
F-3 • upstream end of	No change	No change	?	→	→	?	↘	↘

[14]Shresta, Jiwan. Coldwater Fish and Fisheries in Nepal. http://www.fao.org/docrep/003/x2614e03.htm. (Accessed on 2 November 2012)

[15]Ibid, p7.

[16] Gurung et. al. 2001.*Breeding of pond reared golden mahseer (Tor putitora) in Pokhara, Nepal.* http://www.fao.org/docrep/005/y3994e/y3994e01.htm. (Accessed on 30 October 2012)

[17]Petr, T. and S. B. Swar. 2002. FAO Fisheries Technical Paper 431. "Cold water fisheries in the trans-Himalayan countries."

[18]Bibhuti Ranjan Jha. 2006. "Fish ecological studies and its application in assessing ecological integrity of rivers in Nepal." PhD Thesis, Kathmandu University.

Location	Water Condition	Impact on Habitat	*Bagarius yarrelli*	*Labeo pangusia*	*Neolissochielus hexagonolepis*	*Schizothorax richardsonii*	*Tor putitora*	*Tor tor*
reservoir								
F-4 • dam site	Reservoir	Spawning area and migration route will change to static water	?	↘	↘	?	↘	↘
F-5 • dewatered zone 2 km downstream of dam	No change	Water quality might be changed during construction	?	→	↘	?	↘	↘
F-6 • confluence of Seti River and Madi River	Water volume reduced to 2.4 m^3/s, except during spill flows and reservoir draining.	Spawning area, refuge area for small fishes could be destroyed	?	↘	↘	?	↘	↘
F-7 • powerhouse	Water volume will change daily and seasonally, with flushing once a year.	Daily fluctuation could cause loss of water edge vegetation and slow flows	?	↘	↘	?	↘	↘
F-8 • 3 km downstream of powerhouse	Water volume will change daily and seasonally.	Daily fluctuation could cause loss of water edge vegetation and slow flows	?	↘	↘	?	↘	↘
F-9 • 10 km downstream of powerhouse	Water volume will change daily and seasonally.	Daily fluctuation could cause loss of water edge vegetation and slow flows	?	↘	↘	?	↘	↘

Note:→ minimal change. ↘ population could decrease, without mitigation. ? cannot be estimated.

126. **Overall implications of the project for important fish species, in the context of fish distributions in Nepal and their current status**: Given the importance and concern associated with the IUCN Red List fish species that have been observed in the Project area, and the fact that some impacts will be inevitable, as noted above, it is important to set the concern in the broader context of the distributions of these fish species throughout Nepal, and to consider both their resilience, as well as those factors that may be limiting their populations. This is discussed below, with the main focus on *Tor putitora*.

127. *Tor putitora* is designated as endangered (EN) in the IUCN Red List, where EN is graded as the fourth of six categories, following EW: extinct in the wild, and CR: critically endangered. It is not a Nepali indigenous fish. It is recognized that it has, and still is, spreading (given its migratory nature) from Afghanistan, Pakistan, India (North and North East), Bangladesh, Bhutan, Sri Lanka, Myanmar, Iran and Thailand, according to the IUCN website. While IUCN has no quantitative distribution data for each river, it identifies this fish as being widely found in three major river systems of Nepal from the east to the west, including the Koshi River, the Gandaki River, and the Karnali River.[19] The reason for the EN designation is as

[19] The Koshi River is the largest river of Nepal and the largest tributary of the River Ganges. It is in the eastern part of Nepal and has an average flow of 1,931 m^3/sec. The Karnali is in the western part and has an average flow of 510 m^3/sec. The Gandaki river is in the central part and has 283 m^3/sec (Source: FAO FI:DP/BHU80/007, Field Doc. 1. 46 p. 57740 · K.J. Rajbanshi,, 57740, 2002).

follows: rather than reflecting a threat in some specific location, there is growing concern caused by a rapid decrease of its population, due to urbanization, illegal encroachment, over fishing chemical and physical alterations of their natural habitats, and hydroelectric and irrigation projects. According to IUCN, this is one of several representative game fishes, and continues to be threatened by dynamite and electric shock fishing methods. The situation for *Tor putitora* therefore reflects a declining population numbers trend in what is otherwise a quite pervasive fish. The widespread distribution in South and Southeast Asia is a factor in its favour; however, key refuges throughout the region where current pressures are reduced need to be protected.

128. The Seti River is one of many small tributaries for *Tor putitora*. In Nepal, the Seti River is a relatively small river, compared to other rivers where *Tor putitora* exists. For example, the Seti River makes up approximately 14% of the Gandaki Basin area, which in turn is one of three basins that are known to support *Tor putitora* (the Tamor basin in the eastern area, and the Karnali and West Seti basins in the west, as well as various lakes and reservoirs). Therefore, it is estimated that the Seti River area makes up only about 5% of the known river basin areas where *Tor putitora* occurs in Nepal. Furthermore, many other rivers where *Tor putitora* exists are inside protected areas (where protection can be secured).[20] Actually, water in this area of the project where *Tor putitora* migrates has been showing trends of unabated pollution due to the expansion of the tourist township of Pokara and the upcoming and rapidly expanding urban centers of Damauli, Lekhanath, Khaireni, and Bhimad in the upper catchment area of the project. Regardless of the Project, the river's value as habitat for aquatic species is likely to decline in the near future, without any mitigation measures.

129. In any case, it is also noted in multiple studies in the past that the Seti River is not a significant habitat for *Tor putitora*, since sometimes previous surveys did not find this fish in the Seti River. For example, *Tor putitora*'s habitat areas noted in the past have included the Kali Gandaki, Madi, Trisuli, and the Rapti in the Gandaki River system, and was not found specifically in the Seti River.[21] Most of the Rapti River is located in the national park and the Kali Gandaki River, the biggest and longest in the basin, includes the protected areas in the upstream and downstream areas. In this regard, the available data and literature does not seem to indicate that the Seti River is a critical habitat for *Tor putitora*. Nevertheless, as a precautionary approach, the Project will still assume that the Seti River has potential for migrating *Tor putitora*, and will undertake a multi-pronged approach to mitigate fish migration blockage on the river (mentioned below and described in detail in Volume 2a of the Addendum).

130. In the IUCN's Red List, *Schizothorax richardsonii* is classified as vulnerable. It is widely distributed in India, Nepal, Bhutan, Pakistan and Afghanistan. The species is observed to be declining throughout its range, but there has been no empirical study conducted. In Nepal, this species is also found by IUCN in the major three river systems, similar to *Tor putitora*. With regard to the other four fish species list as near-threatened (NT), *Bagarius yarrelli* is said to be widely distributed throughout south and southeast Asia including Bangladesh, China (Yunnan), India, and Nepal. *Neolissochilus hexagonolepis* is found in Bangladesh, Pakistan, Myanmar, Thailand, Malaysia (Peninsular), China, Indonesia (Sumatra), Nepal, and India. *Tor tor* is identified in Myanmar, Bhutan, Bangladesh, Pakistan, India, and Nepal. *Labeo pangusia* is widely distributed in India, Pakistan, Bhutan, Nepal, Myanmar, and Bangladesh. As noted

[20] In the Koshi river system in the East there is Koshi Tappu Wildlife Reserve (Terai). In the Gandak river system, there are Langtang National Park (Hills & Mountains) and Chitwan National Park (Terai) . In the Karnali river system there are Rara and Khpatad National Park and Shey Phoksundo Reserve (Hills & Mountains) and Bardia National Park (Terai)

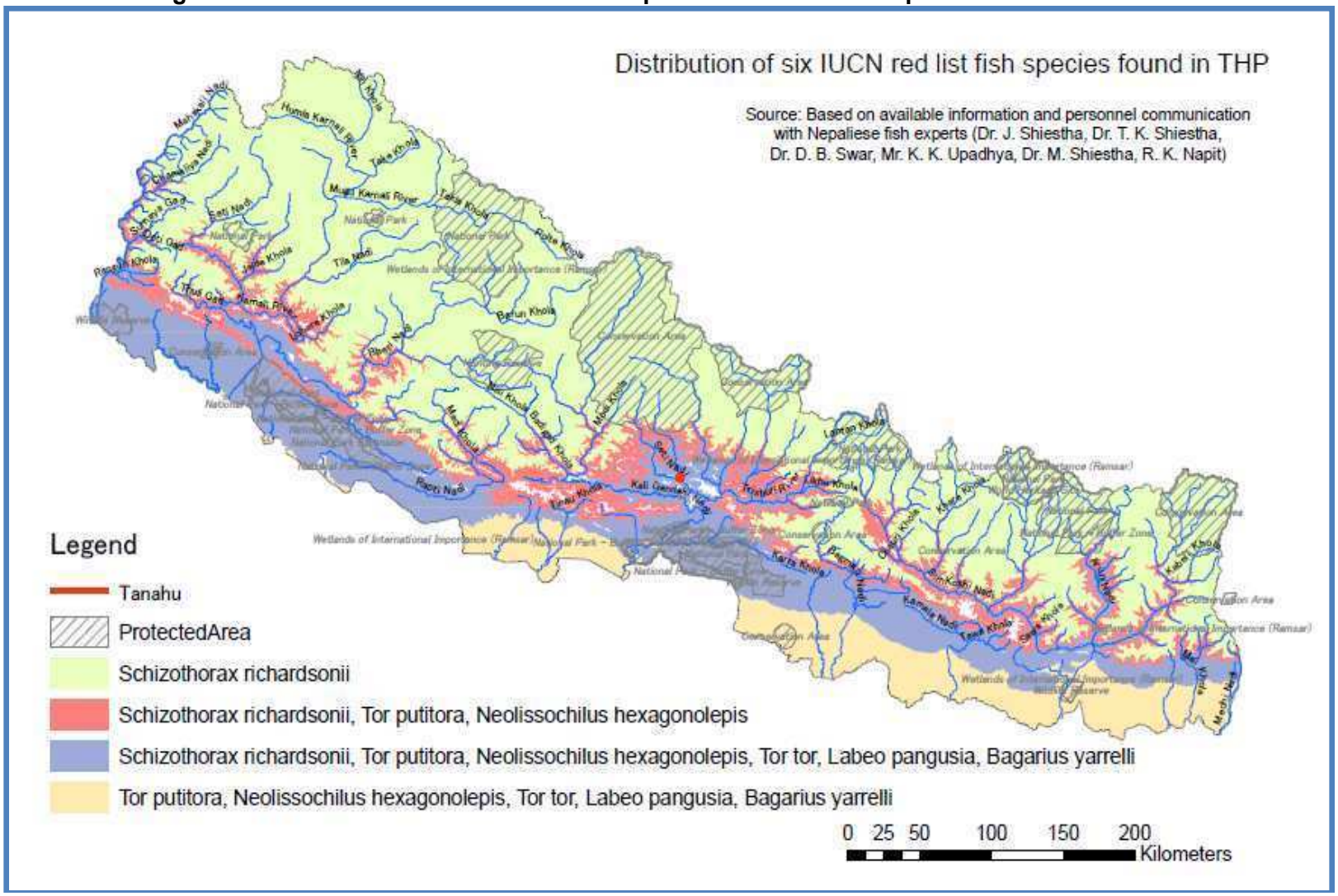
[21] FAO, 2002. Zoo-geological distribution and the status of coldwater fish in Nepal (K.J. Rajbanshi). The fish distribution studies done by ichthyologists have been summarized. *Tor putitora* was not identified in the Seti River, the Marshyangdi river, and the Bhdhi Gandaki River. The studies indicated their habitat in other four rivers in the Koshi River Basin.

previously, clearly all the fish species of concern in the Seti River area occur widely throughout South and Southeast Asia.

131. Within Nepal it is easier to understand the potential distribution and any vulnerability of these Red List fish species when seen graphically and with the Seti River fish habitat expressed as a percentage of available habitat in Nepal. Therefore, an attempt has been made to prepare an eco-distribution map of the six IUCN Red List species (*Tor putitora, Schizothorax richardsonii, Bagarius yarrelli, Neolissochilus hexagonolepis, Tor tor* and *Labeo pangusia*). This is based on the compilation of the available published literature (J. Shrestha, 1981; Rajbanshi, 1982, 2003; T.K. Shrestha, 2008; and Shrestha and Edds, 2012), as well as a series of consultative meetings with the fish experts of Nepal (D.B Swar, J. Shrestha, T.K. Shrestha, M. Shrestha, K.K. Upadhyaya, and R.K. Napit), who have been involved at various times in riverine fish studies in Nepal. **Figure C.17** presents the eco-distributions of the six IUCN fish species in Nepal, taking into account the potential distribution of these fish species along the major rivers and tributaries of Nepal. In doing so, the elevation range of the fish species occurrence was analyzed, based on the findings of the various surveys conducted in the past in the different main rivers and their tributaries. The iso-potential lines are the highest elevations where the target fish species have been sampled frequently. Although river hydrology (discharge volume) and water temperatures have a great influence on fish availability across different seasons in the Himalayan rivers, the analysis undertaken for the preparation of the eco-distribution map covered the above attributes only for the major snow feed rivers (this is a possible limitation of the map).

132. As suggested by the map, the six IUCN Red List species have a wide eco-distribution in Nepal and are found in all the major snow feed river systems, namely the Karnali River System in the far-west and mid-west Development Regions, the Gandaki River System in the Western and Central Development Region, and the Kosi River System in the Central and Eastern Development Region.

Figure C.17 Distribution of Red List Fish Species and Relationship with Protected Areas[22]



[22] While the map has been prepared with the best available data at this time, survey work in Nepal is not extensive or complete, and therefore the map is not considered to be authoritative.

133. Based on the iso-potential eco-distribution of the six fish species, the potential geographical area coverage for each of the species has been calculated. This is shown in **Table C.12**, in which the Seti River area is expressed as a percentage of the geographical area inhabited by the six fish species.

Table C.12 Distribution of the 6 IUCN Red List Species by Percentile of Geographical Area of Nepal

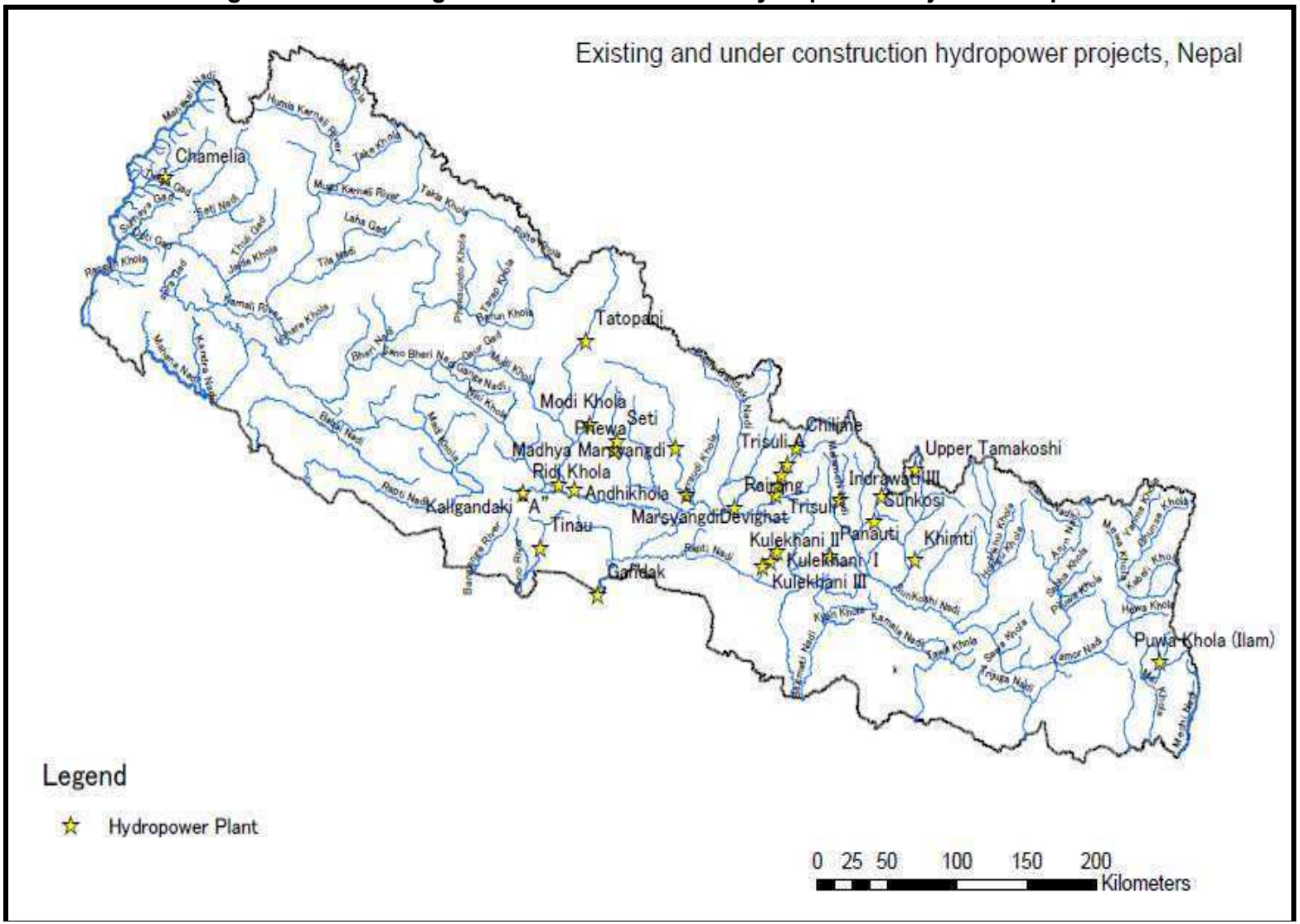
IUCN Red List Fish Species	Fish Habitat as % of Nepal Geographical Area	Fish Habitat as % of Seti River Catchment	Directly Impacted Area as % of Eco-Distribution Area of Nepal
Schizothorax richardsonii	90.8	100.0	1.1
Tor putitora	43.6	61.5	1.4
Bagarius yarrelli	31.1	31.2	1.0
Neolissochilus hexagonolepis	43.6	61.5	1.4
Tor tor	31.1	31.2	1.0
Labeo pangusia	31.1	31.2	1.0

134. *Schizothorax richardsonii* is one of the most widely distributed fish species in Nepal, covering nearly 91% of the national geographical area. *Tor putitora* and *Neolissochilus hexagonolepis* cover nearly 44% of the national geographical area, whereas *Bagarius yarrelli, Tor tor,* and *Labeo pangusia* occur (or have the potential to occur) in about 31% of the geographical area of Nepal. Analysis of the eco-potential distribution of the target fish species in the protected areas of Nepal reflects the occurrence, or potential of occurrence, of *Schizothorax richardsonii* in all of the protected areas of Nepal (see **Figure C.17**), irrespective of their location in the southern plains, middle hills or in the northern high mountains. *Tor putitora, Bagarius yarrelli, Neolissochilus hexagonolepis, Tor tor*, and *Labeo pangusia* show eco-distribution only in the national parks located on the southern plains of Nepal, namely Sukla Phanta Wildlife Reserve, Bardiya National Park, Chitwan National Park, and Kosi Tappu wildlife Reserve. These five species have a more limited distribution in the conservation areas and national parks of the middle hills, and have a very remote potential of occurrence in the conservation areas of high mountains in the north.

135. The THP Project area will affect the riverine fish habitats of the Seti River above the Seti - Madi confluence. The total catchment of the Seti River above the Seti- Madi confluence is about 1,500 km^2, which is about one percent of the area of Nepal (**Table C.12**). These analyses clearly suggest that the potential loss of eco-distributional area of the 6 IUCN Red List fish species by the Project in the Seti River is less than 1.5 percent of the available eco-distributional area at the national level. In addition, the occurrence of the target fish species in the protected areas of Nepal suggests that the expected impacts of the Project on the available Seti River habitat of the target IUCN Red List fish species, including *Tor putitora* (the endangered species) is of low significance in the national context.

136. These fish distributions can also be examined in the context of other hydropower developments in Nepal (shown in **Figure C.18**). To date, hydropower plants have been developed in some parts of the Gandaki and Kosi River Systems of Nepal.

Figure C.18 Existing and Under-Construction Hydropower Projects in Nepal



137. However, Karnali River System catchment constitutes nearly 40% of the area of Nepal, but is not affected by hydropower development or any other forms of water regulation. Similarly, four major tributaries constituting nearly 60% of the Kosi River catchment in eastern Nepal are also not affected by water regulation. In other words, there exists a large fish eco-distribution area to offset the very small impacts of the Project on the target IUCN Red List species.

138. Most of the target IUCN Red List fish species have been successfully bred in captivity, in hatcheries in Nepal (Kali Gandaki, Phewa Lake, Begnas Lake, Trisuli, and Godavari). There is therefore potential for *ex situ* breeding and *in situ* conservation, through stocking in the affected catchment, to further minimize the impacts of potential habitat loss due to obstruction in the fish migration by the dam structure of the Project. It is intended to construct a fish hatchery, as the main mitigation measure to protect fish. The operation of fish hatcheries in Nepal is becoming more reliable; for example, the number of fry produced from pond-reared *Tor putitora* broods in the Kali Gandaki Fish Hatchery has been increasing, from less than 30,000 in 2003 to over 250,000 in 2009, according to Mountain Biodiversity Conservation and Management, ICIMOD working paper in 2012.[23] Moreover, to assure the offset, the project also plans to assess a catch-and-haul fish movement system and the feasibility of a "switchback" fish pass in its Fish Conservation Management Plan, that will also include detailed examination of options in other river systems in Nepal to serve as a fish habitat offset (a brief summary is provided below, with additional details in the EMP, Volume 2a of the Addendum).

C.4.3 Mitigation measures

C.4.3.1 Construction Phase

139. Mitigation measures during construction identified in the EIA (2009; Sect. 7.2.3 Aquatic and Fisheries, items a and b) which include a muck disposal plan and water quality protection measures will not change. Section C.7 of this Addendum provides additional information about muck disposal measures.

C.4.3.2 Operation Phase

Establishment of a fish hatchery

140. A hatchery will be established to produce fish fry of migratory fish species, particularly the endangered species, *Tor putitora*, as well as other fish species with apparent declining populations. The details of fish hatchery development are discussed in the EIA (Sect. 7.2.3.2(e) and (f)) and Appendix E of the EIA (Sect. 7.7, Sect. 8.1 and 8.2). The final location of the hatchery will be determined before the detailed hatchery design. As indicated in the EIA (see Figure 7 of Appendix E), the proposed sites (depending on sustained water temperature and quality) are:

(i) Belbash at the left bank of the Seti River, between the confluence of the Madi River and Seti River and powerhouse site; and,
(ii) Cultivated land (left bank) near the school compound at Bhimad Bazar (end point of the reservoir).

[23] International Centre for Integrated Mountain Development (ICMOD). 2012. Mountain Biodiversity Conservation and Management, Selected examples of good practices and lessons learned from the Hindu Kush Himalayan region. Kathmandu.

141. The fish hatchery will serve to: (i) produce fish fingerlings to replace lost species in the Seti River above the dam; and (ii) to monitor and research the fish populations in the Seti River and Madi River. The main activities of the hatchery are shown in **Figure C.19**. The hatchery will consist of five main facilities:

(i) hatchery complex;
(ii) raceways of various sizes (2.5 ha of water area including a production area);
(iii) main feeding and drain canal;
(iv) training complex; and,
(v) laboratory and accessories.

142. There are four fishery development centres in Nepal dedicated to the development of coldwater fisheries and these are: Godawary Development Centre, Trisuli Development Centre, Pokhara Development Centre, and the Fisheries Development Centre in Kulekhani. Several years of investigation for developing a breeding method for *Tor putitora* have been undertaken in most of the Trans-Himalayan countries, resulting in a better understanding of its spawning biology, ecological aspects, and behaviour in natural habitats. Even so, it is recognized that there is a need to have a standardized breeding method for mass seed production of the species in captivity, due to its complex and partial spawning pattern.[24,25] The use of stripping and injection with pituitary gland extract has been found to be successful in the artificial propagation of *Tor tor*, *Tor putitora*, *Neolissochielus hexagonolepis*, and *Schizothorax* spp.[26] Artificial propagation is therefore expected to help in the conservation efforts for these species. Additional studies have shown that "breeding attempts of *Tor putitora* during spring season could trigger mass-scale seed production."[27]

143. These research results will be used to guide the establishment of a hatchery for this Project. Collaboration with fishery experts will be done during planning and implementation of the hatchery. The fish hatchery and restocking program will be designed in detail during the first year of Project construction and subsequently refined, based on closely monitoring the migration of fish past the dam, commencing in mid-June when natural river flows will occur after the reservoir is drained.

144. Aside from the fish hatchery program for the long-term restocking of *Tor putitora* and other fish with declining populations, a fish management program will be implemented in the Seti and Madi Rivers to enhance the spawning and rearing habitat of these species (including consideration and implementation of an offset habitat protection area). Consulting services will be provided to promote mitigation activities during Project implementation. Collaboration with relevant government agencies, fish experts, and organizations like the IUCN will continue throughout the project cycle, to ensure that it is implemented in a sustainable manner that may provide an example to future hydropower projects in Nepal. THL will also explore the possibility of involving fisher women groups in Phewa and Begnas Lakes, as these groups are focusing on

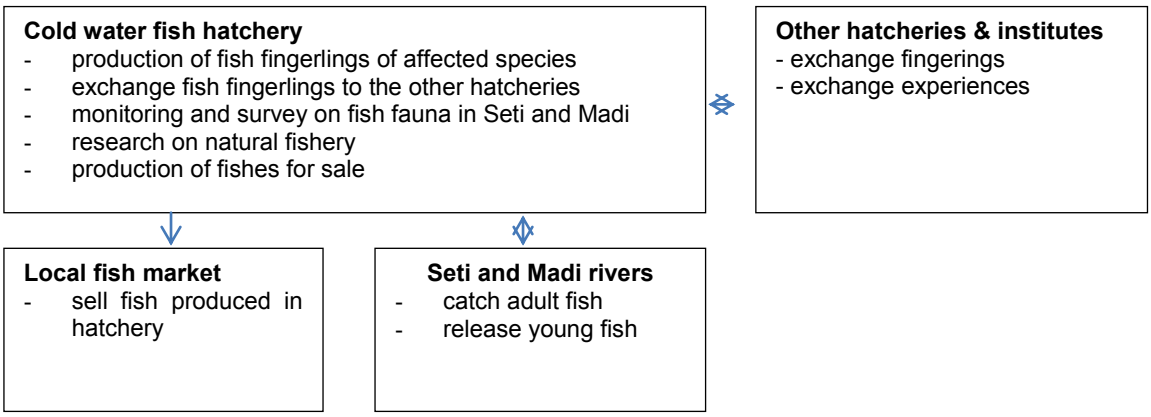
[24] Gurung, et al. 2001.*Breeding of pond reared golden mahseer (Tor putitora) in Pokhara, Nepal.* http://www.fao.org/docrep/005/y3994e/y3994e01.htm. (Accessed on 30 October 2012)
[25] Rai, Ash Kumar. Status of sahar (Tor putitora) domestication and its development in the Himalayan Region of Nepal. Aquaculture Asia Magazine. January-March 2008.
[26] Shresta, Jiwan. *Coldwater Fish and Fisheries in Nepal*. http://www.fao.org/docrep/003/x2614e03.htm. (Accessed on 30 October 2012)
[27] Bista, et al. 2010. *Spawning response of sahar (Tor putitora) in different seasons under pond condition in Pokhara, Nepal.* Proceedings of the 8th National Workshop on Livestock and Fisheries Research in Nepal. June 7-8, 2010. National Animal Science Research Institute. Khumaltar, Lalitpur.

the conservation of high value *Tor putitora*.[28] The main elements of survey and hatchery program are shown in **Table C.13** and **Figure C.19**.

Table C.13 Main Elements of the Survey and Fish Hatchery Program

Item	Construction Period	Operation Period
	Works	Works
Cold water fish hatchery	Field survey and identification of suitable site, facility construction	Hatchery & production of fish fingerlings, training, research on natural fishery, reports and meetings with collaborating agencies

Figure C.19 Fish Hatchery Activities



Learning from problems encountered at existing fish hatcheries

145. Consultations with existing fish hatcheries regarding problems encountered to date and lessons that can be learned have revealed some problems associated with design, location, and approach. The proposed hatchery for the Project will build on the lessons from the experiences in the Kali Gandaki "A" Hydropower Project, Trisuli Hatchery, and the Begnas Fish Hatchery to minimize challenges during implementation. **Table C.14** presents a summary of the problems associated with the existing hatchery.

Table C.14 Summary of Problems Encountered with Hatchery

Existing Hatchery	Problems Encountered
Kali Gandaki "A" Project and the Trisuli Hatchery	*Water quality* • highly turbid and not suitable for plankton growth, resulting in almost 50% mortality of fish fry and reduction of fingerling production • water to the hatchery comes from Kali Gandaki River through a 10" pipe from a surge tank valve chamber • water is highly turbid during monsoon season and moderately turbid in winter, but still unsuitable for fish production *Solution* • improvement in water quality needed to increase fish

[28] AP Nepal, JD Bista, S Prasad, TB Gurung and DP Sharma. 2010. *Resources management and implication of fisher women groups in lakes, Phewa and Begnas of Pokhara valley.* Proceedings of the 9th National Outreach Workshop. Khumaltar, Lalitpur. pp. 366-371.

Existing Hatchery	Problems Encountered
	production
	Water temperature • temperature of natural spring in the adjoining area is high, thus unsuitable for cold water fish breeding *Solution* • water from Kali Gandaki River was used to maintain temperature but adequate prior treatment to lower turbidity should be done
	Inadequate ponds • ponds to breed different species are inadequate • available ponds not enough for the 10 fish species that have been successfully cultured *Solution* • additional 20 ponds are required to increase production • if water quality is improved, production of fingerlings can be increased to 400,000
Begnas Fish Hatchery	Design • occasional malfunction of siphon structure used to source water for the hatchery due to variation in the water level at Begnas Tal, the natural lake where the water is sourced • inadequate ponds to accommodate the breeding of different fish species • 40-50 ponds used for rearing of fingerlings and 10 ponds for broods • broods have been mixed with other species in different ponds due to insufficient ponds available Location • area is limited to build additional ponds • water temperature in the area is not suitable for cold water fish breeding particularly Asla (*Schizothorax richardsonii)* Solution • build additional ponds to increase production • for cold water fishery, area close to the headwaters of a major river is needed • suitable areas for cold water fishery are: Budrung Khola area-Seti River upstream, Madi Khola upstream, and Rasuwa area-upstream of Trisuli River

Water quality

146. A fraction fence will be installed in the reservoir to prevent the upper reservoir water level from becoming nutrient rich. The quality of reservoir and released water will be monitored each month for at least the initial five years of project operation. The downstream river flow quality will be compared with the natural inflow water quality into the reservoir to identify seasonal changes in water quality. If a significant change is identified, a mixing apparatus will be considered at the intake or tailrace to improve the quality of power generation releases.

147. The patterns of dam operation (i.e., reservoir draining, sediment flushing, and peak load of eight months and four months base load) are not expected to significantly change water

quality in the reservoir and downstream. Among other things, the operating patterns for the dam take into consideration the avoidance of passing anaerobic water from the reservoir through the turbines, as this can severely damage the equipment. Peaking operations will allow the riparian zone to be drained and exposed to sunlight daily, which will reduce the impacts due to waterlogging and inundation.[29]

148. Water quality will be monitored at the same sampling stations required for the fish survey, identified as: (i) upstream of the reservoir; (ii) in the reservoir; (iii) dewatered reach of the Seti River from the dam to the powerhouse; (iv) downstream from the tailrace prior to the confluence with Madi River; and, (v) downstream of the confluence of Seti River and Madi River. Three more stations downstream of the powerhouse-tailrace will be established in conjunction with gauging stations and water level stations to relate water quality results with the changes in the river flow and/or water level. As noted previously, temperature, dissolved oxygen, total suspended solids, and conductivity will be critical parameters to be monitored.

149. Prior to operation, mapping of areas or zones that may be susceptible to erosion (in addition to what has already been identified) will be undertaken downstream of the tailrace, using a hand-held GPS. These areas will be monitored to determine the extent of Project impacts during operation (if any) and to ascertain the need for river bank stabilization, particularly if there are morphometric transformations and fragmentation of fish habitats.

Other measures considered

150. To maintain upstream migratory fish diversity and population density, several mitigation measures have been considered. These include: (i) a fish passage/ladder; (ii) fish trapping and hauling; and, (iii) a fish lock. The dam height of over 100 m makes a fish passage or fish ladder very challenging, but it is possible to at least consider the technical feasibility of a “switchback” fish pass over a long distance. Manual or mechanical fish trapping and hauling is possible; the risk that captured fish may be harvested rather than being released upstream due to weak regulation will have to be carefully managed. In addition, the handling of fish during trapping and hauling must be done very carefully to minimize fish mortality. The fish lock alternative is an automated system of fish transport over the dam, consisting of fish locks below and above the dam. The locked fishes are hauled across the dam by a specially designed automatic lift. The limitations of this option include the difficulty of fish accessing the lock when highly turbulent flows are released from the spillway during the monsoon, creating a bottleneck at the very time when this is most required to transport fish. This technical option has therefore been discarded in favor of the fish hatchery, testing of a “catch-and-haul” program, and feasibility assessment of a fish pass.

Stocking of indigenous fish species in the reservoir

151. Open water stocking of indigenous fish species in the reservoir was considered in the EIA (see Sect. 7.7.3 of Appendix E) to minimize Project impacts to cold water fishes. Dam operation will involve draining of the reservoir annually which may not provide adequate retention time to achieve a critical mass to increase the fish population in the reservoir. On the other hand, fish which are introduced to the reservoir will have the opportunity to continue up the Seti River system, which would be very beneficial to the fish populations being considered.

[29] Locher, Helen. Environmental Issues and Management for Hydropower Peaking Operations. Hydro Tasmania.

If stocking is undertaken, fish densities will have to be quite low to avoid organic waste from fish increasing the nutrient levels in the reservoir.

Environmental flow requirement

152. An environmental flow of 2.4 m^3/s will be released throughout the year during the operation phase, to mitigate impacts associated with dewatering the Seti River between the dam and the powerhouse. The environmental flow was determined following the Tennant Method (Tennant 1976) which builds its streamflow requirements on the observation that aquatic habitat conditions are the same in streams carrying the same proportion of the mean annual flow.[30] The Tennant Method is a simple method of estimating environmental flow and the most commonly applied hydrological methodology worldwide.[31] This method was used for this Project, with modifications from the EIA study of the Kali Gandaki "A" project (see Sect. 7.2 of Appendix E, EIA 2009). This environmental flow is in compliance with the *Hydropower Development Policy 2058 (MoWR, 2001)*[32].

C.5 Terrestrial Ecology

153. The EIA (2009) provided information on the existing vegetation, forest type, forest management, mammals, birds, reptiles and amphibians, conservation status of terrestrial flora and fauna, and the beneficial uses of wild plants. Aside from this background, it also discussed the associated impacts during construction and operation, including the appropriate mitigation measures.

154. Following the completion of EIA (2009), an additional flora and fauna survey was done in July 2011 at eight sampling locations, to supplement the previous survey for the EIA and to confirm and/or verify the presence or absence of flora and fauna species.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	• Sect. 4.2.1 Vegetation •Sect. 4.2.2 Wildlife •Appendix D Biological Environment	• Eight sampling stations established from Damauli to Bhimad in July 2011 for terrestrial flora and fauna survey • 206 species of wild plants identified • Presence of five mammalian species confirmed during the July 2011 survey • No change with the 27 mammalian species
Impacts	•Sect. 5.2.1 Vegetation •Sect. 5.2.2 Wildlife	• 422.6 ha of forest land affected by reservoir and project facilities compared to 422 ha in EIA (2009) • No change with number of trees to be cleared (about 162,000) • Three plant species listed by GoN as under conservation • Six species (including four orchids) listed by Convention on International Trade in Endangered Species (CITES)

[30] US Geological Society. *Comparison of Streamflow Requirements*. http://pubs.usgs.gov/of/2002/ofr02-340/html/comparison.html. (Accessed on 30 October 2012)

[31] Tharme, R. E. 2003. A global perspective on environmental flow assessment: emergingtrends in the development and application of environmental flow methodologies for rivers. *River Research and Applications* 19:397-441.

[32] It defines that "Environmental flow should be more than 10% of the minimum monthly average flow."

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
		and two listed by IUCN
Mitigation	•Sect. 7.2.1 Vegetation •Sect. 7.2.2 Wildlife	• No change, but cost estimates revised • Includes measures to reduce impact to tiger habitat corridor that will be traversed partly by associated transmission line

155. All project sites are located outside the designated national and local protected areas (i.e., national parks, wildlife reserves, and conservation areas). The nearest protected areas are Annapurna Conservation Area located at about 30 km north of the reservoir area, and the Chitwan National Park, which is about 15 km south of the 220 kV Bharatpur Transmission Line Substation.

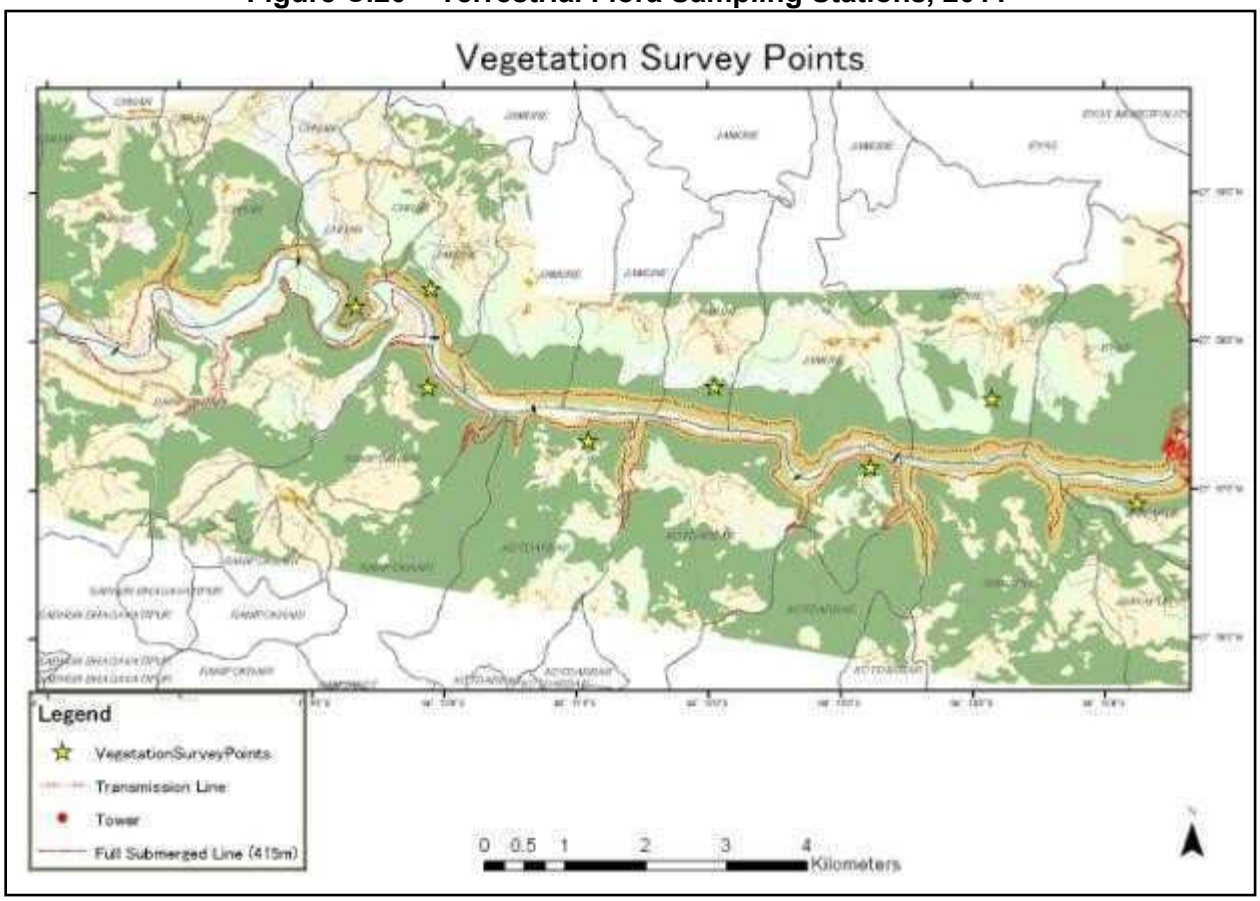
156. The forest that will be affected by reservoir inundation is located in a narrow riverine gorge which is isolated from the nearest forest areas to the north, south, east and west by agricultural land and settlements. The reservoir and project access roads will affect fringe forest habitats in the gorge. The existing break in forest habitat created by the Seti River will be widened by an average of around 150 m with the establishment of the reservoir. Aside from the reservoir and the construction of permanent access roads to the dam and the powerhouse that cross short sections of degraded forest, no fragmentation of forest will occur.

157. Additional flora and fauna surveys were undertaken in July 2011 within the project area to determine any information to supplement and/or update the findings during the EIA 2009.

C.5.1 Flora

158. A flora survey on 18-22 July 2011 was conducted at eight sites from Damauli to Bhimad on steep to moderate slopes between 400 masl and 650 masl (within or immediately adjacent to the reservoir area) along the lower two-thirds of the reservoir, to assess forest values in greater detail and to record pre-project conditions for lifecycle monitoring (see **Figure C.20**).

Figure C.20 Terrestrial Flora Sampling Stations, 2011



159. A total of 206 wild plants were identified, of which three plants are listed by GoN under conservation categories, six (including four orchids) listed by CITES and two listed by IUCN (**Table C.15**). No observed terrestrial flora are listed in the IUCN Red List of Threatened Species as vulnerable, rare, or endangered species; six species are listed in CITES Appendix II.

Table C.15 Plants of Conservation Significance

Species	Conservation Status		
	GoN	CITES	IUCN
Acacia catechu (L.f.) Willd.	+	Not included	Not yet been assessed
Alstonia scholaris (L.) R. Br.	---	Not included	Least Concern
Coelogyne sp.	---	Appendix II	Not yet been assessed
Dendrobium sp.	---	Appendix II	Only those species native from China and Philippines have been assessed[33]
Dioscorea deltoidea Wall. Ex Griseb	---	Appendix II	Not yet been assessed
Cymbidium sp.	---	Appendix II	Only those species native from China

[33] IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Accessed on 15 November 2012

Species	Conservation Status		
	GoN	CITES	IUCN
			have been assessed
Oroxylum indicum (L.) Kurz.	---	Not included	Not yet been assessed
Pandanus nepalensis St. John	---	Not included	Not yet been assessed
Rauvolfia serpentina (L.) Benth.	+	Appendix II	Not yet been assessed
Shorea robusta Gaertn.	+	Not included	Least Concern
Vanda teres Lindl.	---	Appendix II	Not yet been assessed

Least Concern – a taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category (IUCN, 2010).
CITES Appendix II are species which may not be necessarily threatened with extinction but may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with the survival of other species in the wild.
Source: Forestry/Botany Survey - Damauli to Bhimad, Seti River Basin (2011).

160. In the EIA (2009), there were 209 plant species identified within the Project area, of which six species were listed as having different conservation categories, according to the CITES and IUCN (see Sect. 4.2.1.4,Table 4.10). Of these six plants, two species are listed as endangered and one species is rare, based on IUCN classification (see Sect. 4.2.1.4). The endangered species are *Rauvolfia serpentina (L.)Benth.ex Kurz* (Serpentine wood) and *Shorea robusta Gaertn,* while the rare species is *Alstonia scholaris* (White Cheesewood).

161. Based on the latest IUCN Red List of Threatened Species, the conservation status of *Rauvolfia serpentina (L.) Benth.ex Kurz*[34] has not yet been assessed and *Shorea robusta Gaertn*[35] is of least concern, while *Alstonia scholaris*[36] is also of least concern. **Table C.16** shows the species conservation significance identified in the additional flora survey in 2011.

Table C.16 Comparison of Conservation Status of Plants

Species	Flora Survey 2011		
	GoN	CITES	IUCN
Acacia catechu (L.f.) Willd.	+	NI	Not yet been assessed
Alstonia scholaris (L.) R. Br.	---	NI	Least Concern
Coelogyne sp.	---	Appendix II	Not yet been assessed
Dendrobium sp.	---	Appendix II	Only those species native from China and Philippines have been assessed
Dioscorea deltoidea Wall. Ex Griseb	---	Appendix II	Not yet been assessed
Cymbidium sp.	---	Appendix II	Only those

[34] Ibid.
[35] Ashton, P. 1998. *Shorea robusta*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Accessed on 15 November 2012.
[36] World Conservation Monitoring Centre 1998. *Alstonia scholaris*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Accessed on 15 November 2012.

Species	Flora Survey 2011		
	GoN	CITES	IUCN
			species native from China have been assessed
Oroxylum indicum (L.) Kurz.	---	NI	Not yet been assessed
Pandanus nepalensis St. John	---	NI	Not yet been assessed
Rauvolfia serpentina (L.) Benth.	+	Appendix II	Not yet been assessed
Shorea robusta Gaertn.	+	NI	Least Concern
Vanda teres Lindl.	---	Appendix II	Not yet been assessed

Note:
[1]Protected under Forest Act 1993
NI -Not included, E-endangered, T - Threatened
CITES Appendix II are species which may not be necessarily threatened with extinction but may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with the survival of other species in the wild.

C.5.1.1 Loss of Vegetation

162. The Project (reservoir area and dam facilities) will affect a forest area estimated at 422.6 ha containing approximately 162,000 trees (**Table C.17** and **Table C.18**).

Table C.17 Affected Forest Areas

Forest Type	Reservoir (ha)	Project Facilities (ha)	Total Area (ha)
National Forest	259.84	51.91	**311.7**
Community Forest	88.77	16.79	**105.6**
Private forest	5.29	0.00	**5.3**
Total	**353.9**	**68.7**	**422.6**

Table C.18 Number of Trees Affected

Project Area	National Forest	Community Forest	Private Forest	Total
Reservoir	89,643	30,618	2,443	**122,704**
Project facilities	36,644	2,407	212	**39,263**
Total	**126,287**	**33,025**	**2,655**	**161,967**

C.5.1.2 Compliance with the Forest Guidelines

163. Forest Guidelines issued by the Forest Department in 2006 (*Guideline to Avail Forest Land for Other Development Purpose*, 2063) provide that the ratio of lost to planted trees is 1:25, requiring almost 4 million replacement trees for this Project. Based on the Forest Guidelines 2006, the Project is classified as a commercial venture; therefore it has to comply with a number of provisions. To meet these requirements the following mitigation measures are required to be implemented:

(i) survey of forest area in the presence of a forest officer, numbering all trees above 10 cm diameter at breast height (dbh) by species;

(ii) felling of the trees, branch cutting and stacking of the forest products within the felled areas;
(iii) new nursery development;
(iv) nursery seedling production for plantation development;
(v) acquisition of land area equivalent to the land area occupied by project structures;
(vi) plantation and maintenance of seedlings for five years in a new area; and
(vii) lease compensation for project-occupied land as per the Forest Regulation.

164. The EIA procedures require that all existing legal and guideline provisions need to be complied with while preparing the EIA report, therefore a land-for-land compensation for project-occupied forest areas and 1:25 tree replanting have been included in the EIA report (see Table 7.5 of EIA 2009).

165. Following the provisions in the Forest Guidelines, THL and NEA, in consultation with the Ministry of Energy (MOE) and the District Forest Office (DFO), will develop a nursery and afforestation program. To ensure the sustainable implementation of these schemes, consulting services will be financed by ADB. The framework for the organizational structure of program implementation will be developed in consultation with relevant authorities and stakeholders. The afforestation program will include consideration of opportunities to enhance habitat for important wildlife species (for example, additional forest cover near the tiger corridor).

166. NEA and THL will commence a dialogue through the MOE, once the project is awarded a generation license and the application for the tree clearance is filed with the Ministry of Forests and Soil Conservation (MoFSC).

167. Conservation of significant species will be enhanced, with propagation in the nursery from the seed collected from the project-affected trees 6-12 months before they are removed. **Table C.19** presents the activities required to comply with the Forest Guidelines.

Table C.19 Activities to be Undertaken to Comply with Forest Guidelines

Item	Target Area	Works
1. Survey	National forest, community forest	Blaze making, number writing, paint, brush, forester
2. Compensation	Private forest	Private forest, reservoir, project facility
3. Forest clearance	National forest, community forest, private forest	Tree felling, branch cutting, leaf removal, timber collection, making *chatta*, related activities
4. Nursery development		
4.1 Nursery establishment	National forest, community forest, procured land (41.15 ha)	Ground clearance, earthworks, fencing, fencing pole, fencing weir, water arrangements, land rental
4.2 Seedling product	National forest, community forest, procured land (41.15 ha)	• Preparation of polythene bed, polyethylene tube, soil preparation, tube filling, seeding propagation, caretaker, equipment and 10% contingency • Collection of seeds and fertile propagation material from areas to be cleared as base stock for nursery production
5. Land procurement	Procured land (41.15 ha)	---
6. Afforestation and maintenance	National forest, community forest,	Survey, clearing, ground preparation, seedling transportation, planting, maintenance (*shyahar*

Item	Target Area	Works
	procured land (41.15 ha)	*sambhar*) for 5 years, compost and fertilizer application (twice), caretaker for 5 years = 2,500 worker for 5 ha
7. Lease	National forest, community forest, grass land, shrub land	---

C.5.2 Mammals

168. An additional survey of terrestrial fauna was undertaken in July 2011 to assess and evaluate the findings of the earlier faunal surveys in the EIA (2009). Eight sites covering different elevations above the reservoir FSL (415 m) along the Seti River between Damauli and Kilchwok-Chhang were surveyed (see **Table C.20**). The wildlife survey primarily involved transect walk-over observations and consultations with local people. A summary of the observed and reported species recorded during the survey is given in **Table C.21** together with a summary of the previously reported species in the EIA (2009).

Table C.20 Sampling Points for Terrestrial Fauna Survey, 2011

Points	Elevation	Coordinates		VDC Ward	Description
		Easting	Northing		
V1	580 m	84°14'57.3"	27°56'42.2"	Shivapur - 1	West of Lokma settlement
V2	440 m	84°13'21.2"	27°57'04.5"	Kotdurbar - 2	North of Bajhgara
V3	452 m	84°10'39.5"	27°57'17.7"	Kotdurbar - 1	South of Korlan and North north east of Chap
V4	707 m	84°09'34.3"	27°57'42.8"	Rising Ranipokhari - 7	East north east of Bhaisikili
V5	441 m	84°13'50.9"	27°57'17.6"	Jamune -1	South of Manun settlement
V6	501 m	84°12'03.9"	27°57'53.9"	Jamune – 3	South of Thansin settlement
V7	498 m	84°09'22.4"	27°58'07.2"	Jamune - 6	South South west of Kilchok settlement
V8	505 m	84°09'29.8"	27°58'23.2"	Chhan - 2	South of Amdanda and West of Tutuwa across Seti River

169. The survey confirmed the presence of five mammalian species in the Project impact area, based on habitat condition and level of human activity. However, local people had previously reported the presence of 27 mammalian species in the Project area (see Sect. 4.2.2.1 of EIA 2009), including the Royal Bengal tiger (*Panthera tigris*) and four other species whose presence is now considered to be doubtful in the area. Based on independent references, the tiger is not expected to be present in the Project area. The absence of tiger is confirmed by the most recent information from the World Wildlife Fund (WWF) Nepal (WWF Tigers Alive Landscape; Action Plan for Tx2, Draft Report, Terai Arc Landscape, 2012) on Tiger habitat in Nepal which indicates that the dam and reservoir lie approximately 28 km north of the nearest "*core area*" and at least 16 km north of the nearest identified "*tiger habitat corridor*" (**Figure C.22**).[37] However, it was noted that about 7.5 km of the southern end of the proposed 220 kV Bharatpur transmission line crosses the "*tiger habitat corridor*".

[37]A "*core area*" is located in a protected area where tigers are known to occur, while "*tiger habitat corridor*" refers to a habitat link between core areas.

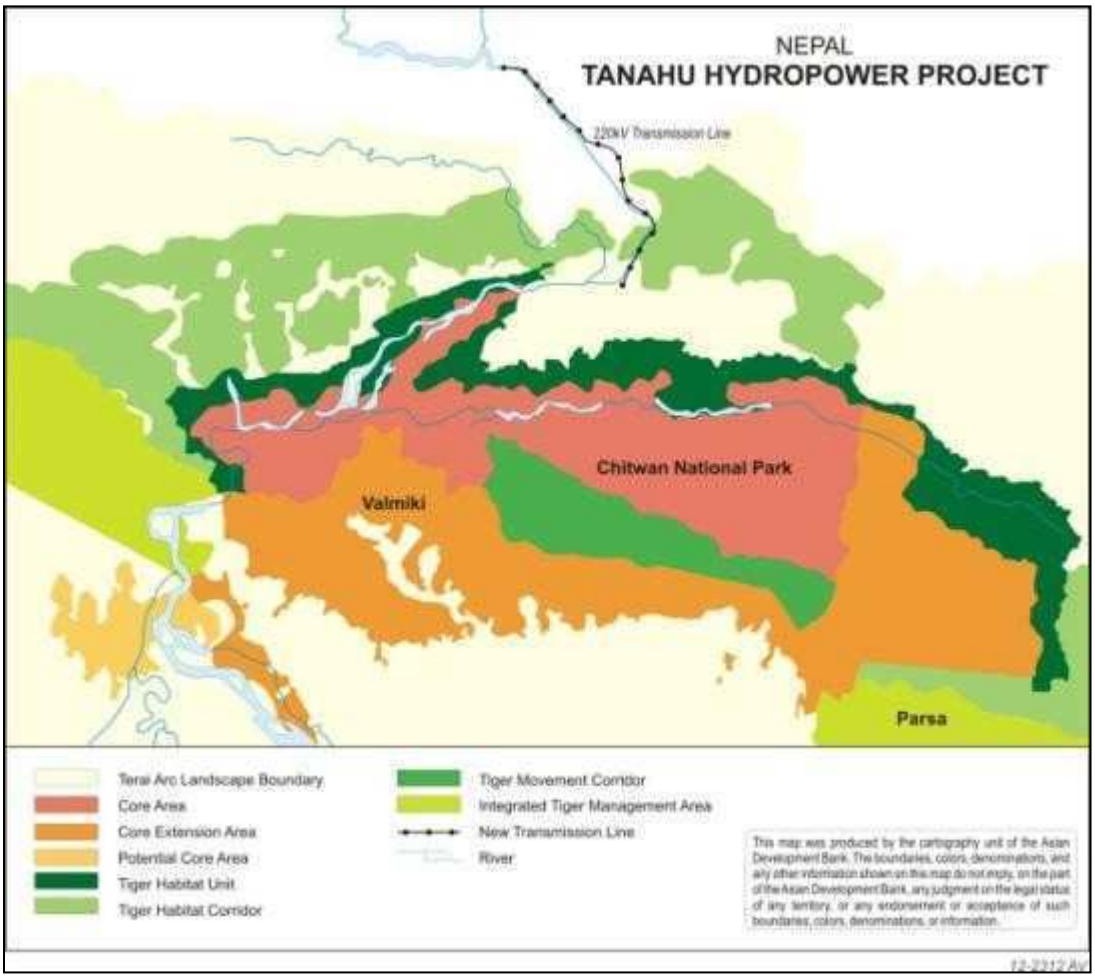
Table C.21 Mammal Species Recorded and Reported During Field Surveys Along the Seti River

Common Name	Scientific Name	Local Name	EIA (2009)	Addendum		Doubtful Presence	Conservation Status		
				Interview 2011	Survey 2011		CITES Annex	IUCN	GoN
Royal Bengal tiger	*Panthera tigris*	Bagh	✓	✓	-	Yes	I	EN	P
Clouded leopard	*Neofelis nebulosa*	Dhwanse Chituwa	✓	✓	-	-	I	VU	P
Himalayan black bear	*Ursus thibetanus*	Kalo bhalu	✓	✓	-	-	I	VU	-
Sloth bear	*Melursus ursinus*	Kathe Bhalu	✓	✓	-	-	I	VU	-
Common leopard	*Panthera pardus*	Chituwa	✓	✓	-	-	I	NT	-
Common Otter	*Lutra Lutra*	Ontt	✓	✓	-	Yes	I	NT	-
Assamese monkey	*Macaca assamensis*	Asami Bandar	✓	✓	✓	-	II	NT	P
Striped Hyaena	*Hyaena hyaena*	Hyaena / Bagh	-	✓	-	Yes	-	NT	-
Langur Monkey	*Semnopithecus entellus*	Langur (Kalo bander)	✓	✓	-	-	I	LC	-
Bengal Fox	*Vulpes bengalensis*	Fauro	✓	✓	-	-	III	LC	-
Jackal	*Canis aureus*	Syal	✓	✓	-	-	III	LC	-
Yellow throated martin	*Martes flavigula*	Malsapro	✓	✓	✓	-	III	LC	-
Palm civet cat	*Paguma larvata*	Bharse	✓	✓	✓	-	III	LC	-
Red fox	*Vulpes vulpes*	Rato Fyauro	✓	✓	-	Yes	III	LC	-
Leopard cat	*Felis bengalensis*	Chari bagh	✓	✓	-	-	-	LC	P
Jungle cat	*Felis chaus*	Ban Biralo	✓	✓	✓	-	II	LC	-
Porcupine	*Hystrix indica*	Dumsi	✓	✓	-	-	-	LC	-
Rhesus monkey	*Macaca mulatta*	Bandar	✓	✓	-	-	II	LC	-
Wild boar	*Sus Scrofa*	Bandel	✓	✓	-	Yes	-	LC	-
Barking deer	*Muntiacus muntjak*	Ratuwa Mirga	✓	✓	-	-	-	LC	-
Common rat	*Rattus rattus*	Musa	✓	✓	-	-	-	LC	-
Flying fox	*Pteropus giganteus*	Chamera	-	✓	-	-	-	LC	-
Bats	*Rhinolophus affinis*	Chamera	✓	-	-	-	-	LC	-
Flying squirrel	*Petaurista petaurista*	Udne lokharke	✓	✓	✓	-	-	LC	-
Mongoose	*Herpestes edwardsi*	Nyauri Musa	✓	✓	-	-	-	-	-
-	-	Hapsilo	✓	-	-	-	-	-	-

Common Name	Scientific Name	Local Name	EIA (2009)	Addendum		Doubtful Presence	Conservation Status		
				Interview 2011	Survey 2011		CITES Annex	IUCN	GoN
Rabbit	*Lepus nigricollis*	Kharayo	✓	✓	-	-	-	-	-
Squirrel	*Funambulus pennanti*	Lokharke	✓	✓	-	-	-	-	-
Wolf	*Canis sp*	Byanso	✓	✓	-	Yes	-	-	-

Note: EN = Endangered, VU = Vulnerable, NT= Near threatened, LC = Least concern (IUCN, 2010).
P = Protected by law.
* Previously reported by some local people, but denied by others.

Figure C.21 Tiger Habitat in the Project Region



Note: Chitwan National Park is the bright red area on the northern side of the Nepal-India border.
Source: WWF Tigers Alive Landscape: Action Plan for Tx2, Draft Report, Terai Arc Landscape (WWF Nepal and WWF India, 2012).

C.5.2.1 Mitigation Measures of Potential Impacts to the Tiger Habitat Corridor along the Transmission Line Right-of-Way (RoW)

170. To minimize the potential impacts on the tiger habitat corridor which will be traversed partly by the associated transmission line, the following mitigation measures were considered:

(i) Increase the tower heights so that RoW vegetation does not have to be cleared. However, this option will increase the vegetation area to be cleared at tower sites, and need longer construction period which can be disturbances for tigers.
(ii) Minimize the vegetation clearance within the RoW.

171. Vegetation removal within the RoW will be undertaken in accordance with electrical safety requirements. Minimizing the clearance will provide cover for tigers by:

- Strictly controlling vegetation clearance and pruning by marking out areas prior to vegetation removal and limiting clearance to areas essential to establish line electrical safety. Vegetation removal will be supervised by the DFO of each concerned district.
- Re-vegetating all RoW areas disturbed during construction. This will include top-soiling and seeding around tower foundations and bio-engineering measures where slopes have to be stabilized (e.g., planting of broom grass *Thysanolaema maxima* in erosion prone areas).
- During the operation of the transmission line, the central 15 m of the RoW will be allowed to regenerate to a height of between 1.5 m to 3 m, except within 8 m of towers where vegetation will be kept to a height of 30 cm to 50 cm. All other RoW areas will be maintained by pruning vegetation.

172. The vegetation of up to 3 m high within the RoW may increase the grazing habitat of tiger prey species, thus, providing a benefit to the tiger.

173. The exact height of towers will be finalized during route selection process which will be based upon vegetation condition and wildlife traffic within the vicinity by assessments on route survey and wildlife survey done before the construction considering condition of trees and traffic of animals within the corridor. A wildlife management plan has been prepared. To promote wildlife awareness and conservation, ADB is financing the required consulting services to implement this plan.

C.6 Reservoir Foreshore Stability

174. The EIA (2009) identified the areas that are susceptible to landslides, the localized construction-induced effects on land stability, and the areas that may have pronounced vulnerability to landslides, due to the formation and operation of a reservoir of about 7.26 km^2. The impacts and the appropriate mitigation measures have been included in the EIA (2009). In 2012, a landslide instability and erosion mapping of the reservoir foreshore was completed and the results are discussed in this section.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	•Sect. 4.1.2 Topography and Land Use •Figure 4.3 Distribution of Instabilities in the Seti Watershed •Sect. 4.1.4.2 Sedimentation	• No change
Impacts	•Sect. 5.1.1 Watershed Conditions •Sect. 5.1.2 Topography, Land Take and Landuse •Sect. 5.1.7 Sedimentation and River Morphology	• Landslide instability and erosion mapping study of reservoir foreshore completed in 2012 • Identified Project-induced processes that will potentially cause foreshore erosion
Mitigation	•Sect. 7.1.1 Watershed Conditions •Sect. 7.1.2 Land Take and Landuse	• No change during construction and operation

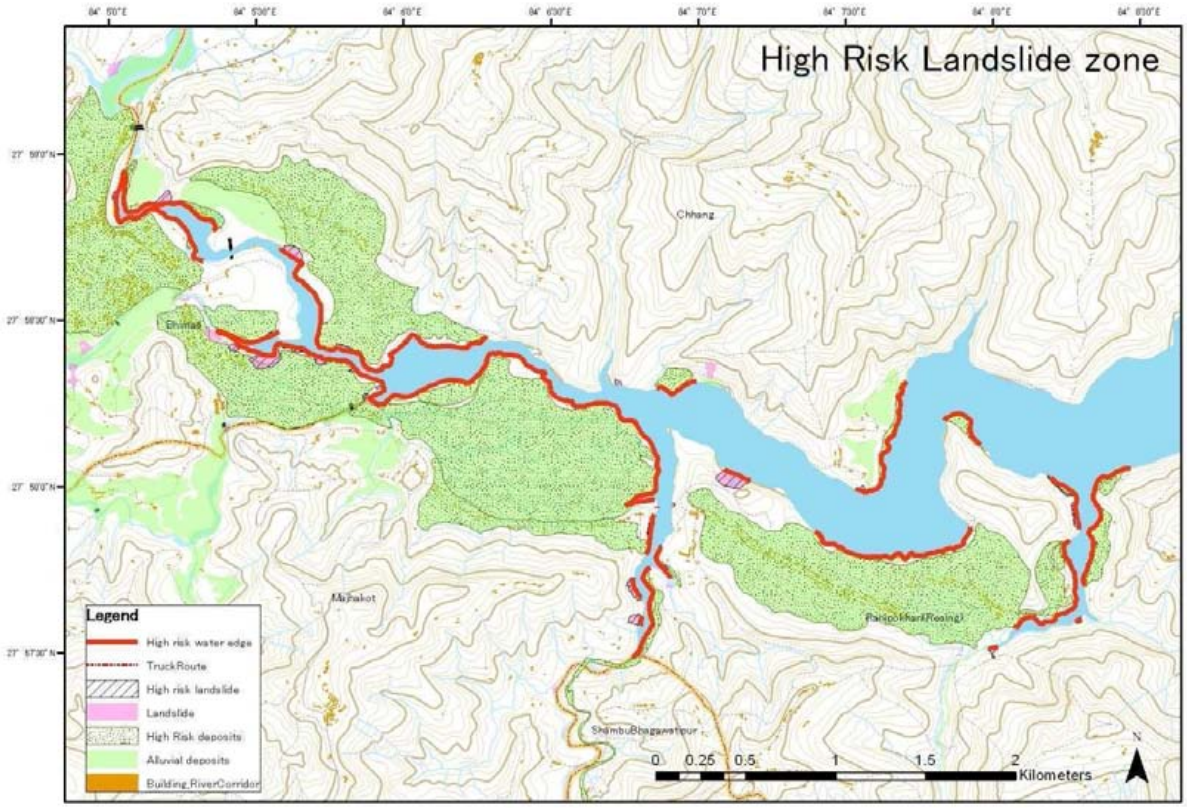
Description	EIA (2009)	Revised Environmental Addendum (November 2012)
	•Sect. 7.1.7 Sedimentation and River Morphology	*Additional measures* • Protection measures along the toe of identified high risk slopes that are at or below FSL and above MOL before reservoir filling

C.6.1 Impacts

175. The operation of the reservoir has the potential to cause erosion, slumpage, and landslides along the foreshore, primarily where the overlying soil structure is weak. A landslide instability and erosion mapping study of the reservoir foreshore was completed in 2012.

176. The study identified that the main instability near project sites occurs in the upper reaches of the proposed reservoir area, especially between Bhimad and Rising Patan (see **Figure C.22**). The steep cliffs of soft sand and gravel composing both banks of the Seti River, as well as the Jyagdi Khola, Wanteng Khola, and Phedi Khola, are highly vulnerable to failure. Another source of instability is the highly weathered colluvium located on steep banks of various streams and gullies.

Figure C.22 High Risk Landslide Hazard Zones



177. Four project-induced processes are likely to create foreshore erosion:

- **Wave action** – small wind-generated waves on the reservoir surface will cause minor soil erosion along the foreshore. Erosion is likely to be greatest at FSL, because water will remain at this level for 3-4 months each year. A lower rate of erosion is likely in the zone between FSL and MOL, as the water level will slowly decrease over six dry season months from the start of December to May, with little to no wave action likely below MOL.

- **River undercutting** – the creation of the reservoir has the potential to redirect river flows onto foreshore banks and cause stream flow erosion. This is most likely to occur along the uppermost 500 m-1,000 m of the reservoir, where sediment deposited into the reservoir backwater and the raised water level may direct the river flow onto reservoir foreshore banks (e.g., onto the riverbank directly below Bhimad village).

- **Rapid drawdown** – the rapid draining of the reservoir over a 10-day period in June each year, reducing the water level by 53 m from MOL (378 masl) to almost empty (325 masl), will result in an average daily drawdown rate of 5.3 m, equivalent to 1 m every 4.5 hours. This rapid rate of drawdown will result in rapid drainage of the saturated foreshore profile. Where soils have low shear strength, the drainage rate is unlikely to release the hydrostatic pressure, unless slumpage of the banks occur.

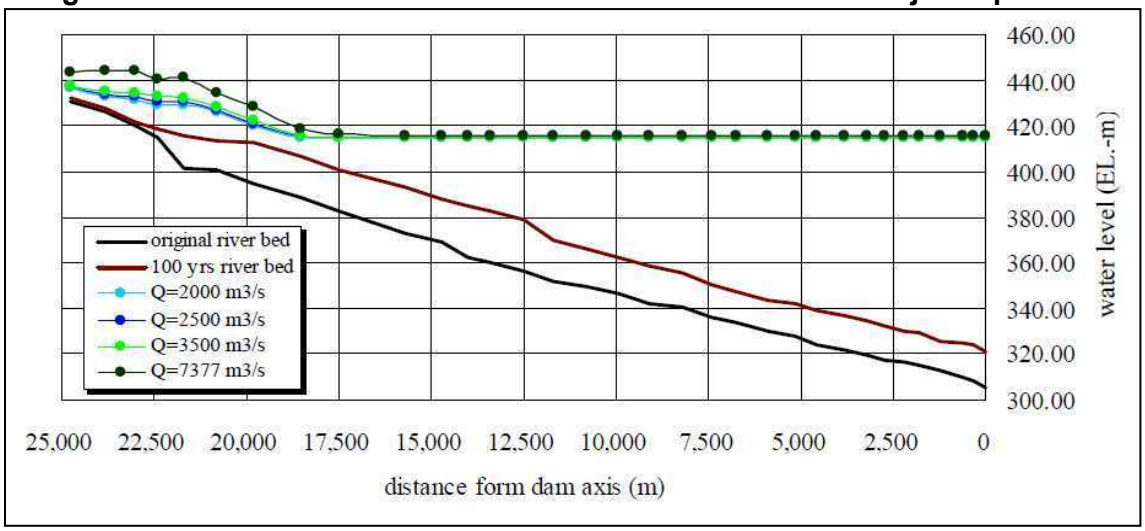
- **Gully erosion** – side watercourses that are not stable due to exposed rock are likely to be destabilized by undercutting where they meet the reservoir, leading to gully erosion progressing upslope.

178. The majority of foreshore instability is likely to result from the rapid drawdown of the reservoir, with the next most destructive processes likely to be river undercutting and gully erosion.

179. The foreshore ground surface along the lower 12 km of the reservoir between MOL and FSL will generally be stable due to shallow underlying rock. Approximately 50% of the foreshore along the upper 5-6 km of the reservoir consists of poorly consolidated alluvial deposits that are prone to erosion and landslip from Project-induced processes (see **Figure C.22**). River undercutting is expected to be greatest at the rear of the reservoir (western end), where deposited sediments will form a delta that will have a meandering river channel cutting through it, that could undercut foreshore banks at different points (see **Figure C.23**).

180. Foreshore erosion, slumpage, and landslides will result in land loss and produce sedimentation in the reservoir. The total amount of sediment that will be deposited into the reservoir is difficult to estimate. Of greater concern is the loss of land along the foreshore, posing a safety hazard for nearby dwellings at a few sites and the loss of productive land in numerous areas.

Figure C.23 Estimated River Bed Level After 100 Years of Project Operation



C.6.2 Mitigation measures

181. The following mitigation measures are proposed:

- Protection works will be installed along the toe of identified high risk slopes that are at or below FSL and above MOL, prior to reservoir filling, to assist these areas to stabilize over time. These locations will include unstable slopes lying directly below houses (see **Figure C.24**, **Figure C.25** and **Figure C.26**).
- Additional slope stabilization works will include slope shaping and bioengineering.
- Where private land is identified as being at risk of landslip or severe erosion, the existing physical land boundary will be surveyed onto cadastral sheets and photographed so that any Project-induced land loss can be accurately compensated after it has occurred.
- If private land along the reservoir foreshore is eroded, the landowner will be fairly compensated in accordance with the Resettlement Plan.
- Deposited sediments at the upper end of the reservoir will be bulldozed into the incised river channel, thereby promoting its downstream transport by river flows.

Figure C.24 Location of the Protection Work (1/3)

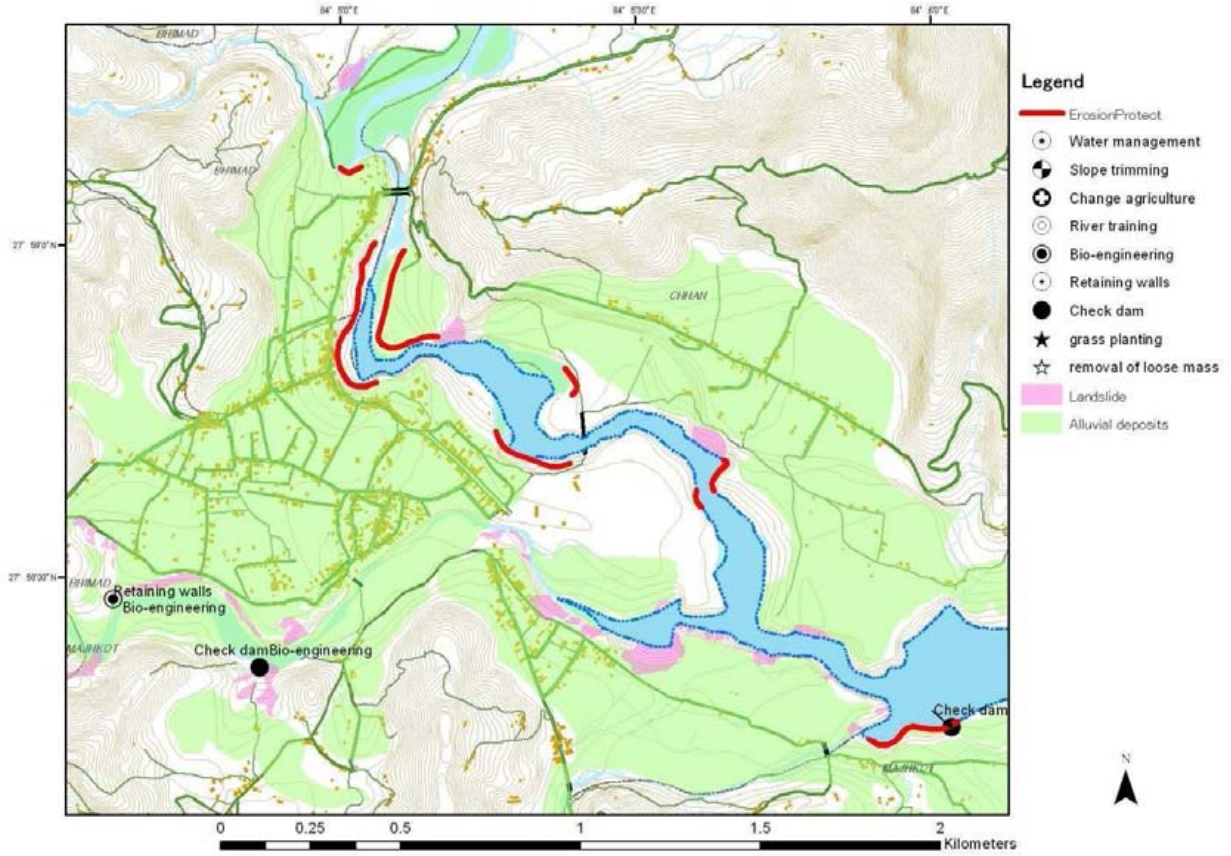


Figure C.25 Location of the Protection Works (2/3)

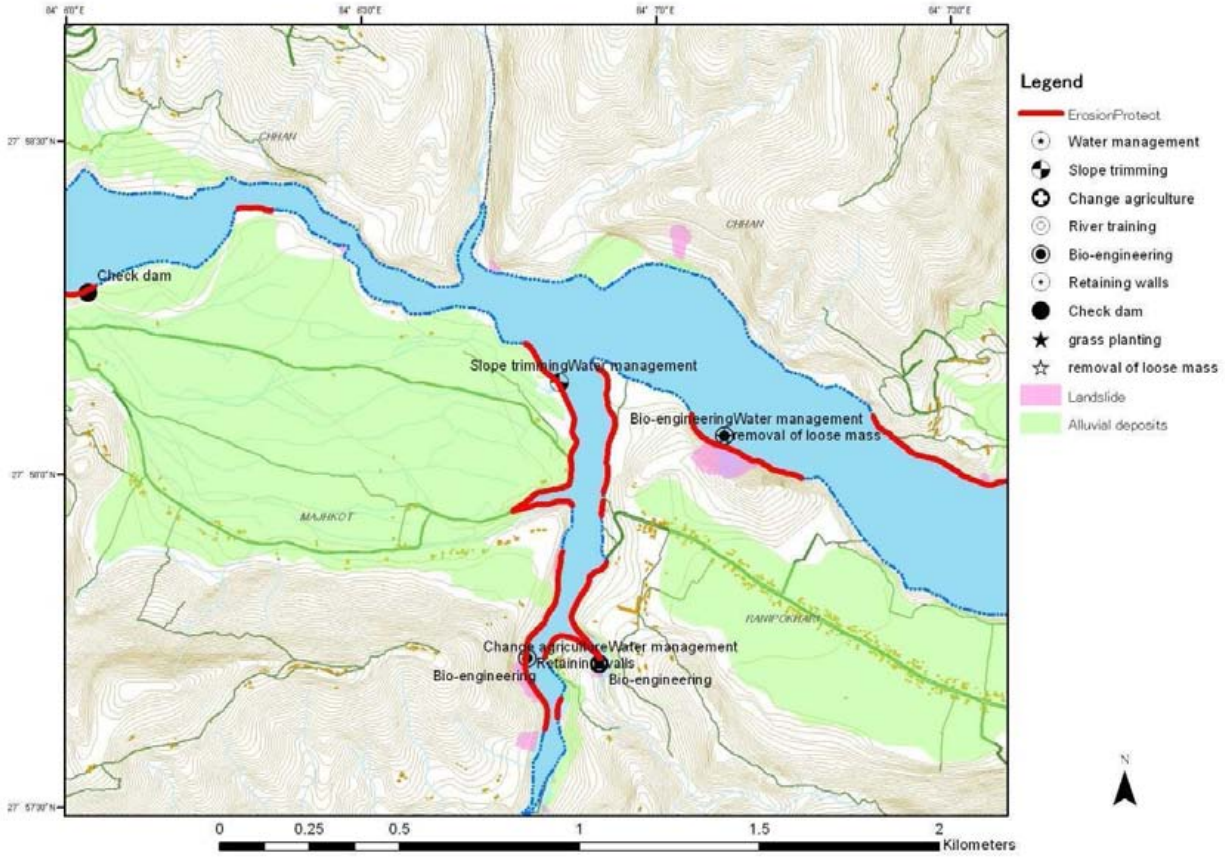
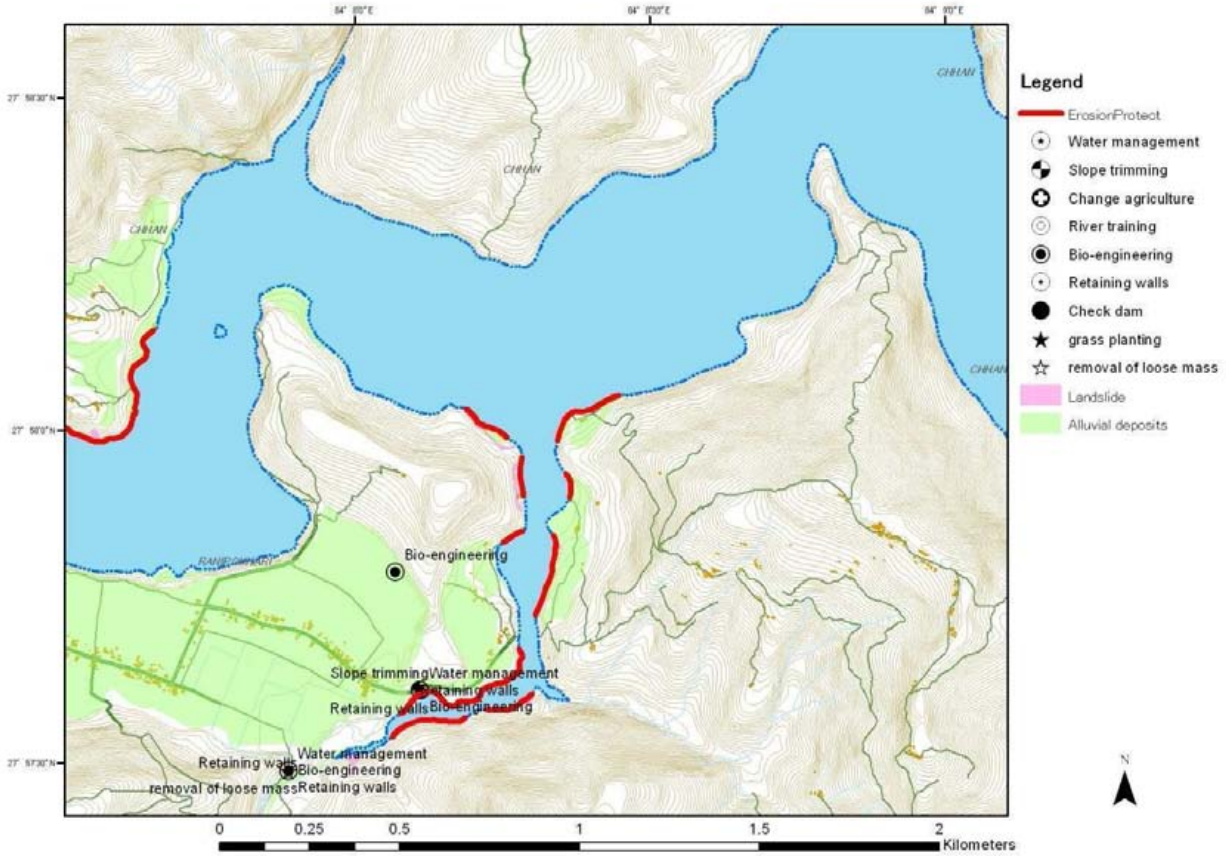


Figure C.26 Location of the Protection Works (3/3)



C.7 Spoil Disposal and Project Facilities

182. The EIA (2009) described the potential borrow areas in the Project description, and identified the impacts and mitigation measures. To supplement the discussion of the borrow areas in the EIA (2009), this section is added, based on the results of a detailed engineering study.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline Data	• Sect. 2.8 Borrow Areas •Figure 2.4 Affected VDCs and Location of Dam, Powerhouse, Borrow Area and Camp Sites of Upper Seti HEP	•Separate discussion on spoil disposal and project facilities to provide updated estimates of materials to be excavated and disposed •Disposal sites changed from 10 different sites in EIA (2009) to five disposal sites with a total capacity of 3.3 MCM and area of 41 ha •Identified seven criteria for selection of disposal site
Impacts	•Sect. 5.1.2 Topography, Land Take and Landuse •Sect. 5.1.11 Spoil Handling and Disposal •Sect. 5.3.2.1 Affected Land Parcels of the Project •Sect. 5.3.2.3 Affects on Private Built	• Potential to increase river levels due to spoil disposal was assessed by modeling • Established 36 river sections at Seti River and Madi River to determine impacts of disposal in areas upstream

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
	Structures •Sect. 5.3.3 Affected Structure Owners of the Project •Sect. 5.3.4 Residential Structure Affected Owners	• Upstream and downstream influence of using the disposal sites to river water level were evaluated
Mitigation	• Sect. 7.1.1 Watershed Conditions •Sect. 7.1.2 Land Take and Landuse •Sect. 7.1.11 Spoil Handling and Disposal •Sect. 7.2.3 Aquatic and Fisheries, (a) Muck Disposal Plan	• No change for physical facilities • Measures specific to spoil disposal sites adjacent to waterways are added

C.7.1 Spoil disposal

183. The disposal of spoil (muck) will be a major issue during project construction, due to the large volume of material generated (from dam site preparation, tunneling, road works, etc) and the limited stable disposal sites available in proximity to construction sites in the Damauli area. An estimated 1.97 MCM of rock and 297,000 m^3 of soil will be excavated for Project facility construction as indicated in **Table C.22**.

Table C.22 Estimated Total Excavated Material

No.	Structure	Excavation		Concrete	
		Common (m^3)	Rock (m^3)	Dam (m^3)	Others (m^3)
1	Access Road of Package 1	29,817	93,376		
2	Diversion Tunnel	13,500	31,500		21,264
3	Dam and Spillway	105,200	1,064,100	806,100	39,710
4	Intake	74,500	291,800		92,580
5	Headrace Tunnel		70,380		20,161
6	Surge Tank		19,530		7,028
7	Penstock		12,509		6,986
8	Draft Tunnel		12,321		2,877
9	Tailrace		14,283		3,451
10	Outlet	1,876	41,939		4,665
11	Powerhouse		81,700		21,649
12	Cable Tunnel & Terminal	7,830	52,614		3,522
13	Main Access Tunnel	4,440	65,840		
14	Access Road of Package 2	60,242	120,509		1,132
Total Excavation					
Slate			783,425		
Dolomite			1,188,976		
Common		297,405			
	Package 1	135,017			
	Package 2	162,388			

185. The total amount of aggregate required for the Project is 911,000 m^3. All of this material will be obtained from rock excavated during the construction of project structures; therefore an estimated 2.00 million m^3 (MCM) excess spoil will require disposal (**Table C.23**).

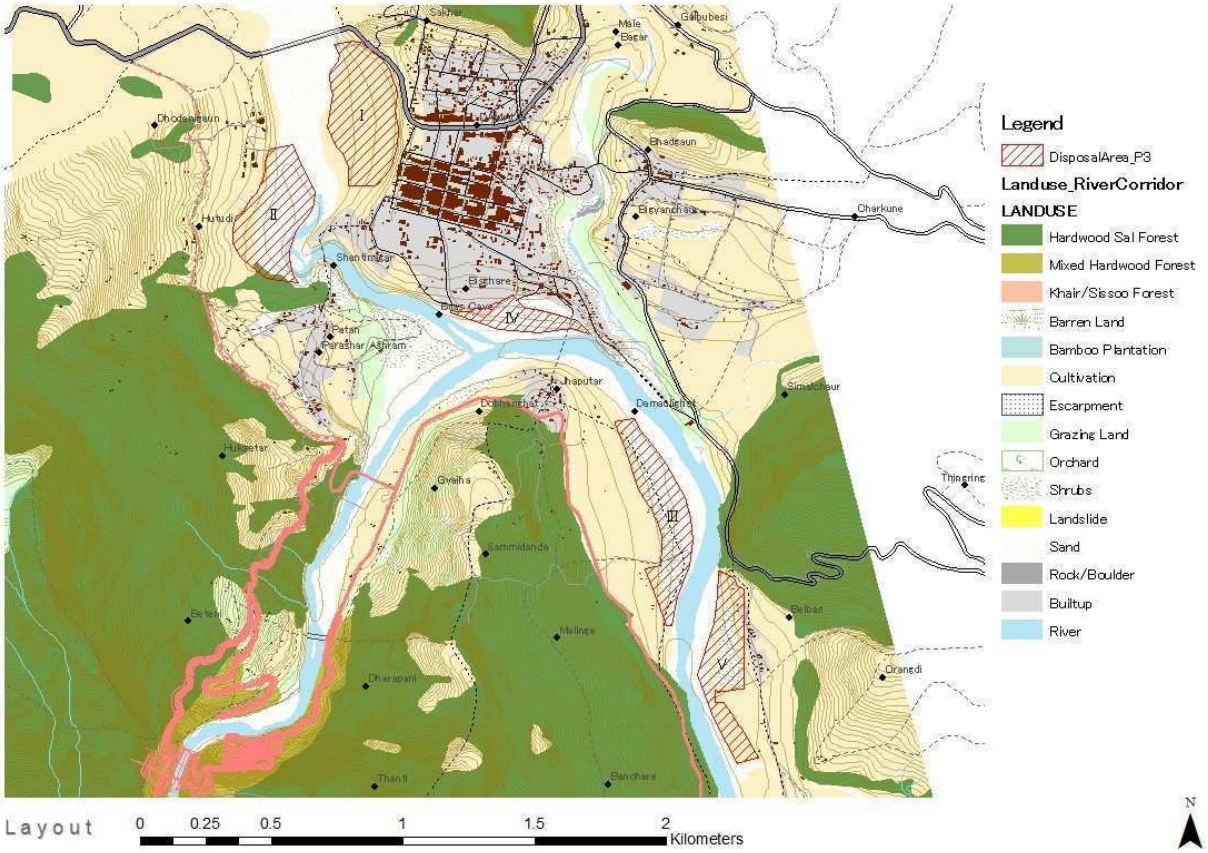
Table C.23 Estimated Disposal Volume per Site

	For Package 1	For Package 2
Disposal Area I Capacity (m^3)	796,500	-
Disposal Area II Capacity (m^3)	801,900	-
Disposal Area III Capacity (m^3)	-	833,500
Disposal Area IV Capacity (m^3)	-	229,400
Disposal Area V Capacity (m^3)	-	590,500
Total (m^3)	1,598,400	1,653,400

186. Disposal areas with a total capacity of 3.3 MCM have been identified in relatively close proximity (within 6-7 km) to the Project sites where excess material will be generated (**Figure C.27**) to ensure that sufficient capacity is available. The suitability of these sites for disposal areas has been evaluated based on:

- proximity to spoil generation sites;
- available capacity;
- land ownership;
- existing land cover and use;
- landowner willingness to sell or lease private land for spoil disposal (sell the land to the Project, retain it for future use, etc);
- potential to create future environmental and social impacts; and,
- potential uses of the final landform.

Figure C.27 Potential Spoil Disposal Sites



187. Spoil disposal site selection has emphasized the avoidance of environmental and social impacts (short and long term). This includes the use of low value land such as riverine deposits and degraded land, in preference to cultivation, sand and shrubs, in that order. Where riverine landforms are to be used, the potential for river redirection, flooding and erosion has considered, while the potential to create usable landforms (e.g., playing fields) from the final spoil landform has also been considered.

188. The land types at each proposed disposal site are summarized in **Table C.24**, consisting of:

- riverine government and private land adjoining the main river banks, where disposal will not unduly restrict flood flows; and
- riverside land with low production value (e.g. recent alluvial deposits, grassland, poor quality occasionally cropped land).

Table C.24 Existing Land Use on Proposed Disposal Sites (ha)

Land Use	I	II	III	IV	V	Total
Forest		0.30				**0.30**
Shrubs			4.42	0.91	2.18	**7.52**
Sand	0.31	6.90	3.07	2.18	1.06	**13.52**
Cultivation	11.01	2.29	1.46	0.08	4.17	**19.01**

Land Use	I	II	III	IV	V	Total
Built Up				0.27	0.14	**0.40**
River		0.27				**0.27**
Total	**11.32**	**9.76**	**8.95**	**3.44**	**7.55**	**41.03**

189. Lower value land will be used wherever possible, such as riverside deposits, degraded or barren areas, and grassland. For this reason the two most northern sites in **Figure C.27**, sites I and II, are preferred. In consultation with the landowners (Government or private), the final formed landform will be made suitable for uses such as playing fields where agreed, although this will not include agreeing to making the landform suitable for the construction of structures on the semi-compacted landfill.

190. The potential for spoil disposal to increase river levels, and thereby alter the path of river flows, and in turn cause downstream riverbank erosion, has been assessed by modeling upstream flow depth increases that are likely to result from the use of the two main spoil disposal sites, I to V.

191. **Influence on upstream area -** The relationship between river discharge rate and water level was calculated for (i) existing conditions and (ii) following disposal of spoil at sites I to V. Thirty six river sections were established along a predetermined stretch of the Madi River and Seti River, as shown in **Figures C.28** and **C.29**, respectively, with final spoil disposal landforms at sites I and II drawn on the plan. **Figures C.30** and **C.31** show the existing Madi River levels at different flow rates, and at different flow rates with the use of disposal sites I and II, respectively. **Figures C.32** and **C.33** show the Seti River levels at various flow rates when disposal site III and disposal site V are used.

Figure C.28 Location of Selected Madi River Cross-Sections

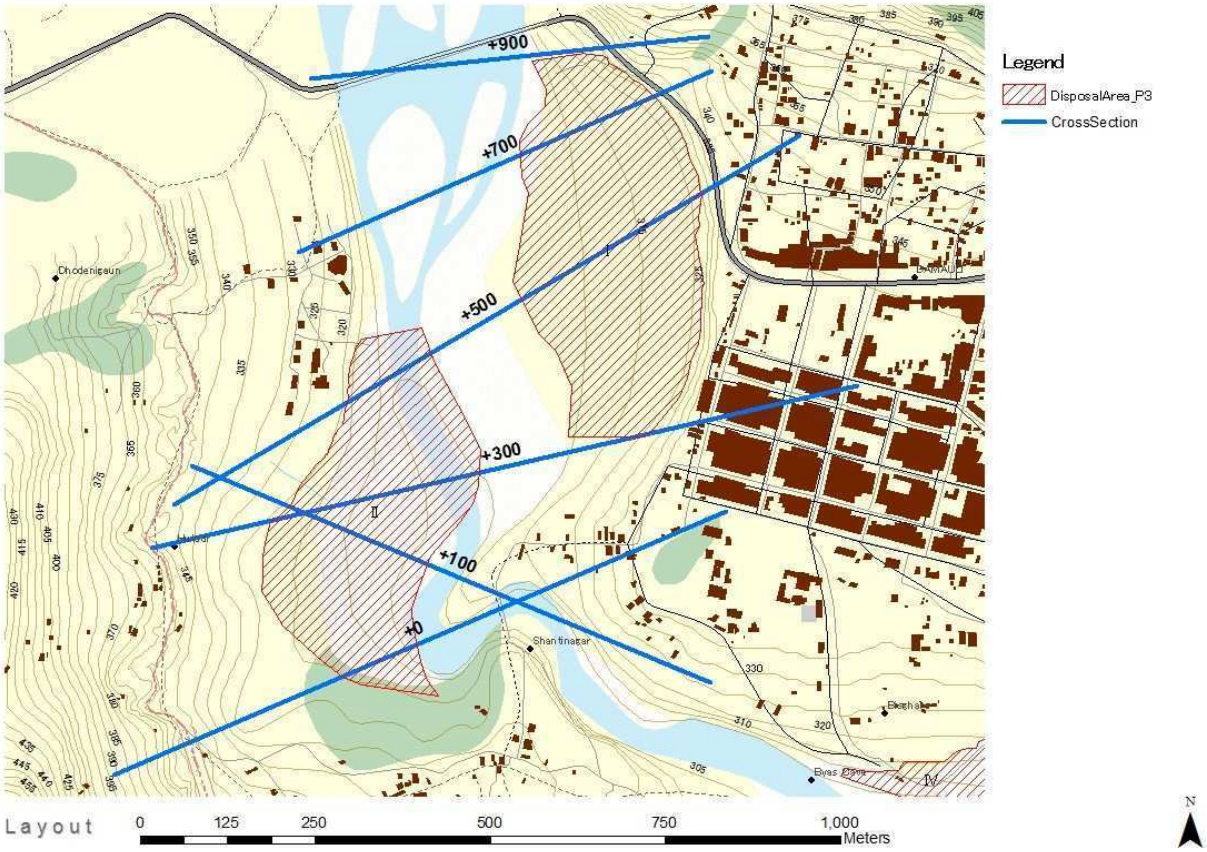


Figure C.29 Location of Selected Seti River Cross-Sections (0 to 4,000)

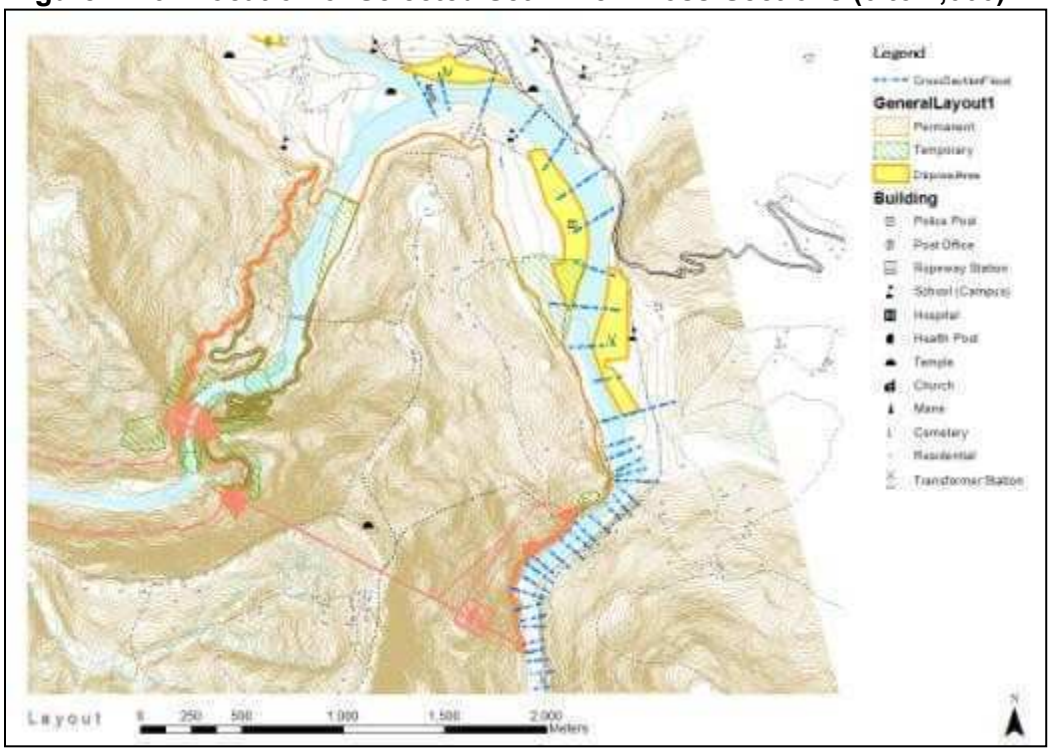


Figure C.30 Existing Madi River Levels at Different Flow Rates

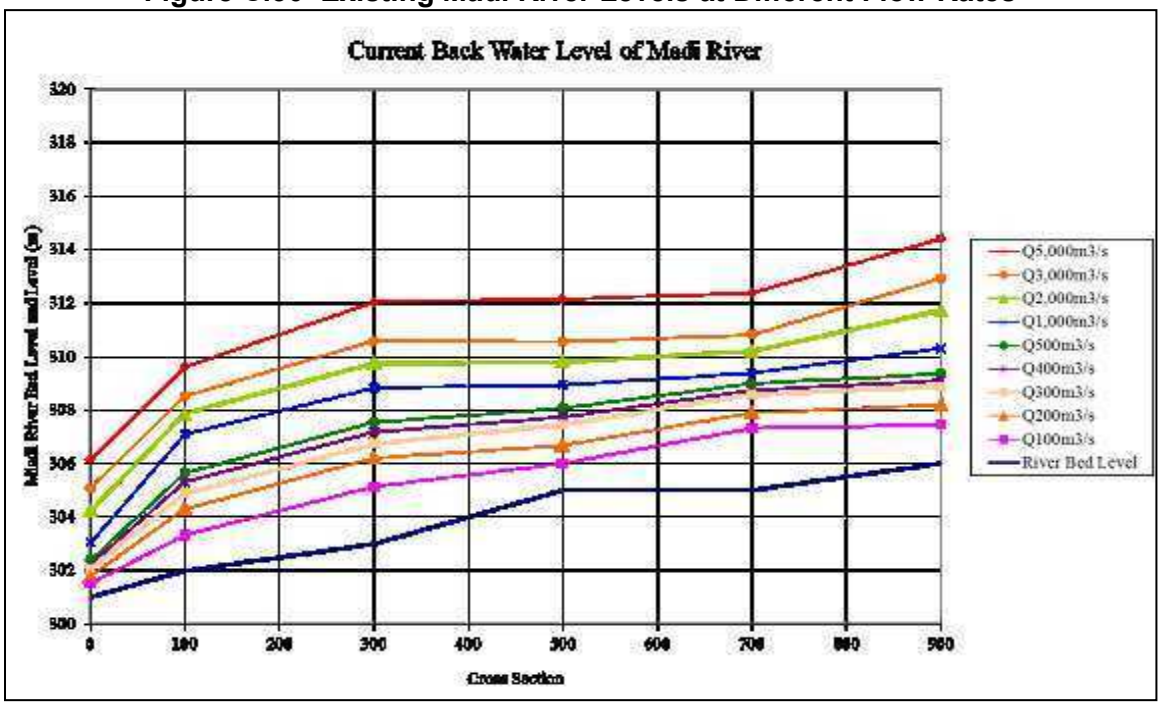


Figure C.31 Madi River Levels at Different Flow Rates Using Spoil Disposal Sites I and II

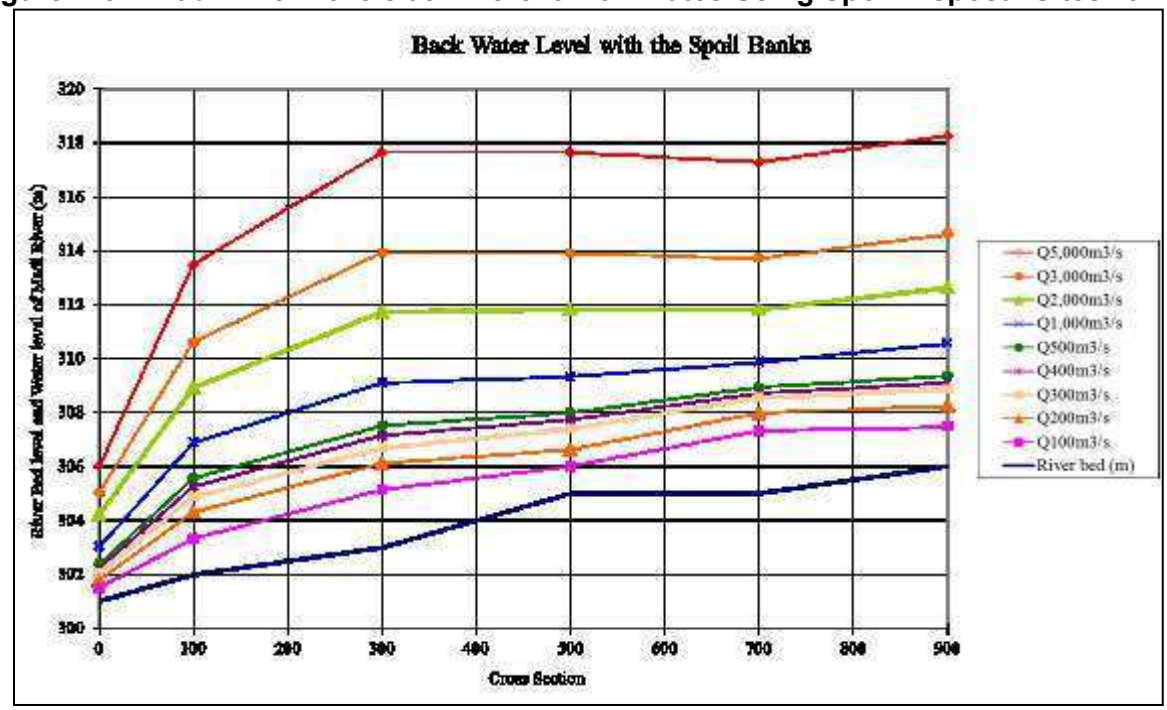


Figure C.32 Seti River Levels at Different Flow Rates Using Spoil Disposal Sites III to V (6,000 m^3 to 13,500 m^3)

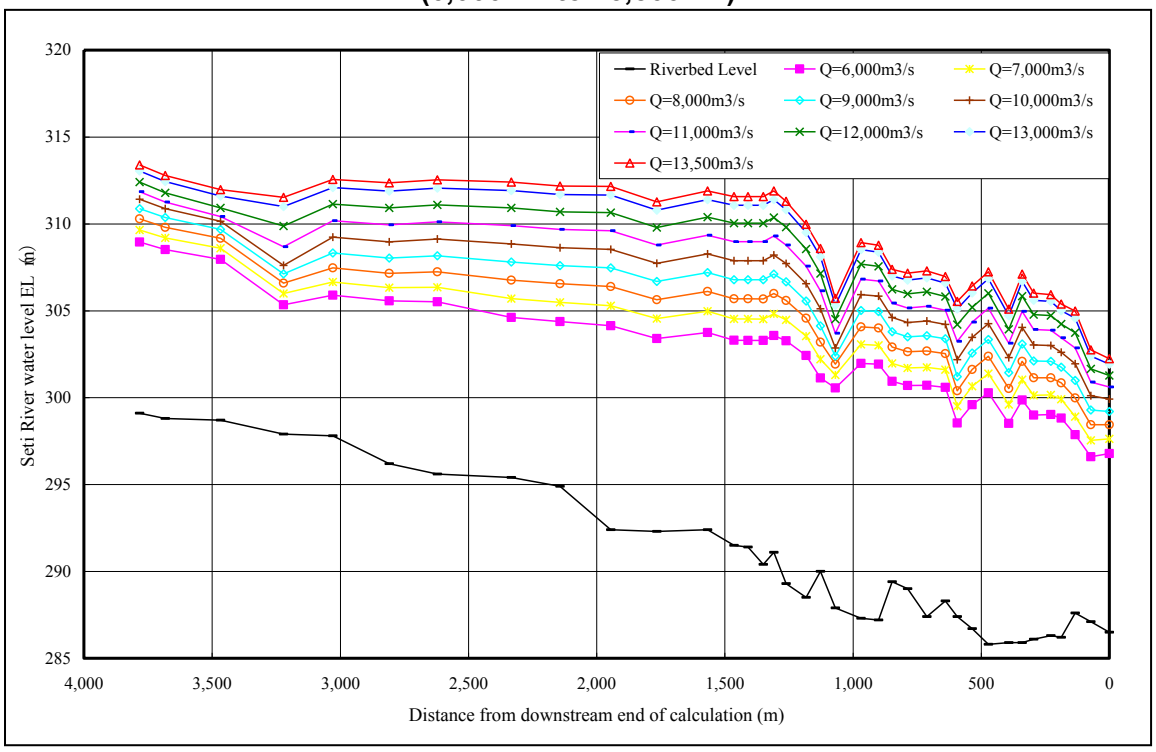
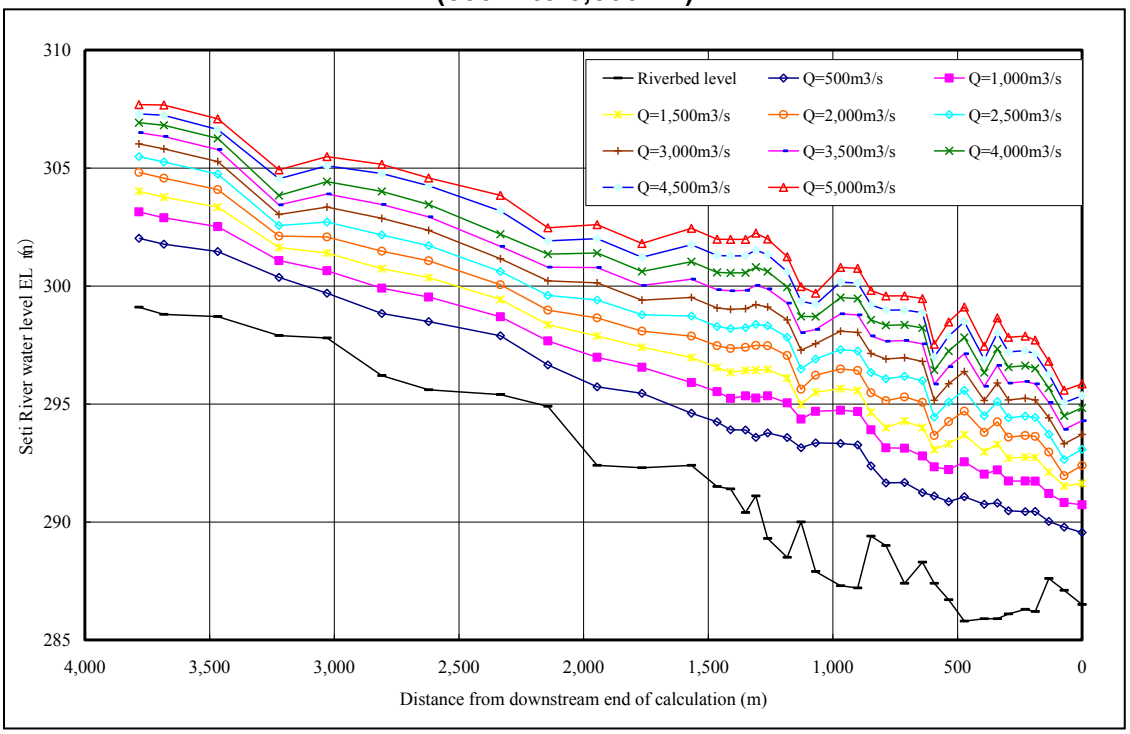


Figure C.33 Seti River Levels at Different Flow Rates Using Spoil Disposal Sites III to V (500m^{3}to 5,000 m^3)



192. The main findings of the estimation of Madi River and Seti River water level changes with the use of spoil disposal sites I to V are:

(i) use of spoil disposal sites I and II will only increase river depth slightly for river discharges of 1,000 m^3/s and less, equal to a 2-year probable flood event, as the spoil disposal landforms will only marginally constrict the river at these depths;

(ii) a 2,000 m^3/s river discharge, equal to a 20-year probable flood, will raise the river water level next to the disposal areas by up to 2 m, but the water level at the upstream end of disposal site I will not rise;

(iii) a 3,000 m^3/s river discharge, equal to 50-year probable flood, will raise the river water level next to the disposal sites and at the upstream end of disposal site I by 3 m and 1 m, respectively;

(iv) a 5,000 m^3/s river discharge, equal to 300-year probable flood, will raise the river water level next to the disposal sites and at the upstream end of disposal site I, 6 m and 4 m, respectively;

(v) use of the disposal areas III-V will hardly affect river water level adjacent to the disposal areas;

(vi) slopes of disposal areas III-V will be protected with rock gabions up to the water level corresponding to a 100-year probable flood; and,

(vii) disposal area IV will not be submerged for a flood of 13,000 m^3/s, corresponding to PMF at the confluence of the Seti River and Madi River converted from the ratio of catchment area at the Tanahu dam site and the confluence.

193. **Influence on downstream area** – The use of spoil disposal sites I and II will narrow the Madi River cross-section as described above, thereby obstructing larger river flood flows. This restriction in the river section will slightly elongate the flood duration and peak flow.

C.7.2 Mitigation measures

194. Spoil disposal site planning will be finalized during the project pre-construction phase, when a detailed plan will be prepared illustrating the agreed boundary of each disposal site, the proposed cross-sections, temporary and permanent drainage and sediment control works, permanent retaining structures, the final land profile, and topsoil stockpile areas.

195. Spoil management measures to be implemented will include:

- topsoil stripping and stockpiling prior to spoil placement;
- progressive installation of retaining structures, benches and drains to ensure landform stability and minimize erosion and sedimentation. This will include stabilizing the toe of the spoil disposal sites fronting the Madi River and Seti Rivers using rock gabion walls, and benching the fill batters of each disposal area that exceeds 7 m in height;
- layering and compaction of spoil as the material is placed; and,
- topsoil spreading and site re-vegetation of the final landform.

C.7.3 Temporary and permanent project facilities

196. Temporary facilities include an area for Package I, an area for Package II,[38] construction road, construction road area, and employees' and engineers' camp. Permanent facilities include the dam and powerhouse access roads and the area for the transmission line and switchyard. **Figure C.32** shows the location of the temporary and permanent project facilities. About 42.1 ha will be affected by proposed construction facilities. **Table C.25** presents the existing land use of the proposed construction facilities.

[38] Package 1 means "The work areas which are related to Dam and Intake construction". Package 2 means "The work areas which are related to construct tailrace tunnel and Power house".

Figure C.34 Temporary and Permanent Facilities

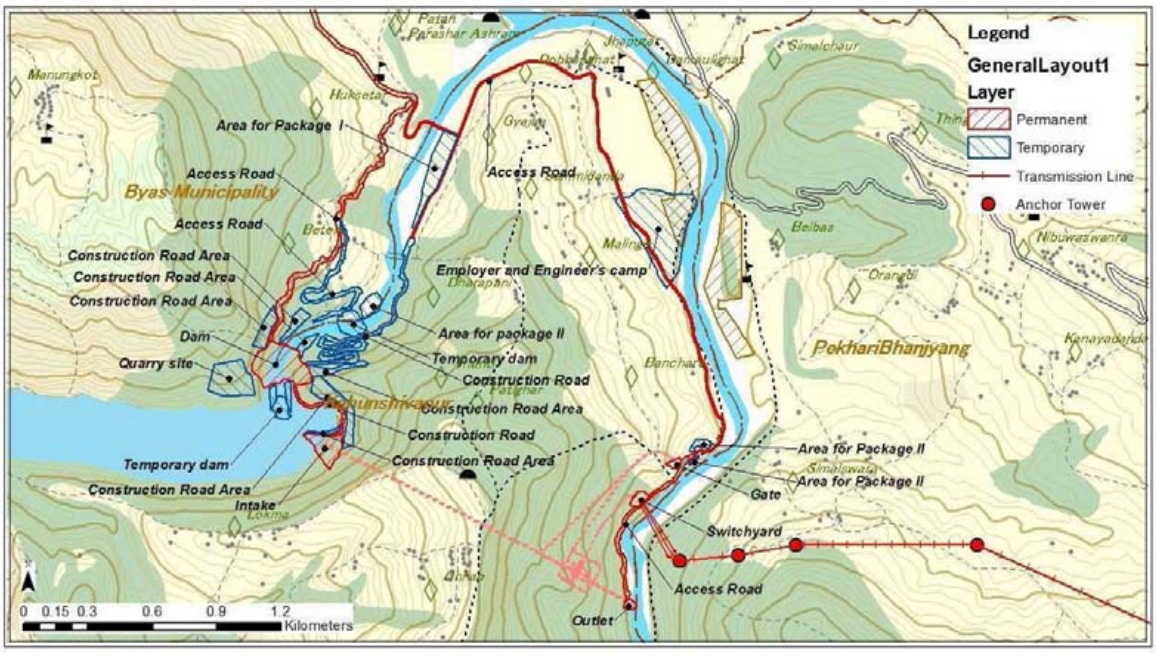


Table C.25 Existing Land Use at Proposed Construction Facilities (ha)

	Built-up	Cultivation	Grazing Land	Hardwood Sal Forest	Mixed Hardwood Forest	River	Sand	Shrubs	Total
Permanent	0.1	3.5	0.4	5.1	4.6	0.8	0.0		**14.5**
Access Road	0.1	3.5	0.4	4.2	0.1	0.0	0.0		**8.4**
Dam				0.3	2.9	0.7	0.0		**3.9**
Gate				0.2					**0.2**
Intake					1.6				**1.6**
Switchyard				0.4					**0.4**
Temporary		9.3	0.7	5.4	8.4	0.7	1.7	1.3	**27.5**
Access Road		0.0	0.6	0.1	0.9		0.0		**1.7**
Area for Package I		2.7					0.0		**2.7**
Area for Package II			0.1	0.4	0.1	0.0	0.6		**1.2**
Construction Road		0.1			3.0		0.1		**3.2**
Construction Road Area				1.2	3.8	0.1	0.2		**5.3**
Employer and Engineer's camp		6.5		0.9			0.1	1.3	**8.8**
Quarry site				2.7	0.1				**2.8**
Temporary dam					0.6	0.6	0.7		**1.8**
Total	**0.1**	**12.8**	**1.1**	**10.5**	**13.1**	**1.5**	**1.7**	**1.3**	**42.1**

C.8 Air Quality

197. The EIA (2009) included a discussion of the existing climate, meteorology and air quality, including the Project impacts and mitigation measures. No update on baseline data was done following the EIA (2009), but additional impacts and mitigation measures were identified and discussed below.

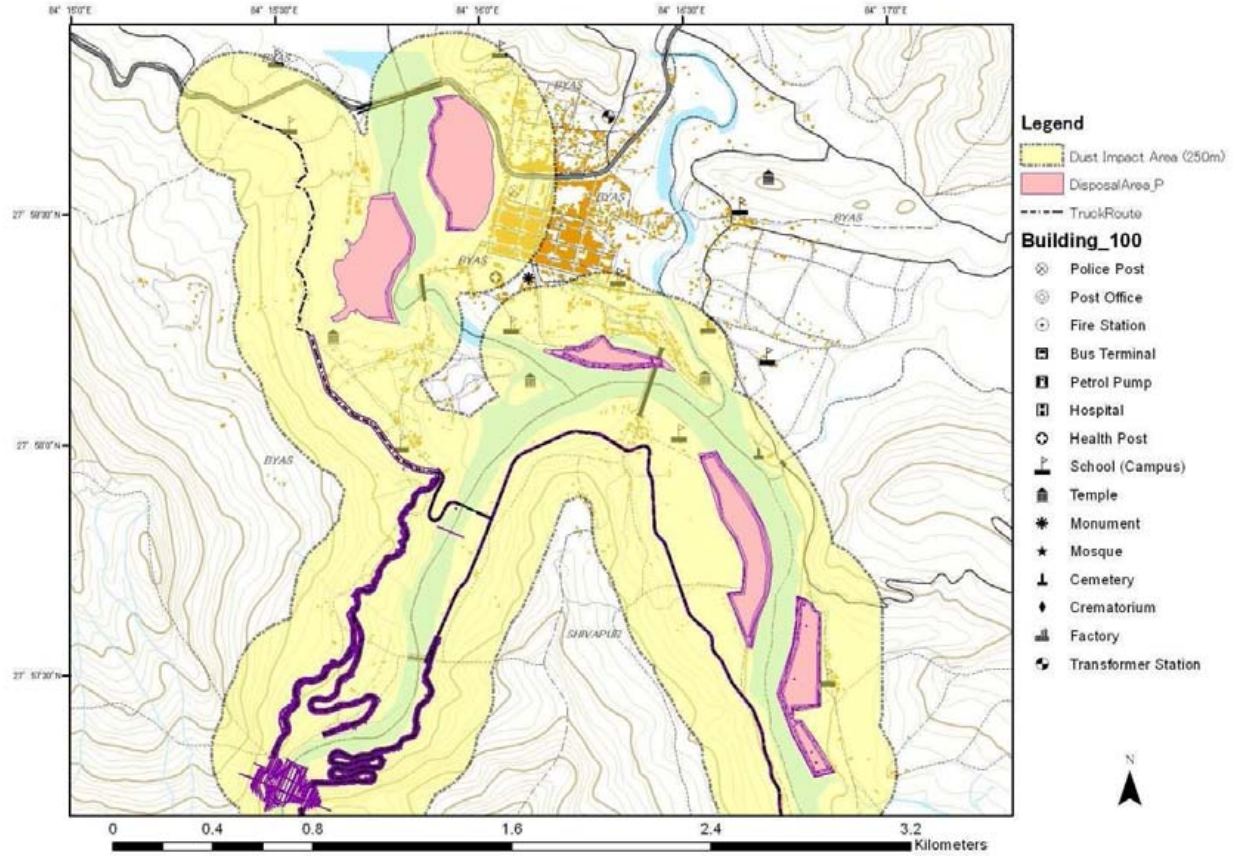
Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	•Sect. 4.1.3 Climate, Meteorology and Air Quality	• No change
Impacts	• Sect. 5.1.3 Air Quality	• No change, but identified area of impact of access roads and estimated 857 buildings may be affected in Shivapur and Byas villages
Mitigation	•Sect. 7.1.3 Air Quality	• No change, but added mitigation measures such as gravelling of main Project access roads, progressive site re-vegetation, etc.

C.8.1 Impacts

198. The main sites where dust will be generated by construction activities include the access roads, dam site, tailrace outlet area, quarries, borrow areas, crushing and batching plants, and spoil disposal sites.

199. Access roads are likely to be the main source of dust, due to the volume of traffic using these accesses, to transport material to the main construction sites. The area of impact of each access road is likely to be up to 250 m from the road (**Figure C.33**). An estimated 857 buildings are located in this zone, primarily consisting of houses adjacent to the dam, access road, and potential spoil disposal areas, in Shivapur and Byas villages. The total duration of dust generation will be the five-year construction period.

Figure C.35 Dust Impact Area from Access Roads and Spoil Disposal Sites



C.8.2 Mitigation measures

200. Dust suppression measures that will be implemented during construction will include:

- gravelling the main Project access roads and adjacent community roads;
- on-site speed restrictions for construction traffic;
- frequent watering of gravel roads each day when visible dust is generated, primarily during the dry season;
- erection of roadside fences near houses/villages to reduce wind-borne dust movement;
- vehicle washing prior to leaving the site;
- careful handling and containment or damping of dusty materials on-site, including the use of dust suppression/filtering on crushing and batching plants;
- frequent watering of spoil disposal areas during dumping and landforming; and,
- progressive site re-vegetation as each landform is completed.

C.9 Greenhouse Gas Emissions

201. This is a new section added to determine the CO_2 emissions that will be avoided due to the Project.

202. According to *Climate Change Policy* (GoN, 2011), Nepal has experienced a recent average maximum annual temperature increase of 0.06^{o}C. This rate of increase is higher in the

mountains than in other regions. Millions of Nepalese are estimated to be at risk due to climate change. In the past 90 years, a glacier in the Sagarmatha region has receded 330 feet vertically. This project will contribute to the reduction of greenhouse gas emissions (GHG).

203. The project is designed to primarily supply power to the Nepal grid, with the possibility of power export to India. According to ADB Results Framework Indicators Definition (2012), the emission factor for oil is 754 ton CO_2/GWh while in an India Clean Development Mechanism (CDM)-registered project with the United Nations Framework Convention on Climate Change (UNFCCC), the emission factor is 949 ton CO_2/GWh. Thus, 169.5 ton CO_2/GWh is applied as the baseline for this project. The annual CO_2 emissions that will be avoided by the generation of renewable energy from the Project during the initial 10 years (587.7 GWh) and from 11 years onward (489.9 GWh) are 97,581 tons CO_2 and 83,038 tons CO_2, respectively (**Table C.26**).

Table C.26 Estimation of Annual Greenhouse Gas Emission Avoidance

Parameter	Initial 10 Years	After 10 Years
CO_2/GWh applied as the baseline for this project	169.5	169.5
Total energy per year (GWh)	585.7	489.9
CO_2 emissions avoided (t CO_2/year)	97,581	83,038

C.10 Rafting

204. The EIA (2009) did not include the existing number of rafting operators along the Seti River downstream of the tailrace, but recognized the potential impacts of regulating the river flows due to power generation during the Project operation phase. Following the EIA (2009), consultations were held in 2012 with current rafting operators using the Seti River downstream of the tailrace. The implications of Project operation for rafters are discussed in the following section.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	• No discussion	• About 75 tour companies operate in Nepal • No available data on rafting operators along Seti River • Rafters are charged about US$60 to US$75 per person per day
Impacts	•Sect. 5.3.8.2 Socio-economic and Cultural Impact during the Operation Phase, (II) Impact on White Water Rafting	• No change *Additional information*: • Flow changes at Seti River in relation to rafting • Current rafting activities and project operation
Mitigation	• Table 7.11 Matrix of Environmental Impact and Mitigation Measures	• Survey rafting activities at Seti River during the rafting season prior to Project operation • Continue consultations with rafting operators once power generation hours are finalized • Installation of sirens in 14 riverside villages and 55 warning signs as well as light posts downstream from dam site to Trisuli River

205. The Seti River is seasonally used for commercial rafting from Damauli (3 km downstream of the dam site) to Gaighat at the Seti River-Trisuli River confluence, with a small number of trips continuing further downstream to Devghat, a religious place in the Chitwan Dun Valley at the confluence of the Trisuli River and the Kali Gandaki River. In addition, the Trisuli River-Narayani River is used for rafting, with the section from the Seti River-Trisuli River confluence downstream to Narayangahat forming the lower part of the Trisuli River rafting route. The Trisuli River is the most popular rafting river in Nepal, primarily due to its close proximity to Kathmandu.

206. During the consultation on 16 May 2012, the Nepal Association of Rafting Agents (NARA), represented by Nani Kaji Thapa, President, and Megh Ale from the Nepal River Conservation Trust (NRCT), reported that rafting is undertaken between 9 am and 5 pm each day from late September to May on the Seti River. The peak season runs from late September to the middle of December, with the middle season being February to May. During the monsoon (mid June to late September) rafting is rarely undertaken, as high river flows make rafting conditions dangerous.

207. Around 75 tour companies operate rafting trips across Nepal, variously headquartered in Kathmandu, Pokhara, and at other locations. The number of rafting companies that use the Seti River is not known, but an estimated minimum of 200 persons raft the Seti River each day during the rafting season, with this number expected to increase over time. Rafters are charged US$60-75 per person per day (NARA, pers. comm.).

208. NARA raised three main concerns about Project-altered river flows: (i) the sudden release of water may affect daily rafting activities; (ii) the rafting season may be shortened; and, (iii) rafting gear may be washed away. NARA stated that the release of water from the reservoir should commence before 9 am and continue until 5 pm. NARA also recommended that tourist companies should be compensated for any loss of business. To determine the extent of existing rafting operations that may be affected by Project operation, a survey of rafting operators along the Seti River at Damauli will be conducted during the rafting season prior to the operation of the Project.

C.10.1 Impacts

209. Flow changes that will be created by the Project along the Seti River from Damauli to the Seti River-Trisuli River confluence that have the potential to affect rafting will consist of:

- **Dry season generation - November to May**

  (i) Generation release of between 144 m^3/s to 173 m^3/s for 6 hours to 19 hours per day. The minimum release for six hours per day (January and February) is likely to occur between 6 AM and 9 AM and 6 PM and 9 PM. The release for 18 hours to 19 hours per day (May and November) is likely to occur between 4 AM until 10 PM to 11 PM, which is the period of highest power grid demand.

  (ii) A reduction in natural flows by around 50% when generation is not occurring over 5 hours to 18 hours per day (see **Table C.2**). During the non-generation periods, no flow will be released from the reservoir. In this case, the downstream flow will be coming from the Madi River which contributes around 45% of the total natural

Seti River flow immediately below the confluence of these two rivers and the environmental flow release of 2.4 m^3/s.

- **Reservoir draining in mid June** (10 days) – release of up to 1,000 m^3/s over 10 days primarily from the dam to drain the reservoir;

- **Sediment flushing in late June** (10 days) – release of the entire natural river flow;

- **Reservoir filling in early July** (5-7 days) - no release from the tailrace outlet or dam apart from the environmental flow release of 2.4 m^3/s; and,

- **Monsoon generation from June to October** – a release of 127 m^3/s generation flow for 24 hours per day, plus spill flows over the dam when the reservoir is full and very high monsoon river flows occur (primarily in August and September).

210. River flow changes created by Project operation during the monsoon will be relatively minor, ranging between 0 and 12.5% (a reduction) from July to September. Given that these small flow changes are well within natural daily flow variations and there is a lack of rafting activity during this season, there will be no discernible effect on rafting during the monsoon. Similarly, the release of 1,000 m^3/s over 10 days when the reservoir is being emptied will have no effect on rafting as the release will occur during the start of the monsoon when no rafting occurs. **Table C.27** presents the rafting operation "with" and "without" the Project.

Table C.27 Rafting – Current and During Project Operation

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Current	I	I	I	I	I	III	IV	IV	III	I	I	I
Project Operation	II	II	II	I	I	III	IV	IV	III	I	I	II

I - rafting
II – less flow for rafting
III - rafting for part of the month
IV – no rafting

211. As per Table C. 27, rafting activities can be impacted from the proposed dam operation and may potentially reduce the months available per year for rafting.

212. Once the Seti River flows into the Trisuli River, then the influence of Project-altered Seti River flows will diminish substantially due to the volume of flows in the receiving Trisuli River, as indicated in **Table C.28.** Except for monsoon period (currently rafting operation is limited during monsoon season) rafting should be available for the rest of the year in Trisuli River which will be ascertained through dialogue with NARA.

Table C.28 Estimated Average Monthly Flow Rate - Immediately Upstream and Downstream of the Seti River-Trisuli River Confluence

River	Phase	Flow Rate (m^3/s)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Seti River – immediately upstream Trisuli confluence	Existing	56	49	49	56	90	251	620	675	450	226	108	71
	Operation	159	153	151	150	170	378	620	601	450	254	186	167
Trisuli River – immediately	Existing	230	195	188	235	473	1,321	3,230	3,715	2,310	949	472	308

downstream Seti confluence	Operation	333	299	290	329	553	1,448	3,230	3,641	2,310	977	550	404

C.10.2 Mitigation measures

213. The objectives of proposed mitigation measures are as follows:

- To ensure that the impact to rafting is adequately addressed, the Project will survey rafting operators along the Seti River at Damauli during the rafting season prior to the operation of the Project. The survey will record the operator's name, number of paying passengers, and destination and length of each rafting trip on the Seti River to determine the extent of rafting operations.
- Once the project generating hours are finalized, consultations will be held with the surveyed operators and NARA and to develop mitigation measures, as required.
- Compensation to rafting operators will be considered if rafting is unduly restricted, but this will be based on the reduction in rafting on the Seti River and the availability of alternative rivers for rafting (e.g., the Trisuli).
- Automatic sirens will be installed at 14 riverside villages from the dam site down to the Trisuli River confluence, as well as 55 signs along this stretch of river, and light posts where needed.

C.11 Access and Infrastructure

214. The EIA (2009) identified the community infrastructure, its ownership, and limitations to access, due to Project construction and operation. During the census survey in 2011-2012, an update on the affected infrastructure was done, including the revised cost estimates associated with replacement, discussed below.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Impacts	•Sect. 5.3.2 Direct Impacts to the Household •Sect. 5.3.3 Affected Structure Owners •Sect. 5.3.7 Socio-economic and Cultural Impact during the Construction Phase	• Update on affected infrastructure based on census survey 2011-2012
Mitigation	• Sect. 7.3.1 Acquisition of Land and Property •Sect.7.3.2 Affected Infrastructure	• No change • Revised cost estimates from the Draft Resettlement Plan (August 2012)

215. Reservoir inundation will affect a range of community infrastructure, including motorable roads, suspension bridges, foot trails, sources of drinking water, *ghats* and *thati*, as summarized in **Table C.29**.

Table C.29 Affected Infrastructure

Items	Number
Temple	2
Sources of Drinking water	2
Ghats (cremation site)	9
Thati (Resting places with/without structures)	6
Suspension bridges	7
Foot Trails	11

Source: Census Survey, 2011-2012

216. The Project will reinstate access to settled areas that will be cut off by the reservoir, most likely with new suspension bridges (see **Table C.30** for costs).

217. The detailed planning of infrastructure reinstatement will occur during the first year of project construction, in consultation with affected communities, and the required works will be installed over the following two years.

Table C.30 Estimated Infrastructure Replacement Cost (Direct Cost)

SN	Description	Cost estimate (NRs)
1	Community Structures	1,500,000
2	New suspension bridges	247,450,000
Total		248,950,000

Source: Resettlement Plan (THL/NEA, Aug. 2012)

C.12 Occupational Health and Safety

218. The EIA (2009) discussed concerns regarding occupational health and safety in various sections, such as water supply, sanitation and health, accidents and occupational health, and the influx of workers during construction.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Impacts	•Sect. 5.3.7.2 Water Supply, Sanitation and Health •Sect. 5.3.7.3 Accidents and Occupational Health •Sect. 5.3.7.5 Inflow of a large number of workers	• No change
Mitigation	•Sect. 7.1.4 Noise and Vibrations •Sect. 7.3.3 Water supply, sanitation and health •Sect. 7.3.4 Safety and occupational health •Sect. 7.3.6.1 Inflow of workers	• No change

219. Given the duration of the construction phase (about five years) and the number of workers, a construction and camp management plan (CCMP) will be required from the Contractors and reviewed by THL/NEA to ensure that there is guidance on issues such as security, maintenance and sanitation of camp facilities, safety trainings, workers' conduct, both in the construction areas and nearby communities. The costs of the measures included in the CCMP to ensure occupational health and safety will be part of the construction budget.

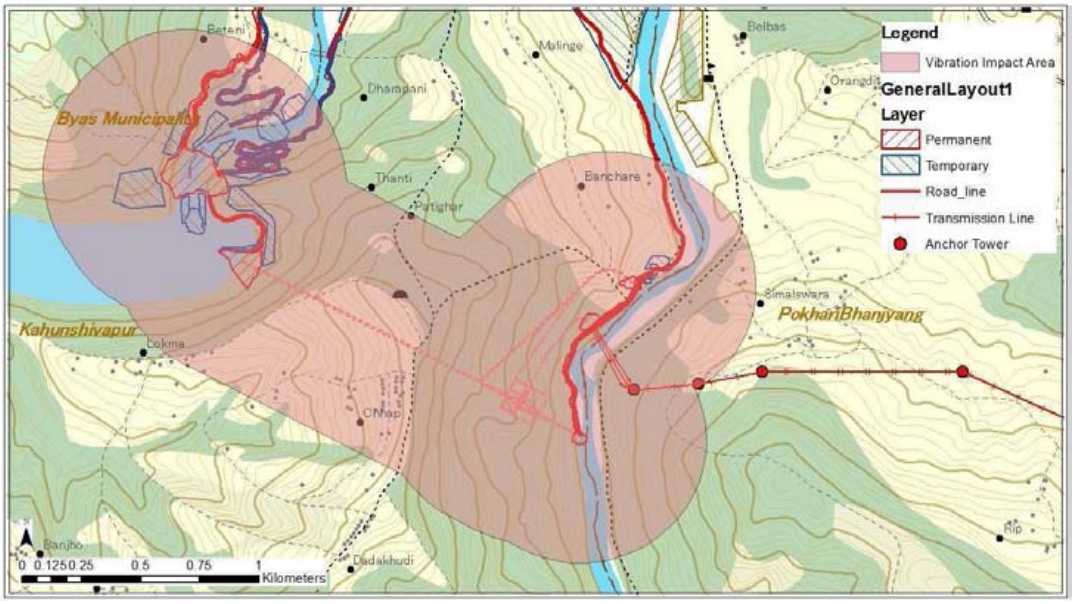
C.13 Community Health and Safety

220. The EIA (2009) discussed the relevant information on community health and safety in several sections, such as health, water supply and sanitation, safety and occupational health, noise and vibrations, and accidents and occupational health. Apart from the information in the EIA (2009), the incidence of malaria in Nepal has been included, based on WHO 2010 health data in relation to potential water-borne diseases that may result from the Project.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	• Sect. 4.3.3 Health • Sect. 4.3.4 Water Supply and Sanitation	• No change, but included the incidence of malaria in Nepal, based on 2010 WHO data
Impacts	•Sect. 5.3.7.2 Water Supply and Sanitation • Sect. 5.3.7.3 Accidents and Occupational Health •Sect. 5.1.5 Noise and Vibration	• No change • Estimated distance of communities that may be affected by noise generated from blasting during construction
Mitigation	• Sect. 7.3.3 Water Supply and Sanitation •Sect. 7.3.4 Safety and Occupational Health • Sect. 7.1.4 Noise and Vibrations	• No change, but identified 55 stations from dam site to Trisuli River where warning signs will be installed • Recruitment of Project Management Contract consultant to review dam design and safety • Construction management plan to minimize safety risks to nearby communities • Public health monitoring will be conducted during operation phase

221. The EIA (2009) identified that noise generated by blasting activities during construction may be felt by settlements downstream of the powerhouse at Huksetar, Beteni, and Bisghare. Beteni is the nearest community downstream of the powerhouse, estimated at 530 m, Huksetar at about 1.1 km, and Bisghare at about 2 km (see **Figure C.36**). The construction management plan will include procedures to be followed during blasting activities, to ensure that no property or community will be affected.

Figure C.36 Communities that may be Affected by Noise Generated by Blasting



222. To ensure community safety, the Tanahu Hydropower Ltd. will recruit a Project Supervision Contract consultant to review the dam design, structural safety, and seismic design to minimize risks and ensure public safety.

223. During Project operation, the creation of the reservoir and the alteration of the hydrological regime of Seti River and also the Madi River may result in an increase of breeding sites for malaria and other water-borne diseases posing health risks to local communities. In 2010, there were 3,155 confirmed malaria cases in Nepal, with case detection rate at only 0.06%.[39] There is a potential increase of breeding sites of mosquitoes; however, the regular water releases from the dam will increase water velocity downstream, which could flush out the breeding sites resulting in a reduction of the vector population. To further reduce risks, community awareness on the prevention of malaria will be conducted in collaboration with the local public health unit in Damauli District. Public health monitoring will be conducted during the operation phase.

C.14 Physical Cultural Resources

224. The information on physical and cultural resources, project impacts, and mitigation has been included in the EIA (2009). A working procedure to handle any new archaeological findings during Project construction has been added as **Appendix 3**.

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
Baseline data	• Sect. 4.3.7 Cultural, Aesthetic and Archeological Value	• No change
Impacts	•Sect. 5.3.7 Socioeconomic and Cultural Impact during the Construction Phase	• Updated (Table C.29)
Mitigation	• Sect. 7.3.1 Acquisition of Land and other	• Contractor(s) to prepare and implement

[39] World Health Organization. Malaria Situation in SEAR Countries. Nepal. http://www.searo.who.int/en/Section10/Section21/Section340.htm. (accessed 4 November 2012)

Description	EIA (2009)	Revised Environmental Addendum (November 2012)
	property, loss of community facilities and resources	a Physical Cultural Resources Management Plan • Appendix 3 – Discovery of archaeological items (physical or cultural)

225. During Project implementation, additional consultations among users of the affected community structures, local communities, and relevant Government authorities will be conducted prior to Project construction to determine if there are any additional concerns.

226. During the construction phase, there is a possibility that additional physical and cultural resources may be encountered or accidentally discovered in excavation sites, borrow areas, and construction sites. The Contractor(s) will be required to prepare a Physical Cultural Resources Management Plan (to be reviewed by THL-NEA and the relevant Government authority, and ADB) which will identify the measures that will be undertaken to protect these cultural resources, in the event of "chance finds." **Appendix 3** presents the general procedures to be followed in case of a "chance find."

C.15 Cumulative River Basin Impact

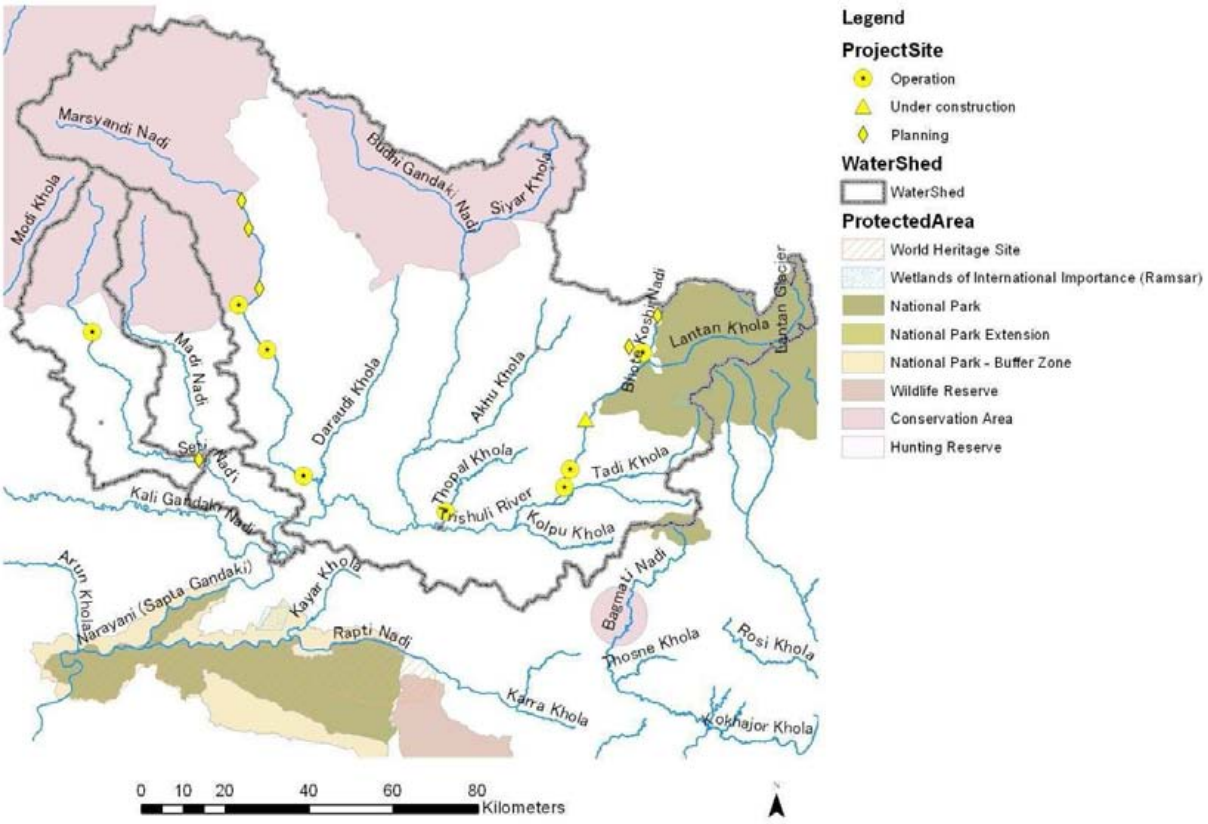
227. The EIA (2009) did not discuss cumulative impacts and this new section is included to provide a broad description of the potential downstream cumulative impacts resulting from the Project.

228. The Project is likely to contribute to two types of cumulative environmental impacts in the Trisuli River basin:

(i) the alteration of river flows (primarily in the Trisuli River); and,
(ii) the alteration of aquatic ecosystems.

229. The Trisuli River Basin above the confluence of the Trisuli River and Kali Gandaki River confluence, incorporating the Seti, Madi, Marsyandi, Daraudi, Budhi Gandaki and Lantan watersheds, flows from the Nepal-China border in the High Himalaya to the edge of the Terai (**Figure C.37**). Settled areas within the basin are predominantly agricultural, with only one major urban area in Pokhara and limited industrial development in the basin. The main forms of development occurring in the basin are the harnessing of river flows for power development, and urban expansion in Pokhara.

Figure C.37 Trisuli River Basin



230. Seven hydroelectric projects are currently operating in the Trisuli River Basin, with a combined capacity of 200 MW (**Table C.31**). The two largest projects are run-of-river with daily storage, while the other five are run-of-river. An additional 60 MW project is under construction in the basin, while another seven projects with a total capacity of 1,137 MW are in various stages of planning, including the Tanahu Hydropower Project.

Table C.31 Existing and Proposed Hydropower Projects in the Trisuli River Basin

Project	Capacity (MW)	River	Project Type	Status	Generation License Issue Date
Marsyangdi	69	Marsyangdi	PROR (daily storage)	Operating	1994 (2051/12/6)
Madhya Marsyangdi	70	Marsyangdi	PROR (daily storage)	Operating	2001 (2057/3/12)
Trisuli	21	Trisuli	Run-of-river	Operating	1994 (2051/12/6)
Devighat	14.1	Trisuli	Run-of-river	Operating	1994 (2051/12/6)
Chilime	20	Chilime	Run-of-river	Operating	1997 (2054/4/26)
Khudi Khola	4	Khudi	Run-of-river	Operating	2004 (2061/11/13)
Thoppal Khola	1.65	Thoppal	Run-of-river	Operating	2007 (2063/3/25)

Project	Capacity (MW)	River	Project Type	Status	Generation License Issue Date
Upper Trisuli 3A	60	Trisuli	Run-of-river	Under construction	2010 (2067/11/15)
Upper Marsyangdi 2	600	Marsyangdi	PROR (daily storage)	Financial closure under way	-
Sanjen	42.5	Sanjen	Run-of-river	Tender document floated	2011 (2068/8/12)
Rasuwa Bhotekoshi	97.5	Bhote Koshi		Tender document floated	2010 (2067/4/27) applied for survey license
Lower Manang Marsyangdi	210	Marsyangdi		Planned	2010 (2066/2/11) applied for survey license
Upper Marsyangdi A	50	Marsyangdi	Run-of-river	Planned	2011 (2068/12/17)
Tanahu	127	Seti	Storage	Planned	-
Third Trisuli Nadi	20.1	Trisuli	Run-of-river		2011 (2068/9/28)

Source: http://www.doed.gov.np/issued_licenses.php

C.15.1 River flows

231. Most existing and planned hydropower projects in the Trisuli River basin are run-of-river type. Accordingly, these projects are expected to have little effect on the monthly average flow rate in the Trisuli River, compared to its natural conditions, but daily peak flows may occur downstream of most tailrace outlets. The flow regimes of selected operating and planned projects are summarized in **Table C.32** to illustrate the effects of larger projects on river flows.

Table C.32 Flow Regimes of Some Peaking Hydropower Projects in the Trisuli River Basin

Project	Dewatered Section of the River	Peaking Generation Hours	Flow Variation	
			Minimum	Maximum
Marsyangdi	8 km - no environmental release, 4 km dry then 4 km with Daraudi River inflow	Morning 3 hours Evening 3 hours	8 m^3/s	88 m^3/s
Madhya Marsyangdi	7.5 km (1 m^3/s environmental release)	Morning 3 hours Evening 3 hours	8 m^3/s	88 m^3/s
Upper Marsyangdi2	15 km (2 m^3/s environmental release)	Morning 3 hours Evening 3 hours	5 m^3/s	117 m^3/s
Tanahu	5 km (2.4 m^3/s environmental release)	Dry season: Morning 3 hours Evening 3 hours Monsoon: 24 hours	Dry season: 23 m^3/s in February Monsoon: 550 m^3/s in July	Dry season: 148 m^3/s in February Monsoon: 550 m^3/s in July

C.15.2 Aquatic ecosystems

232. Aquatic ecosystems in the Trisuli River Basin have been altered by seven existing hydroelectric projects. Relatively high fish diversity still remains in the rivers of Trisuli, Budhi Gandaki, Akhu Khola, Seti and Madi, but the Marsyangdi River has been severely affected. Of the 26 fish species identified in the Marsyandi River prior to the first of the three hydroelectric projects being developed on this river, only three fish species have been identified as surviving, largely due to the blockage created by the dam and the resulting dried-up section of the Marsyandi River at the lowest project.

233. The operation of the Tanahu project has the potential to lower fish diversity, primarily upstream of the dam. Annual river restocking of fish from the hatchery will be done to cushion the Project impact to fish resources, and a trial "catch-and-haul" will be implemented, along with technical assessment of the feasibility of a "switchback" fish pass.

C.16 Social Impact Update Summary

234. The EIA (2009) described the socio-economic and cultural environment of Tanahu District, the eight village development committee (VDC) and one municipality of the Tanahu District. Project impacts affecting households were classified into directly affected people, indirectly affected people, and regional economic impacts, with corresponding mitigation measures on land acquisition and property, and affected infrastructures.

235. Following the EIA (2009), a Census Survey was undertaken in 2011-2012 to verify, update, and quantify households and assets likely to be affected by the Project, thereby providing revised figures to those presented in the EIA (2009).

Description	EIA (2009)/IEE (2010)	Revised Environmental Addendum (November 2012)
Baseline data	• Sect. 4.3 Socio-economic and Cultural Environment	• No change
Impacts	•Sect. 5.3 Socioeconomic and Cultural Environment	• Updated (referred to resettlement and indigenous peoples plan)
Mitigation	• Sect. 7.3 Socio-economic and Cultural Environment • Sect. 7.5 Enhancement Measures	• Updated (referred to resettlement and indigenous peoples plan)

236. A summary of private asset loss identified from the survey is provided in **Table C.33** and **Table C.34,** while **Table C.35** presents the affected households and population.

237. The Project (reservoir and dam) is likely to affect 758 households, consisting of 86 households that will be physically displaced and the remaining 245 houses that will lose more than one type of asset. For the transmission line component of the project, the exact number of affected people and assets will be determined during the preparation of the resettlement plan.

238. By adopting a FSL of 415 masl, the Project has avoided affecting a larger number of households and also avoided schools, health care centers, and community property resources being removed. Similarly, no major impacts will occur to commercial establishments and other livelihood sources, including the significant loss of agricultural land.

239. The presence of an indigenous population is also noted in the Project area and they too

are mainly involved in agriculture just like the non-tribal communities.

Table C.33 Land and House Losses, Affected Households and Population (Dam/ Reservoir Component)

Description	Units
Total number of affected households (AHH)	758
Number of households covered in census survey	608
Number of absentee affected households	150
Total affected private land (in ha)	112 ha
Number of affected persons (covered in census survey)	4,257
Number of AHH with vulnerabilities	502
Number of affected persons of the HH with vulnerabilities	3,652
Number of Janajati HH	453
Number of affected persons of the Janajati HH	3,345
Number of AHH losing more than one type of asset	245
Number of affected persons of the HH losing more than one type of asset	1,647
Number of AHH who would be physically displaced	86
Number of persons of the HH who would be physically displaced	538
Number of affected trees	4,776
Number of community property resources	15
Suspension bridges	7

Source: Census Survey, 2011-2012

Table C.34 Land Acquisition and Affected HHs (Dam/ Reservoir Component)

Project components	Extent of Impact		Land use situation
	Hectare	Affected HH	
Reservoir area	76	336	Large proportion characterized by steep slope, degraded forest. A small proportion is cultivated land.
Camp site	8	102	Mostly cultivated area
Access road	7	165	Cultivated land and private land
Spoil disposal site	19	122	Largely river banks and waste land and a small portion consists of cultivated *khet* land
Temporary construction road area	2	33	A mix of cultivated land and degraded forest area
Total Area	**112**	**758**	

Source: Census Survey, 2011-2012

Table C.35 Affected Households and Population

Project Component	Number of HH	Number of Persons
Camp site	146	944
Access road	96	627
Reservoir area	78	553
Spoil disposal site	270	2,018
Temporary facilities	18	115
Total	**608**	**4,257**

Source: Census Survey, 2011-2012

240. Measures to mitigate social impacts, such as impacts on community-owned or cultural structures discussed in the EIA (2009), have been proposed in the Project Resettlement and Indigenous Peoples Plan.

D. GRIEVANCE REDRESS MECHANISM

241. Except for compliance monitoring by relevant Government authorities, such as the Ministry of Energy, MoEST, and the Ministry of Forest and Soil Conservation, the EIA (2009) did not include a process to handle complaints/grievances from project stakeholders. Hence, a grievance redress mechanism is included in this Environmental Addendum, as part of the required procedures during Project implementation.

242. A grievance redress mechanism (GRM) will be established to receive and facilitate the resolution of affected people's (AP) concerns, complaints, and grievances on social and environmental issues. The GRM aims to be proactive and accessible to APs as an effective way to address their concerns. The GRM will have three levels, with time-bound schedules to function.

- **First level of GRM**. The Public Information Centre (PIC) at the VDC level will be the first intervention to address the grievance. Many grievances can be resolved by providing correct and complete information. The PIC will have full-time staff representing the EA and IA, with full authority to listen and provide information to APs and resolve their issues. The PIC officer may seek the assistance of the supervision consultant safeguards specialists to help resolve the issue. The PIC will fully document the complaint, including: (i) name of the person; (ii) date the complaint was received; (iii) nature of the complaint; (iv) location; and, (v) how the complaint was resolved. These reports will be submitted to the Project Director (PD) and to the Safeguards Unit of THL each month.

- **Second level of GRM.** Should the grievance remain unresolved, the PIC officer will forward the complaint to the Safeguards Unit at THL. The person filing the grievance will be notified by the officer that his/her grievance was forwarded to the safeguards unit. Grievances will be resolved through ongoing interaction with the affected persons, with THL answering queries and resolving grievances regarding various issues such as social and livelihood impacts and environmental issues. NGOs and the Safeguards Unit of THL will undertake corrective measures at the field level for social and livelihood issues within seven days, and environmental safeguards staff will do likewise as required. The Safeguards Unit staff of THL will fully document the following information: (i) name of the person; (ii) date the complaint was received; (iii) nature of the complaint; (iv) location; and, (v) how the complaint was resolved.

- **Third level of GRM**. Should the grievance remain unresolved, the issue will be referred to the Grievance Redressal Committee (GRC). The GRC will be headed by PD and shall consist of members of the concerned VDC, affected persons, NGOs and local area committee. The affected person can present his or her concerns/issues to the GRC. All costs will be borne by the project. The GRC will meet as necessary when there are grievances to be addressed. The GRC will suggest corrective measures at the field level and assign clear responsibilities for implementing its decision within 15 days. The Safeguards Unit of THL will be responsible for processing and placing all papers before

the GRC, recording decisions, issuing minutes of the meetings, and taking follow-up action to ensure that formal orders are issued and decisions are carried out.

243. If each of the above measures fails, the affected person can seek legal redress of the grievance in the appropriate courts, which is the formal legal court system.

E. CONSULTATION

244. Chapter 8 of the EIA (2009) presents the public consultations conducted from February 2001 until 10 May 2007. Subsequent to the EIA (2009), additional consultations were undertaken with various Project stakeholders in 2011 (June, September and November) and again in 2012 (May and June). A summary of comments and discussions from these consultations is given in **Table C.36.**

245. The Government recognizes that consultation with project stakeholders is a continuing process and therefore it will be conducted, as needed, during the entire life of the Project. A Community Liaison Officer (CLO) will be part of the Safeguards Unit in the project implementation arrangements of THL to support the environmental and social management staff in dealing with the concerns of stakeholders, to ensure that they are properly and adequately addressed and in a timely manner, as well.

246. Project briefs in both English and the local language will be made available to the public or any interested individuals at the PMO, construction site office, and the THL office. The CLO will coordinate (as needed) with local communities, local media, youth organizations, NGOs, and relevant Government authorities about the progress of the Project. Any public disclosure of Project information will be cleared by THL. The environmental assessment reports and general information about the Project will be posted on the website of the NEA and THL.

Table C.36 Results of Consultation on Project Environmental Issues

Organization	Comments / Discussion
1st Stakeholder Interchange 8-9 June 2011 (details are in Appendix 4)	The Chairman of one of the concerned peoples groups made representation following NEA's presentation in both Stakeholder Interchanges. The key elements covered in the representation were: • The main requirements for sustainable development of the project relate to four components (i.e. project returns distributed equally; natural and environmental justice ensured; social, economic and cultural preservation to be given importance; and local people to invest in the project to develop the feeling of local participation). • Actions were proposed to implement the four proposed components. • The proposed actions for "project returns being distributed equally" were: - the affected area should be free of load-shedding through alternative power supply mechanism. - project returns should be distributed justifiably. For example, the Kulekhani project distributed money to the affected VDCs every year. • The proposed actions for "natural and environmental justice" were: - measures to be taken to control landslides - measures to be taken to control growth of moss in the forest which makes the routes slippery and hazardous for local people - deforestation to be controlled to the greatest possible level - Since the project will remove 424.5 ha of forest land, adequate afforestation to be done to provide an equivalent area - proper tools and methods should be used to control sound pollution and vibration - methods to be adopted to protect the aquatic and land animals where around 16 varieties will be affected • The proposed actions for "social, economic and cultural preservation" were:

Organization	Comments / Discussion
	- measure to be taken to restore affected structures - 151.22 ha of agriculture land will be affected & 660.77 metric ton/annum of agriculture produce will be lost. The project should adequately rehabilitate affected people. - 828 households will have land acquired and 110 structures will be removed, for which reasonable compensation should be provided. - An Income Generating Scheme (IGS) and economic support should be provided to affected communities (e.g. resettlement allowance, seed money, etc). - skill development and employment generating programs should be planned - affected VDCs, neighbouring VDCs and people of Tanahu should be given first priority for employment. - health and education programs to be launched. - dust, smoke and vehicular pollution to be minimized. - education and women's development program to be provided for the displaced persons. - Improvement of livelihood of affected women should be ensured thorough training and IGS. - suitable plants to be distributed to local people for river bank restoration. - rural electrification program to be launched to provide power to all areas in Tanahu District. - without affecting the project, rural tourism programme to be developed (e.g. boating). - proper security measures to be planned to manage societal degradation - insurance and compensation to be planned for project workers and contractors potentially affected by injury or loss of life. • The proposed actions to allow "investment of local people in the project to develop the feeling of participation" were: - preference given to local people to invest in the project. - study the Upper Tamakoshi model and accordingly plan to distribute shares. - provide emphasis on creation of Power Development Banks. - give preference to the local people for project operation staff • Assurance was provided that local people are going to whole-heartedly support the project, unbiased from the views of political parties. • An appeal was made to involve local people when evaluating the quality, transparency and follow-up of project progress. The development of a mechanism for carrying out Stakeholder Interchange and dialogue with the local people on a regular basis was emphasised. A representation was also made by The Communist Party Maoist Union. It demanded employment of local people based on their capability and socio-economic condition. It said that they will prepare a list along with recommendation for people to be employed and it has to be dealt accordingly. Sri Kotadar VDC, Tanahu made representation, listing the elements that will be affected as a result of the project and suggested actions to be taken for dealing with these impacts.
Department of Forest (1 September 2011)	- The forest guideline 2006 mandates the planting of 25 trees per one tree removed (10 cm DBH or greater is defined as a tree). The project has to meet the cost of planting and tree protection for five years - Forest Norm 2003. - Since forest land is not available for planting, recent directives from the Prime Minister's office have recommended that the Forest Act be changed to require the land area occupied by a development project to be replaced by the developer by purchasing the private land nearby or depositing the money required for land replacement with the Department of Forests. - Amendment of the Forest Act has been initiated but it is yet to be amended by parliament. However, the Department of Forests has already issued directives to all concerned in this regard and some on-going projects have met the intent of the directives. - Projects excluded from land-for-land replacement are Transmission Lines and Roads.

Organization	Comments / Discussion
	- As the Act is yet to be amended, the government may consider relaxing the directive's provisions for the Tanahu HEP. This may be achievable through discussions with a higher government authority. - There is no specific government policy on how to compensate community forest user groups for the loss of forest land and forest stock. Normal practice is to compensate community forest user groups for the loss of trees at market price. - Other compensation modalities should be based on negotiations with affected community user groups.
Kaligandaki "A" Hydroelectric Project Hatchery (3 September 2011)	Fish breeding problems at the hatchery include: - ***Water quality*** – water is highly turbid and not suitable for plankton growth. As a result nearly 50% of fish fry die, thus substantially reducing fingerling production potential. Hatchery water is currently sourced from the Kaligandaki River, supplied via a 10" pipe from a surge tank valve chamber. During the monsoon season the water is highly turbid, however in winter it has moderate turbidity but it is still unsuitable for fish production. An improvement to water quality is essential to increasing the fish production. - ***Water temperature*** – for cold water fish breeding, the temperature of natural spring water in the adjoining area is high and hence unsuitable. It is for this reasons, the tapping of Kaligandaki water is preferred. Hence to maintain the temperature of water, the only alternative is to use Kaligandaki water after adequate treatment for suspended solids, the main reason for turbidity. - ***Inadequate ponds*** – the number of ponds available are inadequate for breeding different species of fish found in the Kaligandaki River. The available ponds are not adequate for the 10 fish species which have been successfully cultured. The further addition of 20 fish ponds for broods and fingerlings are required to increase the production potential of the hatchery. Under existing conditions production could be increased by around 400,000 fingerlings if water quality is improved. Effects of the Kaligandaki on fish migration: - The downstream area below dam is dominated by fish species such as fresh water eel, gardi and gonj. These species are in decline above the dam wall. The existing program of open water fish stocking has not been able to breed these species and release them upstream of dam. It is likely that the existing dam structure prevents upstream migration even in the monsoon season. - The dam does not have a fish passage. The circular and vertically aligned environmental flow release structure is not suitable for fish passage. Water is released from spillway at high speed and is turbulent, preventing upstream fish migration. Even the downstream migration might involve high mortality because of the fall and water turbulence below the spill way - Upstream of the dam the dominant species are Katle, Sahar, and Asla. On-going stocking programs may be responsible for maintaining fish stocks even though upstream migration has been curtailed by the dam structure.
Begnas Fish Hatchery (4 September 2011)	Problems with the fish hatchery include: - the siphon structure used to source water for the hatchery occasionally malfunctions due to the water level variation in the Begnas Tal, the natural lake that water is drawn from; - the available ponds are not sufficient to cater for the breeding of different fish species. A total of 40-50 ponds are used for fingerling rearing and 10 ponds for broods. As the number of available ponds is insufficient, broods have been mixed with other species in different ponds. (1) To increase the production potential, additional ponds need to be built. (2) The area available to expand the number of ponds within the hatchery is limited. (3) Water in the area is not suitable for cold water fish breeding (particularly Asla) due to the high temperature. (4) For a cold water fishery, an area close to the headwaters of a major river has to be identified. The best areas for such a purpose could be: ▪ Budrung Khola area - Seti River upstream; ▪ Madi Khola upstream;

Organization	Comments / Discussion
	▪ Rasuwa area - upstream Trisuli River.
District Forest Officer, Tanahu (5 September 2011)	- It is difficult to allocate afforestation areas within the geographical limits of the affected VDCs as per the provisions of the forest guideline 2006. Accordingly, it is recommended that: 1. afforestation should be permitted in the Seti River watershed; and 2. other forest mitigation options should include management options to reduce the burden to the remaining forests such as: o increasing in forest stocks through silviculture and other suitable options; o community awareness forestry programs; o fencing existing forests to encourage natural regeneration by removing gazing animals; o agro-forestry programs for communities whereby forest products for household needs are grown on agricultural lands. - In the forest areas near construction sites, the provision of forest guards should be included to protect the forest products from illegal harvesting by the construction workforce and others. - Forest clearing and stockpiling in designated areas to be borne by the project. - If the collected stockpile cannot be sold by the district office, the project should meet the forest revenue as per the existing act provisions. - A catchment area treatment plan focusing on the control of land degradation (erosion) should be considered. - Community forests: o The community forest user group should be compensated for the lost trees as per the local market price; o Cleared tree should be given to the community forest user groups free of costs o Other compensation measures for community forest user groups should be developed following consultation with these groups o Community forest user groups should be given training on non-timber forest products (NTFP) suitable to the area. o Forest-based income generation training and support should be provided to the community forest user groups. o Assistance should be provided on community forestry management and leasehold forestry management skill enhancement. o Since community forest areas will be changed, the project should assist in the upgrading or revision of the community forest management plan of the affected community forest and the rehabilitation of the forest areas under the community forest.
Federation of Community Forest Users Nepal (FECOFUN), Tanahu (5 September 2011)	- People in the project area are very happy that the project is being built in their area and have expressed full support for the project. - FECOFUN has not developed a policy on compensation for project-affected forest areas, trees and forest production potential. - The project should provide compensation for felled trees as per the norms in the local area. - The project should provide felled trees free of cost to community forest user groups. - The project should provide employment opportunities to economically deprived members of the affected community forest user groups. - Other measures should be decided based on consultation with the affected community forest user groups.
Directorate of Fishery Development (11 November 2011)	- Standard actions for maintaining fisheries include open water fish stocking. For this there is a requirement of suitable fish hatchery for the production of indigenous fish species found in the rivers. Nepal has both warm water and cold water fisheries; therefore there is a need to develop dedicated warm water and cold water fish hatcheries at the regional level for the supply of the required fish fingerlings to the hydropower project. A project-based fish hatchery could also supplement the required fish fingerlings, but a single location may not be suitable for both warm and cold water fish hatchery development. A high level co-ordination in this respect with the Directorate of Fishery is always desirable for the design and location of the fish hatchery. Apart from this Directorate of fishery has to be given some responsibility

Organization	Comments / Discussion
	by the projects not only for the establishment but also for the operation management of fish hatchery developed by the projects. - Kaligandaki fish hatchery experience indicates that the long-term affiliation of the Department of Fishery in the hatchery is essential because the project could not operate the hatchery on its own despite the allocation of an adequate budget by the project. - Fish passages have been incorporated into many projects, but the usefulness of these structures to the riverine fish in Nepal is not well understood. This is the subject of study for the selection of fish passage structure in Nepal. - Knowledge on the riverine fisheries of Nepal is rudimentary, scattered and fragmented, particularly on lifecycle behavior (seasonal migration, habitat preferences, breeding, and spawning). Project based study could provide species diversity, but not sufficient to make a long term planning for in-situ or ex-situ conservation of the indigenous, threatened/endangered species. - Government of Nepal from this fiscal year is planning to start a study on the cold water riverine fishery of Nepal. Since there is shortage of trained manpower and financial resources, the expected results of the survey could not be of up to the mark. - The project could assist as a part of the project activity to prepare required specialized manpower. One of the options could be Ph.D grants to the interested manpower of the department or outside who will work in the Seti River with a contract to work for 5 years in the project program after the completion of the Ph.D degree. - If such specialized manpower could be developed, then the project can think of establishment of cold water fish hatchery. - The best location of cold water fish hatchery would be either in the border area of Manag and Lamjung or at Myagdi District, or at Rasuwa district. These areas are facilitated with motorable roads and establishment of infrastructures would be easy. Seti River location near the proposed site is not good for cold water fish hatchery. However, site selection for cold water fishery has to be done. Directorate of fishery could assist the project on this respect.
Nepal Association of Rafting Agents (NARA) and Nepal River Conservation Trust (NRCT) (16 May 2012)	- rafting is undertaken between 9 am and 5 pm each day from late September to May on the Seti River. The peak season runs from late September to the middle of December, with the middle season being February to May. During the monsoon (mid June to late September) rafting is rarely undertaken as high river flows make rafting conditions dangerous. - around 75 tour companies operate rafting trips across Nepal, variously headquartered in Kathmandu, Pokhara and at other locations. - an estimated minimum of 200 persons raft the Seti River each day during the rafting season, with this number expected to increase over time. Rafters are charged US$60-75 per person per day. - NARA has three main concerns about Project-altered river flows: (i) the sudden release of water may affect daily rafting activities; (ii) the rafting season may be shortened; and (iii) rafting gear may be washed away. - the release of water from the reservoir should commence before 9 am and continue until 5 pm. - tourist companies should be compensated for any loss of business.
IUCN Nepal (19 & 26 June 2012)	19 June 2012 - The PPTA team met with IUCN Nepal and explained the location of the Upper Seti (Tanahu) Hydroelectric Project and its 220 kV Transmission Line, the general habitat conditions (terrestrial and aquatic) of project impact areas and the observed and reported wildlife of conservation significance, including the mitigation strategy adopted by the project. The PPTA team enquired about further information on identified wildlife of conservation significance and any recommendations on mitigation measures to be adopted to minimize or avoid project impacts. The IUCN country representative commented that the hydropower project site does not form habitat of the Bengal Tiger and the mitigation strategies adopted for the transmission line are adequate to minimize impacts considering the development requirements of the country. The hatchery and fish stocking program to maintain species

Organization	Comments / Discussion
	and population density are well planned. Strict implementation and monitoring during the project construction and operation phases will be required. 26 June 2012 – IUCN commented that the reforestation program may have to aim not only to replace forest resources such as fuelwood and timber that will be lost, but also to improve the quality of existing forests and protect healthy forest ecosystems. Planting species that can improve forest ecosystems will help to protect other plant and animal species living in the forests, soil quality, etc. Internationally recognized environmental NGOs with local experience in ecosystem and biodiversity protection may be able to be involved in planning strategies for a reforestation program that incorporates an ecosystem conservation approach. Such NGOs may be able to work effectively with community forest users' groups for sustainable reforestation and forest management. Since 400 ha of the forest will be lost, the pressure on the remaining forests in the area may increase. In order to avoid this, the reforestation program should include environmental education and sensitization activities to protect the remaining forests, and promote alternatives to the forest resources such as cooking gas. 20 August 2012- IUCN and ADB agreed on the following in the meeting; 1. Considering (i) the importance of the project to contribute in alleviating Nepal's critical power shortage, and (ii) IUCN confirming that the project area is not a national park, protected area or a critical habitat, IUCN supports the Project and will be pleased to participate in the Project activities by providing advisory services to the project to achieve appropriate environmental management and monitoring. 2. IUCN confirmed their readiness to provide advisory services to THL and NEA in the forest and watershed management program.
WWF Nepal (20 & 25 June 2012)	20 June 2012 - The PPTA team met with WWF Nepal and explained the location of the Upper Seti (Tanahu) Hydroelectric Project and its 220 kV Transmission Line, the general habitat conditions (terrestrial and aquatic) of project impact areas and the observed and reported wildlife of conservation significance, including the mitigation strategy adopted by the project. The PPTA team enquired about further information on identified wildlife of conservation significance and any recommendations on mitigation measures to be adopted to minimize or avoid project impacts. The WWF expert team indicated that they had no recommendations to make on the conservation of aquatic life. With regard to Bengal Tiger, the team acknowledged the proposed mitigation measures. 25 July 2012 - WWF will seek opportunities to collaborate with the project on biodiversity conservation and project impact mitigation on wildlife animals in the project area, such as advising and monitoring during project implementation. WWF and the project team will have further discussions continuously.

APPENDIX 1 REVISED TRANSMISSION LINE ALIGNMENT

Figure A1.1 Transmission Line Alignment – start to turning point 5

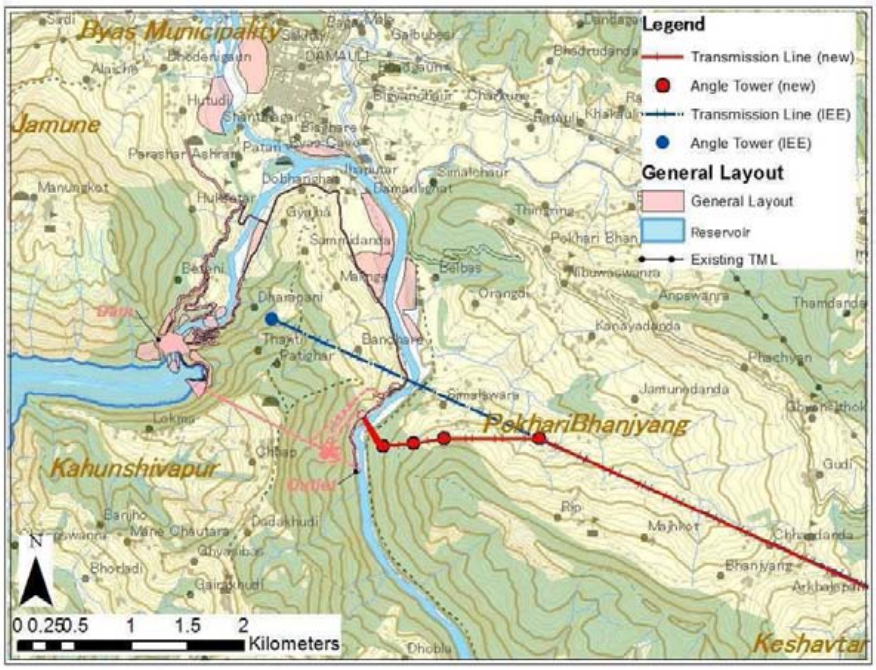


Figure A1.2 Transmission Line Alignment – turning points 5 to 7

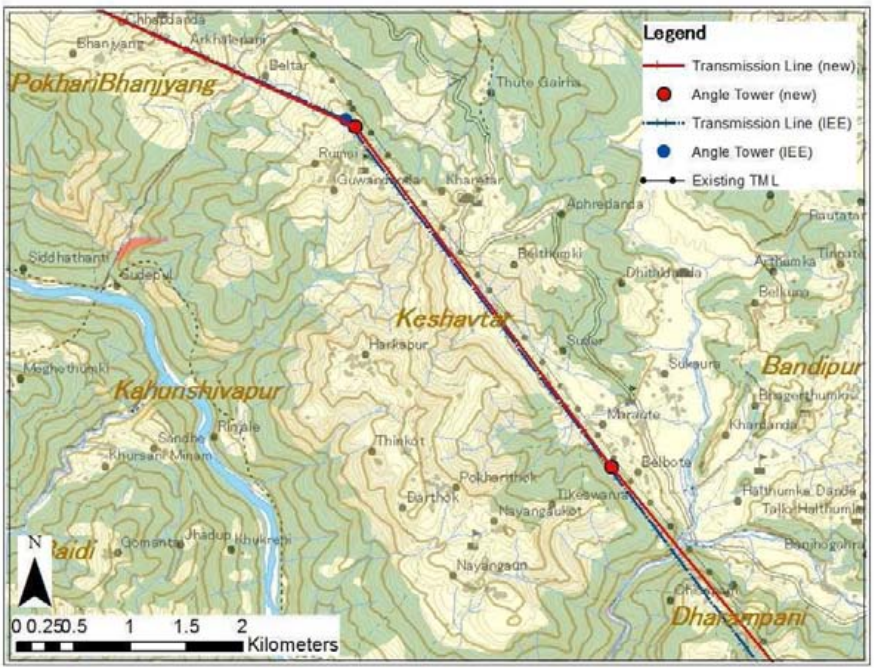


Figure A1.3 Transmission Line Alignment – turning points 7 to 8

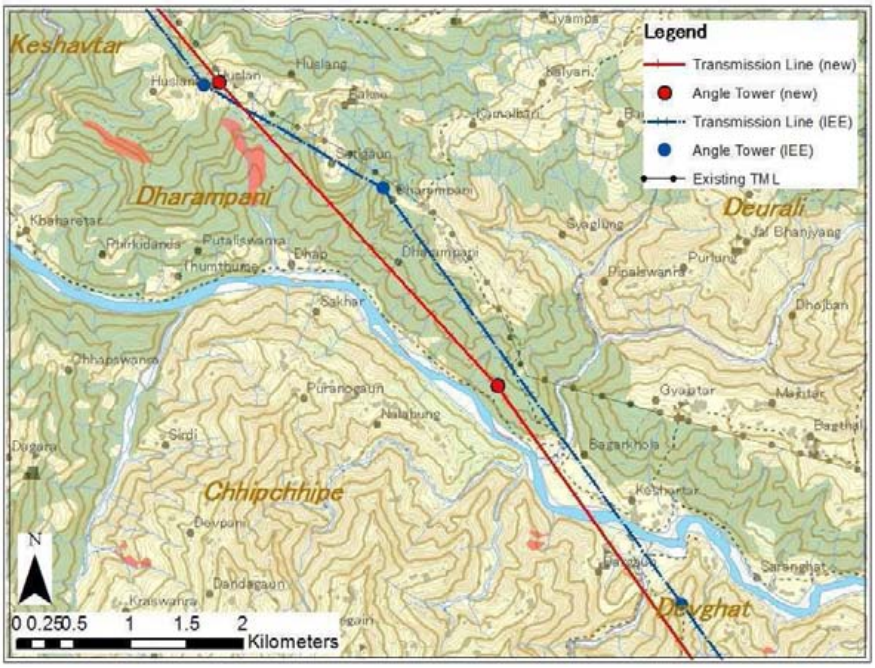


Figure A1.4 Transmission Line Alignment – turning points 9 and 10

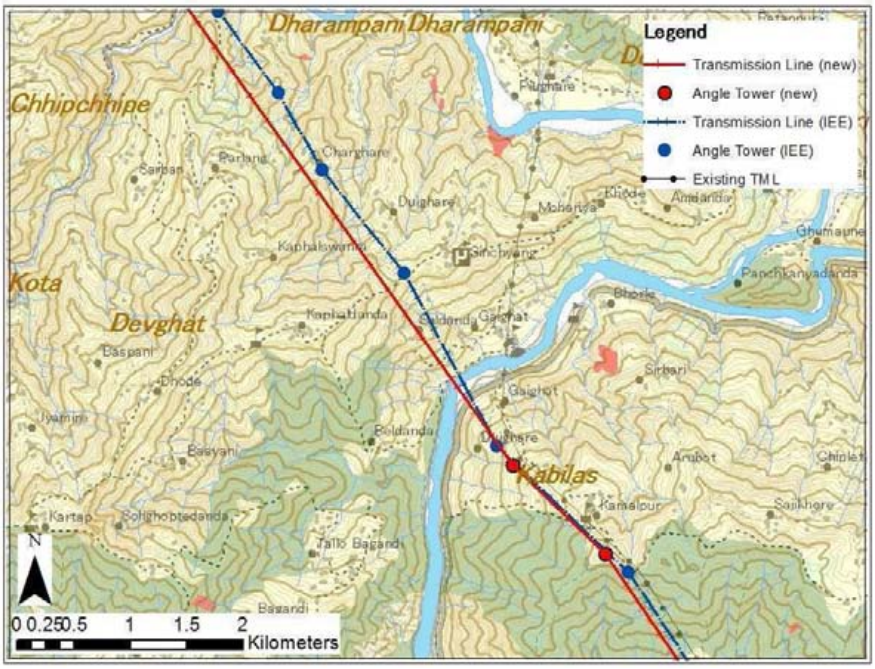


Figure A1.5 Transmission Line Alignment – turning points 11 to 15

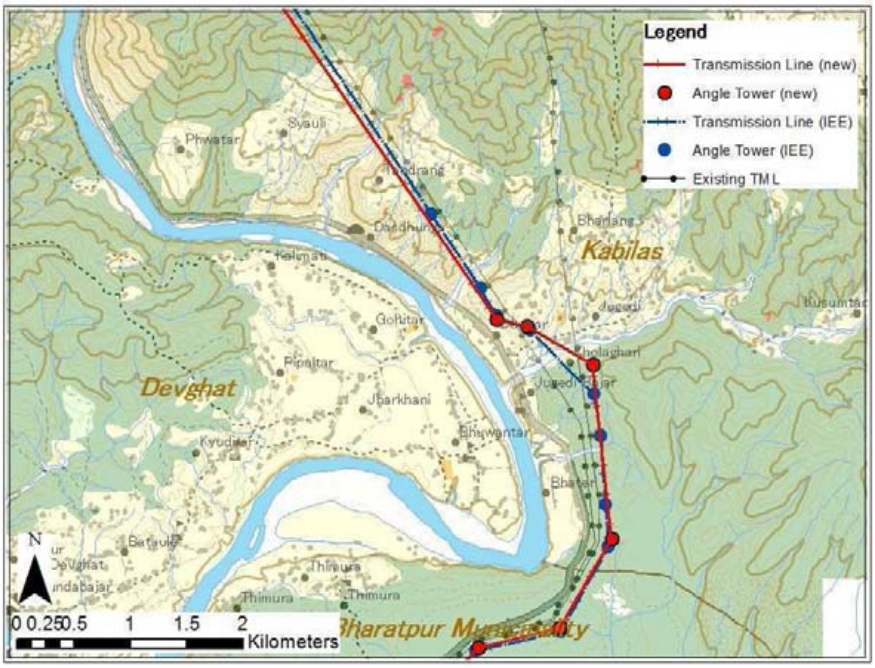
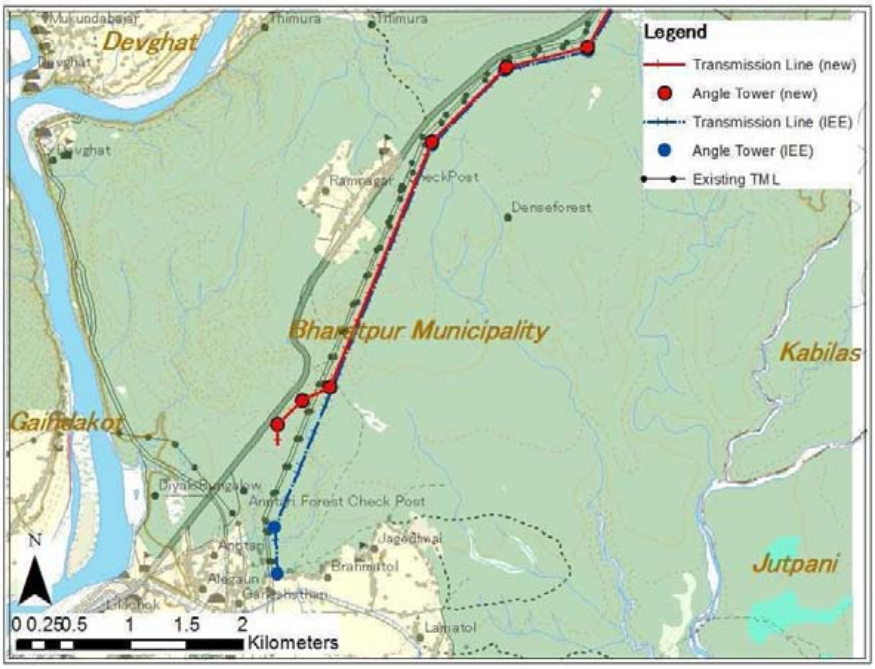
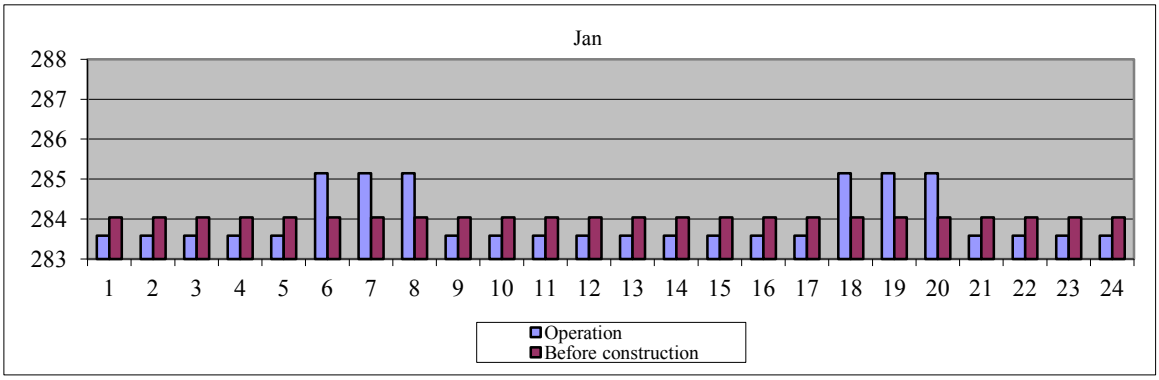
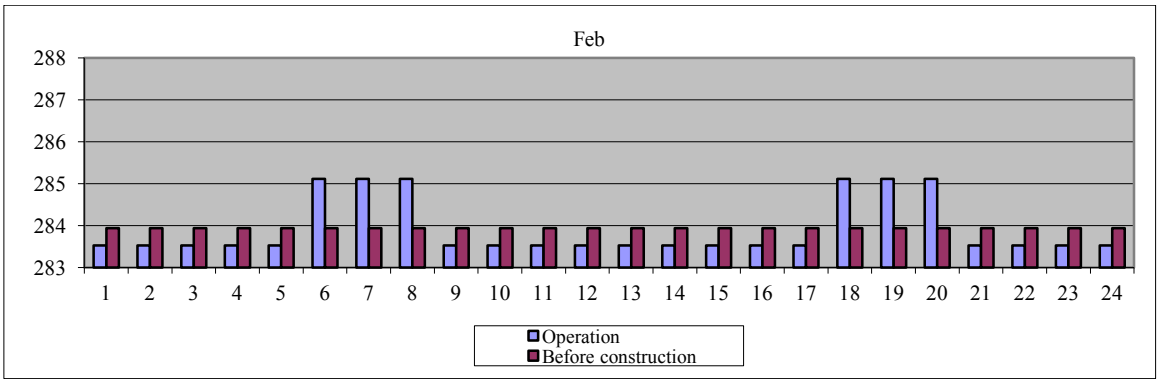


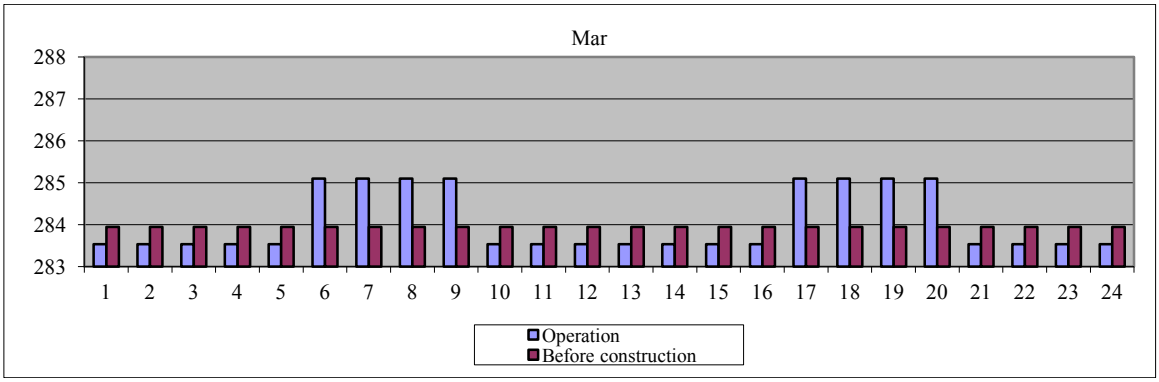
Figure A1.6 Transmission Line Alignment – turning points 15 to end

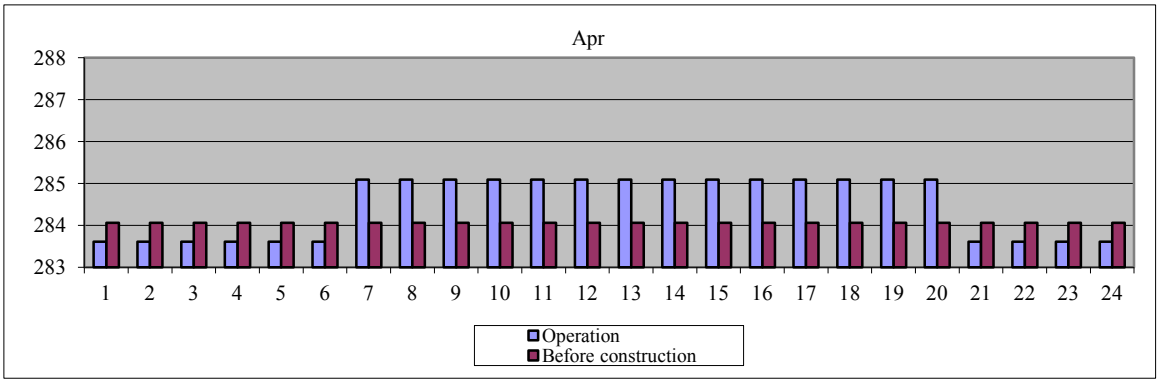


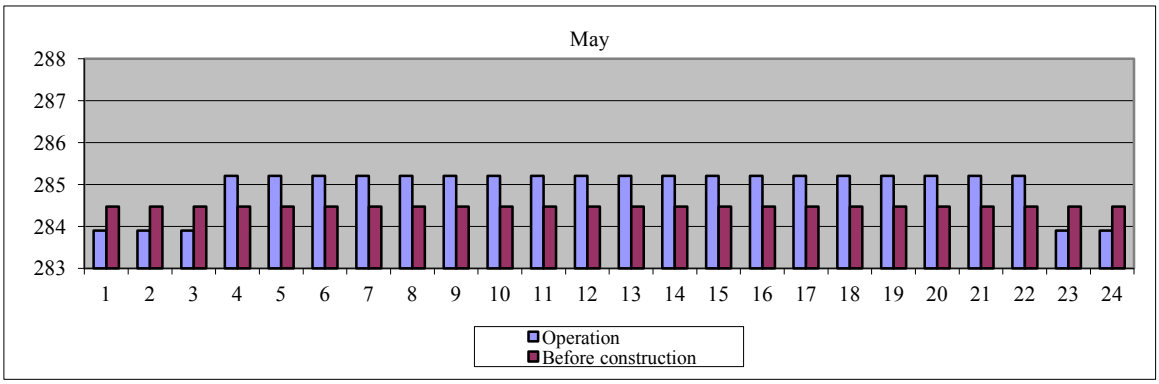
APPENDIX 2 RIVER LEVEL CHANGE BELOW THE TAILRACE OUTLET – EXISTING AND PROJECT OPERATION (TENTATIVE)

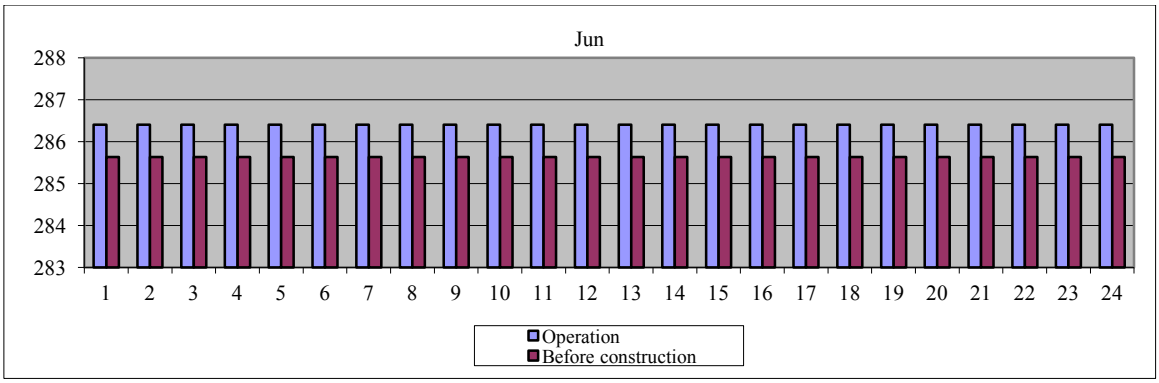


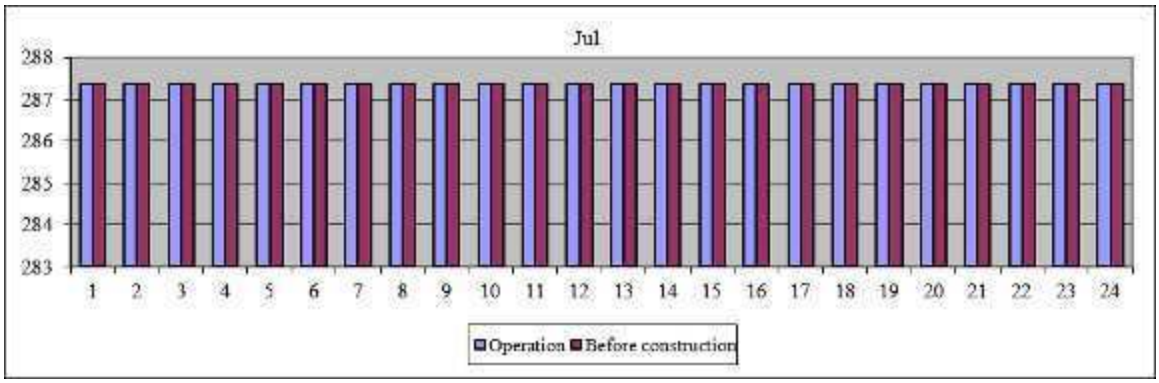


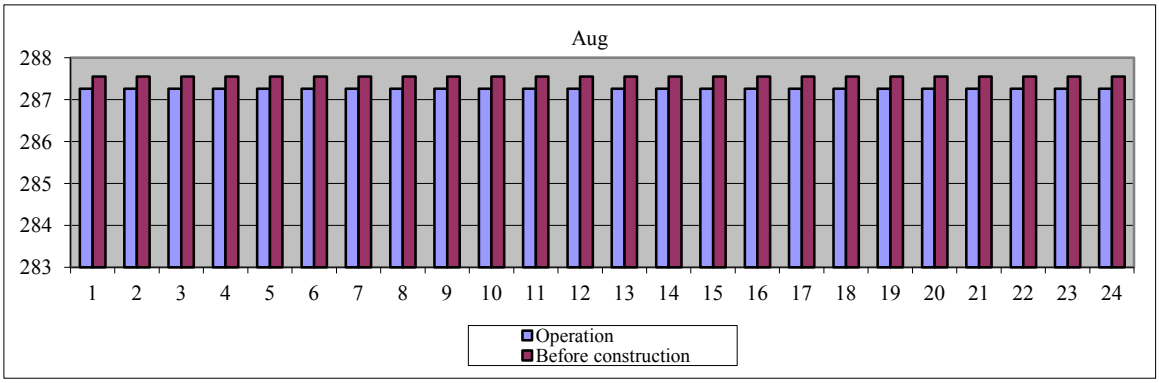


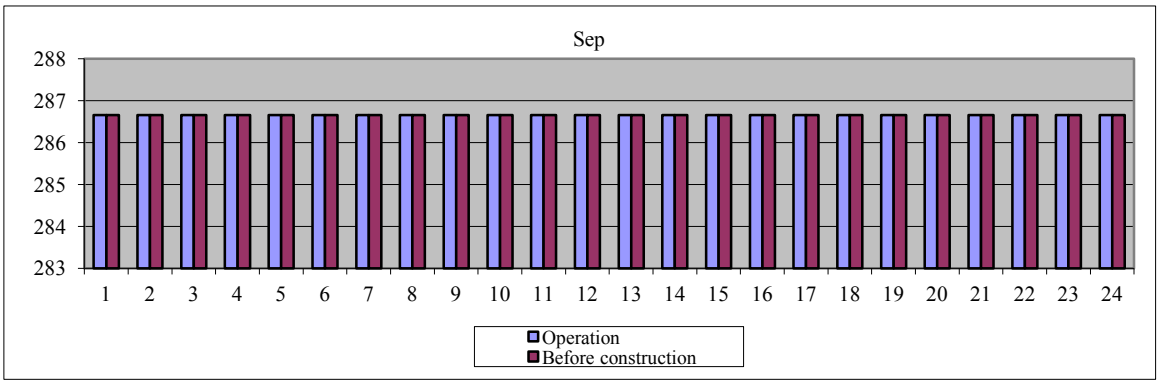

Apr
288
287
286
285
284
283
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Operation
Before construction

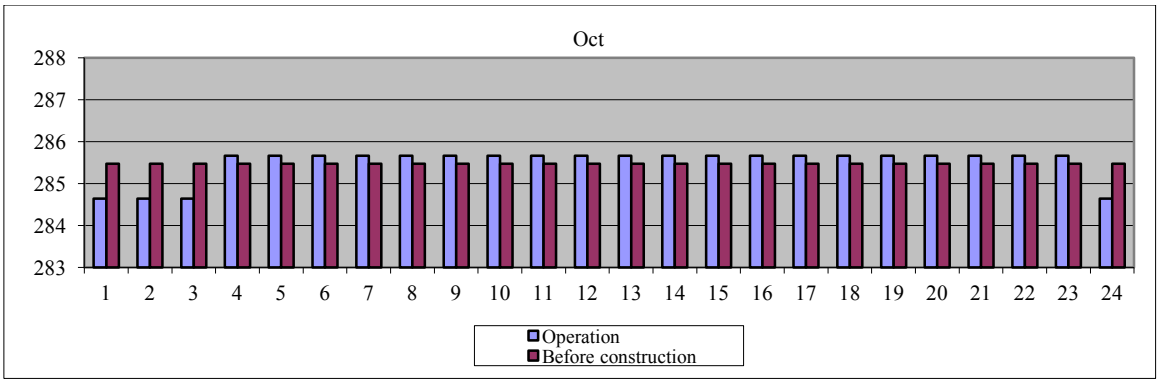

May
288
287
286
285
284
283
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Operation
Before construction

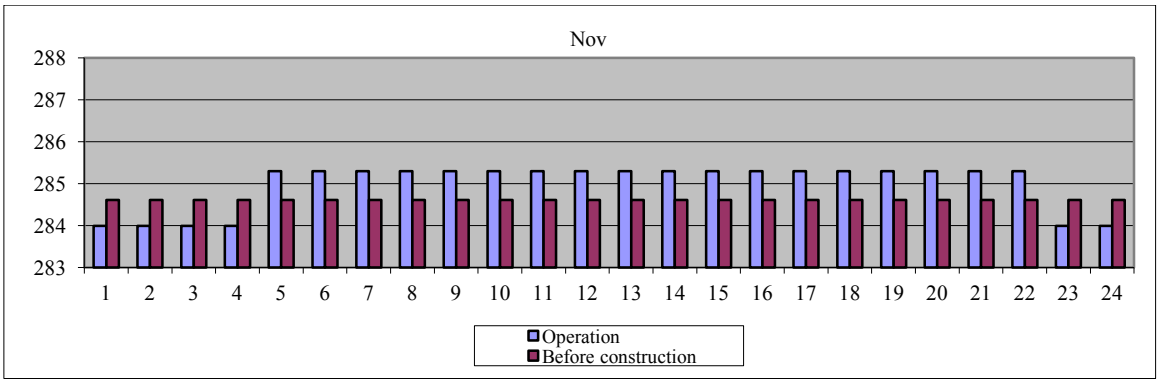

Jun
288
287
286
285
284
283
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Operation
Before construction

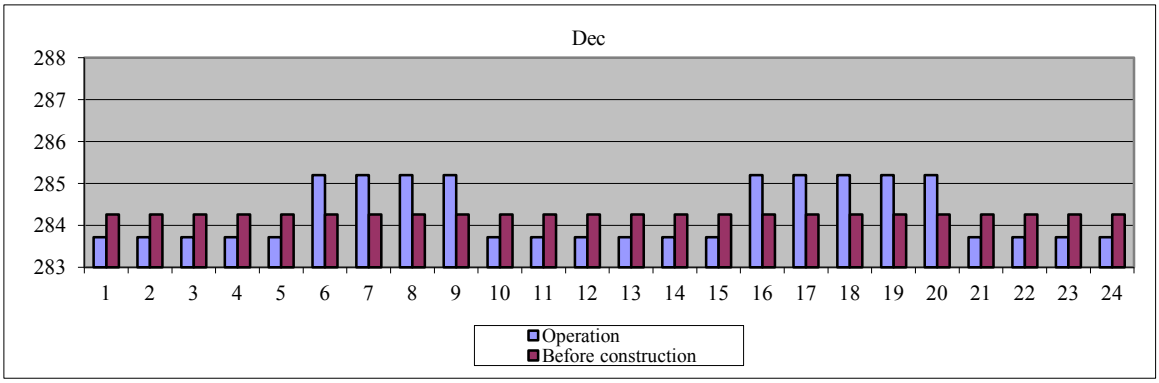

Jul
288
287
286
285
284
283
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Operation
Before construction


Aug
288
287
286
285
284
283
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Operation
Before construction


Sep
288
287
286
285
284
283
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Operation
Before construction


Oct
288
287
286
285
284
283
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Operation
Before construction


Nov
288
287
286
285
284
283
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Operation
Before construction


Dec
288
287
286
285
284
283
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Operation
Before construction

APPENDIX 3 DISCOVERY OF ARCHAEOLOGICAL ITEMS (PHYSICAL OR CULTURAL)

1.0 Introduction

1. The following procedures outline the measures that will be undertaken in the event of an accidental discovery of or an encounter with a physical cultural resource (PCR) during the construction phase. Chance find procedures will be finalized as Physical Cultural Resources Plan (PCRP) by NEA and THL, in consultation with the relevant Government authorities, to ensure compliance with applicable regulations. The PCRP will be included in the Construction Management Plan that will be required from the Contractor(s) and will be an integral part of the bid documents. These procedures aim to identify and promote the preservation, protection, and recording of any PCR that may be discovered or exposed during the earthmoving works and ground alteration.

2.0 Orientation of Workers

2. The Contractor(s), with the assistance from relevant Government authorities, will conduct an orientation or training for all workers, particularly those who will be involved in earth movements, excavation, and tunnelling, regarding how to recognize artifacts that they may encounter or discover.

3. An archaeological map of Nepal (if available) will be secured from the relevant Government authority to examine if there are potential "hot spots" within the Project's area of influence. This map will be part of the references on-site to guide the construction supervision staff in determining the potential "hot spots."

3.0 Procedures

3.1 General

4. In the event a PCR is discovered, construction activities in the area will be stopped. The site or area discovered will be marked or demarcated using a global positioning system (GPS) unit to determine the exact coordinates, and photographs will be taken. The construction supervision staff will secure the site to prevent damage, loss or pilferage of removable objects. The supervising engineer will be responsible for coordinating with the relevant Government authorities.

5. If the discovery involves removable items, a security person will be posted until the representative of a relevant Government authority arrives to assess and determine its value. The Government representative will be responsible for determining the appropriate course of action. Further excavation or earth moving works may be conducted at the distance and demarcation area recommended by the representative of Government authority.

6. If the chance find is expected to have significant cultural value, this may entail consequent changes in the Project lay-out, particularly if the discovery is the remains of cultural or archaeological importance that is not removable.

7. The Contractor will not be entitled to compensation due to work stoppage as a result of the discovery and its associated subsequent actions.

3.2 Tunnelling

8. Appropriate heavy equipment, such as a wheel loader, will be made available to recover the excavated material from the tunnel to allow the on-site geologist/archaeologist or

the representative of a relevant Government authority to inspect, recover or conduct sampling. A safe storage area will be provided to protect the discovered object. If the “chance find” is part of a large artifact, deposit or structure, the inspection or recording will include photography and video in an "as-is, where is" manner. The exact location will be recorded using a GPS unit.

3.3 Resumption of Work

9. The Contractor can resume the construction works within the affected area after clearance is given by the relevant Government authority. All the discovered objects of value will be given to the Government.

4.0 Report

10. The Contractor(s) will prepare a Chance Find Report within a week, showing the date and time of discovery, specific location, description of the PCR, and interim protection measures implemented. This Report will be submitted to NEA-THL, who will provide it to the relevant Government authority.

Appendix 4 Stakeholder Interchange: An Initiative

The 1st Stakeholder Interchange (SI) under this PPTA was conducted on 8th June at Damauli and 9th June at Bhimad Bazar. It was felt that the Stakeholder Interchange should be conducted before the Census and the Socio-Economic Survey, to appraise the people about the developments in the Upper Seti Project. Such an approach will help in gaining co-operation from the local people, a key element to make the surveys successful.

The Project Director, NEA had prior meetings with the representatives of the affected community and agreed upon the time and date of the Stakeholder Interchange which got scheduled accordingly.

The SI was initiated with distribution of pamphlets, prepared in local Nepali language, to the participants. The key elements which were covered in the pamphlets are as follows.

- Technical details of the project.
- Explanation of R-O-R & importance of reservoir based project.
- Details of evacuating power from Upper Seti through Bharatpur S/S.
- The present situation of the various studies undertaken under PPTA & DES.
- Details of JICA FSR which was done from 2006-2008.
- The details of affected VDCs as identified under JICA study.
- The environmental & socio-economic impacts along with mitigation plans
- The affected areas and species were explained in detail
- Explanation of Environmental Management Plan (EMP) & Social Management Plan (SMP).
- Plan for implementation of the project through involvement of VDC, NGO, AP, Dist Authority etc.
- Explanation of the three phase roll out plan namely study, construction & operation.

A scanned copy of the pamphlet is attached as **Annexure – 1.**

The Interchange commenced with the opening speech by the Upper Seti Project Director (PD) Mr.Mahesh Acharya wherein he highlighted the key aspects of the project along with the studies which are undergoing presently. This was followed by a detail presentation duly anchored by the PD with support from his officers of the engineering & administration discipline. The presentation was made in local Nepali language for the sake of the local people. Following were the key elements discussed in the presentation:

- The current electricity situation in Nepal
- Features of the Upper Seti Project
- Various aspects to be covered under the project
- Current activities under the project
- Possible outcome of the project along with the benefits & challenges
- The time frame of the project.

The governing thought which got articulated clearly through the SI presentation is that

'Everyone Can Benefit From This Project, But Only If It Happens. So let us all work together to make it happen'.

The detailed English version of the presentation is attached as **Annexure – 2**.

The Stakeholder Interchange at Damauli, 8th June 2011

Project Director, Upper Seti presenting at Stakeholder Interchange at Damauli, 8th June 2011

The Stakeholder Interchange at Bhimad Bazar, 9th June 2011

The presentations were followed by Question & Answer sessions, wherein the participants we allowed to provide questions in writing and the same were responded by PD with due support from his officers. As a strategy a list FAQ's along with suitable answers were developed before the SI & NEA officers were suitably trained on the same. Such an exercise was gainfully utilised in responding to the questions raised by the audience. Most of the questions were common form the developed list of FAQs. The translated list of key questioned rose in the respective SI's are attached as **Annexure – 3**.

A Women Representative of the Affected Community Group raising a question at Bhimad Bazar

The Chairman of one of the concerned people's group requested for making a representation following the presentation of NEA. He was allowed to carry out the same in both the SIs. The key elements covered by him in the representation are as follows:

- Key requirements for sustainable developments of the project floats around the four components i.e. Returns of the project to be distributed equally, Natural & Environmental justice to be ensured, Social, Economical & Cultural preservation to be given importance and to allow investment of local people in the project to develop the feeling of participation.
- Actions were proposed to implement the proposed four components.
- The proposed action for Returns of the project to be distributed equally:
  - The affected area should be free from load-shedding through alternative power supply mechanism
  - Returns of the project should be distributed justifiably. For e.g. In Kulekhani project, some money is distributed to the affected VDCs every year through a scheme
- The proposed action for Natural & Environmental justice to be ensured:
  - Measures to be taken to control land-slides
  - Measures to be taken to control growth of moss in the forest which makes the routes slippery & hazardous for local people
  - Deforestation to be controlled to the level possible
  - Since the project will take away 424.5 hectres of forest land, adequate afforestation to be done for restoration of the same
  - Proper tools & methods should be used to control sound pollution & vibration
  - Methods to be adopted to protect the aquatic & land animals where around 16 varieties will be affected

- The proposed action for Social, Economical & Cultural preservation:
  - Measure to be taken to restore the affected structures
  - 151.22 Hectares of Agriculture land will be affected & 660.77 metric ton of Agriculture product will be decreased. The project should be adequately planned to rehabilitate the affected people.
  - 828 household lands will be acquired & 110 structures will be damaged. So reasonable compensation should be planned.
  - Income Generating Scheme (IGS) & economical support to be provided to affected communities e.g. resettlement allowance, seed money etc.
  - Skill development & employment generating programmes to be planned
  - Affected VDCs, neighbouring VDCs & people of Tanahun should be given 1st priority for employment
  - Health & educational programmes to be launched
  - Dust, smoke & vehicular pollution to be minimised
  - Education & women development programme to be launched for the displaced persons
  - Improvement of livelihood of affected women should be ensured thorough training & IGS
  - Distribution of suitable plants to be made to local people for restoration of river banks
  - Rural electrification programme to be launched to make power available to all areas under the Tanahun Dist
  - Without affecting the project, rural tourism programme to be developed e.g. boating
  - Proper security measures to be planned to manage societal degradation
  - Insurance & compensation to be planned for the workers & contractors who will get affected by injury or loss of life.

- The proposed action to allow investment of local people in the project to develop the feeling of participation:
  - Preference to be given to local people for making investment in the project
  - Study the model of Upper Tamakoshi and accordingly plan to distribute shares
  - Give emphasis on creation of Power Development Banks
  - Give preference to the local people in operation of the project

- Assurance was provided that the local people are going to whole heartedly support the project duly unbiased from the views of political parties.

- Appeal was made to involve the local people for evaluating the quality, transparency & follow-up of the progress of the project. Requirement for development of a mechanism for carrying out Stakeholder Interchange & dialogue with the local people on a regular basis was emphasised.

A representation was also made by The Communist Party Maoist Union. They demanded employment of the local people based on their capability and socio-economic condition. They said they will prepare a list along with recommendation for people to be employed and it has to be dealt accordingly.

Further Sri Kotadar Village Development Committee, Tanahun in their representation, listed the elements that will be affected as a result of the Upper Seti project and suggested actions to be taken for dealing with the same.

Scanned copies of the Concerned People Chairman representations is attached as **Annexure – 4a,** The Communist Party Maoist Union representations is attached as **Annexure – 4b** and the Sri Kotadar Village Development Committee, Tanahun representations is attached as **Annexure – 4c**.

A representative of the Affected Community Group making a representation at Damauli

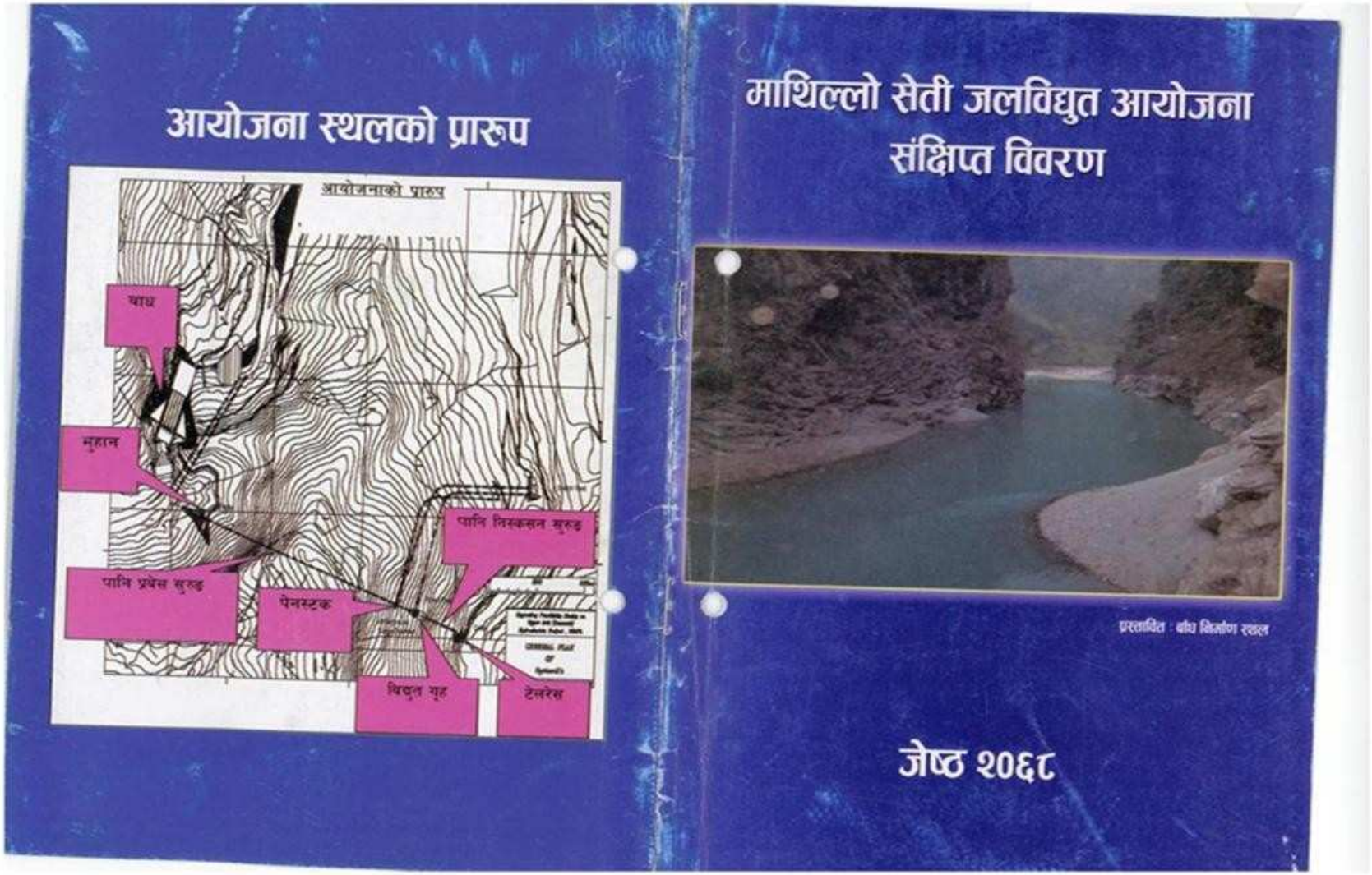
The Interaction was quite successful and the participants seemed pleased with the information disseminated. The meeting received coverage by the local media and details were published in the local newspapers. The essence of the newspaper extracts is elucidated as follows:

The Lokwani Daily wrote that the project is going to help development of the surrounding locations and will not only provide electricity to the affected district on priority basis but will also lead to the Social & Economic development of the district. Upper Seti Project is more reliable as it is snow fed project rather than rain fed. The project is currently under study stage, Detail Engineering along with other key studies on Environmental, Socio – Economic, Financing etc are under process. The report emphasised that successful commissioning of Upper Seti will lead to reduction of power shortage not only in and around the area but to the Nepal Country as a whole. It appealed to local people come forward and support the project whole heartedly.

The Bhanjyang National Daily covered that the SI is conducted before the detail survey is being rolled out. The Project Director Mahesh Acharya explained the details of a reservoir based project. He provided the technical details of the project. It mentioned that 424.5 Hectre land equivalent to 8337 ropani forest-land will get affected. The reservoir will be 27km from Bhimad bazaar. The project will reduce 20% of the present load-shedding in Nepal. The other officers explained in details the effects & advantage of the project. Similarly Mr. Sesh Kanta Khanal, the Chairman of the concerned people group has explained his views on the compensation & alternative power arrangements.

The scanned copy of the news extracts are attached as **Annexure – 5**.
There was a good amount of participation in both the SIs. The SI at Damuli had a participation of 111 (One Hundred and Eleven) participants and the same at Bhimad Bazar had 100 (One Hundred). The participants consisted of a mix of local people, representatives of concerned groups, media personalities, government officials etc. The scanned copy of the participant's signature is attached as **Annexure–6.**

Annexure – 1 Scanned Copy of the Pamphlet



जलाशय क्षेत्रको माथिल्लो भाग (भिमाद बजा

माथिल्लो सेती (दमौली) जलाशययुक्त जलविद्युत आयोजनाका मुख्य प्रारूपहरू

१.	जलाशय	
	पूर्ण जल सतह	४१५ मि.
	कुल भण्डारण क्षमता	२९.५१ करोड घन मि.
	उपयोगि भण्डारण क्षमता	१६ .७० करोड घन मि.
	जलाशय क्षेत्र	७.२६ वर्ग कि.मि.
	जलाशयको लम्बाई	२७ कि.मि.
	पानी घटने सतह	२७.८ मि.
	डिजाईन बाढी	७३७७ घन मि./सेकेण्ड
२.	बांध	
	प्रकार	कंक्रिट ग्राभिटि
	बांधको उचाई (समुन्द्र सतहबाट)	४२० मि.
	बांधको उचाई र लम्बाई	१४० मि., र १७० मि.
	बांधको ढोकाको प्रकार	रेडियल ढोका
	बांधको ढोकाको नाप	१२.५ मि. X १२.५ मि. X ६ गोटा
३.	विद्युत गृह	
	प्रकार	
	भूमिगत	
	चौडाई X उचाई X लम्बाई	२२ मि. X ४२ मि X ९० मि.
	टर्बाईनको प्रकार	भर्टिकल फ्रान्सीस
	टर्बाइनको संख्या	दुई (२) वटा
४.	जेनरेटर	
	कुल हेड	११५.८ मि.
	उपयोगि हेड	११३.० मि.
	सर्वाधिक पानी बहाव	१२७.४ घन मि/सेकेण्ड
	जडित क्षमता	६४ मेघावाट X २
	वार्षिक विद्युत उत्पादन	४७.५२ करोड युनिट
	दोश्रो दर्जा	२०.९८ करोड युनिट
	प्राथमिक	२६.५४ करोड युनिट
५.	आयोजनाको कुल लागत	३४.१० करोड यु एस डलर
६	आयोजना निर्माण अवधि	प्रारम्भिक कार्य सहित ६ वर्ष

१

माथिल्लो सेती (दमौली) जलाशययुक्त जलविद्युत आयोजना संक्षिप्त विवरण

१. पृष्ठभूमि

देश विकासको लागि महत्वपूर्ण स्रोतको रुपमा पहिचान भएको एकमात्र सुलभ जलस्रोतको समुचित उपयोग गर्ने नेपाल सरकारको नीति रहेको छ। हाल नदीमा बगिरहेको पानी फर्काएर बनाईएका जलविद्युत गृहहरुबाट विद्युत मागको ठूलो हिस्साको आपूर्ति भई रहेको छ। यस्ता आयोजनालाई Run-of River (ROR) जलविद्युत गृह भनिन्छ। यस्ता जलविद्युत गृहहरुले नदीको बहावको पूर्ण क्षमताको उपयोग गर्न सक्दैनन्। त्यसैले हिउँदका महिनाहरुमा हुने उर्जा संकटको समस्याबाट पार पाउन नेपाल विद्युत प्राधिकरणले जलाशययुक्त (Storage) जलविद्युत गृहहरु (जसले नदीको पानीको बहावलाई नियन्त्रण र भण्डारण गरी सुख्खायामा समेत चाहिएको मात्रामा विद्युत उत्पादन गर्न सक्दछन्) को कार्यान्वयनमा जोड दिएको छ। नेपाल विद्युत प्राधिकरणले जलाशययुक्त जलविद्युत आयोजना विकासका लागि गरेको अध्ययनले माथिल्लो सेती जलाशययुक्त जलविद्युत आयोजनालाई पहिचान गरेको हो। नेपाल सरकारले यसलाई प्राथमिकता प्राप्त आयोजनाको श्रेणीमा राखेको छ। माथिल्लो सेती जलाशययुक्त आयोजना मध्य नेपालको तनहुँ जिल्लामा पर्छ भने विद्युत प्रशारण लाईन सो आयोजनाको विद्युतगृहबाट भरतपुरस्थित हाल विद्यमान मुख्य प्रसारण लाईनमा जोडिने छ। आयोजनाको अध्ययन क्षेत्रको अनुमान निम्न बमोजिम छ :

- जलाधार - करिब १,५०२ वर्ग कि.मि.
- जलाशय र यसको वरीपरीको क्षेत्र - करिब १२० वर्ग कि.मि.

२. आयोजना कार्यान्वयनको वर्तमान स्थिति:

नेपाल सरकारले जापान सरकारलाई जापान अन्तराष्ट्रिय सहयोग नियोग

(जाईका) को प्राविधिक सहयोग अन्तर्गत परिमार्जित संभाव्यता अध्ययन (Upgrading feasibility Study) कार्यान्वयन गर्न अनुरोध गरेको थियो। सोहिअनुसार जाईका अध्ययन टोलिले २००६ जनवरीबाट शुरु गरी सन् २००८ परिमार्जित संभाव्यता प्रतिवेदन पेश गरेको थियो।

उल्लेखित परिमार्जित संभाव्यता अध्ययन अनुसार यस आयोजनाको अनुमानित लागत ३४.१ करोड अमेरिकी डलर रहेको छ। हाल एसियाली विकास बैंकको अनुदान सहयोगमा यस आयोजनाको विस्तृत ईन्जिनियरिङ अध्ययन (Detailed Engineering Study -- DES) तथा आयोजना तयारी कार्य (Project Preparatory Technical Assistance -- PPTA) सुचारु छन्। आयोजनाको प्रवेश मार्ग, पुल र कर्मचारी तथा परामर्शदाताका लागि आवास तथा कार्यालय भवनहरुको डिजाईन कार्य सम्पन्न भईसकेको छ। आयोजनाको डिजाईनको लागि आवश्यक हुने टेष्ट अडिट निर्माण कार्य अन्तिम अवस्थामा छ।

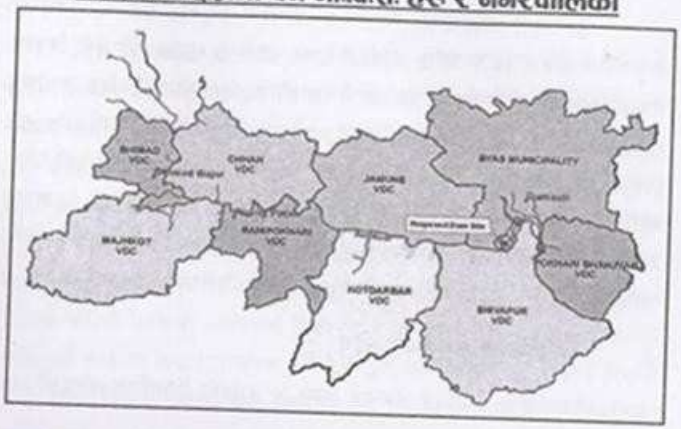
३. आयोजना प्रभावित क्षेत्र

आयोजना प्रभावित क्षेत्रलाई निम्न ४ समुहमा विभाजित गरिएको छ।

सि.नं.	विवरण	स्थान
१.	जलाशय क्षेत्र	भिमाद, छाङ, माझकोट, रिभिङ रानीपोखरी, कोट दरबार, जामुने, काहुँ शिवपुर गा.वि.स., व्यास नगरपालिका
२.	बाँध, विद्युत गृह, पानी निस्कासन सुरुङ्ग र स्वीच यार्ड	काहुँ शिवपुर गा.वि.स., व्यास नगरपालिका
३.	आयोजना सुविधा संरचनाहरु (पहुँच मार्ग, बसोबास क्षेत्र, व्याचिङ्ग यार्ड, दुङ्गा माटो थुपार्ने क्षेत्र आदि)	काहुँ शिवपुर गा.वि.स., व्यास नगरपालिका

४.	तल्लो तटीय क्षेत्र	काहुँ शिवपुर, पोखरी भञ्ज्याङ्ग, केशवटार, धरमपानी, बैदी, छिपछिपे, देवघाट, देउराली गा.वि.स.

आयोजना क्षेत्रमा पर्ने गा.वि.स. हरू र नगरपालिका



४. सामाजिक-आर्थिक प्रभावहरु तथा प्रभाव न्यूनीकरण :

आयोजना क्षेत्रमा केहि सामाजिक-आर्थिक प्रभावहरु पनि पर्न सक्छन्। स्थानीय व्यक्तिको घर-जग्गा, नीजि वन आदि आयोजना क्षेत्रमा पर्नसक्दछन्। यसै गरी सामाजिक संरचना/ सांस्कृतिक तथा धार्मिक स्थलहरु पनि प्रभावित हुन सक्छन्। यस्ता सामाजिक-आर्थिक प्रभावहरु के कति हुन्छन् भन्ने कुरा अहिले भैरहेको आयोजना तयारी अध्ययनहरुले निर्क्योल गरी समाधानका उपाएहरु बारे सुझाव र प्रभाव न्यूनीकरण गर्न कार्ययोजनाहरु तयार गर्नेछन्। यसरी सामाजिक-आर्थिक प्रभावहरु न्यूनीकरण गर्दा आयोजनाले असर पुऱ्याएका व्यक्ति, परिवारको अवस्था कम्तिमा आयोजना पूर्वको अवस्था वा सो भन्दा राम्रो हुनेछ।

५. वातावरणीय अध्ययनले पहिचान गरेका वातावरणीय प्रभावहरु

वि. सं. २०६२ को अन्त्यतिर जाईका अध्ययन टोलीले नेपाल विद्युत प्राधिकरणले तयार गरेको वातावरणीय प्रभाव मुल्यांकन अध्ययन प्रतिवेदनको समिक्षा गरि पुरक वातावरणीय प्रभाव मुल्यांकन अध्ययनको लागि क्षेत्र निर्धारण कार्य सम्पन्न गरेको थियो। यस क्षेत्र निर्धारण कार्यले जाईकाको वातावरणीय तथा सामाजिक पक्षको निर्देशिकालाई समेत अगिंकार गरेको थियो। पूरक वातावरणीय अध्ययनको सर्भे कार्य नेपाली वातावरण परामर्शदाता बाट कार्तिक २०६३ मा संपन्न गरिएको थियो। पूरक बातावरणीय अध्ययनले आयोजना कार्यान्वयन गर्दा निम्न वातावरणीय प्रभावहरु हुन सक्ने आंकलन गरेको छ।

- सेती जलाधार योजनाका सवालहरु र जलाशय निर्माणले भू-बनोट, भू-उपयोगमा पार्ने प्रभावहरु र तिनिहरुको न्यूनिकरण कार्य मुख्यतया: भू-क्षय र पहिरोहरुका संबन्धमा।
- सेती-मादी दोभान बरपर निर्माण गरिने संरचनाहरु र त्यसले भू-बनोट, र भू-उपयोगमा पार्ने प्रभावहरु।
- जलाशयमा गरिने पानी नियन्त्रण र दैनिक परिवर्तन हुने नदी बहावले सेती नदीको तल्लो तटीय क्षेत्रमा पार्ने प्रभावहरु।
- लेऊ संक्रमणका कारण हुने जलाशयको पानीको गुणस्तरमा प्रभाव।
- जलाशय निर्माणका कारण करिब ४२४.५ हेक्टर (८३३७ रोपनी) राष्ट्रिय, सामुदायिक तथा निजि वन क्षेत्रमा पर्ने प्रभाव।
- जोखिम क्षेत्र, जलाशय निर्माणका कारण जंगली जिवजन्तुहरुमा पर्ने प्रभावहरु (करिब १६ प्रजाति स्तनपायी जनावरहरु साईटिस तथा आई यु.सि एन को संरक्षण सुचिमा पर्दछन) को निर्क्यौल।

- जलाशय निर्माण तथा जलश्रोतको थिग्रयान (Sediment) सफा गर्ने प्रक्रियाका कारण जल पर्यावरण तथा माछामा पर्ने प्रभावहरु ।
- दमौलीको विद्युत गृह देखि भरतपुरको सवस्टेसन जोड्ने करिब ३८.४ कि.मि. लामो २२० के.भि. विद्युत प्रशारण लाईनबाट पर्न सक्ने प्रभावहरु ।

जलाशय क्षेत्रको माथिल्लो भाग (भिमाद बजार)

६. वातावरणीय प्रभाव न्यूनीकरण

माथिल्लो सेती जलशाययुक्त जलविद्युत आयोजनासंग सवै वातावरणीय पक्षलाई व्यवस्थापन गर्न आयोजना क्षेत्रमा एउटा छुट्टै सामाजिक तथा वातावरणीय अनुगमन इकाई गठन गरिनेछ । यस इकाईले वातावरणीय अध्ययन प्रतिवेदनले सिफारिस गरेको न्यूनीकरण तथा कार्यान्वयन भए नभएको अध्ययन गर्नेछ ।

यसले सरोकारवालाहरुलाई प्रगति र सभाव्य प्रभाव विषयमा जानकारी दिनेछ । सामजिक तथा वातावरणीय प्रभाव न्यूनीकरण कार्यका लागि नेपाल विद्युत प्राधिकरण, वातावण तथा सामाजिक अध्ययन विभाग, आयोजना प्रभावित आयोजना प्रभावित क्षेत्रका सरोकारवालहरु- जि.वि.स., न.पा., गा.वि.स., गैर सरकारी संस्थाहरु, समुदायमा आधारित सामाजिक संघ, संस्थाहरुका साथै प्रभावित विभिन्न समुहहरु, राजनीतिक दलहरु, आदिसंग समन्वय गरी कार्य गरिनेछ ।

माथिल्लो सेती जलाशययुक्त जलविद्युत आयोजनाको वातावरणीय अनुगमन क्रियाकलापहरु तीन भागमा विभाजन गरी गरिनेछ । (i) निर्माण पूर्व गरिने अनुगमन (ii) निर्माण अवधिमा गरिने अनुगमन (iii) निर्माण पश्चात गरिने प्रभाव अनुगमन । आयोजनाबाट प्रभावित सबै क्षेत्रको अनुगमन नियमित रुपमा विभिन्न विधि प्रयोग गरी कार्य तालिका अनुसार गरिनेछ ।

७. अनुगमन तथा मूल्यांकनको व्यवस्था:

यस आयोजनाको वातावरणीय पक्षको अनुगमन, मूल्यांकन तथा व्यवस्थापनको लागि विभिन्न विषयको विशेषज्ञहरु समावेश भएको एउटा वातावरणीय इकाईको व्यवस्था गरिने छ । नेपाल विद्युत प्राधिकरण वातावरण तथा सामाजिक अध्ययन विभागले यस आयोजनाको वातावरणीय पक्षको सुपरीवेक्षण गर्नुका साथै केन्द्रीय स्तरमा वातावरण सम्बन्धी कार्यहरुको समन्वय समेत गर्ने छ । प्रस्तावित वातावरण इकाईले वातावरणीय पक्षको अनुगमन तथा मूल्यांकन, सुधाईको वातावरणीय प्रभाव न्यूनीकरणका कार्यक्रमहरु लागू गर्ने तथा स्थानीयस्तरमा वातावरणीय कार्यको समन्वय समेत गर्नेछ ।

८. निष्कर्ष

माथिल्लो सेती जलविद्युत आयोजनाको हालसम्मको अध्ययनबाट यो आयोजना सामाजिक, आर्थिक, प्राविधिक एंव वातावरणीय दृष्टिकोणले उपयुक्त देखिएको छ । बांध १५० मि. उचाईको बनाउदा यो आयोजना आर्थिक रुपमा झनै आकर्षक हुने प्रारम्भिक अनुमान गरिएता पनि प्रभावहरु धेरै हुने भएकोले

बाँधको उचाई १४० मि. कायम गरी डिजाईन गरिने छ। आयोजना जलाशययुक्त किसिमको भएता पनि यसबाट पर्ने वातावरणीय तथा सामाजिक प्रभावहरु न्यूनीकरण तथा व्यवस्थित गर्न सकिने किसिमका छन्। तसर्थ, यस आयोजनाको निर्माणले विद्युत आपूर्तिमा टेवा पुगी विद्युत कटौतीको संकटबाट मुक्त गर्दै मुलुकलाई आर्थिक समुन्नती तर्फ उन्मुख गराउन सक्ने छ भन्ने नेपाल विद्युत प्राधिकरणको विश्वास छ।

Annexure – 2 Presentation – English Version

Upper Seti Hydropower Project

Stakeholders Interchange

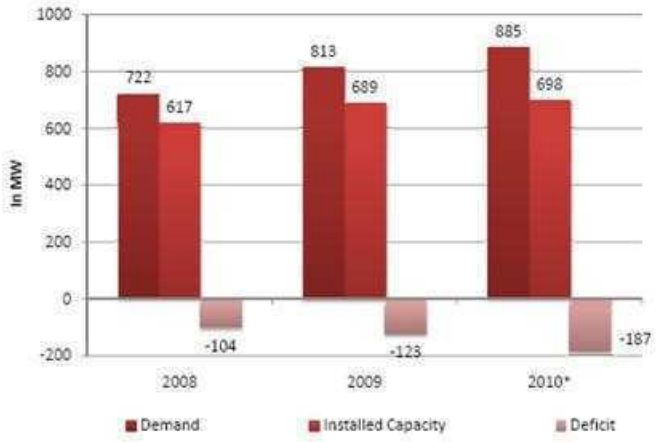
8-9 June, 2011
Damauli and Bhimad Bazaar

The Situation in Nepal

- The Electricity Crisis
  - Less than 50% 0f Nepalis have any electricity
  - Power shortages and extensive load shedding (last year s4 hours)
  - Significant difference in generation in wet and dry seasons
  - Shortage of commercial energy has a limiting effect on growth of industries and services
- The Situation will get worse and worse each year as demand increases

2

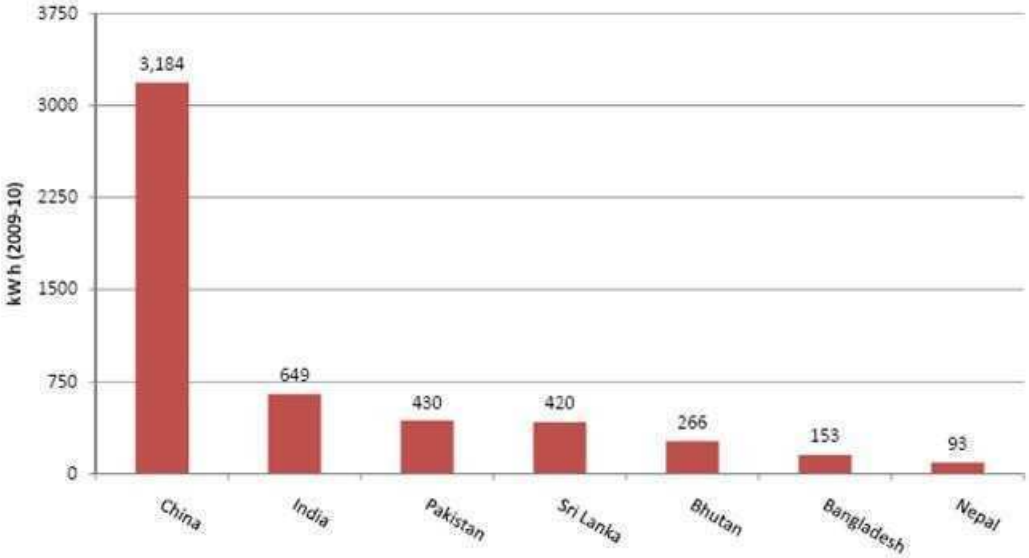
Nepal's Power Deficit

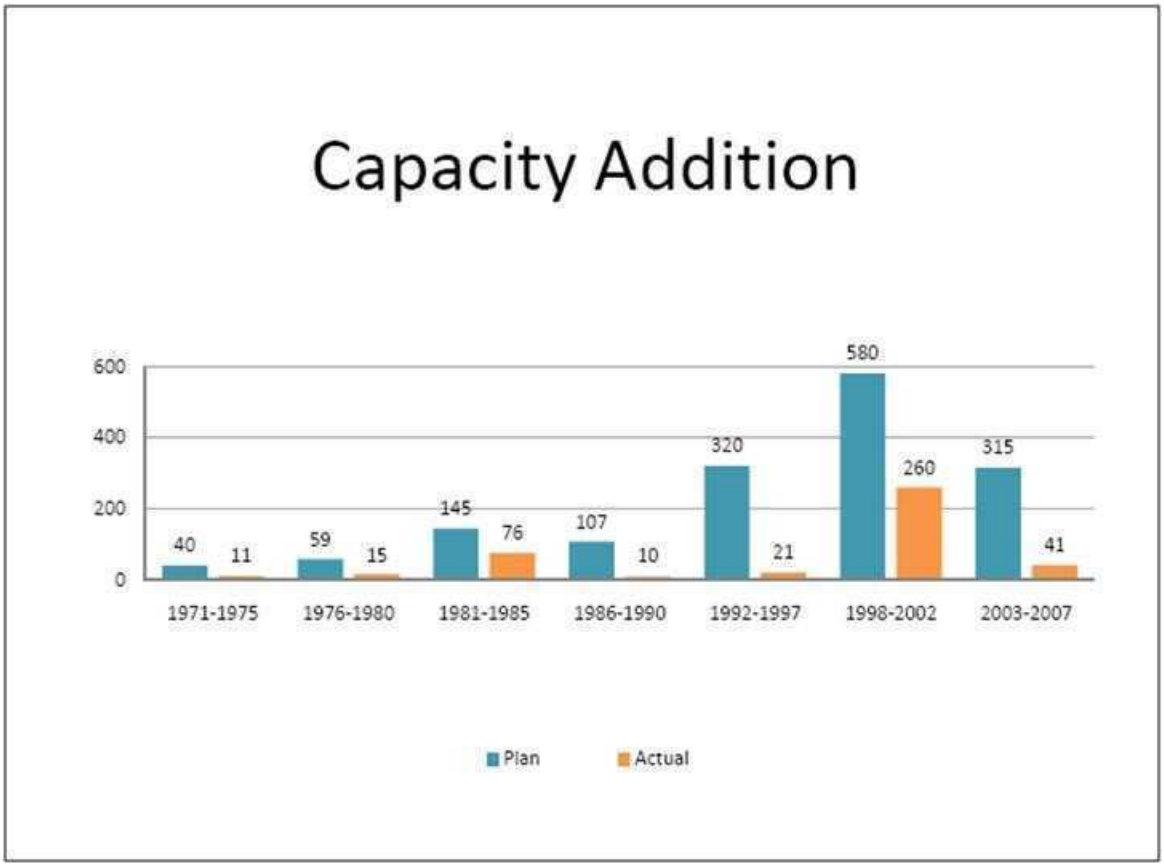


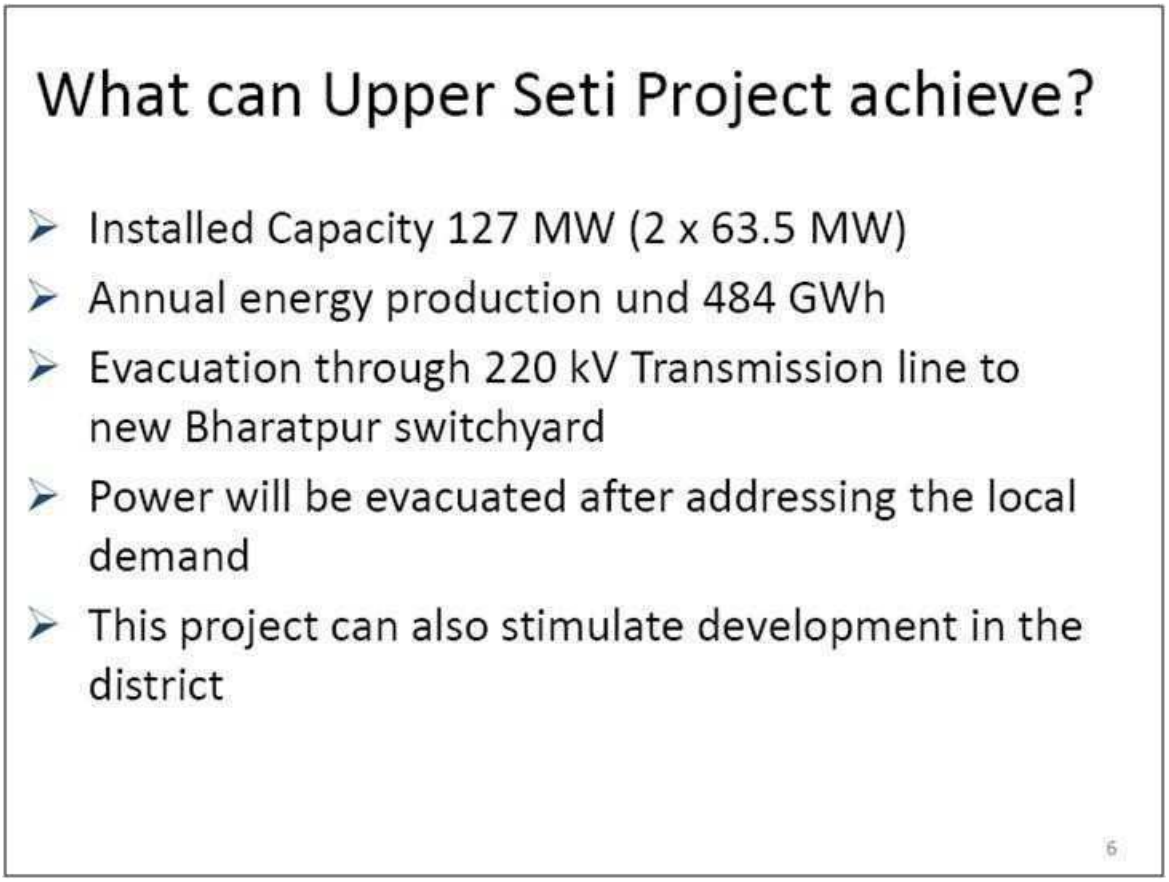
Source – NEA Annual Report , PwC Analysis (data for a wet season)

3

Per Capita Power Consumption




Capacity Addition
600
400
200
0
40
11
59
15
145
76
107
10
320
21
580
260
315
41
1971-1975
1976-1980
1981-1985
1986-1990
1992-1997
1998-2002
2003-2007
Plan
Actual


What can Upper Seti Project achieve?
Installed Capacity 127 MW (2 x 63.5 MW)
Annual energy production und 484 GWh
Evacuation through 220 kV Transmission line to new Bharatpur switchyard
Power will be evacuated after addressing the local demand
This project can also stimulate development in the district
6

Why Upper Seti Project?

- Near load centre
- Accessible
- Low environmental impacts
- Peaking capacity
- Hydrologically sound: snow fed
- High level of interest shown by local people in project study phase
- Significant government support in project implementation

7

Project area

Full Supply Level = EL. 415 m

Reservoir length = 27km (up to Bhimad Bazaar)

Reservoir surface area at FSL(EL.415) = 6.5km^2

8

What is happening now?

- Following two activities are going on currently:
  - Project preparation study (PPTA)
  - Detailed Engineering Study (DES)
  - Development of infrastructure

9

What is being done under PPTA?

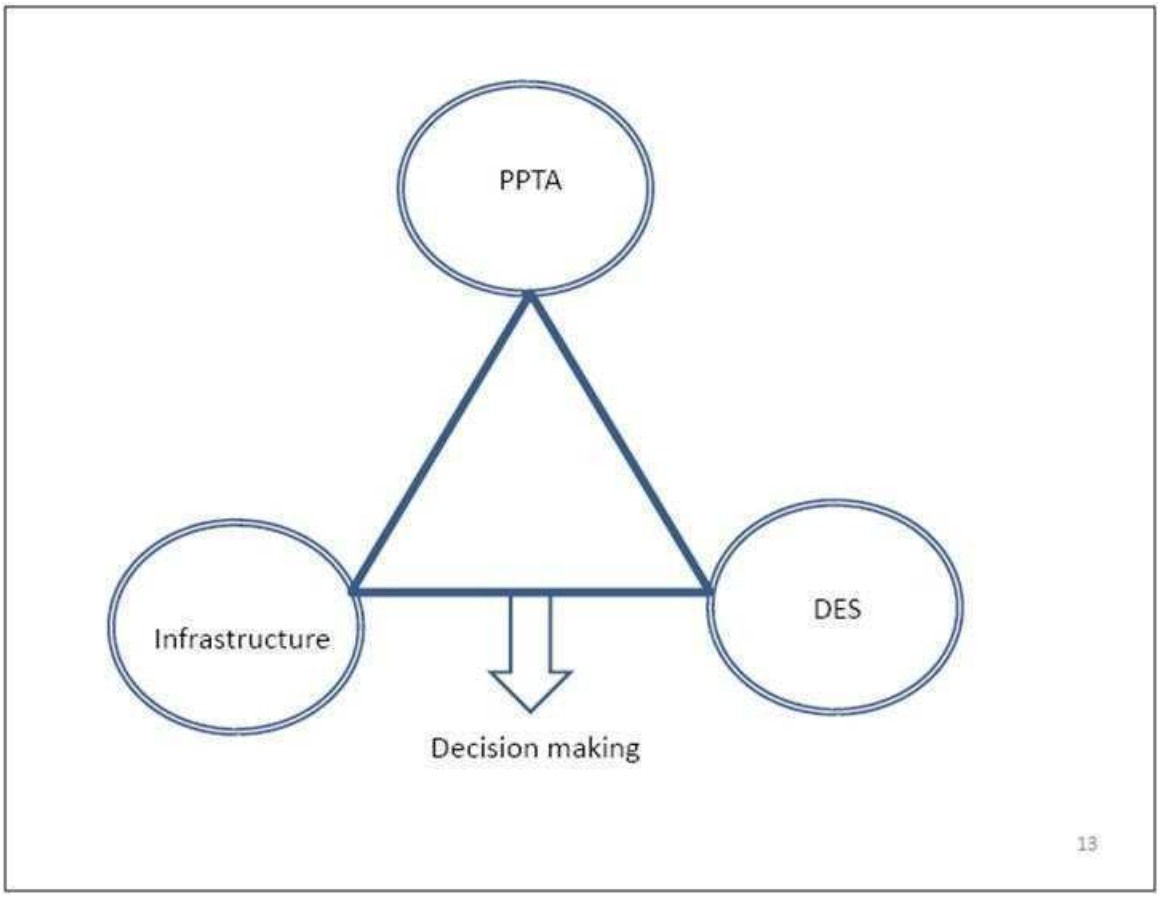
- PPTA will cover the following:
  - Finance and economics
  - Environment
  - Social safeguards
  - Community development

11

What is being done under PPTA?

- Social safeguards
  - Land and assets acquisition
  - Displacement and relocation
  - Compensation for losses
  - Mechanisms for compensation
  - Livelihood restoration for vulnerable and affected families
  - Grievance redress mechanisms

12


PPTA
Infrastructure
DES
Decision making
13

What is being done under PPTA?

- Community development
  - Support to local schools, health centres, drinking water
  - Renovation/ replacement of affected infrastructures and facilities
  - Rural electrification
  - Skills and income-generation training and support
  - Support to community institutions

14

What is being done under PPTA?

- Environment
  - Deforestation and replacement
  - Water retention and discharge
  - Aquatic life and flora and fauna
  - Cultural and religious sites
  - Support to community institutions
  - Bank erosion and protection
  - Sedimentation management
  - Local influences of influx of workers

15

What is being done under DES?

- Detailed Engineering Study
  - Model testing of dam
  - Preparation of basic design of
    - Dam
    - Powerhouse
    - Tunnel
    - Preparation of technical specifications

16

Ongoing Infrastructure Development

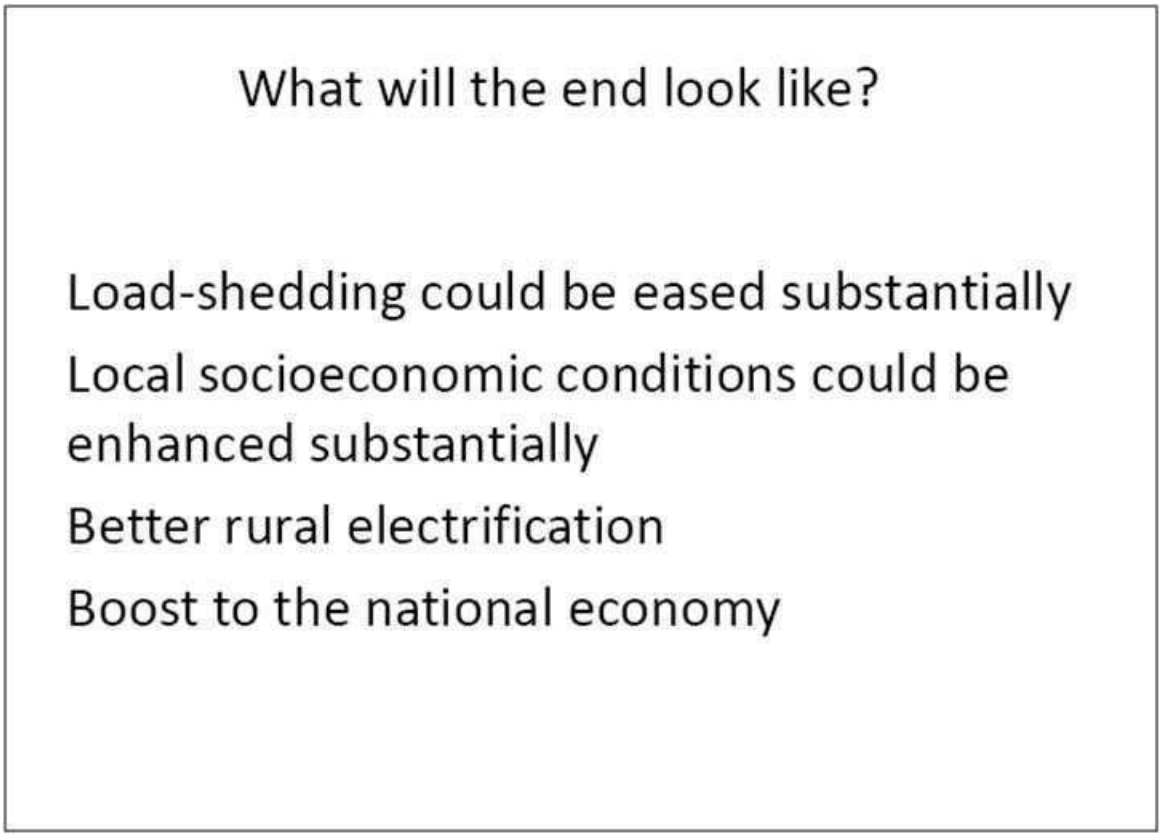
- Design of the permanent bridge over Seti River
- Design of road for construction
- Design of the project camp facilities
- From next fiscal year (FY 2068/69) construction of the infrastructure will begin

17

Addressing social and environmental safeguard

Consultations at different levels

- Surveys (socioeconomic, census)
- Participatory planning of community development programs
- Participatory Resettlement Action Plan
- Implementation plans
- Monitoring and reporting


What will the end look like?
Load-shedding could be eased substantially
Local socioeconomic conditions could be enhanced substantially
Better rural electrification
Boost to the national economy

What will the end look like?

Local jobs, higher incomes

Local socio economic conditions will be equal or better off after the project

Skill enhancements

Could be a model project for Nepal and region

20


The Complexities
Potential complexities will be addressed in consultation with stakeholders. Such complexities may arise in following areas:
• Social
• Community
• Financial
• Environmental
• Economic
• Engineering
Slide 21

Tentative project timeline

- The Study Phase (this Project) 2011-2012
  - All reports expected by December 2012
- Construction Phase 2013-2017
- Operational Phase 2017

22

… and finally

We Can All Benefit from The Upper Seti Project

But Only if it Happens

Annexure – 3 List of Questions asked

Questions raised by participants at Damauli 8 June 2011

- How many people will be displaced?
- What is the exact definition of Affected People (AP) & how will they be managed?
- What sort of employment opportunity will be there for the project?
- How will you plan Social safeguards & compensation mechanism?
- Demand: Tanahun should be 100% load-shedding free, the tariff of electricity should be lower for the people of Tanahun
- The work on this project is going on for a long time however still it is not initiated, please explain?
- The cost of the project is estimated around $400mn. How much money is coming from which investors?
- The length of reservoir is 27Km. How do you propose to plan the transportation facilities?
- Are you also planning Lower Seti Hydro-power project?
- All documents as per ADB & JICA is to provided in simple language, however such is not done & shared with public. Please explain the reason for the same?
- All the concerned people were not informed properly & hence there are limited representatives. Please explain the reason and take care of such issues in future?
- Demands: Women to given priority for skill- development program according to their capabilities
- The local people have always got priorities in all projects. What are the plans for Upper Seti?
- How do you plan the Income Generating Scheme (IGS) & skill-development programmes?
- What are your plans for the employment of directly affected people?

Questions raised by participants at Bhimad Bazar 9 June 2011

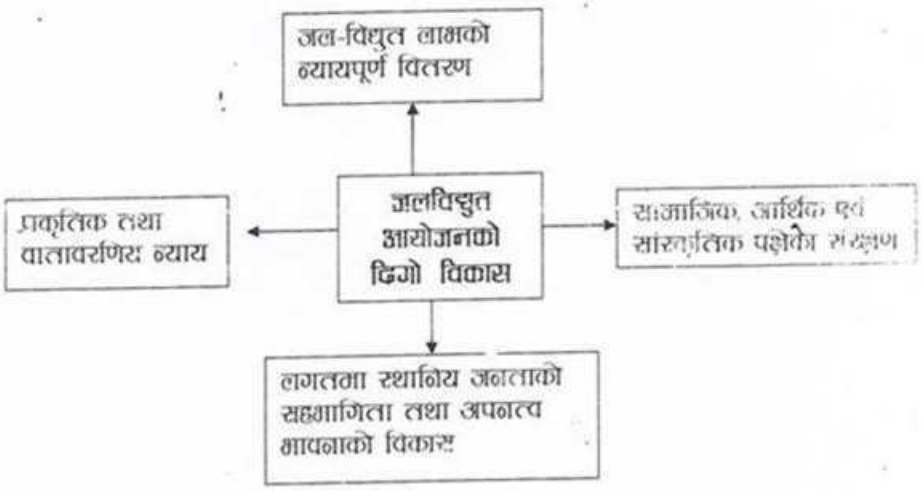
- Please consider the landslide issues while planning the project?
- The land for the local school is not registered. How to do you plan to compensate such projects?

- What media will be utilised to disseminate project related information on a regular basis?
- How do you plan to meet & inform the committees of concerned people?
- Do you need permission from Indian Govt. to construct this project?
- The reservoir will inundate all cremation centres. So please develop electric based cremation centres as alternatives
- What is the outline of the affected area, please explain?
- Suggestions: Guarantee employment to the people of affected families, evaluate the to be inundated areas properly, provide support to the affected families, directly provide compensation to the affected people & not through political leaders
- Who will provide the compensation, the Govt. or NEA? How do you plan the appropriate compensation?
- For power evacuation. why is the project not connected to the nearest Pokhara S/S & instead of Bharatpur S/S which is quite at distance and also increases the transmission cost?
- The constructing of this project will be difficult considering that it is planned on a hilly terrain. Also the cost is quite high. How do you feel that the project will be economically viable?
- Certain lands are used by communities which are not registered. How do you plan to compensate such people?
- Detail interaction programmes should be conducted in the affected areas.
- Rishing Patan will be most affected. Roads should be built for that area on an urgent basis.
- The positive & negative effects of the project should also be explained to the teachers & students of the localities.

Annexure – 4a . Scanned Copy of the Concerned People Chairman's Representation.

अपर सेती जलाशययुक्त जलविद्युत परियोजनाको
सद्भावना र चुनौतीहरु

तनहूँ जिल्लाको मध्यभागमा निर्माण हुन गईरहेको यस अपर सेती जलाशययुक्त जलविद्युत परियोजना (१२७ मेगावाट) सम्पन्न गर्नमा आयोजना, कार्य निकाय, सरोकारवाला तथा सम्पूर्ण यस जिल्लावासीहरुको दायित्व तथा कर्तव्य भएको हुंदा हामी सबैलाई आग्रह/पूर्वाग्रह नराखी समयमा नै आयोजना सम्पन्न गर्न/गराउनका लागी आग्रह गर्दछौं । राजनीतिक प्रभाव तथा कुनै पुर्वाग्रह नराखी यस आयोजना सम्पन्न गर्नमा हामी सबै प्रयत्नशिल तथा इमान्दारी पुर्वक लाग्नका लागी समेत अनुरोध गर्दछौं. ।



क. जल विद्युत लाभको न्यायपूर्ण वितरण :

१. प्रभावित क्षेत्रलाई लोड सेडिङ्ग मुक्त क्षेत्र घोषणा
२ वैकल्पिक उर्जाको व्यवस्था
३. विद्युतबाट प्राप्त लाभको न्यायोचित वितरण । जस्तै (कुलेखानी जलाविद्युत आयोजनाले प्रभावित गा.वि.स.हरुलाई वार्षिक रकम उपलब्ध गराउने गर्दछ ।)

Representation by Upper Seti Concerned People Group

ख. प्राकृतिक तथा वातावरणिय न्याय :

१. भू-स्खलनको रोकथाम
२. जोखिम क्षेत्रमा ढाल मजवुतीकरण
३. लेउ वृद्धिको रोकथाम
४. वन विनासको रोकथाम (वृक्षारोपण ४२५ हे. संरक्षित वन डुवान हुने हुनाले ।
५ ध्वनी तथा कम्पनवाट हुने प्रभावको न्युनिकरणको उपायहरु
६. जलचर तथा जनावरहरुको को सुरक्षाका उपायहरु (१६ संरक्षित जनावरहरु प्रभावित हुने)

ग. सामाजिक, आर्थिक एवं सांस्कृतिक पक्षको संरक्षण

१ आयोजनाले असर पुर्‍याएका भौतिक संरचनाको पुनर्स्थापना तथा निर्माण कार्य :
१५१.२२ हे. कृषि भूमि माथिको असर तथा ६६०.७७ मे. टन कृषि उत्पादन घट्ने ।
२. आयोजनाले असर पुर्‍याएका व्यक्ति तथा समुदायहरुको पुनर्स्थापना योजना ल्याउनु पर्ने : ८२८ घरधुरीको जग्गा अधिकरण, ११० घरधुरीहरुमा रहेको संरचनाको अधिकरण पर्ने जसका लागी उचित क्षतीपूर्तिको व्यवस्था गरिनु पर्ने ।
३. प्रभावित समुदायहरुको लागी आयमुलक सीपको व्यवस्था तथा आर्थिक सहयोग कार्यक्रमको व्यवस्था:
पुनर्वास, भत्ता, सीट मनी आदी
४. दक्षता अभिवृद्धि तथा रोजगामुलक कार्यक्रमको व्यवस्था :
प्रभावित गा.वि.स., छिमेकी गा.वि.स. तथा तनहूँ जिल्लावासीलाई रोजगारीमा पहिलो प्राथमिकता ।
५. जनस्वास्थ्य तथा शैक्षिक अभिवृद्धि कार्यक्रम :
धुलो धुंवा सवारी ध्वनी प्रदुषणवाट असर पर्ने खालका न्युनिकरण गर्ने उपायको खोजी । विस्थापित हुने समुदायको शिक्षाको उचित व्यवस्था ।
६. महिला विकास कार्यक्रम :
प्रभावित क्षेत्रकाँ महिलाहरुको पहिचान गरी उनीहरुको जीवनस्तर उठाउने खालका तालिम तथा रोजगार कार्यक्रमको व्यवस्था ।
७. जलाधारको व्यवस्था :
विभिन्न प्रजातीका विरुवाहरु वितरण गरी आयोजनाले ओगट्ने क्षेत्रमा समुदायको प्रत्यक्ष संलग्नतामा सामुदायिक जलाधार व्यवस्थापन कार्यक्रमको व्यवस्था गर्ने ।

Representation by Upper Seti Concerned People Group

८. ग्रामीण विद्युतीकरण कार्यक्रम :
विद्युत पहुच नपुगेका तनहूँ जिल्लाका ग्रामिण क्षेत्रमा विद्युतीकरण गर्ने ।

९. पर्यटन विकास कार्यक्रम :
आयोजनालाई असर नपर्ने गरी ग्रामीण पर्यटन पूर्वाधार विकास कार्यक्रमको खोजी गर्ने । जस्तै नौका विहार

१०. सुरक्षाका उपायहरु अवलम्वन गर्ने :
आयोजनावाट हुने सामाजिक विकृति न्युनिकरण गर्ने । मजदुर तथा आयोजना क्षेत्र तथा तेश्रो पक्षमा पर्न जाने चोटपटक तथा मृत्यु हुन गएमा विमा, ओषधोपचार तथा क्षतीपूर्तिको उचित व्यवस्था गर्ने ।

घ. लागतमा स्थानिय जनताको सहभागिता तथा अपनत्व भावनाको विकास

१. लगानीमा स्थानिय जनताको अग्राधिकार :
शेयर/तामाकोशी मोडलको सम्भावनाको अध्ययन, उर्जा विकास वैंक स्थापनाको कार्यान्वयनमा जोड ।

२. आयोजना सञ्चालनमा स्थानिय तथा प्रभावित क्षेत्रका जनताहरुको संलग्नतालाई प्राथमिकिकरण ।

३. आयोजनाको गुणस्तर मापन, आयोजना सञ्चालनमा पारदर्शिता कायम गर्न अनुगमन तथा मूल्यांकनका लागी स्थानिय तथा प्रभावित क्षेत्रका जनता तथा सरोकार समुहहरुका प्रतिनिधि समेत रहने गरी संयन्त्रको विकास गर्ने ।

४. आयोजना, प्रभावित क्षेत्रका जनताहरु तथा सरोकार समुहहरु वीच निरन्तर अन्तर्क्रिया, तथा छलफल गर्ने संयन्त्रको विकास गर्ने ।

मिति : जेष्ठ-२५,२०६८

शेषकान्त खनाल
अध्यक्ष
अपर सेती सरोकार समुह
ढुमौली तनहूँ

Representation by Upper Seti Concerned People Group

Annexure – 4b Scanned Copy of The Communist Party Maoist Union representations

नेपाल कम्युनिष्ट पार्टी (माओवादी)

पोखरीभञ्ज्याङ गाउँ पार्टी समिति

केशवटार तनहुँ

पत्र संख्या ०६८/०६९

चलानी नं ०९६.

मिति २०६८।२।१६.

Demand placed by Nepal Communist Party (Maoist)

श्री कार्यालय प्रमुख ज्यू
सेती माडी, प्रोजेक्टस,
तनहुँ,

विषयः- प्रभावित इलाका, पोखरी भञ्ज्याङ, तथा केशवटार गा.वि.स. बेरोजगार लाई रोजगार सम्बन्धमा।

प्रस्तुत सम्बन्धमा हाम्रो महान तथा गौरवशाली पार्टी ए.ने.क.पा.(माओवादी) मा, दशवर्षे जनयुद्ध देखि हाल सम्मको अवस्थामा, आस्थाका आधारमा तथा सरकारी उदासिनता, कारण, नातावाद कृपावादरुप बाट नियुक्ति का कारण हाम्रा कैयन कार्यकर्ता आस्थावान, साथी हरु बेरोजगारी रहनुपरेकोमा हालको अवस्थामा निकै ठाउँबाट क्षमता अनुसार तथा निर्वाध रुपबाट, रोजगारी मा राख्नेन, अनुरोध गरिन्छ। अत: यसै अनुसार पिडित तथा जटिल परिस्थिति मा गुज्रीरहेका साथी हरुको नाम वलि, हिजै बैठक बसी अनुशासन मा कार्यरत, रहेका, साथी हरु को नाम वलि पेश गरिने व्यहोरा अनुरोध गरिन्छ। साथै अनुरोध लाई कमजोरी का रुपमा नलिन र सहज तथा सकारात्मक रुपमा लिई सिफारिस भए अनुसार का मित्र हरुलाई व्यवस्थापन गर्न अनुरोध गरिन्छ।

*: केशवटार, पोखरीभञ्ज्याङ २ वटै गा.वि.स. [illegible]

क. दीलिप
सेक्रेटरी
(पोखरीभञ्ज्याङ)

९८४६२६४०७५
०६५-६९३२०५

Representation by Nepal Communist Party (Maoist)

Annexure – 4c Scanned Copy of the Sri Kotadar Village Development Committee, Tanahun Representation

श्री कोटदरबार गाउँ विकास समितिको कार्यालय
Shree Kotdarbar Village Development Committee
कोटदरबार, तनहुँ
Kotdarbar, Tanahun
फोन: ०६५-६९२२८२
गण्डकी अञ्चल, नेपाल

प.सं./Ref.No. :- ०६७।६८
च.नं./Des.No.:- ३३०
मिति/Date:- २०६८।५।२६

विषय/Subject:- जानकारी सम्बन्धमा।

Representation by kotdarbar VDC

श्री/Shree माथिल्लो सेती जलविद्युत परियोजना

उपरोक्त विषयमा माथिल्लो सेती जलविद्युत परियोजना संचालन भएमा यस कोटदरबार गा.वि.स तपसिल बमोजिम प्रभावित हुने भएकोले तपसिल बमोजिमका कामकाजहरु अगाडि बढाउन उक्त परियोजना संग माग गर्ने भनी यस गा.वि.स को सर्वदलीय बैठक बाट निर्णय भएकोले सोही व्यहोरा जानकारी गराइन्छ।

तपसिल

प्रभावित हुने विषयहरु

१) लिगाङ्, झो.पु. चुलेनी झो.पु र रहुलीबारे झो.पु डुबान हुने।
२) लाश जलाउने परम्परागत घाट डुबान हुने।
३) गौचरण को सोंधे घाट दाउरा डुबान हुने।
४) सामुदायिक वन र सरकारी वन डुबान हुने।
५) सदरमुकाम जाने पैदलबाटोहरु डुबान हुने।
६) व्यक्तीहरुले खेतीपाती गरेको जग्गाहरु डुबानमा पर्ने

माग गरेका विषयहरु।

१) उक्त झो.पु हरु डुबानमा परेकाले १ ठाउँमा मटर-लेवल पुल माग गर्ने।

Representation by Shree Kotdarbar Village Development Committee

श्री कोटदरबार गाउँ विकास समितिको कार्यालय
Shree Kotdarbar Village Development Committee
कोटदरबार, तनहुँ
Kotdarbar, Tanahun

फोन: ०६५-६९२२४२
गण्डकी अञ्चल, नेपाल

प.सं./Ref.No. :-
च.नं./Des.No.:-

मिति/Date:-.........................

विषय/Subject:-

(२)

श्री/Shree

२) घाट घाटमा लास जलाउने घाटको व्यवस्था गर्ने ।

३) सामुदायिक वनको डुबान र कटान को क्षतिपूर्ति दिनु पर्ने साथै निजी जग्गाहरु डुबानमा परेकालाई उचित क्षतिपूर्ति दिनुपर्ने ।

४) डुबान क्षेत्र भन्दा सबैभन्दा बढी पर्ने कोटदरबार गा.वि.स. परेकाले यस कोटदरबार गा.वि.स.का नागरिकहरुलाई योग्यता अनुसार रोजगारीमा प्राथमिकता दिनुपर्ने ।

५) जग्गाहरु डुबानमा परेका व्यक्तिहरुलाई रोजगारीको अवसर दिनुपर्ने ।

६) क्षतिपूर्ति, रोजगारीको अवसरहरुको व्यवस्थापन र क्रियाशील को लागी सर्वदलीय संयन्त्रको निर्णयहरुलाई आधार मान्नु पर्ने

७) प्रभावित क्षेत्रका बासिन्दाहरुले यस बाट उत्पादित विद्युतमा केहि सहुलियतका साथै लोड सेडिङ नहुने व्यवस्था मिलाउनु पर्ने ।

८) प्रभावित क्षेत्रका बासिन्दाहरुले यस जलविद्युत परियोजनामा लगानी गर्न चाहेमा लगानी गर्ने अवसर दिनुपर्ने ।

९) सामुदायिक वन र सरकारी वन र खोला ग्रेडमा डुबानमा परेकाले क्षतिपूर्तिको लागी वृक्षारोपण र खोला बाली विस्थापन र रोजगारी को कार्यक्रम ल्याउनुपर्ने ।

Representation by Shree Kotdarbar Village Development Committee

Annexure – 5 Scanned Copy of the News in Local Newspaper.

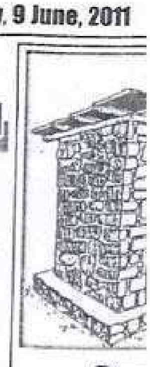
वर्ष ५ अंक ३०३, २०६८ जेठ २६ गते बिहीबार, नेपाल सम्बत ११३१ LOKWANI DAILY Thursday, 9 June, 2011

संघीय लोकतान्त्रिक गणतन्त्रप्रति समर्पित

लोकवाणी

www.lokwanidaily.wordpress.com

राष्ट्रिय दैनिक



माथिल्लो सेती आयोजना निर्माण सम्पन्न पश्चात तनहुँको आर्थिक विकास हुने

लोकवाणी संवाददाता

दमौली, जेठ २५

निर्माणाधिन माथिल्लो सेती जलाशययुक्त जलविद्युत आयोजनाको निर्माण सम्पन्न भए पश्चात तनहुँको आर्थिक र सामाजिक क्षेत्रमा निकै विकास हुने अपेक्षा गरिएको छ । माथिल्लो सेती जलविद्युत आयोजनाको आयोजनामा बुधबार दमौलीमा सम्पन्न आयोजना सम्बन्धि जानकारी एवं अन्तरक्रिया कार्यक्रममा बोल्ने वक्ताहरुले १२७ मेगावाटको माथिल्लो सेती जलविद्युत आयोजनाले जिल्लाको आर्थिक तथा सामाजिक विकासमा ठुलो टेवा पुग्ने बताए ।

माथिल्लो सेती जलाशययुक्त आयोजना सम्बन्धी जानकारी दिँदै आयोजना प्रमुख महेश आचार्य । तस्विर : लोकवाणी

कार्यक्रममा आयोजना प्रमुख महेश आचार्यले आयोजना नेपालकै नमुना हुने हुँदा यसले तनहुँको आर्थिक, सामाजिक तथा पर्यटकीय विकास हुने भएकोले सबैले आयोजना सफल पार्न सहयोग गर्नुपर्ने बताए । आयोजनाबाट उत्पादित बिजुली स्थानीय रुपमा आपूर्ति भएपछि मात्र केन्द्रीय विद्युत प्रणालीमा जोडिने हुँदा यसले जिल्लाको विद्युत विकासमा पनि टेवा पुग्ने आयोजना प्रमुख आचार्यको भनाई थियो ।

कार्यक्रममा आयोजनाको हालसम्म भएका गतिविधिहरुको बारेमा जानकारी दिँदै नेपाल विद्युत प्राधिकरण अन्तर्गतको माथिल्लो सेती जलविद्युत आयोजनाका इन्जिनियर केशव वाग्लेले नेपालले विद्युत उत्पादन गर्न थालेको १ सय वर्ष भई सके पनि हाल सम्म ८ सय मेगावाट भन्दा बढि विद्युत उत्पादन हुन नसकेको बताए । एसियाका अन्य देशहरुको तुलनामा विद्युतको विकासमा नेपाल निकै पछाडी परेको भन्दै वाग्लेले माथिल्लो सेती आयोजनाको निर्माण सम्पन्न पश्चात सरकारलाई विद्युतमा थप राहत पुग्ने बताए ।

आयोजनाका उपप्रबन्धक सुनिल रिमालले माथिल्लो सेती जलविद्युत आयोजनाबाट वार्षिक रुपमा ४८ दशमलव ४ करोड युनिट विद्युत उत्पादन हुने जानकारी दिए । उनका अनुसार यसरी उत्पादित विद्युत स्थानीय आपूर्ति पश्चात भरतपुर स्टेशन मार्फत केन्द्रीय विद्युत प्रणालीमा जोडीने हुँदा आयोजना सम्पन्न भएपछि तनहुँलाई लोडसेडिङ मुक्त गर्न सहयोग पुग्ने बताए ।

यस आयोजनामा हिमालबाट सुरु हुने पानीको बहाव भएकोले भरपर्दो भएको पनि उनले बताए । यसका साथै राजमार्ग र सडक पुर्वाधारको नजिकै रहेको हुँदा पनि यसको निर्माणमा सरकारलाई ठुलो लागत नपर्ने उनको भनाई थियो । हाल आयोजनाको विस्तृत ईन्जिनियरिङ डिजाईनको काम, पूर्वाधारहरु पुल, सुरुङ आदिको काम भईरहेको पनि उनले बताए । रिमालका अनुसार आयोजनको क्षेत्र भीमाद देखि सुरु भई २७ किलोमिटरसम्म रहेको छ ।

आयोजनाका उपनिर्देशक लोकप्रसाद नेपालले आगामी आ.व.२०६८/६९ देखि आयोजनाको पुर्वाधार निर्माण कार्य सुरु गर्ने बताए । हाल सम्म आयोजनाको वातावरणिय, समाजिक, सामुदायिक र आर्थिक तथा विनिय सम्बन्धि अध्ययन भईरहेको भन्दै उनले आगामी आर्थिक बर्षमा आयोजनको प्रवेश मार्ग, सेती नदिमा पुल, आयोजनाको कार्यालय तथा आवास निर्माण कार्य सुरु गरिने बताए ।

३४ दशमलव १ करोड अमेरिकी डलर लागत अनुमान गरिएको सो आयोजनको निर्माण सम्पन्न पश्चात देशमा हाल रहेको उर्जा संकटलाई केहि मात्रामा भए पनि घटाउने नेपाल विद्युत प्राधिकरणको अपेक्षा रहेको छ । एसियाली विकास बैंकको अनुदान सहयोगमा हाल सम्म आयोजनाको विस्तृत ईन्जिनियरिङ कार्य भईरहेको छ । यस अघि नेपाल सरकारको अनुरोधमा जापान सरकारको अन्तराष्ट्रिय सहयोग नियोग (जाईका) ले सन २००६ देखि २००८ सम्म आयोजनाको सम्भाव्य

(बाँकी पृष्ठ ३ मा)

उपाध्यक्ष

लोकवाणी

दमौली,

नेपाल सरकार निर्णयबाट हाले उत्थान जिल्ला उपाध्यक्षमा नियुक्त रसाईलीको बुधबार भयो । स्थानीय छविराज रिजालको

उपाध्यक्ष रसाईली

सम्पन्न सो कार्यक्रममा अधिकारी रुद्रप्रसाद क्षेत्रका दलित र महिला लागि समितिले काम

उनले समितिले उत्थानको लागि काम राज्यका हरेक निकायह गरेर काम गरेमा सफल नेकपा एमालेका जि केदार सिग्देलले तनहुँक उत्थानको लागि पार्टीले सिफारिस गरेको भन्दै र सबै राजनीतिक दलह

News Article in Lokwani Daily dated 9th June 2011

झण्डै ६ सय वर्ष पहिले प्रताप्ने पौंडसरी छान्ने गरिन्छ ।

माथिल्लो सेती...

अध्ययन गरेको थियो । सो अध्ययन पश्चात जाईकाले सरकारलाई आफ्नो प्रतिवेदन पेश गरिसकेको छ । सोही प्रतिवेदनको आधारमा प्राधिकरणले माथिल्लो सेती जलाशय युक्त आयोजना निर्माण गर्ने निर्णय गरेको थियो ।

प्राधिकरणले आयोजनाको अवधि तीन चरणमा छुट्याएको छ । जस अनुसार पहिलो चरण अन्तर्गत सन २०११ देखि २०१२ सम्म विस्तृत अध्ययनको चरण, सन २०१३ देखि २०१७ सम्म आयोजना निर्माण र सन २०१७ देखी २०१८ सम्म आयोजना सञ्चालनमा आउने अपेक्षा गरिएको छ । आयोजना निर्माण सम्पन्न पश्चात स्थानीय तहको सामाजिक र आर्थिक विकास हुने, देशकै नमुना आयोजना भएको कारण जिल्लाको पर्यटनको समेत विकास हुने, स्थानीय तहमा रोजगारीको अवसर सिर्जना भई आय आर्जनमा सुधार हुने र देशको विद्युत विकासमा सहयोग पुग्ने आयोजनाले अपेक्षा राखेको आयोजना प्रमुख आचार्यले बताए ।

कांग्रेसको नेतृत्वमा राष्ट्रिय सरकार: महत

काठमाडौं, जेठ २१

नेपाली कांग्रेसका नेता डा. रामशरण महतले अब बन्ने राष्ट्रिय सरकारको नेतृत्व कांग्रेसले गर्ने बताएका छन् । गुल्मीजिल्ला मुसाकोटमा बुधबार सञ्चारकर्मीहरूसँग कुरा गर्दै महतले राष्ट्रिय सहमतिको नयाँ सरकारको नेतृत्व कांग्रेसले गर्ने बताए । उनले नयाँ सरकार कहिलेसम्म बन्छ भन्नेबारे भने केही उल्लेख गरेनन् ।

उनले शान्ति र संविधान निर्माण प्रक्रियाले गति लिने वा नलिने माओवादीमा भर पर्ने बताए । दोहोरो सुरक्षा प्रणाली हटाउने माओवादी प्रयास प्रशंसायोग्य रहेको भन्दै उनले भने, 'माओवादी लचक हुने हो भने निर्धारित समयमा शान्ति र संविधानले पूर्णता पाउँछ ।'

शान्ति प्रक्रियाको कार्य ९० प्रतिशत टुङ्गिएतापनि संविधान निर्माणको कार्य भने ९० प्रतिशत नै बाँकी रहेको उनको भनाई थियो ।

राष्ट्रिय...

वेवसाईटको पनि निर्माण गरिने कार्कीले बताए ।

यसैबीच मेलामा प्रदर्शनीको लागि जिल्लाका दरै समुदायले उत्पादन गरेको विभिन्न वस्तुहरु बुधबार जिल्ला विकास समितिमा ल्याईएको छ । सो अवसरमा दौरहरुले निर्माण गरेको गुदको गुन्दी, धेउरी, ढडिया, छत्री, टोप, कुचो, डेली लगायतका मौलिक वस्तुहरु रहेका छन् ।

News Article in Lokwani Daily dated 9th June 2011

वर्ष ३०, अंक ४७ पृष्ठ ४, बिहीबार २६ जेठ २०६८, June 09, 2011, मूल्य- ३ -
व्यासनगर तनहुँबाट प्रकाशित हुने BHANJYANG NATIONAL DAILY
पहिलो
भञ्ज्याङ
bhanjyangnews.com.np
राष्ट्रिय दैनिक

माथिल्लो सेती आयोजनाको सरोकारवालाहरु बीच अन्तरक्रिय

जलाशयका कारण करिब सवा चार सय हेक्टर जमिन डुबानमा पर्ने

भञ्ज्याङ सम्वाददाता
दमौली, २५ जेठ

नेपाल विद्युत प्राधिकरण इञ्जिनियरिङ सेवा अन्तरगत माथिल्लो सेती जलाशय युक्त जलविद्युत आयोजनाले दमौलीमा बुधवार कार्ययोजना क्षेत्रका सरोकारवालाहरुसंग अन्तरक्रिया कार्यक्रम सम्पन्न गरेको छ । आयोजना क्षेत्र, सामाजिक तथा आर्थिक सर्वेक्षण पूर्व सरोकारवालाहरु बीच सो सम्बन्धी जानकारी गराएको हो ।

आयोजना निर्देशक इ. महेशप्रसाद आचार्यले जलाशय युक्त जलविद्युत आयोजनाका मुख्य पक्षहरुका बारेमा सरोकारवालाहरु बीच जानकारी गराउँदै प्रस्तुत आयोजना निर्माणका क्रममा जलाशयमा गरिने पानी नियन्त्रण र दैनिक परिवर्तन हुने नदीको बहावले सेती नदीको तल्लो तटीय क्षेत्रमा पर्ने प्रभावका बारेमा पनि सो अवसरमा भाषाङ्गत जानकारी गराएका थिए ।

उक्त अवसरमा निर्देशक आचार्यले जलाशय निर्माणका कारण करिब ४२४४ हेक्टर (८ हजार ३ सय ३० रोपनी) क्षेत्रफल जमिन, सामुदायिक तथा नीजि वन क्षेत्रमा प्रभाव पर्ने तथ्याङ्क सर्वेक्षणले देखाएको बताउनु भयो । कार्यक्रममा जलाशयको क्षेत्र २० किलोमिटर सम्म फैलिने ... बगरसम्म रहने ... यसबाट उत्पादित विद्युतले हालको लोडसेडिङमा करिब २० प्रतिशत कम गर्न सकिने सो अवसरमा जानकारी गराइएको थियो ।


सरोकारवालाहरुबाट उठेका प्रश्नको जवाफ दिँदै आयोजनाका निर्देशक इ. महेशप्रसाद आचार्य । तस्बिर : ...

कार्यक्रममा इन्जिनियर सुनिल तिजाल, लोकेन्द्र नेपाल लगायतले योजनाको ... र ... हुने ... लाभका बारेमा आ-आफ्नो धारणा व्यक्त गर्नु भएको थियो भने अपरलेली सरोकार समूहका अध्यक्ष ... सरोकारवालाहरुका लागि ... र वैकल्पिक ... बारेमा पनि आफ्नो जिज्ञासा प्रस्तुत गर्नु भएको थियो ।

पाँच सामुदायिक अभावमा

भञ्ज्याङ सम्वाददाता
दमौली, २५ जेठ

आज भोली तपाई गाउँ घर का बाक्लो बस्ति तिर पुग्नु भयो भने त्यता तिर पनि बिहान ८ बजेदेखि १० बजेसम्म टाइसुटमा स-साना नानीबाबुहरु कुर्कुच्चै भोला बोकेर गन्तव्य तिर जाँदै गरेको देख्नु हुन्छ । त्यहाँ तिर तपाईले बुझ्ने पर्ने हुन्छ, त्यहाँ पनि बोर्डिङ स्कूल छ भनेर । त्यस्तै गाउँ घरको पातलो बस्ती र कतै टिनको छानो, गिट्टीढुङ्गा परेका भवन र थोरै मेला एवं भुत्रे पोशाकमा बालबालिका गेटपरिसरमा आउँदै गरेकाहरु देख्नु भयो भने त्यो सरकारी (सामुदायिक) विद्यालय हो भनेर बुझ्न सहज हुने छ ।

त्यस्तै, तनहुँको ब्यास्था गाउँ विकास समिति वडा नं २ को चण्डिका प्राथमिक विद्यालयमा पाँच जना विद्यार्थीलाई चार जना शिक्षकहरुले अध्यापन गराउँछन् । विद्यालयका शिक्षक कृष्णदेव पौडेलका अनुसार कक्षा १ मा ०, २ मा २ जना र तीन ...

संस्कृत शि... र जनजाति

भञ्ज्याङ सम्वाददाता

News Article in Bhanjyang National Daily dated 9th June 2011

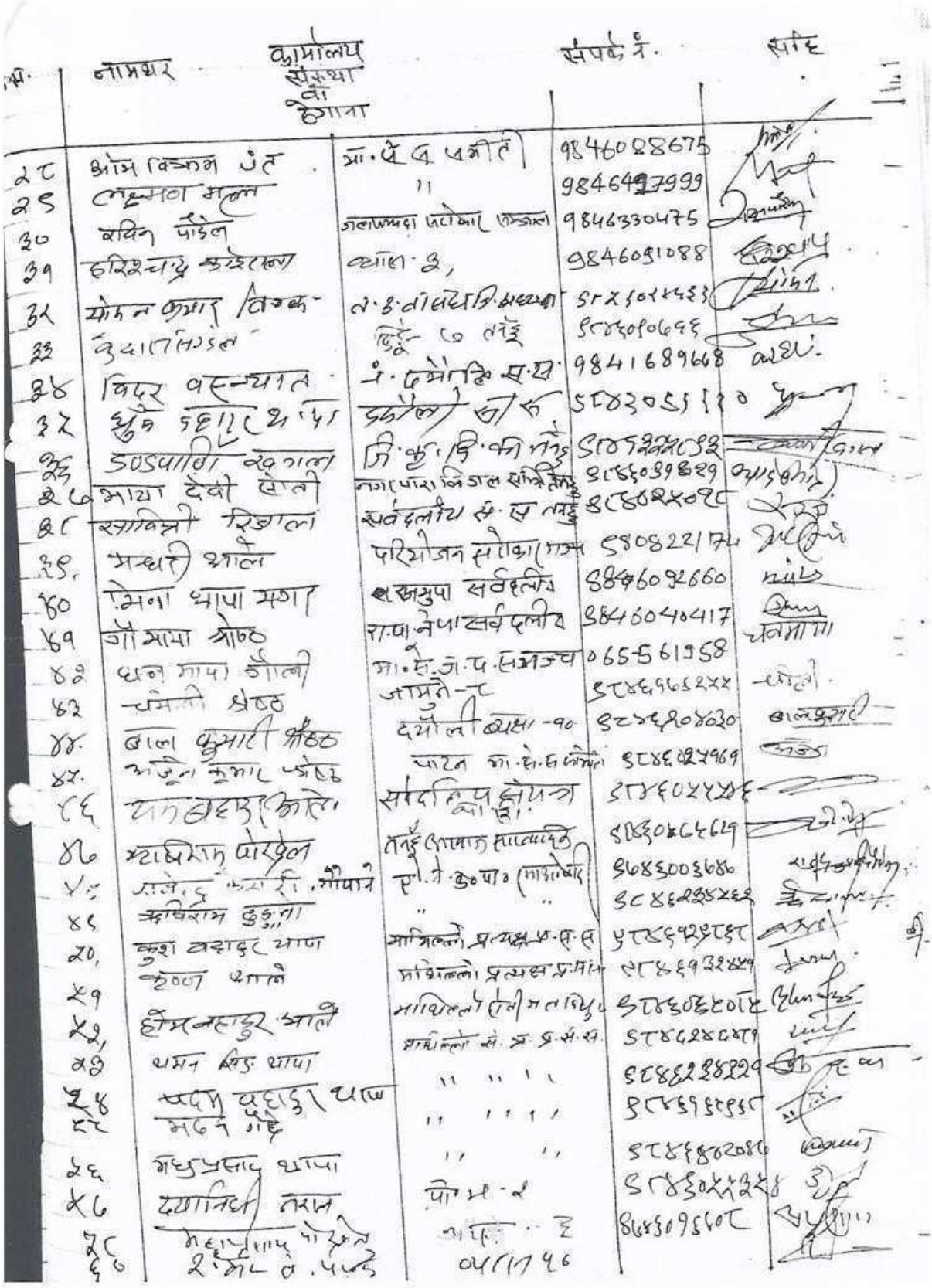
Annexure – 6 Signatures of Participants.

June 8, 2011 (२०६८ जेठ २५)

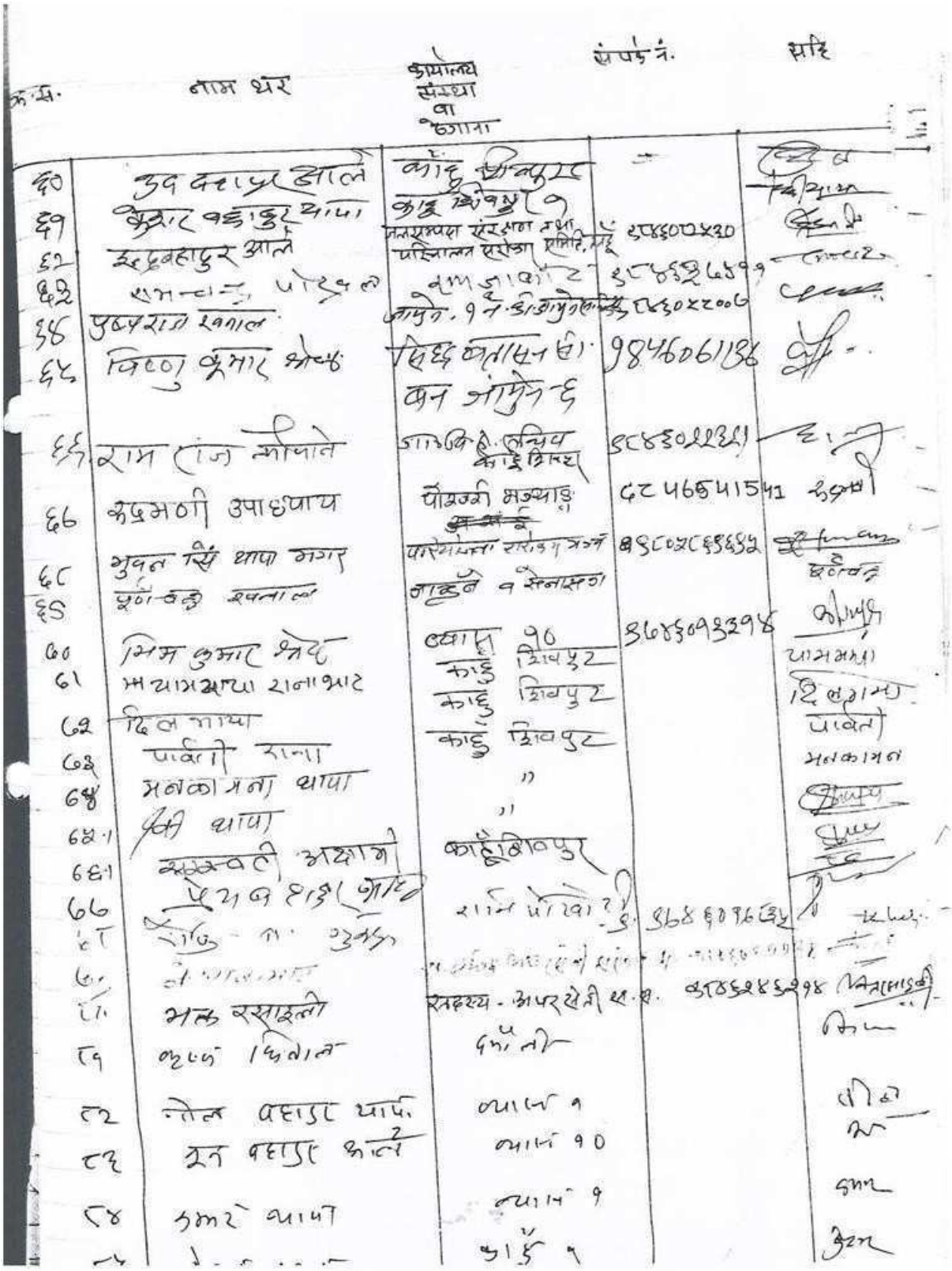
नेपाल विद्युत प्राधिकरण माथिल्लो सेती जलविद्युत आयोजना, अन्तरक्रिया कार्यक्रम २०६८ जेठ २५ गते दमौली तनहुँमा उपस्थित सम्पूर्ण महानुभावहरूको उपस्थिति पुस्तिका:-

क्र.सं.	नामथर	कार्यालय संस्था वा ठेगाना	सम्पर्क नं.	सहि
१.	[illegible] प्रसाद पौडेल	जिल्ला प्रशासन	५६०१२२	[signature]
२.	राम बाबु पौड्याल	जिल्ला वन कार्यालय	५६०१२५	[signature]
३	विश्वराज कोइराला	[illegible] गुल्म	५६०५९६	[signature]
४	रामचन्द्र तिवारी	व्यास नगरपालिका	५६०२२२	[signature]
५	[illegible]	व्या.न.पा १०	9846062306	[signature]
६	[illegible]	व्यास - ११	[illegible]	[signature]
७.	[illegible]	व्यास ८	[illegible]	[signature]
८	फणीन्द्र निर्मल	व्यास - ८	[illegible]	[signature]
९	ईश्वरी चापागाईं	जि. [illegible] कार्यालय तनहुँ	9849045235	[signature]
१०	हरि बहादुर [illegible]	[illegible] (माओवादी)	[illegible]	[signature]
११	[illegible] विश्वकर्मा	[illegible]	[illegible]	[signature]
१२	[illegible]	[illegible] कार्यालय	[illegible]	[signature]
१३	[illegible] ढुंगाना	जि. वि. स., तनहुँ	[illegible]	[signature]
14	ओंकार भट्टाचार्य	वि वि डि प	9813239337	[signature]
15	Akiko Urago	IC Net Ltd.	+81.566.234509	[signature]
16	[illegible]	नेसं. [illegible]	9851014617	[signature]
17	[illegible]	[illegible] एफ.एम	9846254145	[signature]
18	[illegible]	[illegible]	[illegible]	[signature]
१९.	[illegible]	[illegible]	[illegible]	[signature]
२०.	[illegible]	[illegible]	[illegible]	[signature]
२१	[illegible]	[illegible]	[illegible]	[signature]
22	[illegible]	[illegible]	[illegible]	[signature]
23	[illegible]	[illegible]	[illegible]	[signature]
24	[illegible]	NCESS, Kathmandu	9841769491	[signature]
25	सुरेश [illegible]	व्यास - 2 Damauli	9841195746	[signature]
26	[illegible]	[illegible] मा.सं.स. [illegible]	9846090618	[signature]
26	[illegible]	" " "	9846027813	[signature]

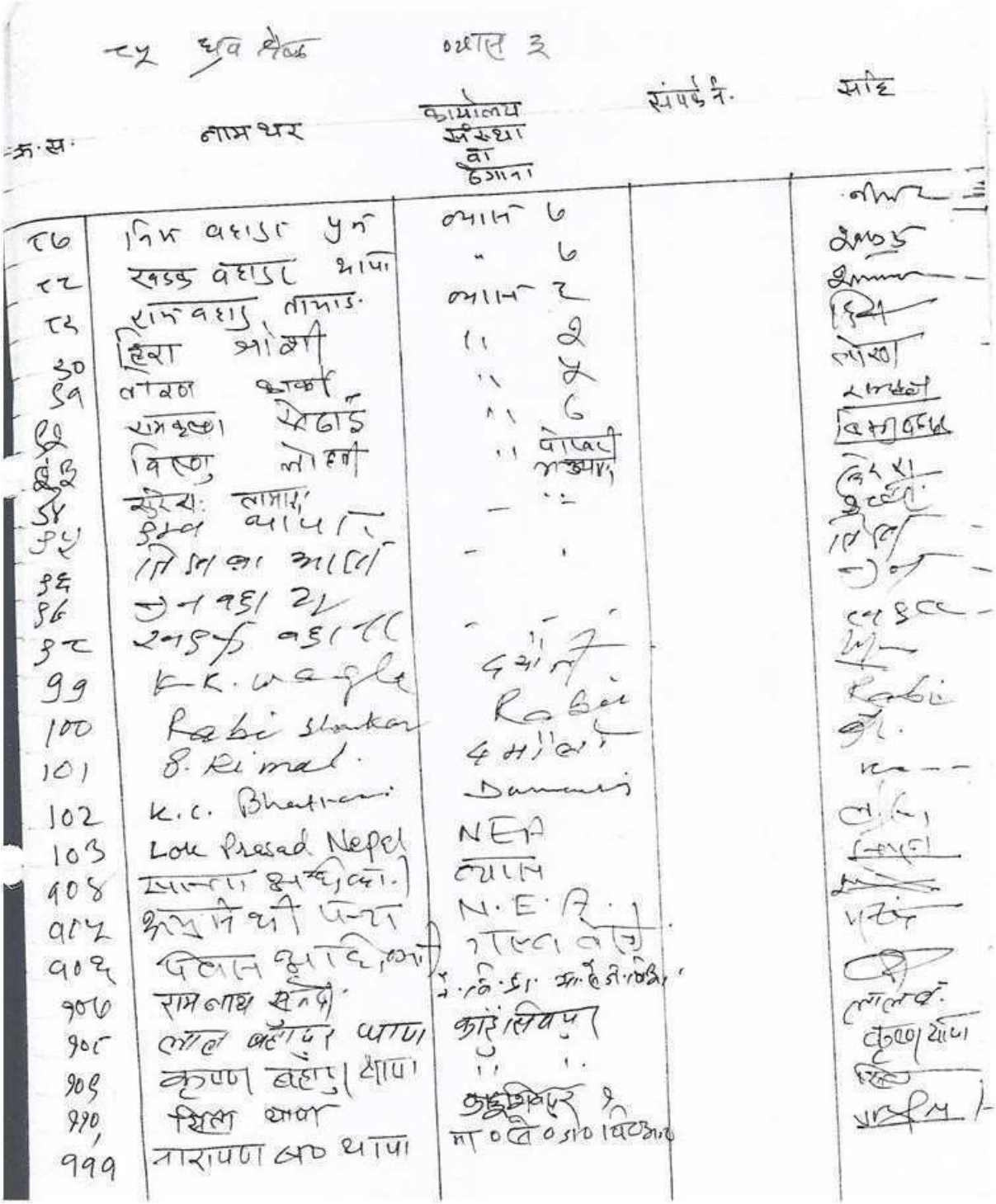
Participant's Signature: Damuli dated 8th June 2011



Participant's Signature: Damuli dated 8th June 2011



Participant's Signature: Damuli dated 8th June 2011

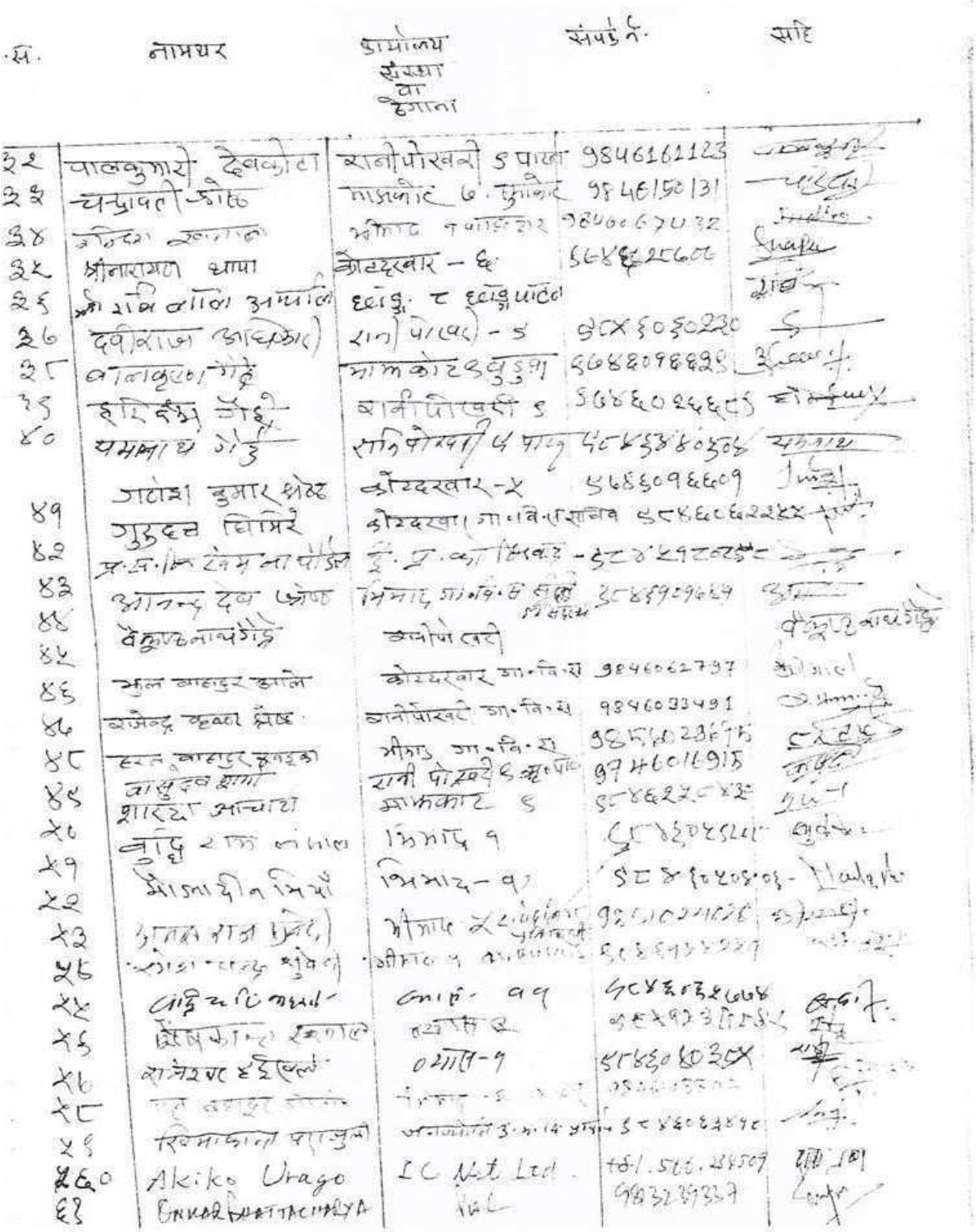


Participant's Signature: Damuli dated 8th June 2011

[illegible]
महानुभावहरुको उपस्थिति पुस्तिका –

क्र.सं.	नामथर	कार्यालय संस्था वा ठेगाना	सम्पर्क नं.	सही
१	गीत प्रकाश आले	[illegible]	9856030650	[illegible]
२	[illegible] थापा	[illegible]	9846065602	[illegible]
३	त्रिवत थापा	[illegible]	9846245435	[illegible]
	[illegible]	[illegible] - ८	98461-53727	[illegible]
४	[illegible] राना	[illegible]	९८४६४५२३२५	[illegible]
५	[illegible] थापा	[illegible] २	9746032491	[illegible]
६	[illegible] थापा	[illegible] १	९८०६६२५३२१	[illegible]
७	[illegible]	— ” —	9746006[illegible]	[illegible]
८	रामचन्द्र गैह्रे	[illegible] रानीपोखरी		रामचन्द्र गैह्रे
९	[illegible]	[illegible]	९६८४०२८०६९	[illegible]
१०	[illegible]	[illegible]	[illegible]	[illegible]
११	राम चन्द्र [illegible]	[illegible]	9846084737	[illegible]
१२	[illegible]	[illegible]	9941769491	[illegible]
१३	सिता गैह्रे	[illegible] ८	9841200 96	सीता
१४	बाबुराजा गैह्रे	रानीपोखरी ८		बाबुराजा गैह्रे
१५	विर बहादुर [illegible]	[illegible] प्रतिनिधि	9746016939	[illegible]
१६	[illegible] गैह्रे	[illegible]	9846149429	[illegible]
१७	[illegible]	[illegible] - ७	[illegible]	[illegible]
१८	पर्शुराम गैह्रे	रानीपोखरी - ९ [illegible]	९८०३०५५[illegible]	[illegible]
१९	[illegible] गैह्रे	” ”	९८४६०२०८६५	[illegible]
२०	[illegible]	[illegible]	९८४६९४१४३४	[illegible]
२१	[illegible]	[illegible]	[illegible]	[illegible]
२२	[illegible]	[illegible] - १	९८४३०५४४०८	[illegible]
२३	[illegible] पाण्डे	रानीपोखरी - ९	९८४५९३९३६३	[illegible]
२४	[illegible] आले	[illegible]	९८५६०६५०३१	[illegible]
२५	[illegible]	[illegible] - ३	९८४६०६८५५७	[illegible]
२६	[illegible]	[illegible] - ९	९८४६०६५०३२	[illegible]
२७	[illegible]	[illegible]	[illegible]	[illegible]
२८	[illegible] बहादुर [illegible]	[illegible]	९८४३९८७४३	[illegible]
२९	[illegible]	[illegible]		[illegible]
३०	[illegible] थापा	[illegible] २		[illegible] थापा
३१	[illegible] कुमार [illegible]	[illegible]	9805970773	[illegible]

Participant's Signature: Bhimad Bazaar dated 9th June 2011



Participant's Signature: Bhimad Bazaar dated 9th June 2011

क्र.सं.	नामथर	कार्यालय संस्था वा ठेगाना	सम्पर्क नं.	सहि
६२	दीननाथ पराजुली	भिमाद - १	९८४६५४३४४	[signature]
६३	कृष्ण राज सुवेदी	भिमाद - ४	९८०६७६०४५४	[signature]
६४	देवेन्द्र गौतम	माझकोट - ८	९८४६१३५१३८	[signature]
६५	तिर्थराज वाग्ले	[illegible]	९८४६०४३९७३	[signature]
६६	कृष्ण बहादुर सुनार	भिमाद वडा - १	९८४६१४४००१	[signature]
६७	कुमारी नेपाली	भिमाद ४	९८०६७८८९०२	[signature]
६८	चन्द्र कान्त पौडेल	छाङ ८ छाङ्गाउन	९८५६०४८८५२	[signature]
६९	गणेश प्रसाद [illegible]	शान्ति पोखरी [illegible]	९८४६३२६४६६	[signature]
७०	रामशरण शर्मा [illegible]	[illegible] चौतारी	९८४६००२२३	[signature]
७१	केशर ब. खड्का	[illegible]	९८४६०२१८३०	[signature]
७२	[illegible] राज [illegible]	[illegible] २		[signature]
७३	धर्मराज खनाल	छाङ ८	९८४६१९८४०३४	धर्मराज
७४	[illegible]	भिमाद - ६	[illegible]	[signature]
७५	बाबुराम तिमल्सिना	माझकोट ८	९८४६४८४५५३	[signature]
७६	दुर्गा प्रसाद पराजुली	भिमाद - ७	९८४६०२७३३८	[signature]
७७	मोहन ब थापा	भिमाद - ३	९८४६०३३४८८	[signature]
७८	शिव कुमार श्रेष्ठ	भीमाद १	९८४६०२०५२२	[signature]
७९				
८०	[illegible]	[illegible]	०६५-६९०८२	[signature]
८१	कृष्ण गिरी	झालिङ्ग - ४ मल्पुर	९८४९०९२८८८	[signature]
८२	प्रदिप महर्जन	किर्तिपुर - २ काठमाडौं	९८४९९४४६२५	[signature]
८३	सुरेश लामा	काठमाडौं - भिमाद	९८४१३४१६४८	[signature]
८४	वधु राम नेपाल	हाल भिमाद	९८४२०२६५०७	[signature]
८५	बाबुराम [illegible]	[illegible]	9846107028	[signature]
८६	नारायण ब. थापा	मा० हे० आ० [illegible]	9841205917	[signature]
८७	सुशिल रिमाल	"	9851071404	[signature]
८८	खड्क ब० कुँवर	ब्यास ६		[signature]
८९	ईश्वर ब० थापा	ब्यास ७		[signature]
९०	कृष्ण चन्द्र भट्टराई	" ३	०६५५६३२००४	[signature]
९१	केशर ब थापा मगर	ब्यास १०	९८४१६५७६८४	[signature]
९२	रामनाथ सुवेदी	ब्यास [illegible]	९८४६०२४८२२	[signature]
९३	चन्द्र नाथ [illegible]	शान्तिपोखरी [illegible]	९८४६०[illegible]	[signature]

Participant's Signature: Bhimad Bazaar dated 9th June 2011

क्र.सं.	नामथर	कार्यालय संस्था वा ठेगाना	सम्पर्क नं.	सही
९४	हरिमाया पराजुली	भीमाद - २	९८४६०८०३८४	हरिमाया
९५	विश्व प्रकाश [illegible]	रानीपोखरी - ९	९८५६९१०२२६	[illegible]
९६	अर्जुन प्रसाद गौड़	" "	९८४६०४४९०६	[illegible]
९७	मञ्जु सुवेदी	भीमाद - १	९८४६१३६०२०	[illegible]
९८	टेक बहादुर आले	काईं शिवपुर १	९८०५१८२६८८	[illegible]
९९	वीर बहादुर थापा	कोटदरबार-७, [illegible]	९८०३४५९१८०	[illegible]
१००	भीमप्रसाद गौड.	रानीपोखरी	९७४६०३८५६३	[illegible]

Participant's Signature: Bhimad Bazaar dated 9th June 2011

Volume 2a. Environmental Management Plan: Dam/ Reservoir Component

Prepared by Tanahu Hydropower Limited for the Asian Development Bank.

List of Abbreviations

AP	Affected People
CBO	Community Based Organization
CC	Construction Contractor
CDS	Community Development Strategy
CLO	Community Liaison Officer
DDC	District Development Committee
DFO	District Forest Office
DOED	Department of Electricity Development
DOR	Department of Roads
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environment Protection Act
EPR	Environment Protection Rules
ESCP	Erosion and Sediment Control Plan
ESMU	Environmental and Social Management Unit (THL)
ESSD	Environmental and Social Study Department (NEA)
ESU	Environmental Sub-Unit (THL-ESMU)
FSL	Full Supply Level
GESI	Gender Equality & Social Inclusion Plan
GoN	Government of Nepal
GRC	Grievance Redressal Committee
GRM	Grievance Redress Mechanism
IEE	Initial Environmental Examination
IMERP	Incident Management and Emergency Response Procedures
IMP	Issue Management Plans
IUCN	International Union for Conservation of Nature
MoE	Ministry of Energy
MoEST	Ministry of Environment, Science and Technology
MoFSC	Ministry of the Forests and Soil Conservation
MoPE	Ministry of Population and Environment
NARA	Nepal Association of Rafting Agents
NARC	National Agricultural Research Council
NEA	Nepal Electricity Authority
NGO	Non-Governmental Organization
PIC	Public Information Center
PMO	Project Management Office
PSC-EMC	Environmental Management Consultant (PSC)
PSC-SMC	Social Management Consultant (PSC)
PSC	Project Supervision Consultant
RoW	Right-of-Way
RP	Resettlement Plan
RSASU	Resettlement and Social Action Sub-Unit (THL-ESMU)
SEP	Site Environmental Plans
THL	Tanahu Hydropower Limited
THP	Tanahu Hydropower Project
USHEP	Upper Seti Hydropower Project
VDC	Village

PREFACE

The Tanahu Hydropower Project (Nepal) has been in development since at least 2009, at which time a detailed Environmental Impact Assessment (EIA) was prepared for the dam and reservoir on the Seti River in the Western Region. In 2010, an Initial Environmental Examination was also completed for the Transmission Line component of the project (by the Nepal Electricity Authority). Since some technical details and environmental considerations were still unclear in 2010, more detailed surveys and technical assessments were undertaken, with ADB support, in 2011 and 2012. As a result of this consolidating activity, there is now a need to update both the EIA and the Environmental Management Plans (EMPs) that were prepared as part of the original work in 2009 and 2010. These volumes have been prepared, and include the following:

- Volume 1: Updated Tanahu Hydropower Project **Addendum to EIA 2009 and IEE 2010** (for both the dam/reservoir component and the transmission line);
- Volume 2a: Updated **Environmental Management Plan** for the **Dam/Reservoir** Component (this document); and,
- Volume 2b: Updated **Environmental Management Plan** for the **Transmission Line** Component.

Table of Contents

Tables

Figures

Foreword

The Upper Seti Hydroelectric Project (USHEP) was changed to Tanahu Hydropower Project (THP), to avoid confusion with the proposed West Seti Hydroelectric Project in far western Nepal. The name is derived from Tanahu District, in which all proposed Project structures are located. To avoid confusion, the project is therefore referred to as the “THP” in this report.

1. Introduction

1.1 Background

1. This Environmental Management Plan (EMP) has been prepared for the THP to define project environmental management measures and procedures, thereby helping to ensure that all mitigation measures and monitoring requirements specified in the *Environmental Impact Assessment* (EIA, 2009) and *Environmental Addendum* (2012) are implemented during each phase of project development and operation. There are two components to the EMP:

- the EMP for the dam/reservoir component; and,
- the EMP for the transmission line.

2. This document is the dam/reservoir component and pertains to the activities of THL (there is a separate document for the NEA environmental management of the transmission line; see Environmental Addendum Volume 2b).

3. The EMP outlines the organizational structure of the Environmental and Social Management Unit (ESMU) within the Tanahu Hydropower Limited (THL) and describes the main roles and responsibilities of the parties involved in project environmental management. This EMP updates and supersedes the EMP contained in the project EIA and incorporates the management measures contained in the project *Environmental Addendum* (2012; see Volume 1). All environmental management measures previously proposed in the 2009 EIA are included in this EMP, except for several measures that have been revised in light of recent more detailed project impact assessment and management planning contained in the Addendum. The EMP also takes into account the findings of the Community Development Strategy (CDS), Resettlement Plan (RP), and the Gender Equality & Social Inclusion Plan (GESI).

1.2 Aims of the EMP

4. This EMP has been prepared by the THL to specify the opportunities for environmental design and the environmental management requirements in the final design, pre-construction, construction, operation and de-commissioning phases of the THP. This plan clarifies the environmental responsibilities of all parties that will be involved in Project environmental management, and the environmental mitigation measures, monitoring, auditing and reporting that shall be undertaken.

5. The primary aims of the EMP are to:

- define environmental management principles and guidelines for the design, construction and operation of the THP, including statutory requirements;
- establish the roles and responsibilities of all parties involved in the environmental management of the THP;
- describe measures that shall be implemented to avoid or mitigate adverse environmental impacts;
- establish a supervision, monitoring, auditing and reporting framework for Project environmental management;
- clarify the sequence of EMP activities; and,
- estimate the resources required to implement the EMP.

6. The EMP should be considered as an environmental operations manual for use by THP management and staff, contractors, and regulatory authorities. It reflects the commitment to

environmental management by THL. As such, for major Management Plans within the overall EMP (for example, addressing fish conservation issues, river safety, wildlife concerns, and watershed/forest management), these plans are presented as *programs* that span the design, pre-construction, construction, and operation phases, to maintain coherence and the integrity of the overall objectives and expected outcomes, rather than presenting elements of these plans separately for each phase of the Project. Nevertheless, the specific sequence of activities within each major Management Plan is clear with regard to the design, pre-construction, construction, and operation of the Project (evident within the schedules and budgets).

2. Statutory Requirements

7. The acts, regulations, rules, policies, guidelines and conventions relevant to the planning, design, construction and operation of the Project are described in this section. THL will be responsible for fulfilling the provisions of all relevant acts while implementing the project; these are also elaborated within individual Management Plans, where relevant.

2.1 Environmental Legislative Framework

8. Nepal's environmental legislation is multi-sectoral in nature and enables the Ministry of Environment, Science and Technology (MoEST) to specify the mitigation of all potential sources of air, land and water degradation that may adversely affect natural and social environments. In this capacity, MoEST is responsible for updating and revising national legislation relating to environmental impact, and has jurisdiction to develop, and coordinate the development of, additional sectoral guidelines.

9. The *Environment Protection Act 1997* (EPA) is a comprehensive, umbrella-type environmental act enforced through appropriate regulatory measures. It provides a legal basis for authorities to regulate an Environmental Impact Assessment (EIA) and/or Initial Environmental Examination (IEE). Section 3 of the EPA requires the project proponent to conduct an EIA or IEE for the prescribed proposal. Section 6 (1) of the EPA empowers the relevant agency to grant approval of an EIA report, only if it finds that the implementation of the proposal will have no significant adverse effects on the environment. The *Environment Protection Rules 1997* (EPR) provides a legal basis for concerned authorities to regulate an EIA and/or an IEE.The Act and Rules are administered by the MoEST, emphasising environmental conservation and management through internalizing of the environmental assessment system, pollution control and prevention, conservation of natural heritage sites, compensation for environmental damages, etc.

10. All activities carried out as part of Project construction and operation must comply with the relevant provisions of all Acts and Regulations, including:

- *Aquatic Animals Protection Act 2017 (1960)&Amendment 2055 (1999);*
- *District Development Committee (Working Agreements) Regulations 2050 (1993);*
- *Electricity Act 2049 (1992)* and *Electricity Regulation 2050 (1993);*
- *Environment Protection Act 2053 (1997)* and *Environment Protection Regulations 2054 (1997);*
- *Explosives Substances Act 2018 (1961);*
- *Forest Act 2049* (*1993* and *1995* amendments) and *Forest Regulation 2052 (1995);*
- *Hydropower Development Policy 2056 (2001);*
- *Labor Act 2048 (1992);*

- *Land Administration Act 2024 (196);*
- *Land Acquisition Act 2034 (1977)* and *Land Acquisition Guidelines 2049(1993);*
- *Local Self Governance Act 205 (1999)* and *Local Self Governance Regulation 2057 (2000);*
- *National Parks and Wildlife Conservation Act 2029 (1973)* and *National Parks and Wildlife Conservation Regulation 2030 (1974);*
- *Public Roads Act 2030 (1974);*
- *Soil and Watershed Conservation Act 2039 (1982);*
- *Solid Waste (Management and Resource Mobilization) Act 2044 (1987), 2067 (2010);*
- *Village Development Committee (Working Procedures) Rules 2050 (1994);* and,
- *Water Resources Act 2049 (1992)* and *Water Resources Regulation 2049 (1993).*

2.2 Environmental Policies and Guidelines

11. Relevant Government policies and guidelines that apply to the Project include:
- *Hydropower Development Policy 2056(2001);*
- *National Environmental Impact Assessment Guidelines 2049 (1993);*
- *Draft EIA Guidelines for Water Resources Sector 2050 (1994);*
- *EIA Guidelines for Forestry Sector 2050 (1995);* and,
- *Forestry Sector Policy 2057 (2000).*

2.3 Project Conditions of Approval

12. The Upper Seti (now Tanahu) Hydroelectric Project *Environmental Impact Assessment* (EIA, 2009) was approved by the Government of Nepal (GoN) in July 2009 (Vikram2066/07/05).There are no conditions associated with this approval.

2.4 Environmental Permits and Approvals

13. The key permits and approvals required for Project development that must be obtained, after the Generation Licence has been granted, are listed in Table 2.1.

Table 2.2. Environmental Permits and Approvals.

Permit/Permission	Approval Authority	Information Required in Permit/Agreement	Suggested Timing of Application[1]
Occupation of forest land	Cabinet, through the Ministry of Forests and Soil Conservation	EIA approval letter from MoEST, approved EIA report and detailed information on: o forest area (ha); o Government managed forest by type (District Forest, Community Forest, Leasehold Forest - by ha); o number of trees by species category in each forest type; o afforestation plan. Justification that forest land is required for project development (including an alternative analysis).	Application lodged at least 120 days prior to proposed occupancy of forest land
'Felling permit' for trees on (cabinet permitted) public land 'Permission' to fell trees in Community Forests	District Forest Office (DFO), Department of Forests Forest User Group (and DFO)	Estimated number of trees to be felled / lopped; marking process; party responsible for cutting and transport of trees; monitoring process; involvement of DFO staff in tree clearance and construction monitoring; compensatory planting	Application lodged at least 60 days prior to proposed commencement of felling

Permit/Permission	Approval Authority	Information Required in Permit/Agreement	Suggested Timing of Application[1]
		proposal and budget estimate.	
Permit to upgrade DoR road, bridge, culvert, etc	Department of Roads (DoR)	Site location, proposed upgrading works, program of works.	Application lodged at least 60 days prior to proposed commencement of upgrading works
Permission to relocate archaeological, religious, cultural sites	VDC	Party/s responsible for relocation – NEA and VDC (or traditional religious or cultural community (Guthi, etc.) of respective site (the Department of Archaeology is not involved as no significant sites will be affected).	Agreement at least 30 days prior to proposed relocation
Permit to extract material	District Development Committee (DDC)	Site location, extraction area dimensions and volume, timing of extraction.	Application lodged at least 60 days prior to the proposed commencement of extraction
Written permission from private landowner (or bilateral agreement) for temporary use of leased land	Landowner	Information about land use negotiation.	Agreement at least 15 days prior to land occupation
Relocation or disturbance of community infrastructure (e.g. irrigation canals, water supply lines, foot trails, suspension bridges)	Respective user committees/Village Development Committee and Ward Office	.	prior to

1 There are no set lead-in times for applications. These application times are suggested to avoid construction being delayed.

14. The ESMU of THL will apply for the necessary permits and permissions, including reaching a M . As noted previously, many of these are incorporated directly into the specific Management Plans that are intended to address the most vulnerable environmental attributes in the Project area.

3. Project Description

3.1 Location

15. The Project is located on the Seti River in the Western Development Region of Nepal (Figures 3.1 and 3.2). The Project site is located in the Middle Mountains at elevations ranging from 300-420 meters above sea level (asl).The Project is located in Tanahu District, within several kilometers of the township of Damauli. The Project area is accessed by the v Highway from Mugling (40 km) and from Pokhara (48 km).

Figure 3.1. Location of the Tanahu Hydropower Project in Nepal.

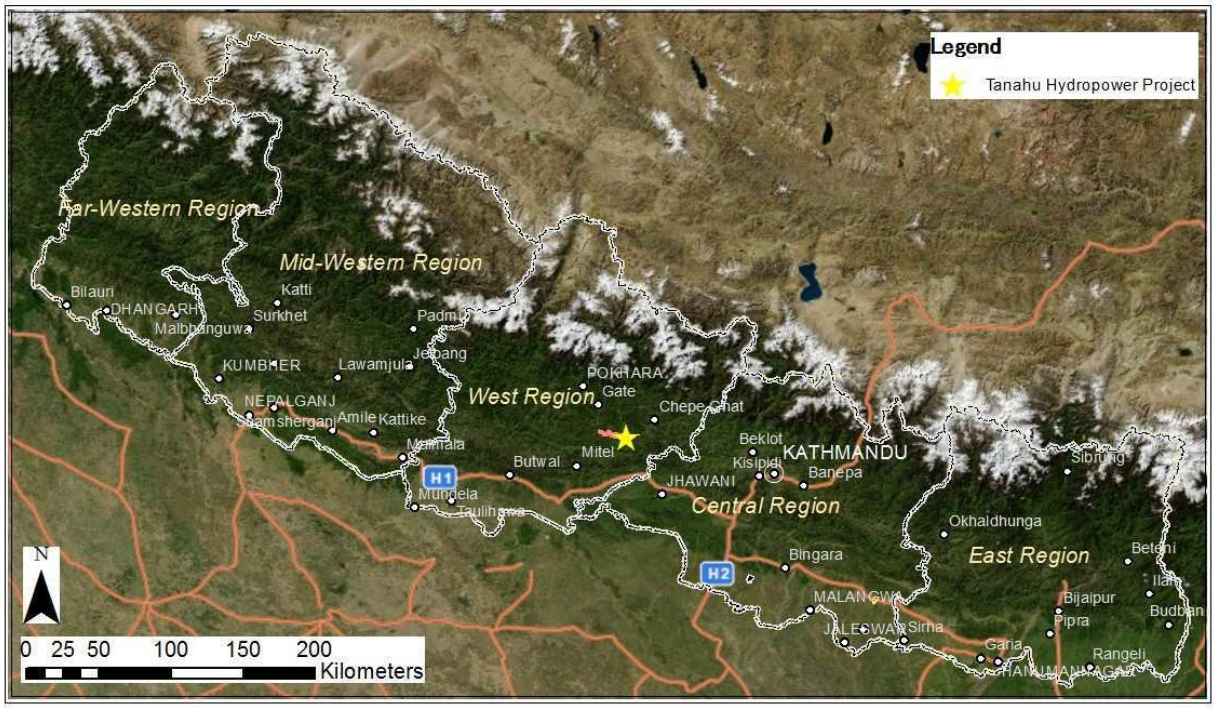


Figure 3.2. The Tanahu Hydropower Project; reservoir area, dam site, tailrace location.

3.2 Project Components

16. The THP is a storage type hydropower project with a rated capacity of 140 MW, with estimated average annual energy generation of 587.7 GWh (Years 1-10) and 489.9 GWh (Year 11 onwards). THP is designed to supply power to the Nepalese grid. The main features of the Project are summarized below:

- **Dam and spillway**: a 140 m high concrete gravity dam, with a crest length of 175 m will be constructed on the Seti River, approximately 2 km upstream of the confluence with the Madi River. The spillway will have three gates, each sized at 16.5 m width by 16.5 m height, designed to safely discharge the probable maximum flood estimated at 7,377m^3/s. There will also be two mid-level gates for reducing reservoir levels during annual reservoir flushing.

- **Reservoir:** a reservoir with a total surface area of 7.26 km^2 at FSL (EL 415 m) will be created. The reservoir will have a minimum operating level (MOL) of EL 378 m, providing a 37 m available drawdown (fluctuation zone) between MOL and FSL. The total storage volume of the reservoir at FSL will be 295.1 million m^3, with 200.3 million m^3 (68%) of this being effective storage at the date of completion.
- **Waterway**: a 7.4 m (diameter) by 1,203 m long headrace tunnel will be constructed on the right bank of the reservoir. This will connect to a 160 m long penstock that divides into two (going from 7.4 m in diameter to 2 x 3.1 m in diameter) near its end. A 190 m long tailrace tunnel will be constructed to discharge the flow used for power generation back into the Seti River.
- **Powerhouse:** an underground powerhouse will be constructed 6 km downstream of the dam. Two units of vertical axis Francis turbines, three phase synchronous generator and transformer will be installed. The powerhouse dimensions are 27 m wide by 46 m high by 97 m long. Surface facilities will include an outgoing terminal and administrative buildings.
- **Access roads:** two permanent access roads (totaling 7.3 km) and a number of temporary access roads will be constructed at the Project site.
- **Workforce camps, work areas and administration buildings:** a permanent operation and maintenance workforce camp will be established near the powerhouse site at Kahunshivapur. During Project construction, this camp will serve as the Project management staff camp. Temporary workforce camps are also likely to be established near the dam and powerhouse sites.
- **Transmission line:** a 37 km long 220 kV transmission line of double circuits will be constructed from the Tanahu Hydropower Plant to the new Bharatpur substation in Chitwan District (as noted previously, this is addressed in a separate EMP, managed by NEA; see Environmental Addendum Volume 2b).

4. Summary of Environmental Impacts

17. The most significant environmental impacts that are likely to result from Project construction and operation are summarized below. These provide the focus of the EMP.

4.1 River Hydrology

18. Natural flows in the Seti River will be altered by the Project, primarily by:
    - storage of monsoon season flows; and,
    - use of stored water to generate during the dry season.

19. The maximum increase in river flow will occur in February, when the flow rate will be 3.44 times greater, during generation, than the average monthly flow. The maximum decrease in river flow will occur in November when the average monthly flow rate will be decreased to 48.3% of the existing flow during non-generation (Table 4.1). River flow changes during the monsoon will be relatively minor, ranging between 0 and 12.5% (reduction) between July and September. The main flow change will be a daily variation in Seti River flows below the tailrace outlet, created by peaking power generation for between 6 and 20 hours per day between October and May. The river water level below the tailrace outlet will rise by a maximum of 1.66 m during peak generation (in February) above existing natural levels, based on flow modeling in the existing river channel.

Table 4.1. Average Monthly Seti River Flow Rate: Existing, and During Project Operation.

	Existing	Generation Flow	Non-Generation Flow

Month	Flow (m^3/s)	m^3/s	% of Existing Flow	m^3/s	% of Existing Flow
Jan	49.2	152.6	**310.2**	25.4	**51.6**
Feb	43.0	147.9	**344.0**	22.5	**52.3**
Mar	43.4	145.5	**335.3**	22.9	**52.8**
Apr	50.1	144.1	**287.6**	26.4	**52.7**
May	80.1	160.1	**199.9**	40.9	**51.1**
Jun	222.2	348.8	**157.0**	228.8	**103.0**
Jul	550.2	550.2	**100.0**	550.2	**100.0**
Aug	598.1	523.3	**87.5**	403.8	**67.5**
Sept	395.5	395.3	**99.9**	267.9	**67.7**
Oct	199.1	226.9	**114.0**	99.5	**50.0**
Nov	95.8	173.7	**181.3**	46.3	**48.3**
Dec	62.9	159.1	**252.9**	31.8	**50.6**

The other major Seti River flow rate changes will occur over 10 days in June, when up to 1,000 m^3/s will be released from the dam to empty the reservoir at, or immediately prior to, the start of the monsoon. This release will increase the natural Seti River water level by a maximum of 4.3 m.

4.2 Land Use

20. Project facilities will permanently occupy a total of 828 ha of land, primarily consisting of the 726 ha reservoir area (88% of the total land-take). Existing land uses that will be displaced are summarized in Table 4.2.

Table 4.2. Existing land use on permanent Project sites.

Land Use	Area(ha)
Cultivation	18.9
Forest	3
Shrubland	
Grassland	3
Riverine features	
Other	7
Total	**846.1**

21. *Reservoir Foreshore Stability*: The operation of the reservoir has the potential to cause erosion, slumpage and landslides along the foreshore, primarily where the overlying soil structure is weak. Four project-induced processes are likely to create foreshore erosion:

- wave action;
- river undercutting;
- rapid reservoir drawdown; and,
- gully erosion.

22. The majority of foreshore instability is likely to result from the rapid drawdown of the reservoir, with the next most destructive processes likely to be river undercutting and gully erosion. The raised and fluctuating water level in the reservoir will increase the risk of slope instability in the immediate reservoir foreshore area. Approximately 50% of the foreshore along the upper 5-6 km of the reservoir consists of poorly consolidated alluvial deposits that are prone to erosion and landslip from Project-induced processes. Foreshore erosion, slumpage and landslides will result in private land loss at some sites and produce sedimentation in the reservoir.

4.3 River Use

23. The Seti River (in the Project area) is variously used for domestic and stock water supply, religious rites (including cremation), fishing, and rafting. Domestic water supply primarily comes from hillside springs, with water from the river used for religious bathing and cremation. No water is diverted from Seti River for irrigation. Within the project area, fishing on the Seti River occurs mostly for recreational purposes. With the project operation, the envisaged effects on the above-noted river water uses are considered to be relatively insignificant.

24. The Seti River is also used for commercial rafting on a seasonal basis, primarily from Damauli (2 km downstream of the dam site) to Gaighat at the Seti-Trisuli confluence. A small number of trips continue further downstream to Devghat, a religious site in the Chitwan Dun Valley at the confluence of the Trisuli-Kali Gandaki rivers. Rafting is undertaken between 9 am and 5 pm each day, from late September to May. The Project has the potential to affect rafting by reducing river flows during the daytime to a volume that might be insufficient for rafting, as noted in Table 4.3.Further additional consultation with the rafters is needed to verify the gravity of the potential impacts.

Table 4.3: Rafting operations; current situation and during Project operation.

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Current	I	I	I	I	I	III	IV	IV	III	I	I	I
Project Operation	II	II	II	I	I	III	IV	IV	III	I	I	II

I - rafting II – less flow for rafting III - rafting for part of the month IV – no rafting

25. Generation releases (up to 127.4 m^3/s), and emptying of the reservoir in mid-June (releasing up to 1,000 m^3/s) creates a risk to the safety of unaware users in the downstream Seti riverine area.

4.4 Ecosystems

4.4.1 Aquatic Ecosystems

26. The Project will affect the Seti River aquatic ecosystem by flooding a 18 km stretch of the river and altering daily and seasonal flows below the dam. The key Project impacts on aquatic ecosystems will be:

- the creation of a barrier preventing upstream and downstream fish migration throughout the year (except over the 10-40 day period when natural river flows will occur in late June), possibly resulting in long-term effects on fish populations and species diversity;
- annual draining of the reservoir that could reduce downstream water temperature over 10-40 days each year;
- replacement of lotic fish species by lentic fish species in the reservoir stretch (18 km) of the Seti River;
- a reduction of fish between the dam and Madi River confluence; and,
- possible downstream water quality change (primarily a reduction in temperature and increased suspended sediment levels) due to reservoir operation, including a reduction in the nutrient base supplying downstream river sections due to reservoir trapping of organic matter, with implications for fish.

4.4.2 Terrestrial Ecosystems

27. The Project will convert 400.3 ha of forest, 18.7 ha of shrubland and 94.3 ha of grassland to Project facilities. The forest area consists of a mix of National, Community and private forest (Table 4.4) containing an estimated 162,000 trees. The main areas of tree loss will occur in the reservoir submergence area, with smaller areas cleared for dam, intake, tailrace outlet, and road construction.

Table 4.4: Affected forest area.

Forest Type	Reservoir (ha)	Other Project Sites (ha)	Total Area (ha)
National Forest	259.84		
Community Forest	88.77		
Private forest	5.29		
Total	**353.9**		

28. The creation of the reservoir will widen the existing barrier to animal movement that is currently created by the Seti River.

4.5 Social Impacts

29. The main physical impacts on people in the Project area will be household displacement, loss of assets, and loss of / disruption to access and services.

30. *Involuntary Resettlement Impacts*: The Project will involve loss of lands, loss of public infrastructure and resources (trails, suspension bridges, loss of forest, grazing lands, etc). Actual land acquisition is mainly confined to the campsite, access roads, reservoir, and spoil disposal areas. A small proportion of privately owned land will also be affected (for creation of temporary facilities). Table 4.5 below provides details of the total land to be acquired and the number of households that will be affected.

Table 4.5. Project components requiring land acquisition and affected households (HH).

Project Components	Extent of Impact		Land use situation
	Hectare	Affected HH	
Reservoir area	76	336	Large proportion characterized by steep slope, degraded forest. A small proportion is cultivated land.
Camp site	8	102	Mostly cultivated area.
Access road	7	165	Cultivated land and private land.
Spoil disposal site	19	122	Largely river banks and waste land and a small portion consists of cultivated khet land.
Temporary construction road area	2	33	A mix of cultivated land and degraded forest area.
Total Area	**112**	**758**	

Source: Census Survey, 2011-2012.

31. *Common Property Resources and Facilities*: Apart from private assets, the Project construction will lead to impacts on Common Property Resources (CPR), such as cremation grounds, wells, bridges, tanthi, etc. Table 4.6 lists the different types of community assets that will be affected as a result of the Project.

Table 4.6. Common Property Resources affected by the Project.

Items	Number
Temple	2
Sources of Drinking water	2
Ghats (cremation site)	9
Thati (Resting places with/without structures)	6
Suspension bridges	7
Foot Trails	11

Source: Census Survey, 2011-2012.

4.6 Temporary and Spatially-Limited Construction Impacts

32. General construction impacts, typical of large-scale earthmoving and construction, using a large workforce over an extended period, will occur and have to be effectively managed over the construction phase. The impacts will include:

- erosion and sedimentation;
- noise and vibration;
- air quality decline;
- water quality decline; and
- safety hazards.

5. Implementation Responsibilities

33. Project environmental management will involve the following main designated parties: the THL Environmental & Social Management Unit (THL-ESMU); THL-appointed contractors; GoN agencies; and an independent Panel of Experts (Table 5.1). In addition, consultation will occur with local communities and non-governmental organizations (NGOs) during implementation of the EMP (see Figure 5.1).

Table 5.1.Project Environmental Management Organizations.

Category	Organization/Contractor
Project Owners	Tanahu Hydropower Limited (THL): Environmental and Social Management Unit (ESMU): Environmental Sub-Unit(ESU) Resettlement and Social Action Sub-Unit (RSASU) Community Liaison Officer (CLO)
Construction and Operation Supervision	Project Supervision Consultant (PSC): Environmental Management Consultant (PSC-EMC) Social Management Consultant (PSC-SMC)
Advisory Organizations	International NGOs (for example, IUCN, WWF)
Contractor	Construction Contractor (CC) Other Local Contractors for Hatchery, Forest, and Wildlife
Independent Monitoring	Panel of Experts
GoN	Ministry of Environment, Science and Technology (MoEST) Ministry of Energy (MoE)

5.1 THL

34. THL will be directly responsible for the implementation, management and supervision of THP's environmental management plan, through the ESMU. THL will hire a number of consultants to design and oversee, and contractors to implement, the environmental management measures, as well as an independent Panel of Experts to provide periodic review and advice.

35. *Environmental and Social Management Unit (ESMU)*: The Environmental and Social Management Unit (ESMU) under the THL will have four major roles:

i) implementing and administering planned actions in the EMP, RP, CDS, and GESI;
ii) monitoring the environmental and social impact and compliance as per EMP, RP, CDS and GESI;
iii) revising the EMP, RP, CDS and GESI, based on the monitoring results; and,
iv) disseminating information to project stakeholders and coordinating with the different line agencies.

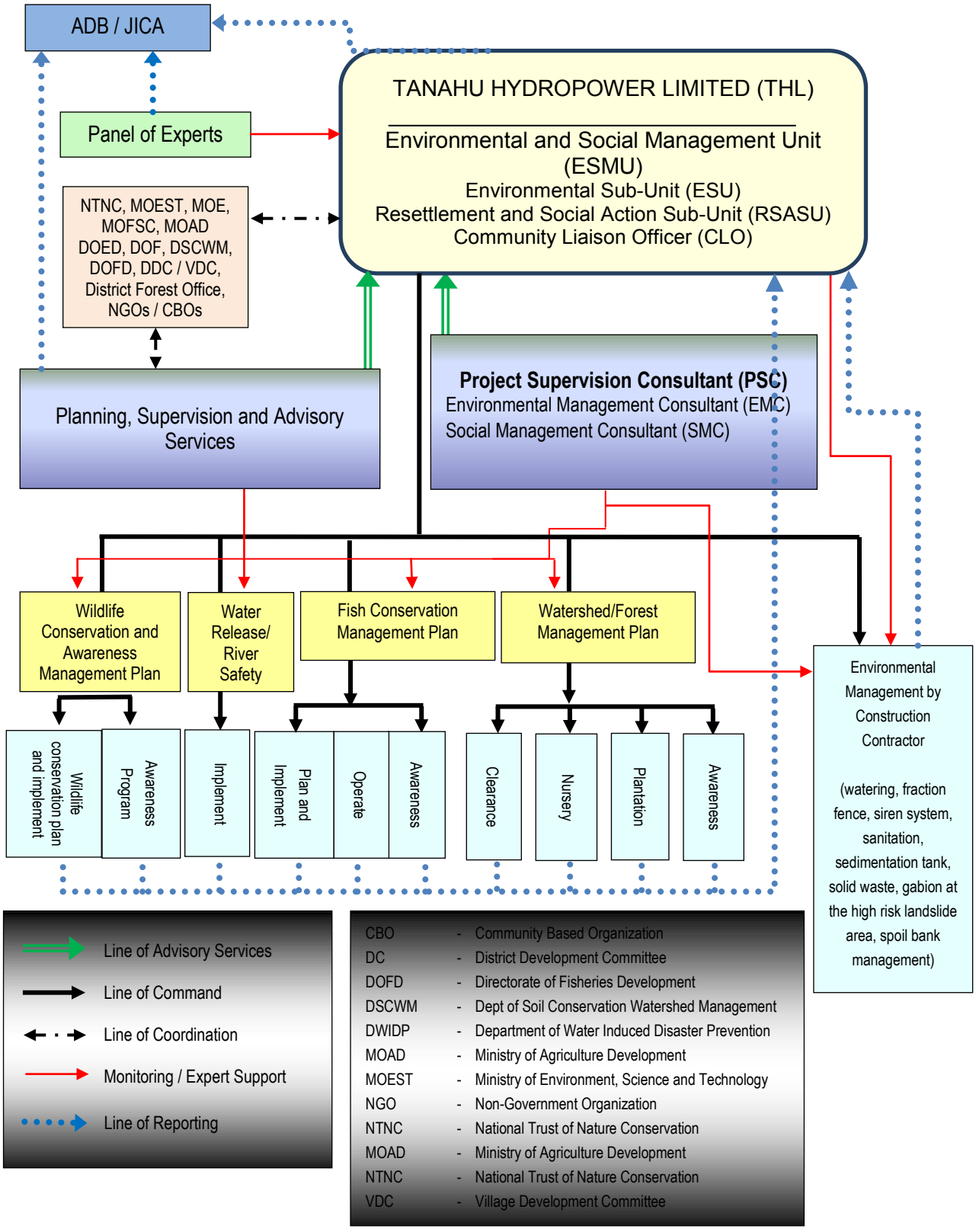
36. The ESMU will consist of the Environmental Sub-Unit (ESU), the Resettlement and Social Action Sub-Unit (RSASU) and Community Liaison Officer (CLO). The ESU will coordinate with PMC-EMC, whereas the RSASU will coordinate with other stakeholders such as Local VDCs, DDCs, NGOs, CBOs, affected parties, DOED, MOE, and MOEST.

37. *Environmental Sub-Unit (ESU)*: The ESU will be responsible for: (i) mitigation measures planned in the EMP; (ii) environmental baseline monitoring and environmental compliance monitoring; and, (iii) corrective action and reviewing the EMP during pre-construction, construction and operation. ESU duties will include:

Pre-construction:

- acquiring all necessary permits and approvals for Project construction and operation (for land and forest-based activities);
- ensuring that EMP design recommendations are included in the final Project design;
- preparing Issue Management Plans (IMPs);
- reviewing and approving CC's Site Environmental Plans (SEPs) and Incident Management and Emergency Response Procedures (IMERP);
- monitoring mitigation measures as per EMP and recommending corrective actions;
- preparing regular monitoring reports to ADB/JICA; and,
- reviewing and approving surveyed and pegged Project sites prior to construction activities.

Figure 5.1. Organizational structure for implementation of the EMP



Construction and Operation:

- monitoring baseline conditions and compliance of the CC;
- preparing regular monitoring reports to ADB/JICA;
- publishing monitoring results on the Project web site;
- implementing mitigation and monitoring actions in the EMP;
- monitoring and reviewing CC's activities and other mitigation programs;
- auditing CC compliance with the EMP, IMPs, SEPs, Project approval and permit conditions and any other statutory requirements;
- issuing corrective action requests and conduct follow-up inspections and evaluation of corrective actions; and,
- liaising with MoEST, MoE and other GoN agencies to ensure that they have access to environmental documentation and Project personnel, and responding to their comments and directives.

38. *Resettlement and Social Action Sub-Unit (RSASU)*: The RSASU will be responsible for implementing the RP, GESI and CDS and liaison with the government and non-governmental organizations on related issues. As these works require official responsibilities, the members of this sub-unit can be deputized members of THL, with experience in the implementation of such plans. The sub-unit will also be responsible for the operation of the Public Information Center (PIC) and handling grievances, as well as the following:

- implementing, supervising and recording the land acquisition, compensation and resettlement program as per RP;
- implementing and supervising the CDS and GESI as per CDS and GESI;
- liaising with other Government authorities on environmental management and resettlement;
- disseminating information through PICs and other media, and collecting feedback through regular consultation with various stakeholders;
- distributing ESMU's bimonthly monitoring reports to central and local level stakeholders; and,
- managing the project grievance and complaint handling process.

5.2 Project Supervision Consultant

39. The Project Supervision Consultant (PSC) will be hired by and shall directly assist the ESMU with its duties. The PSC will include the Environmental Management Consultant (PSC-EMC) and Social Management Consultant (PSC-SMC). PSC duties shall include:

Pre-construction/Construction Phase:

- preparing the final Project design to minimize adverse impacts, consistent with the technical and economic objectives of THP, engineering designs prepared to date, EIA/EMP design recommendations and Project conditions of consent;
- monitoring of all the mitigation measures taken by THL and monitoring survey results by contractors; and,
- submitting half-yearly environmental management reports, including monitoring record sheets, to THL.

Operation Phase:

- developing and submitting *Incident Management and Emergency Response Procedures* to THL for approval;

- operating the Project and undertaking all associated activities in accordance with the measures set out in this EMP, the IMPs and any additional measures required to meet Project approval conditions and statutory requirements;
- environmental monitoring and carrying out any necessary repairs and maintenance of Project components, including implementation of any necessary environmental safeguards;
- submitting half-yearly environmental management reports, including monitoring record sheets, to THL;
- implementing corrective actions as directed by THL or any government agency with legislative or permit responsibilities; and,
- liaising with the local community regarding any environmental issues that they feel concerned about; and,
- maintaining an EMS in full compliance with the International Organization of Standardization standard 14001 (ISO 14001).

5.3 Construction Contractor

40. The Construction Contractor (CC) shall be primarily responsible for the implementation and internal monitoring of all environmental management measures associated with Project design, pre-construction and construction. The CC shall have sole responsibility for all activities on sites under its control for the duration of construction. This includes the activities of all sub-contractors, whether employed or contracted directly or indirectly by the CC. Accordingly, it shall be the CC's responsibility to ensure that all activities are compliant with Project plans, permit and approval conditions, and any other statutory requirements.

CC duties will include:

Pre-construction:

- preparing SEPs for each construction and ancillary site that the CC is responsible for, and *Incident Management and Emergency Response Procedures* covering all activities;
- providing environmental training to all staff and sub-contractors, to ensure personnel have a clear understanding of environmental requirements relevant to their scope of work and can meet their environmental responsibilities; and,
- surveying and pegging all Project sites where works are due to commence within the next six months.

Construction:

- constructing the Project and undertaking all associated activities in accordance with the measures set out in this EMP, the IMPs, the SEPs and any additional measures required to meet Project approval and permit conditions and other statutory requirements;
- regularly maintaining environmental protection measures;
- participating in and assisting with ESU's site inspections and audits, and following ESU directions to ensure that all works are conducted to specified standards;
- environmental monitoring, recording and reporting as specified in the EMP, IMPs, SEPs, etc;
- coordinating emergency response procedures;
- implementing corrective actions as directed by the ESMU, MoEST, MoE and any other government agency with legislative responsibilities; and,

- maintaining an environmental management system (EMS) in full compliance with the International Organization of Standardization standard 14001 (ISO 14001).

5.4 Panel of Experts

41. A Panel of Experts, including the environmental experts who will be appointed to provide guidance to the ESMU, will be established for the entire Project. The environmental experts in the Panel will comprise an environmental specialist, a resettlement and social development specialist, and a dam safety specialist. The panel will undertake overall evaluation of the environmental management, dam safety, resettlement and livelihood restoration work planned and undertaken by the THP. The Panel will be appointed early in the pre-construction phase. The Panel will convene once a year at least during construction and in the initial operational phases.

42. The scope of work of the Panel will include:
Pre-construction:

- reviewing the adequacy of this EMP, the Issue Management Plans (IMPs), Site Environmental Plans (SEPs), RP, CDS, and GESI and the provision of recommendations for improvements; and,
- reviewing Project design and Tenders, and provision of any recommended design changes and other improvements if any.

43. *Construction:*

- assessing the adequacy of, and providing advice to improve, the environmental management system, CC performance, environmental supervision, monitoring and auditing, and the effectiveness of remedial actions;
- reviewing internal monitoring data and reports and audit reports, as well as quantitative and qualitative socioeconomic monitoring reports;
- visiting resettlement sites and consulting resettled and host communities to verify the success of the resettlement program;
- evaluating Project institutions, including capacity and operating constraints;
- analyzing budgets and expenditure in relation to milestones and site realities; and,
- advising on any emerging issues and providing recommendations on how to address issues and improve the resettlement program.

5.5 Government Agencies

5.5.1 Ministry of Environment, Science and Technology (MoEST)

44. MoEST, the government agency responsible for environmental management and development approval, will monitor Project environmental management as it sees fit during Project design and construction, and audit the Project after two years of operation to assess compliance against Project approval, license and permit conditions, statutory standards and Project environmental management plans (EMP, etc). MoEST will also conduct an audit of Project environmental performance every two years during Project operation. MoEST will provide formal feedback to THL on non-complying aspects of the Project.

5.5.2 Ministry of Energy (MoE)

45. The Department of Electricity Development (DoED), within the Ministry of Energy (MoE), is responsible for monitoring Project environmental management during Project design, construction and operation to assess compliance against Project approval and license conditions, statutory standards and Project environmental management plans. This will be undertaken on an as-required basis during construction and operation phase. DoED duties will include:

- reviewing the final Project design, providing approval if acceptable;
- providing formal feedback to THL on non-complying aspects of the Project;
- inspecting Project sites at any time during construction to assess if construction activities are being undertaken in accordance with licence requirements; and,
- inspecting Project sites and operational activities at any time to ensure that Project activities are in accordance with licence requirements.

5.6 Community

46. Community participation is an important component of effective environmental management and will be fundamental during Project design, construction and operation for the formulation and updating of the Community Development Strategy (CDS). Initially, community participation will occur through consultation between the ESMU, CC, directly affected landowners and local communities during the design and pre-construction phase. Negotiations will occur with affected landowners where land is to be acquired or leased, with details provided on the intended use of the land, construction activities and environmental management measures (including site rehabilitation of leased land).

47. Consultation with local communities will commence during the pre-construction phase and continue throughout the construction and operation phases. A community forum of local representatives will be established, including elected VDC representatives, and shall meet on a regular basis with THL, ESMU and CC representatives to discuss local environmental and social issues. The forum will commence with a detailed Project briefing, covering such issues as the construction program, major construction activities, local employment on the Project, the extent of construction sites and the maintenance of services during construction. Individual community members will have the right to present issues to the forum.

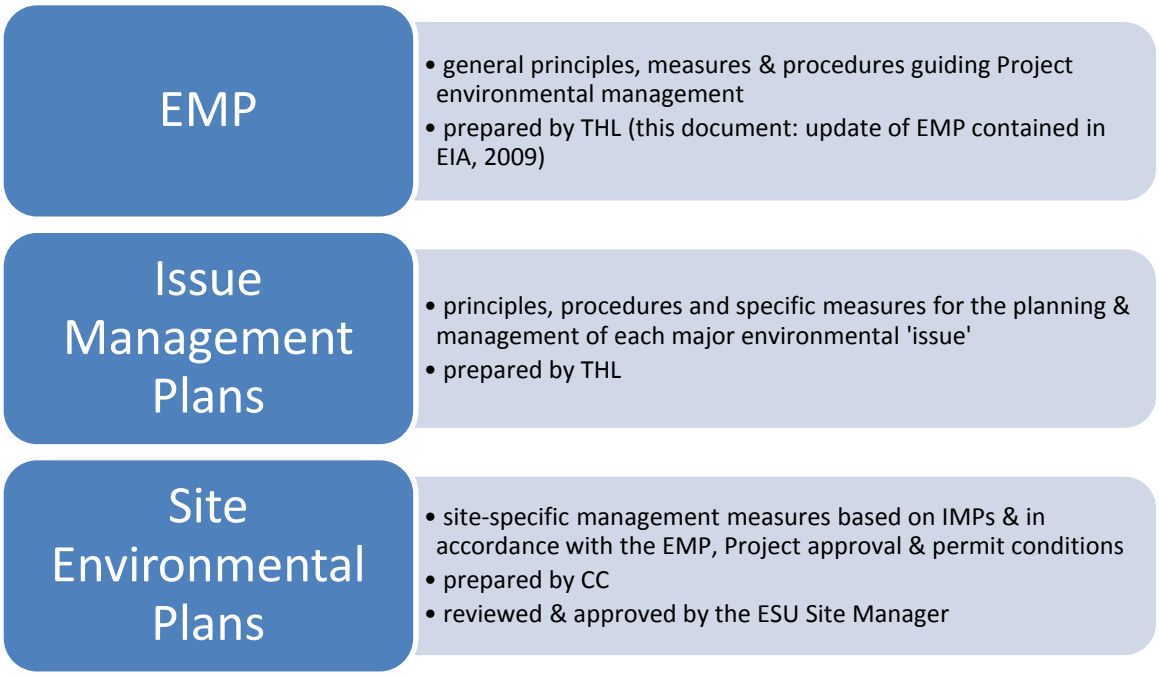
48. The ESMU shall employ a Community Liaison Officer (CLO) to manage community relations during Project construction, including sitting on the community forum. The key tasks of the CLO will include:

- ensuring that the community is well informed;
- ensuring that the CC understands community concerns;
- providing a clear point of contact for individuals and community groups regarding environmental issues, with a formalized complaint procedure and grievance mechanism; and,
- liaising with individuals, community groups and the CC to resolve local environmental issues.

6. Environment Planning

49. Three levels of environmental management plans will guide and control site environmental management (Figure 6.1). This EMP, incorporating the measures approved in the EMP contained in the approved EIA (2009) prepared by THL will establish the guiding principles, responsibilities and main mitigation measures for environmental management.

Figure 6.1. Levels of Project Environmental Management Plans.



50. The overall EMP will be supported by Issue Management Plans (IMPs) that will be prepared by the EMSU, providing detail on the planning requirements, management principles and mitigation measures for each major environmental issue (Section 6.2). The EMP and IMPs provide the CC with references for the preparation of Site Environmental Plans (SEPs). A SEP will be prepared by the CC for each major construction and ancillary site, converting the IMP principles and generic measures into workable, site-specific measures. In addition, the CC shall prepare its own ISO-14001 EMS that incorporates the above plans, and *Incident Management and Emergency Response Procedures*.

6.1 EMP

51. This EMP provides a single-source, overarching environmental framework for all implementing parties, government agencies and stakeholders. All environmental management measures previously proposed in the EIA (2009) are included in this EMP; there are also refinements as a result of recent surveys (documented in the *Environmental Addendum,* 2012; see Volume 1).

6.2 Issue Management Plans (IMPs)

52. A set of IMPs will be prepared by THL, covering each major Project environmental issue. The IMPs will build upon the general principles of environmental management set out in the EMP, providing a greater level of detail on responsibilities, proposed mitigation and management measures, implementation of measures, and monitoring and reporting procedures for each major environmental issue. The proposed IMPs are:

Plan No.	Issue Management Plan/Program
IMP 1	Environmental Training
IMP 2	Watershed/Forest Management Plan
IMP 3	Wildlife Conservation and Awareness Management Plan
IMP 4	Fish Conservation Management Plan
IMP 5	Water Release/River Safety Management Plan
IMP 6	Air Quality Control
IMP 7	Noise Control
IMP 8	Water Quality Control
IMP 9	Land stability
IMP 10	Spoil Management
IMP 11	Waste Management
IMP 12	Hazards management
IMP 13	Workforce Management and Safety
IMP 14	Traffic Access control
IMP 15	Archaeology management
IMP 16	Water supply
IMP 17	Demobilization management
IMP 18	Site Rehabilitation
IMP 19	Reinstatement of Services
IMP 20	Emergency Response Plan

53. IMPs may be updated by the ESU from time to time, in response to government requirements or to clarify management responsibilities, planning, permits and approvals, mitigation measures, and monitoring and reporting procedures. This EMP document contains the first framework for the IMPs (see Section 7), which will then be verified and provided with more detail as the Project proceeds through the approval process.

6.3 Site Environmental Plans

54. A SEP shall be prepared by the CC for each construction and ancillary site, converting the principles and generic measures contained in the EMP and IMPs into site-specific controls. Each SEP shall contain a layout map(s) of the main measures and describe:

- construction activities and associated works that will occur over the construction life;
- environmental features that have the potential to be impacted by construction activities;
- the environmental mitigation measures that will be installed over the duration of construction and illustrate these on a plan(s); and,
- operation and maintenance of mitigation measures.

55. Separate SEPs shall be prepared for the following Project sites:

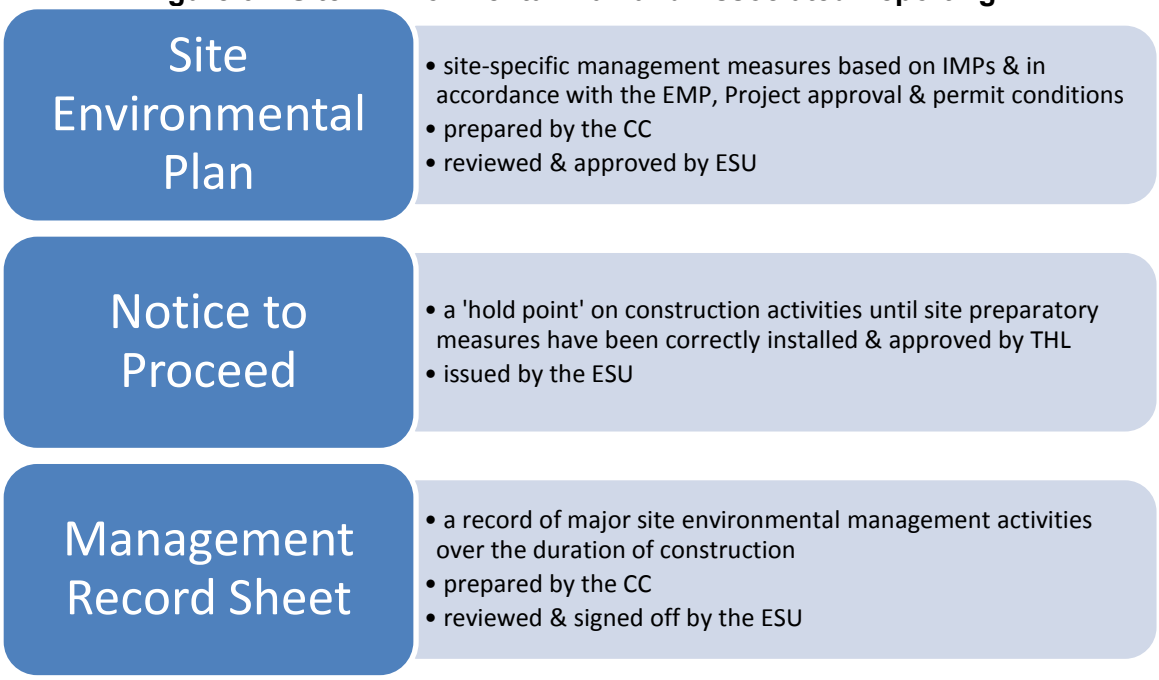
Plan No.	Site Environmental Plan
SEP 1	Project access roads
SEP 2	Coffer dam
SEP 3	Diversion tunnels
SEP 4	Dam and spillway
SEP 5	Intake
SEP 6	Headrace, tailrace and power station
SEP 7	Batching plant (each)
SEP 8	Camp site (each)
SEP 9	Machinery depot / mechanical workshop (each)
SEP 10	Storage area (each)
SEP 11	Reservoir foreshore protection
SEP 12	Spoil disposal sites

56. The level of detail contained in a SEP will be relative to the potential environmental impact of site activities, varying according to the site and proposed activities. For example, the Dam SEP will be a detailed plan, whereas the SEP for a separate materials storage area will be simple. Sub-components of a SEP will normally, but not always, include:

- Vegetation Management Plan;
- Erosion and Sediment Control Plan;
- Earthworks Plan;
- Waste Management Plan; and,
- Site Rehabilitation Plan.

57. SEPs will be living documents (see Figure 6.2), subject to revision as construction proceeds. Site layout plans will be required for different phases of construction on major sites where the landform and/or construction activities will vary substantially over time to ensure that the controls are coordinated with construction works and sufficient space is provided for implementation (e.g. sediment basins for tunnel effluent). Each SEP shall contain a *Pre-Commencement Checklist* that will be completed by the CC and reviewed by the ESU prior to construction activities being permitted to commence on that site. Each SEP shall be submitted to the ESU at least two weeks prior to the proposed commencement of site activities. The outcome of the review will either be ESU approval of the SEP in the form of a *Notice to Proceed* or the provision of instructions to the CC to revise the plan and resubmit it for approval. The CC must obtain a formal *Notice to Proceed* for each site from the ESU before any construction activities can commence. Each SEP will also contain a *Record of Mitigation Measures*, summarizing the measures contained in the plan that shall be used as a checklist.

Figure 6.2.Site Environmental Plan and Associated Reporting.



7. Management Measures

7.1 Overview

58. Environmental management measures will be implemented over the three Project phases: (i) pre-construction; (ii) construction; and, (iii) operation. Some of the proposed measures are very specific to the Project phases, and are described accordingly; many of these reflect routine practices that are usually encoded within construction contracts, or are reflected in design adjustments to minimize environmental impacts, and are increasingly assumed as "standard" practices for hydropower projects, based on extensive global experience. In addition to those, there are four key Management Plans (which provide a frame for IMPS #s 2-5) that address site specific concerns associated with this project. These include the following:

- Fish Conservation Management Plan;
- Water Release and River Safety Management Plan;
- Wildlife Conservation and Awareness Management Plan; and,
- Watershed/Forest Management Plan.

59. Given that the issues associated with fish, river safety, wildlife, and forests span all the Project phases, and need continuous oversight, linking of activities, and continuity over a ten-year period (at least), these four main Management Plans are described as coherent programs; that is, **they are articulated once as seamless management measures (rather than being repeated three times, for each of the Project phases)**. However, within each of the four main Management Plans, the scheduling clearly shows the duration and sequence of activities through the three phases, and the allocation of Plan resources is separated into pre-construction/construction and operation phases (however, note that the consulting services

budget covers up to the end of the construction phase; the operational phase budget has been filed for the information of the Government of Nepal). The four main Management Plans are explained first, followed by the Project phase-specific environmental management measures.

60. The preliminary estimated total costs of the mitigation measures and the associated monitoring are shown below (this shows both the dam/reservoir component and the transmission line). These costs include the Government of Nepal expenses related to the fish and forestry management plans, as well as the costs associated with the consulting services required for each of the four main Management Plans, which are then described below. Several proposed mitigation measures will be finalized prior to construction, depending on further technical design and feasibility studies (including the fish hatchery, a fish habitat offset, and possible construction of a switchback fish pass). If necessary, additional budget will be allocated from the project contingency.

Item			NRs
Mitigation	Hydropower Plant	Tree planting and watershed management	1,564,631,138
		Wildlife conservation and awareness program	42,941,635
		Fish conservation and awareness program	158,413,810
		Rivers safety program	28,751,959
		Provisional cost for House repair and drying spring	4,000,000
		Sub total	**1,798,738,541**
	Transmission Line	Tree planting and watershed management	130,411,347
		Wildlife conservation and awareness program	20,777,497
		Sub total	**151,188,844**
Monitoring	Hydropower Plant	Spring water	500,000
		House Crack	500,000
		Vegetation	3,720,000
		Terrestrial fauna	3,720,000
		Aquatic fauna	18,432,000
		Land use	313,060
		Sub total	**27,185,060**
	Transmission Line	Frontline environmental monitoring	3,500,000
		Third party monitoring	1,000,000
		Sub total	**4,500,000**
Grand Total (Rp.)			**1,981,612,445**
Grand Total (USD)			**23,293,904**

7.2 Proposed Seti River Fish Conservation Management Plan

7.2.1 Introduction

61. Some of the main environmental concerns associated with the Tanahu Hydropower Project include the blockage of fish migration in the Seti River, caused by the dam, and the risk of degradation of fish habitat in both the reservoir and the immediate areas downstream of the tailrace (in the Madi River), as well as in the short run of the Seti River before the confluence with the Madi River (about 2 km); these are all documented in the Project EIA. The fish species at risk *do* occur throughout Nepal, albeit with various levels of status (from commonly occurring, to endangered), but that does not diminish the need for a concerted fish conservation management plan in the vicinity of the Tanahu dam and reservoir, as fish populations in Nepal face obstacles at other hydropower locations in the country.

62. The purpose of the proposed plan described below is therefore to ensure adequate quality of fish habitat in the areas adjacent to the project site and to intervene to sustain stocks of migratory and at-risk fish species in the reservoir and upstream areas in the Seti River. The approaches described below are based on a sound understanding of the fish resources currently in the Seti River (above and downstream of the confluence with the Madi River) and a review of the most practical and successful approaches for fish conservation associated with hydropower projects in similar settings (in Nepal and elsewhere). The plan includes articulation of the specific issues, the proposed objectives and outcomes of the fish conservation management plan, the approach and methodology, implementation arrangements, schedule, and consulting packages.

7.2.2 Context, Project Design and Activities, and Potential Residual Impacts on Seti River Fish Populations

63. Figure 7.1 shows the basic features of the Tanahu hydropower project, as they pertain to fish populations in the Seti Basin. The dam, with a height of 140 meters, will obstruct upstream migration of fish, and will create a reservoir that is slightly more than 100 meters deep at the dam face, extending about 18 kilometers west of the dam site, with an area of 7.26 km^2, inundating, for most of the year, fish spawning and rearing areas along the Seti River. Table 7.1 shows the expected hydraulic regime of the Tanahu dam and reservoir. The minimum required environmental flow will be 2.4 m^3/sec[1]. This will address the short section of the Seti River before the confluence with the Madi River. From that point downstream, the Madi River discharge more than adequately compensates for the reduced flows from the Seti River, making up about half of the combined discharge that would normally be experienced after the confluence of the two rivers. From the tailrace outflow area, river discharge rates will be more than adequate for fish passage, due to the Madi River discharge and the release from the Seti Reservoir (see Table 7.1). The reservoir will be drained each June, to flush sediments, then will be filled again over a period of days. The reservoir will therefore not only have fluctuating water levels, but will revert from a relatively static water body (which has implications for resident fish populations) to its original state (a flowing river) near the end of the monsoon each year. This is the context which fish populations in the Seti River will encounter.

[1] The adequacy of this minimum flow will be assessed through subsequent monitoring and can possibly be adjusted, if needed.

Figure 7.1. The Tanahu Hydropower Project; reservoir area, dam site, tailrace location.

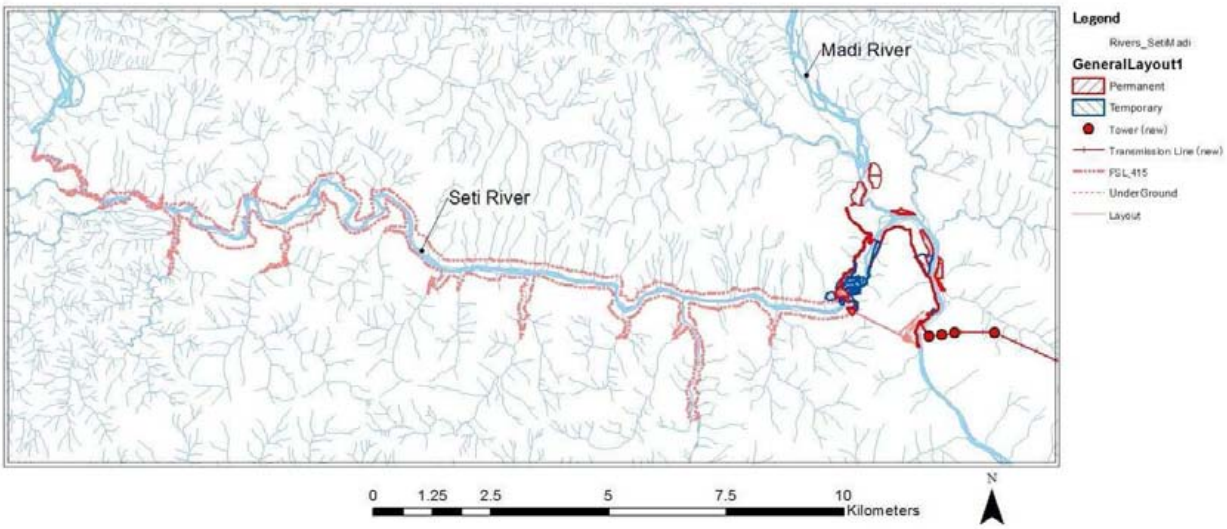


Table 7.1. Average Monthly Seti River Flow Rate: Existing and with Project Operation (in the first ten years; subsequent to that, annual flushing will be spread out over 40 days in June/July, which will affect the average operation flow rates in those months).

Month	Existing Flow Rate (m^3/s)			Project Operation Flow Rate (m^3/s)					
	Seti River	Madi River	Total	Spill Flow	Generation Release	Environmental Release	Total	While Generating	Not Generating
Jan	26.2	23.0	**49.2**	0	127.1	2.4	**129.5**	152.6	25.4
Feb	22.9	20.1	**43.0**	0	125.4	2.4	**127.8**	147.9	22.5
Mar	22.9	20.5	**43.4**	0	122.6	2.4	**125.0**	145.5	22.9
Apr	26.1	24.0	**50.1**	0	117.8	2.4	**120.2**	144.1	26.4
May	41.6	38.5	**80.1**	0	119.2	2.4	**121.6**	160.1	40.9
Jun	119.5	102.7	**222.2**	123.6	120.0	2.4	**246.0**	348.8	228.8
Jul	290.3	259.9	**550.2**	287.9	0	2.4	**290.3**	550.2	550.2
Aug	319.5	278.6	**598.1**	122.8	119.5	2.4	**244.7**	523.3	403.8
Sept	227.1	168.4	**395.5**	97.1	127.4	2.4	**226.9**	395.3	267.9
Oct	110.6	88.5	**199.1**	8.6	127.4	2.4	**138.4**	226.9	99.5
Nov	51.9	43.9	**95.8**	0	127.4	2.4	**129.8**	173.7	46.3
Dec	33.5	29.4	**62.9**	0	127.4	2.4	**129.8**	159.1	31.8

64. In addition to the change in the hydraulic regime of the Seti River (which will affect the nature of fish habitat), and the blocking of fish migration, the water quality above and below the dam will likely be affected. For example, during the filling and storage of water in the reservoir, accumulated sediments and nutrients will build up in the reservoir, with a risk of low oxygen levels in deeper parts of the reservoir. In addition, during draining of the entire reservoir over 10 days in mid-to-late June, the released water will be cooler (possibly 4-7^{o}C) and will probably have lower dissolved oxygen levels than the natural Seti River flows expected in mid-June (generally 20-24^{o}C). The release water may also contain higher levels of phosphorus (see the Environmental Addendum 2012, EIA, Volume 1 for more specific details on the possible water quality changes in the reservoir). These possible changes will occur in the context of current seasonal variability in the Seti River, in any case, a situation that local fish species have probably adapted to. For example, Seti River water quality is seasonally variable, ranging from highly turbid during the monsoon season (June-September), and relatively clear during the remainder of the year, apart from stormwater runoff that is usually turbid. Water temperature

ranges from 15°C in winter to a high of around 24-27°C in the hot late dry season in May. The water is slightly alkaline, and biological oxygen demand and chemical oxygen demand values reflect relatively good water quality, with minimal organic and chemical inputs (which in turn reflects low population density in the watershed and lack of industrial activity).

65. The Seti River is one of the major tributaries of the Trisuli River that drains the central and eastern parts of the Gandaki River basin of the Nepal Himalaya. The Seti River comprises approximately 14% of the Gandaki Basin area and around 11% of the total volume of basin river runoff (see Figure 7.2). The Seti River is therefore part of the drainage network that provides habitat conditions suitable for fish, both resident species and migrating fish species of the Gandaki River system.

Figure 7.2. The Seti River location in the Gandaki Basin.

66. The Seti River supports both warm and cold water fish, similar to other drainage networks of the Gandaki Basin (Trisuli, Marsyangdi, Madi, Kaligandaki). Warm water fish species migrate upstream from the Narayani River into the Trisuli, Seti and other rivers to spawn at the onset of the monsoon (June), leaving the eggs and fingerlings in the upstream stretches of these river networks. Cold water fish, however, are confined to the upstream stretches of these rivers, only moving locally upstream and downstream over a limited range, depending upon the rise and fall of water temperatures and flows. The aquatic ecosystem values of the Seti River are similar to other rivers of the Gandaki Basin system, in terms of species diversity and ecological status. In recent years, however, with the rapid expansion of Pokhara, Lekhanath, Bhimad, and Damauli townships in the middle and upstream sections of the Seti River, the ecological status of the river, for fish species, has been greatly compromised due to urban activities, particularly from the discharge of untreated sewage and solid waste. As a result, the middle and upstream sections of the Seti River (above where the reservoir will be located) may not continue to provide pristine fish habitat. On the other hand, the Madi River, which joins the Seti River about 2 km downstream of the dam site, has a catchment free of large urban areas and hence provides better quality habitat for aquatic life found in this river basin, including IUCN Red List species (discussed below). A key part of the Fish Conservation Management Plan is to commit to protection of the Madi River habitat, as partial compensation

for any constraints on fish populations in the Seti River, which are already possibly being compromised by urban growth[2].

67. Surveys in 2011 indicated that there are at least 46 fish species in the Seti River (of 49 reported since 1986). The most dominant fish species in the Seti River are *Neolissochilus hexagonolepis* (copper mahseer, a short- to mid-range migrator), *Barilius bendelisis* (Indian hill trout), *Schizothorax richardsonii* (snowtrout; a short- to mid-range migrator), *Garra annandalei* (stone roller), *Labeo pangusia* (ghora muikkha), *Garra gotyla* (sucker head), and *Tor putitora* (putitor mahseer; a long-distance migrator). Other long-distance migratory fish found in the Seti River system include *Anguilla bengalensis* (Indian mottled eel), *Bagarius yarrelli* (giant devil catfish, or goonch), *Tor tor* (mahseer), *and Clupisoma garua* (garua bachcha). There are also other short- to mid-range migratory species, including *Schizothorax progastus* (dinnawah snowtrout), *Labeo angra* (angra labeo), *and Labeo dero* (gardi). There are six IUCN Red List species (see Table 7.2) in the Seti River, which are also present in other locations in Nepal (in the Gandaki Basin, and in the Sapta Koshi River system in eastern Nepal, and the Karnali River system).

Table 7.2. IUCN Red List fish species present in the Seti River system.

Scientific Name	Nepali Name/ English Name	Reported by John 1986	NEA Survey 2001	EIA Upgrade Survey 2006	PPTA Survey 2011	Migratory Status	IUCN Red List Category
Tor putitora	PaheloSahar/ putitor mahseer	-	*	*	*	LD	EN
Schizothoraxrichardsonii	Asala/ snowtrout	-	-	*	*	MD	VU
Bagariusyarrelli	Gounch/ giant devil catfish	-			*	LD	NT
Neolissochilushexagonolepis	Katle/ copper mahseer	*	*	*	*	MD	NT
Tor tor	Sahar/ mahseer	-	*	*	*	LD	NT
Labeopangusia	Rewa/ ghora muikkha	-	-	-	*	R	NT

LD: long distance migratory species; MD: mid-distance migratory species. R: locally resident species.

EN: Endangered - a taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

VU: Vulnerable - a taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

NT: Near Threatened - a taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

(Source: IUCN Standards and Petitions Subcommittee. 2010. Guidelines for Using the IUCN Red List Categories and Criteria. Version 8.1. Prepared by the Standards and Petitions Subcommittee in March 2010.)

68. Most migratory species migrate upstream at the start of monsoon (May through June) and migrate downstream towards the end of the monsoon (September through November). River hydrology (the flow regime) and temperature are the basic factors that influence fish migration, which coincides with the general spawning season of the long-distant migratory fish. Immediately after upstream migration, most fish species spawn in the clean, oxygenated waters of tributaries, then migrate downstream as river/stream flows reduce in the late monsoon. Mid-distant migratory fish also spawn in the monsoon season; however some species, particularly

[2] However, discussion of the current status of plans for hydropower on this river system will be required; alternatives may have to be found, if hydropower development is pending, and cannot be changed.

Schizothorax species, spawn in the early pre-monsoon period (March-April), as snow in high altitudes melts.

69. The main impacts of the project on fish populations in the Seti River will be as follows:

- the creation of a barrier preventing upstream and downstream fish migration throughout the year (those species noted above), with possible long-term effects on migratory fish populations and overall fish species diversity;
- annual draining of the reservoir that could reduce immediate downstream water temperature over 10 days (in the first ten years) and 40 days each year thereafter (in the mixing area at the tailrace), and will revert the reservoir to a temporary river flow system (through the sediment flush gates);
- replacement of lotic (moving river water) fish species by lentic (relatively still water) fish species in the reservoir stretch (18 km) of the Seti River, with annual stresses on this potentially new fish assemblage caused by annual reservoir flushing (new lentic fish populations may not be stable, as some of these fish will be flushed out during the June reservoir-emptying program);
- a reduction of fish between the dam and Madi River confluence (however, in a short stretch of about 2 km); and,
- possible downstream water quality change (primarily a reduction in temperature during annual flushing, along with increased suspended sediment levels) due to reservoir operation. This also includes a reduction in the nutrient base supplying downstream river sections due to reservoir trapping of organic matter, with possible implications for fish populations and species diversity.

70. The opening of the dam to natural flows over a 10-day period (Years 1-10) and then over 40 days (Year 11 onwards), starting in late June each year after the reservoir has been drained, will create a short "window" for the natural migration of fish during this early monsoon period (but perhaps just fingerlings moving downstream, rather than mature fish going upstream, given the head difference between the gate and the river bed). Reservoir draining, which will release between 298 and 1,048 m^3/s over a 10-day period via the middle and sediment flushing outlets, will release colder water, possibly with lower dissolved oxygen levels, downstream, but in an area that will have been compromised by dam operation anyhow. It is expected that re-oxygenation of the water will occur rapidly in the stream riffles and river bends just below the dam, which will also help with mixing and temperature equilibration over a fairly short distance, before this water enters the Madi River at the confluence (it is also proposed that a boulder field be examined, to enhance re-aeration of the release water).

71. Those fish species which already exist upstream from the dam site will continue to have access to the full range of required habitats (see Figure 7.2, which indicates that there is an additional 70-80 km of upstream tributaries and river bifurcations which can accommodate short- and medium-range migratory fish). In particular, the copper mahseer (*Neolissochilus hexagonolepis*) and snowtrout (*Schizothorax richardsonii*) will continue to have scope in a relatively large river habitat. The migration and upstream access to spawning grounds by the mahseer (*Tor Tor*), putitor mahseer (*Tor putitora*), and giant devil catfish (*Bagarius yarrelli*, long-range migrators) will be obstructed, except when the dam is open to natural flows in June of each year (although still facing a challenge to make it through the gates). These fish species, which also occur in the Madi River, will need attention there, in compensation for potential losses in the Seti River.

7.2.3 Objectives and Expected Outcomes of the Fish Conservation Management Plan

72. The main concern with the Tanahu Hydropower project, with regard to fish populations, is the obstruction of migration of the long-ranging species. Therefore, the main effort in the proposed fish conservation management plan is to ensure that these migratory species (*Tor putitora*, *Bagarius yarrelli*, *Tor tor)* continue to have *some* form of access to areas upstream from the Seti dam and that their access to spawning and rearing areas on the Madi River upstream from the Seti-Madi confluence is fully guaranteed for the foreseeable future, as a compensation (offset) measure. This will require:

- establishing a hatchery where water input temperatures are appropriate, for rearing juveniles of the vulnerable fish species, for stocking in the reservoir, especially at the western end, where spawning and rearing habitat will still be available to these species, and in adjacent rivers;
- experimentation with a "catch-and-haul" system, in which adult migrating fish are caught (before spawning) below the dam and released at the western end of the reservoir;
- fish habitat protection throughout the Seti reservoir catchment and in the Madi River catchment, through effective land use management (some of which will be addressed with other management plans within the EMP), water quality monitoring and management, and associated public awareness-raising and education; and,
- examination, over the longer term, of innovative technical options for installation of a fish pass/ladder that could allow migratory fish to climb the +140 meter gradient from the outlet of the Seti River to the reservoir water level (this has been discarded to date, because of perceived high cost, additional land acquisition, impact on vegetation, and doubtful effectiveness, but it has not been fully examined as a meandering or zigzag/switchback narrow watercourse, for example using a long system of open half-culverts and pools, over a long distance on the north side of the dam site, to permit a suitable grade for upstream migrating fish; this will at least be further investigated before dam operation).

73. Prior to construction, an analysis of options to establish a fish habitat reserve or protection area will be undertaken (with a priority focus on the Madi River). This will inform the design of a fish habitat offset, providing suitable habitat for the protection of migratory fish species and their spawning grounds. The fish habitat offset design will be prepared through appropriate consultation with the Government of Nepal and other relevant stakeholders. Following agreement on the design, the fish habitat offset will be established as part of the EMP.

74. The expected outcomes of the fish conservation management plan include:

- measurable continued presence (although possibly diminished) of viable populations of long-ranging fish species (those on the IUCN Red List) in the area upstream from the Seti dam (determined through regular monitoring);
- measurable stable populations of these long-ranging fish species in the Madi River system upstream from the Seti-Madi confluence (monitored as above, along with habitat quality assessment);
- alternatives are explored and implemented to enhance the population of endangered fish species in other favorable habitat conditions within Nepal's river system; and,
- increased understanding and capacity of local residents to protect fish habitats and to exploit the fisheries in a sustainable manner, with a reduction in use of illegal fishing methods.

7.2.4 Rationale for Proposed Approach

75. Experience at other hydropower dam sites indicates that a multi-pronged approach in a fish conservation management plan can be successful (for example, salmonid and bass migration in obstructed rivers in Sweden and North America). These approaches include protection of fish habitat, enhancement of fish movements where feasible (fish pass, as well as a catch-and-haul program), and hatchery subsidies to the natural population. Nepal does not have a well-documented experience with fish passes and ladders, given the large gradients between upstream and downstream reaches near obstructions, but this should not preclude some innovative experimentation with high gradient fish passes. With regard to hatchery subsidies to natural fish populations, the experience at the Kali Gandaki Fish Hatchery has been quite well documented, and indicates that at least *Torputitora*, *Schizothorax richardsonii*, and *Neolissochilus hexagonolepis* (as well as several other species, such as *Labeo pangusia*), can be spawned and reared in a hatchery (for example, 202,000 fingerlings of these species were raised and released in one of the first years of operation of the hatchery[3]).*Tor tor* is under domestication there, but has not been bred yet. This indicates that concerns for at least four of the five IUCN Red List migratory fish species can be addressed through the proposed hatchery program. There are no conclusive data for hatchery rearing of *Bagarius yarrelli* (giant devil catfish), which is apparently a long-distance migratory fish[4], so this species needs more attention in the proposed hatchery program (it has been domesticated at the Kali Gandaki hatchery, but not yet bred). Specific activities and methodologies are noted below.

7.2.5 Activities and Methodology

76. *Proposed Fish Hatchery for Migratory Species*: The proposed fish hatchery is a key feature of the fish conservation management plan and will involve several steps to ensure that it is effective in supplementing the natural populations of migratory fish in the Seti River area. These include:

- confirming the appropriate hatchery techniques for the target species (*Bagarius yarrelli*, *Tor putitora*, *Schizothorax richardsonii*, *Neolissochilus hexagonolepis*,and *Tor tor*);
- selecting the most suitable site for establishment of the fish hatchery;
- construction of the fish hatchery;
- operation of the fish hatchery; and,
- annual distribution of fingerlings in the western reservoir area and in the rivers.

77. These are described below (and will inform a related loan covenant).

78. *Confirming the appropriate hatchery techniques*: A qualified agency will be engaged to examine and confirm the most appropriate hatchery techniques for the target species (*Tor putitora*, *Schizothorax richardsonii*, *Neolissochilus hexagonolepis*,and *Tor tor*, all of which have been spawned and reared at the Kali Gandaki hatchery and the Godawary Fishery Laboratory[5], and possibly *Bagarius yarrelli*, which may or may not be a concern, but which can be

[3]NARC Newsletter Volume 13 No. 2, June 2006.
[4]This species is documented as *not* being a long-distance migrator in the Mekong River, and apparently there are sub-populations in smaller stretches of river systems; therefore, in Nepal it is possible that *Bagarius* is more sedentary than thought, and therefore less vulnerable than currently believed. A.F. Poulsen *et al*., 2004. MRC. Distribution and Ecology of Some Important Riverine Fish Species of the Mekong River System.
[5]NARC Newsletter Volume 13 No. 2, June 2006; also pers. comm. Dr. Gurung, NARC; and, Status of Sahar *(Tor putitora)*:Domestication and its Development in the Himalayan Region of Nepal by A. K. Rai, 2008, Aquaculture Asia Magazine.

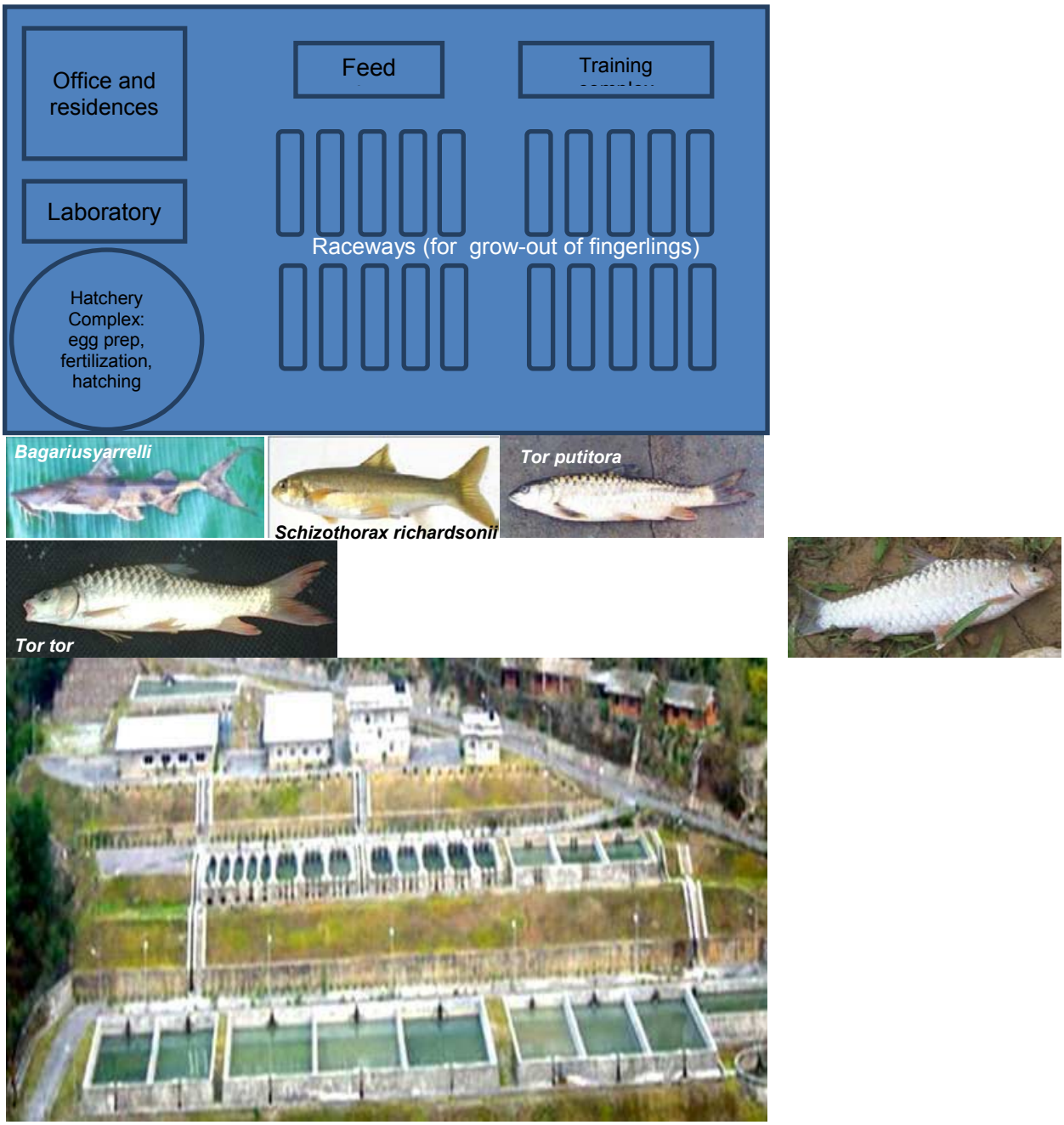
experimented with, in any case). This initial work will involve review of the annual hatchery data and assessment of the most successful spawning and rearing methods for each of the target species, as well as detailed review of the relevant technical literature. Special attention will be paid to water temperature and quality as they pertain to successful fertilization of eggs and growth rates of fingerlings. This information will help with the field survey and identification of a hatchery site for the Seti fish hatchery.

79. *Field survey and identification of a fish hatchery site*: The location of the hatchery is critical to the potential success of the hatchery. The agency will select the best hatchery site for the target cold water fish species, based on their experience at Kali Gandaki and also Trisuli. Ideally, the location and water source will meet the requirements for water quality, as well water temperature, for natural hatching of the target fish species (without application of hormones, if possible). The experience at Kali Gandaki, Trisuli, and Begnas suggests such an approach. It will be important to have year-round access to good quality water within the appropriate temperature range (10-20^{o}C). A survey of year-round water quality and water volume fluctuations will therefore be carried out in the vicinity of the Seti reservoir (there may be a need to access Madi River water). Another key factor is the land site, which should have a slope of no more than about 1-3%, be suitable for concrete installations, and of course have access to electricity and roads. Approximately 2.5-3 hectares is required for the proposed hatchery. The fish hatchery facility will consist of a hatchery complex, raceways, feed plant, training complex, laboratory facility, and office and residences (reflecting the layout at Kali Gandaki; see Figure 7.3). The design goal of the fish hatchery will be 30,000,000 eggs, 10,000,000 fry, and 2,000,000 fingerings (spread amongst the five species, on an annual basis; the physical set-up and timing to handle five species concurrently will have to be carefully determined).

80. The process of siting the fish hatchery will include:

- with the hatchery site layout as a guide, and technical requirements known (water volume, quality, and temperature; site size and grades), investigating locations in the Seti and Madi areas that have proximity to the water source, as well as proximity to infrastructure and services;
- collecting data over an annual cycle, for water volume, temperature, and quality;
- preparing site layout drawings for each practical site (hopefully at least 2 will be practical, for comparative purposes);
- examining land ownership and use at each site, and the possible requirements for compensation;
- undertaking an IEE and benefit-cost analysis for each of at least two sites;
- selecting the optimal site on the basis of criteria for practicality of operation, ease in construction, cost, and minimal residual environmental and social impacts;
- detailed designing of the fish hatchery; and,
- acquiring the land.

Figure 7.3. Proposed layout of the Seti fish hatchery, and the current hatchery at Kali Gandaki, as an example.



81. *Construction of the fish hatchery*: Three years will be allocated for construction of the fish hatchery. The hatchery needs to be in operation for at least two years before the Seti River is impounded (so that fingerlings are available for the first year of the dam/reservoir operation). The hatchery will be constructed by a local contractor, chosen through competitive bidding.

82. *Hatchery operation*: The Seti fish hatchery will be operated by the selected agency. Getting the hatchery operating (once constructed) will involve the following steps, in sequence:

- preparing the organizational structure for the hatchery (identifying different functions, staff responsibilities, and time sequence of tasks);
- preparing the operational plan for the hatchery, including the catch-hatch-release schedule for each target fish species;
- integrating the Seti hatchery plan with the other hatcheries in Nepal, including establishing a fish procurement and selling plan;
- hire qualified workers (competitive selection);
- purchase experimental instruments, technical equipment, consumables supply, reagents, and ingredients for fish food;
- set up a training program for the hatchery workers;
- testing all hatchery systems (electrical, water supply, pumps, filters, etc.); and,
- exposing the Seti fish hatchery to the public, through a series of "Open Houses" in the first few months of operation.

83. Routine operation of the Seti fish hatchery (regular production of fingerlings of the five target species) will involve the following activities:

- catching the mature fish of each target species in the migration season, in the Seti and Madi Rivers, for bolstering of the fish domestication program;
- breeding these fish (extracting the eggs and fertilizing);
- raising the fingerlings at the hatchery;
- releasing the fingerlings of the five target species (IUCN Red List; see Figure 7.3) at the downstream of end of the reservoir, at the western end of the Seti reservoir (for acclimatization to the reservoir), and in the Madi River;
- releasing the mature fish at the upstream end of the reservoir (for onward upstream migration);
- providing fingerlings to other hatcheries in Nepal;
- releasing excess fingerlings to other degraded rivers in the vicinity;
- selling commercial fishes at the local fish market (those grown to maturity and in excess of hatchery needs);
- establishment and implementation of protocols for monitoring and preventing diseases within the fish hatchery;
- monitoring hatchery operations and fish stocks in the Seti reservoir, Madi River, and downstream areas below the tailrace (compared to a solid set of baseline data, to be collected in the 3-5 years before dam operation); and,
- publishing annual reports and minutes of meetings with collaborating agencies.

84. While the hatchery systems for at least four of the five target species are quite well-defined and tested, the effective release and survival of fingerlings is less well-known. Restocking a river or sub-basin with fingerlings produced in a hatchery needs careful planning (e.g., timing and location) to be effective in supplementing wild populations. There will therefore have to be ongoing monitoring of both the natural and supplemented populations of the target species in the Seti reservoir, upstream reaches of the Seti River, and the Madi River, which will field surveys, anatomical examination of fish, identification of spawning areas of the target fish species, detailed habitat survey in those locations (including water quality, current velocity, bottom sediments, vegetation, and so on).

85. The introduction of invasive fish species is a significant and recognized threat to the conservation of native fish species in Nepal. Attention will therefore be given to this issue, to ensure that invasive species are not introduced as a result of the project. To address this risk, and tied to the monitoring tasks noted immediately above, there will be active monitoring and

management of invasive species (which will be identified and described in training sessions for project and hatchery staff). This will be supported with education and awareness-raising activities on invasive species for local communities as well. The objective is to ensure that the fish hatchery does not breed or introduce invasive species into the reservoir or any river systems in Nepal.

86. *Experimentation with a "catch-and-haul" system*: Initial thoughts regarding the fish conservation management plan for the Tanahu Hydropower Project discounted the practicality of a "catch-and-haul" system, in which mature specimens of the five target fish species would be collected in the river and transported upstream of the dam (in the reservoir). This reflected a concern that the reservoir will be emptied and flushed each year (although the specific issue was not articulated; any effort to get mature fish above the dam and in the upstream reaches above the reservoir, where they may spawn, would be beneficial). It is now believed that a "catch-and-haul" system may have some merit, as a back-up to the hatchery stocking plan described above. The point here is that unless it is tried and monitored, there is a risk that an alternative fish conservation measure may be abandoned unnecessarily.

87. The hatchery program will require the capture of mature target fish species for breeding. This program can be expanded to ensure that additional specimens are caught below the dam and below the tailrace, maintained in tanks, then transported (by truck or by boat) to areas at the western end of the reservoir and released, in an area where these fish will encounter spawning and rearing habitat that is not directly affected by the reservoir. This approach would be one of the four prongs in the fish conservation management plan, but, as noted above, requires some experimentation and monitoring (involving tagging of released fish) before being assumed as a regular activity within the overall program. If it proves to have merit, the "catch-and-haul" system can then be expanded with input from local people, which would involve paying a set price for mature specimens of each target species during the pre-spawning season only. This would require careful management (specified quotas) to avoid over-exploitation of individual species, which would then run counter to the overall intention of the program. The "catch-and-haul" system can be managed as an adjunct activity of the staff of the proposed Seti Fish Hatchery. Related to this is the need to control fishing in general: to establish a compliance/enforcement system that reduces the incidence of electric and dynamite fishing (based on the existing Fisheries Regulations).

88. *Fish habitat protection in the Seti and Madi watersheds*: All the other initiatives in the Fish Conservation Management Plan can be optimized if there is a concerted effort to manage fish habitat in the rivers (Seti and Madi), reservoir, and upper reaches of the Seti, beyond the reservoir. The proposed afforestation plan will help address land use issues and the increased risk of sedimentation into the reservoir (by soil protection through planting of trees, in compensation for those lost in the reservoir area, and shoreline protection to minimize erosion). In addition, actual fish habitats can be optimized, as follows:

- monitoring and control of point sources of water pollution, which will involve routine river and reservoir water quality monitoring (especially for BOD, total dissolved solids, coliform, dissolved oxygen, ammonia, nitrogen, and phosphorus); this will be undertaken at the 9 monitoring locations previously sampled, as well as 3 locations on the Madi River, at different depths and during different seasons; this will require coordinated action with other agencies, if point sources are identified and not immediately and effectively addressed;
- routine monitoring of land use/clearing, to minimize soil loss to the reservoir;
- solid waste control, which will involve establish a observation reporting system for disposal of solid waste into the river, onto the river bank, or into the reservoir; as above,

this will require coordination with other agencies to ensure effective enforcement and ongoing compliance with specified controls;
- management of river bed mining, which will require periodic patrolling of the Madi and Seti sub-basins, especially in areas that are known to support spawning and rearing of the target fish species; and,
- design of the proposed shore protection works in the Seti reservoir so that fish spawning and rearing habitat physical features and conditions can be simulated as much as possible.

89. All these proposed measures, as well as the limits and conditions associated with catching the mature specimens of target fish species, will require a good deal of public awareness-raising and education. It is expected that NARC and local consultants will design and implement the public awareness and education program (involving village visits and brochures), which will include an overview of existing fishing regulations, fish vulnerabilities associated with the dam project, and the obligations and opportunities associated with the Fish Conservation Management Plan.

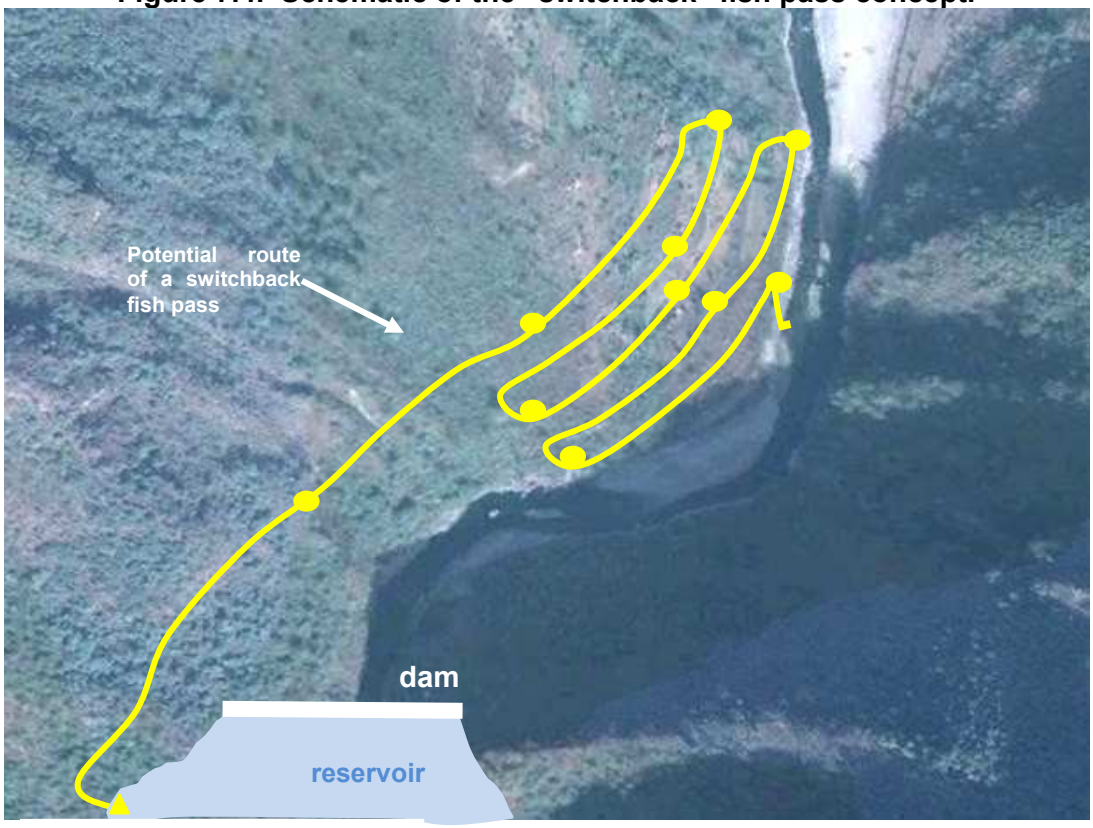
90. *Examination of technical options for installation of a "switchback" fish pass*: As noted above, a key principle of the proposed Fish Conservation Management Plan is to assume a multi-pronged approach, in case one or several approaches are not as effective as planned. There is significant international experience with fish passes and ladders, albeit with smaller dams and elevation differences. As noted previously, the concept of a fish pass was rejected as being too costly, but that assumption was based on unit costs for very complex fish passes and ladders. It is possible to examine less expensive options. The current proposal is to at least examine the technical feasibility and cost of a long, low-gradient fish pass, based on literature review and some field experimentation.

91. The requirement (and challenge) is to allow upstream mature migrating fish to climb approximately 140 meters, in water, from the current outflow of the Seti River, where it meets the Madi River, to the proposed water level in the reservoir. A review of the literature indicates that migrating fish in other areas can climb fish passes with a gradient of up to 10-15%, and can travel along passes up to a distance of 10 km[6]. There is scope with the Tanahu dam site and land on the north side of the Seti River, before the confluence with the Madi River, to construct a simple fish pass (perhaps using open culverts and a series of resting pools). This is shown as a schematic in Figure 7.4. The concept would require about 2.5 km of fish pass, switching back, to climb about 140 meters, which would provide a gradient of 5%, which is well within the scope noted in the technical literature. This sub-project, if it were to go ahead, would require its own safeguard analysis, as it would encroach on land that is not currently designated for the project.

92. Because there is negligible experience with fish passes for high dams in Nepal, it is suggested that this element of the proposed Fish Conservation Management Plan be restricted to a technical feasibility study at this stage, which would involve examination of the literature, assessment of the practicality of relatively inexpensive materials being used to create the fish pass, site assessment, some experimentation, and a benefit-cost analysis. If the concept still has merit after this study, then it could be factored into the work program for the Tanahu Hydropower Project.

[6]Makrakis *et al*., 2007. The Canal da Piracema at Itaipu Dam as a fish pass system. Neotropical Ichthyology 5(2): 185-195; this system is 10 km long. And, UK Environment Agency Website. 2012. Types of Fish Pass; in fact some fish can handle a gradient up to 25%, as long as resting pools are incorporated into the fish pass system.

Figure 7.4. Schematic of the "switchback" fish pass concept.



7.2.6 Implementation Arrangements

93. Tanahu Hydropower Limited (THL) will be the Executing Agency for the Tanahu Hydropower Project and an appropriate agency will be responsible for coordination and implementation of the Fish Conservation Management Plan (under the supervision of the Environmental Sub-Unit of the Environmental and Social Management Unit of THL), with consultant support as needed for technical inputs to each of the four prongs of the plan (to be set up as consultancy services). International NGOs are expected to provide advisory support to the Fish Conservation Management Plan (and all the other management plans, as well), if they are not directly engaged as technical consultants (in some cases, they may be). Relevant government institutions, such as the Nepal Agriculture Research Council, Fisheries Development Directorate, will also be actively involved to ensure that the fish hatchery approach, in particular, is developing properly. In this manner, sufficient technical oversight can be provided to ensure successful implementation of the Fish Conservation Management Plan.

94. It is expected that the management plan will require 54 person-months (6 International and 48 National) during pre-construction and construction and 7 person-months (National) per year during operation. The consultants will address the technical requirements and design aspects of each of the four prongs in the plan, and will be engaged according to ADB Guidelines on the Use of Consultants. The equipment will be procured according to ADB's Procurement Guidelines. The study is expected to be implemented over 10 years, from 2013 to 2022. The

disbursements will be made according to ADB's *Technical Assistance Disbursement Handbook.*[7] Consultant needs are listed below.

7.2.7 Terms of Reference for Consultants

95. The following consultants will be required to assist with implementation of the Fish Conservation Management Plan:

- Cold-water fish/hatchery specialist (International and National, to work with national counterparts): responsible for technical advice and oversight for the hatchery design and operation;
- Fish habitat/water quality specialist (International and National): responsible for assessing fish habitat quality in the environs of the Tanahu Hydropower Project, identifying a fish habitat offset area in the vicinity, and promoting fish habitat protection in general;
- Fish/dam management specialist (International and National): responsible for technical feasibility assessment and trials with the proposed "catch-and-haul" fish movement system and the "switchback" fish pass, as well as assistance to monitoring of fish moved above the dam ; and,
- Fisheries regulation/enforcement specialist (National): responsible for assessment of the effectiveness of current fisheries regulations and promoting compliance through public awareness and education programs.

96. The cold-water fish/hatchery specialists will be responsible for the following tasks:

- Review and summary of Nepal hatchery experience with the five target species, including consultation with relevant Government agencies;
- Review and summary of hatchery experience with these species elsewhere;
- Definition of the operational requirements and techniques for hatching and rearing the five target species at the Seti Fish Hatchery;
- Design of the Seti Fish Hatchery (based on previous practical experience in design and operation of a successful cold-water fish hatchery);
- Assistance with site selection for the hatchery;
- Technical inputs to the construction of the hatchery;
- Periodic monitoring and supervision of the hatchery operations, including release of fingerlings and sustainability of stocked fish populations, with appropriate documentation;
- Establishment and implementation of protocols for monitoring and preventing diseases within the fish hatchery;
- Provision of capacity-building to the Seti Fish Hatchery staff for specific techniques, tasks, and operational responsibilities, including the following: collection of mature fish; appropriate holding facilities; extraction of eggs; hormone inducements; egg fertilization and hatching; handling and grow-out of fingerlings; feeding regimens; stocking density in raceways; disease management; transportation of fish; wild release of fingerlings; quality control; monitoring and documentation systems; etc.; and,
- Collaboration with the fish habitat/water quality specialists.

97. The fish habitat/water quality specialists will be responsible for the following tasks:

[7] ADB. 2008. *Technical Assistance Disbursement Handbook*, Manila.

- Field survey and assessment of cold water fish habitats in the immediate Seti River and Madi River environs, during pre-monsoon and post-monsoon periods (over two years and then less frequently thereafter; including physical features of habitats and water quality; this will include time-series assessment of river discharge rates and possible correlations with rainfall and temperature, to determine if ongoing climate variability is reflected in the river system);
- Periodic monitoring of stresses on fish habitat, due to the dam and reservoir operation (including upstream, reservoir, and downstream reaches of the Seti and Madi Rivers: the latter, in particular, to address concerns regarding low oxygen water being released during annual flushing – it is proposed to construct a boulder field at the water release area to create agitation and rapid oxygenation of release water, but this will require careful monitoring to determine its effectiveness); parameters will include at least DO, nutrients, ammonia, DOC, TDS, SPM;
- Periodic monitoring of natural populations (representative samples) and local fish catches (the five target fish species), with associated documentation;
- Identification of priority fish habitat areas for future protection (especially on the Madi River, which could serve as a fish population offset area, to compensate for potential Seti River losses); the most suitable future offset area will then need careful demarcation, clarification of attributes, assessment of future potential stresses (hydropower development and urban growth), and negotiation with the Government of Nepal to secure a "no-development" covenant for the selected offset area;
- Support to public awareness-raising and education programs related to fish habitat management, including: explanation of the impacts of illegal fishing activities; impacts of sediments and land-based nutrients/fertilizers/sewage on fish habitat; the need for vegetative cover adjacent to waterways; the nature of spawning and rearing habitats; construction of artificial fish habitat; fish life cycles; etc.; and,
- Collaboration with the cold-water fish/hatchery specialists, as needed, especially regarding the control of invasive fish species, and establishment and implementation of protocols for monitoring and preventing diseases within the fish hatchery.

98. The fish/dam management specialists will be responsible for the following tasks:

- Examination of the feasibility and potential effectiveness of a "catch-and-haul" system for the five target fish species;
- If feasible, design of a trial "catch-and-haul" system, to be implemented in the pre-monsoon period of the first full year of dam/reservoir operation;
- With the assistance of the other specialists, monitoring of the survivability of the fish moved to the reservoir, with associated documentation;
- Examination of the feasibility and practicality of a "switchback" fish pass, for the five target fish species, involving review of relevant technical literature, site assessment, pilot scale experimentation with various materials, gradients, and lengths; and,
- If feasible, design of a full-scale "switchback" fish pass, for subsequent funding consideration, including the tagging and telemetry monitoring of fish movements.

99. The fisheries regulation/enforcement specialist will be responsible for the following tasks:

- Examining the current informal and commercial fisheries activities in the Seti and Madi River areas, and the degree of compliance with current fisheries regulations;
- Determining the extent to which the five target fish species are affected by illegal fishing activities;

- Developing and delivering a public awareness-raising/education program related to conservation of the five target species (and others in the Seti and Madi sub-basins); this will require collaboration with the fish habitat/water quality specialists, but with a focus on the impacts of illegal fishing activities and the development of alternative approaches to maintain income from fisheries (such as cage fish culture);
- Establishing a patrol and reporting system throughout the local sub-basins to address illegal fishing activities, such as use of poison, dynamite, and batteries; and,
- Making recommendations for improvements in regulations and innovative measures to encourage more compliance with fisheries regulations.

7.2.8 Schedule

100. The consultancy services required to support the Fish Conservation Management Plan are expected to start in the second half of 2013. The schedule for each of the activities in the Plan is shown below.

Activities	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Pre-constn		Construction						Operation	
Fish hatchery										
Confirming the appropriate hatchery techniques.										
Field survey and identification of a fish hatchery site.										
Construction of the fish hatchery.										
Hatchery operation.										
Annual distribution of fingerlings in the western reservoir area and in the rivers.										
Provision of capacity-building to the Seti Fish Hatchery staff.										
Experimentation with a "catch-and-haul" system										
Examination of the feasibility and potential effectiveness of a "catch-and-haul" system.										
Design and implementation of a trial "catch-and-haul" system.										
Monitoring of the survivability of the fish moved to the reservoir.										
Fish habitat protection in the Seti and Madi watersheds										
Field survey and assessment of cold water fish habitats in the immediate Seti River and Madi River environs.										
Periodic monitoring of stresses on fish habitat.										
Periodic monitoring of natural populations (representative samples) and local fish catches.										
Identification of priority fish habitat areas for future protection.										
Support to public awareness-raising and education programs related to fish habitat management.										
Examining the current										

Activities	2013	2014		2015	2016	2017	2018	2019	2020	2021	2022
		Pre-constn		Construction						Operation	
informal and commercial fisheries activities in the Seti and Madi River areas.											
Developing and delivering a public awareness-raising/education program related to conservation of the five target species (fishing methods).											
Making recommendations for improvements in regulations.											
Examination of technical options for installation of a "switchback" fish pass											
Examination of the feasibility and practicality of a "switchback" fish pass.											
Design of a full-scale "switchback" fish pass, for subsequent funding consideration.											

7.3 Proposed Water Release and River Safety Management Plan

7.3.1 Introduction

101. The Tanahu Hydropower Project will result in alteration of river discharge in the short run to the confluence of the Seti River and the Madi River, in the Seti River below the tailrace running to the confluence with the Trisuli River, and then less obvious alterations beyond the Trisuli River. The expected water discharge variations below the dam will be due to the storage/generation cycle during each month of the year, and the annual flushing of the reservoir (June, July); these have to be well-understood and predictable in the future scenarios and in near-real time. There is also a need to understand the hydrology of the downstream rivers in the event of a catastrophic failure of the dam. These have been examined in a detailed scenario analysis, described in the Environmental Addendum (2012; see EIA, Volume 1). Regular daily/monthly releases through the dam, whether for generation or from spillover, will result in water discharge additions with quality that is likely to be within the normal range for the reservoir and upper reaches of the Seti River. Releases during the annual sediment flushing exercise, which will purge deeper water in the reservoir, will probably have lower levels of dissolved oxygen (DO) and higher levels of sediment. These annual releases will also result in higher volume discharges over a shorter period.

102. The implications of expected and unexpected variations in water discharge below the dam include the following:

- relatively rapid changes in water level below the dam, down to the confluence of the Seti River with the Trisuli, putting people living adjacent to the river, or undertaking activities on or adjacent to the river, at risk; the corollary of this is that the reservoir area upstream from the dam will revert to river flow for 10-40 days per year (during sediment flushing), which can affect users in upstream areas; and,
- alteration of water quality in the immediate discharge area, below the dam and the tailrace, with possible impacts on aquatic fauna (these are addressed in the Fish Conservation Management Plan).

103. The exact frequency, duration, and volume of extraordinary water releases from the Tanahu reservoir will continue to be analyzed and assessed up to the time of final design and

construction of the project. Regardless of these technical details (which are still somewhat in flux), a water release and river safety management plan can be devised now to handle the expected range in water releases, to ensure that water release and resultant variations in water levels downstream from the project are communicated to all possible water users and residents who might be affected, in time to mitigate any risks due to water level changes over short periods. The immediate discharge area can also be engineered to increase mixing and oxygenation of release water, so that alteration of downstream river habitats can be minimized.

104. The purpose of the proposed water release and river safety management plan described below is to address all human safety concerns due to variable water levels in the river system and to mitigate potentially poor water quality in the immediate water release area. The plan includes articulation of the specific issues, the proposed objectives and outcomes of the water release and river safety management plan, the approach and methodology, implementation arrangements, and schedule.

7.3.2 Context, Project Design and Activities, and Potential Issues Regarding Water Releases and River Safety

105. Figure 7.5 shows the basic features of the Tanahu hydropower project, including the reservoir area, dam, and tailrace. Figure 7.6 shows the river areas below the dam, indicating the area likely to be most affected by water quality changes during the sediment flushing in June (the section before the confluence with the Madi River), and the mixing and dilution area between the confluence and the tailrace. Figure 7.7 shows the combined Seti-Madi River[8] to the point of confluence with the Trisuli River. This is the river section of concern with regard to fluctuating water levels. Beyond this point, the collective river discharge of the Trisuli, and other rivers downstream from that point, mitigates any water level changes due to the Seti River alone, and river behavior and existing water level control mechanisms and warning systems will continue to handle those downstream systems.

106. Table 7.3 shows the expected flow regime from the dam/reservoir over a typical annual cycle during the first ten years. Generation releases (up to 127.4 m^3/s), periodic dam spill flows during the monsoon season and emptying of the reservoir in mid June (releasing up to 1,000 m^3/s) will certainly create water level changes in the downstream sections of the river. Figure 7.8 shows the expected water level differences in the river immediately downstream from the tailrace outlet. The river water level below the tailrace outlet will rise by a maximum of 1.66 m above existing natural levels during peak generation (in February). The main flow change will be a daily variation in Seti River flows below the tailrace outlet, created by peaking power generation for between 6 and 20 hours per day between October and May. Water levels will be higher in the downstream sections during the power generation cycle, and this will occur mostly during the daytime.

107. The other major Seti River flow rate change will occur over 10 days in June, when up to 1,000 m^3/s will be released from the dam to empty the reservoir at or immediately prior to the start of the monsoon (to purge sediments from the reservoir and allow maintenance. This release will increase the natural Seti River water level in the immediate downstream area by a maximum of 4.3 m. This water level rise is obviously much more significant than the water level fluctuation caused by the regular power generation cycle.

[8] The formal name of the river, after the confluence with the Madi River, is still the Seti River; however, to indicate the combined flows of the Madi and Seti, after that confluence, this document frequently refers to the "Seti-Madi" River.

108. In addition to these expected water level variations, there is the risk of dam failure (albeit extremely small). The maximum rise in the river water level, assuming that Tanahu dam were to disappear almost instantaneously, and stored water (the full supply level) flows down the Seti River (estimated at 47,500 m^3/s over 90 minutes) would be quite significant, reaching to 330 m above sea level, and inland as much as 500 meters (see Figure 7.9). In the first two cases of water level variation (routine daily and monthly variations, and the June reservoir emptying), these are predictable and will become standard practice over time. In the latter case (dam failure), some warning would be expected, based on observations of the condition of the dam. In any case, all water level variations can create a hazard for downstream river users, especially if there are rapid rises in river levels.

109. The human safety concern pertains mostly to river users. This includes people who may be working near or on the river, as well as those involved in rafting. The Seti-Madi River is used seasonally for commercial rafting from Damauli (3 km downstream of the dam site) to Gaighat at the Seti-Trisuli confluence; up to 200 persons/day. In addition, there is rafting further down the river system (away from the dam site). Figure 7.10 shows the "put-in" point for rafting operations near Damauli. Rafting is undertaken between 9 am and 5 pm each day from late September to May. The peak season runs from late September to the middle of December. During the monsoon (mid-June to late September) rafting is rarely undertaken, as high river flows make rafting conditions dangerous.

Figure 7.5. The Tanahu Hydropower Project; reservoir area, dam site, tailrace location.

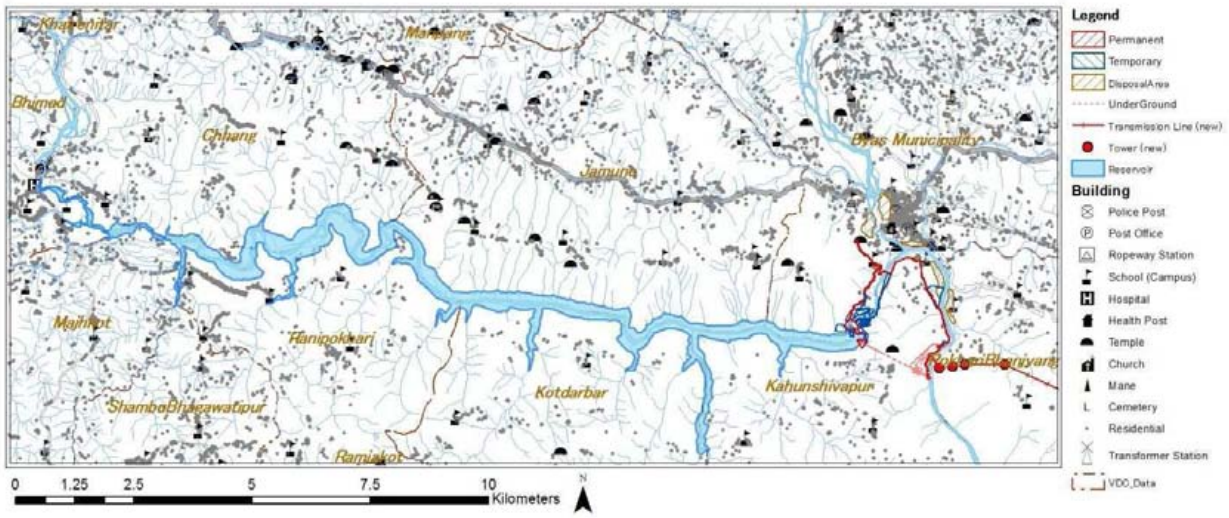


Figure 7.6. Dam and tailrace locations (areas of water release impact indicated).

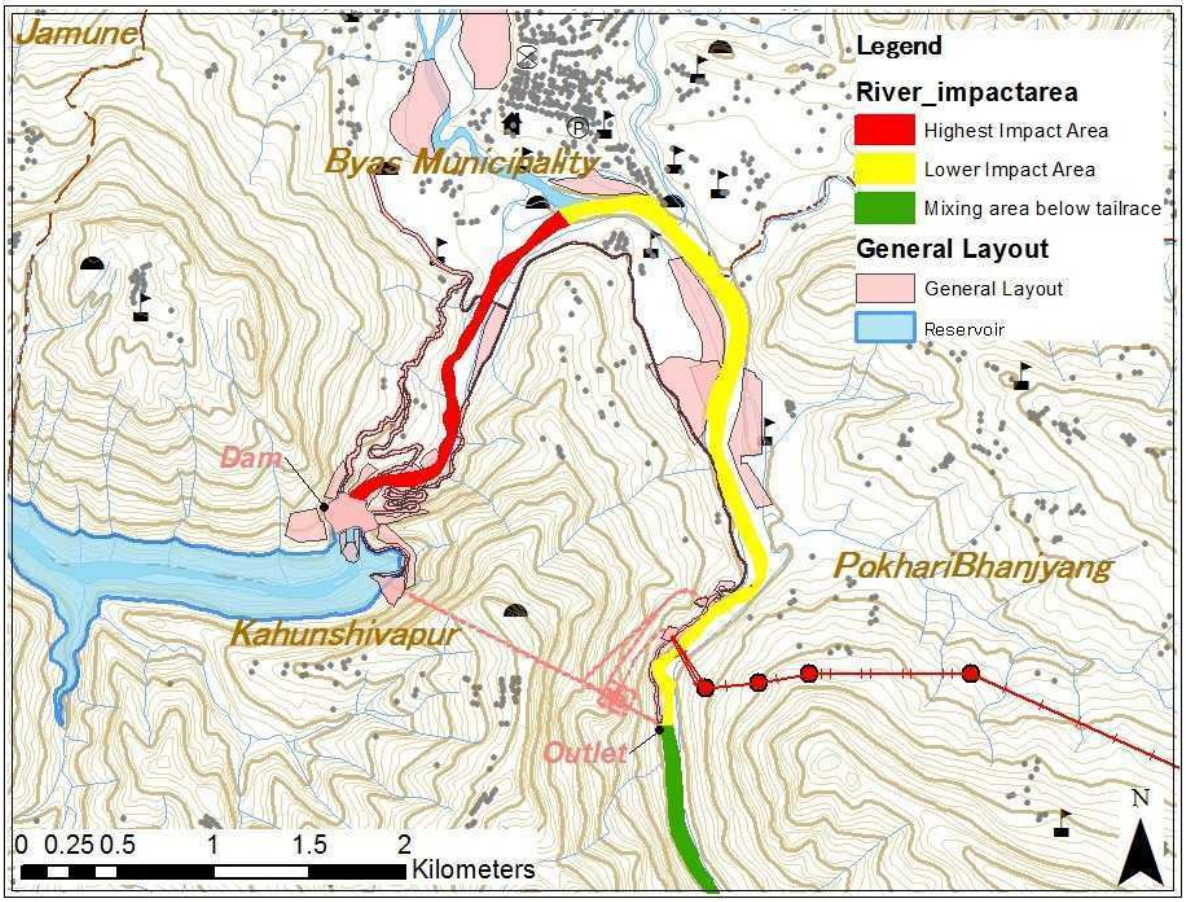


Figure 7.7. Downstream area of Seti-Madi River.

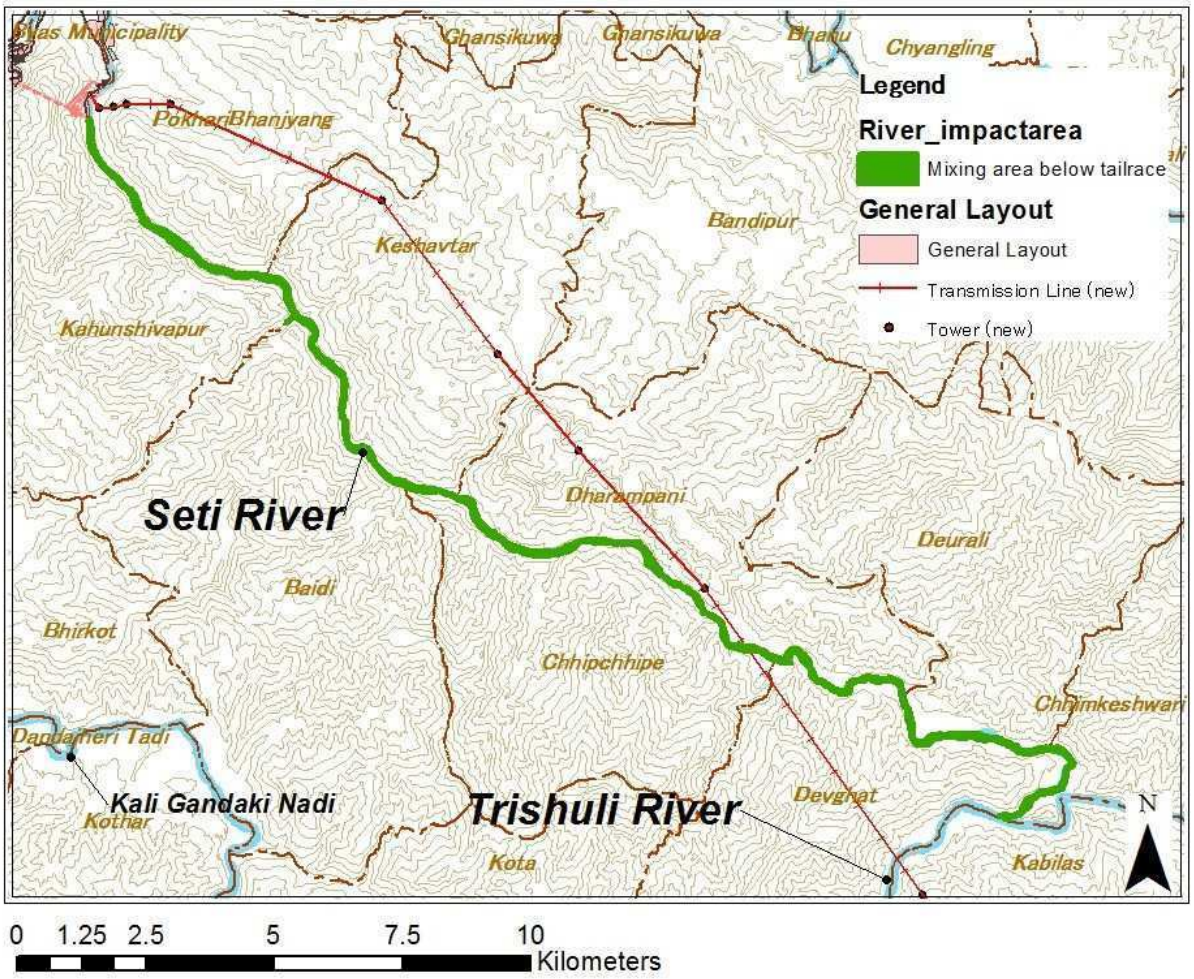


Table 7.3. Average Monthly Seti River Flow Rate: Existing and with Project Operation (in the first ten years; subsequent to that, annual flushing will be spread out over 40 days in June/July, which will affect the average operation flow rates in those months).

Month	Existing Flow Rate (m^3/s)			Project Operation Flow Rate (m^3/s)					
	Seti River	Madi River	Total	Spill Flow	Generation Release	Environmental Release	Total	While Generating	Not Generating
Jan	26.2	23.0	**49.2**	0	127.1	2.4	**129.5**	152.6	25.4
Feb	22.9	20.1	**43.0**	0	125.4	2.4	**127.8**	147.9	22.5
Mar	22.9	20.5	**43.4**	0	122.6	2.4	**125.0**	145.5	22.9
Apr	26.1	24.0	**50.1**	0	117.8	2.4	**120.2**	144.1	26.4
May	41.6	38.5	**80.1**	0	119.2	2.4	**121.6**	160.1	40.9
Jun	119.5	102.7	**222.2**	123.6	120.0	2.4	**246.0**	348.8	228.8
Jul	290.3	259.9	**550.2**	287.9	0	2.4	**290.3**	550.2	550.2
Aug	319.5	278.6	**598.1**	122.8	119.5	2.4	**244.7**	523.3	403.8
Sept	227.1	168.4	**395.5**	97.1	127.4	2.4	**226.9**	395.3	267.9
Oct	110.6	88.5	**199.1**	8.6	127.4	2.4	**138.4**	226.9	99.5
Nov	51.9	43.9	**95.8**	0	127.4	2.4	**129.8**	173.7	46.3
Dec	33.5	29.4	**62.9**	0	127.4	2.4	**129.8**	159.1	31.8

Figure 7.8. Water Level Fluctuation Immediately Downstream of the Tailrace Outlet

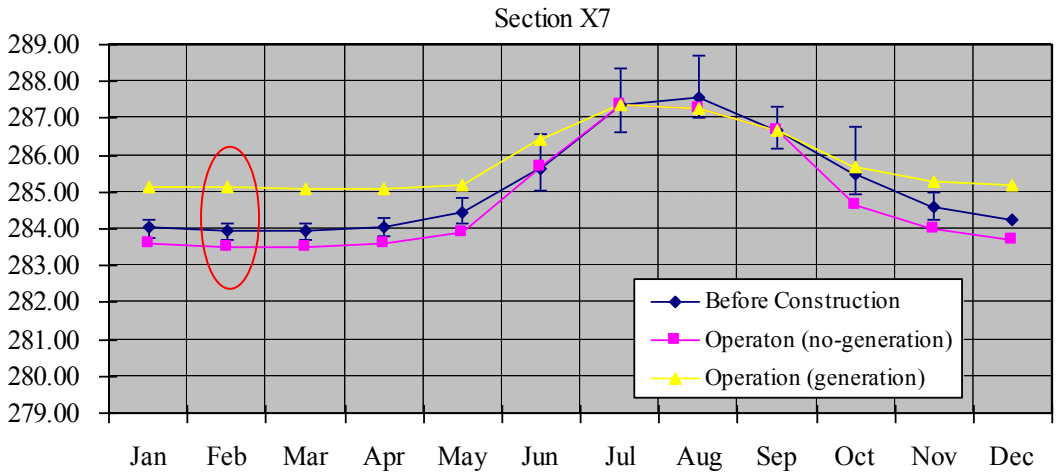


Figure 7.9. Potential flooded areas (at 330 m asl), in the event of a catastrophic dam failure.

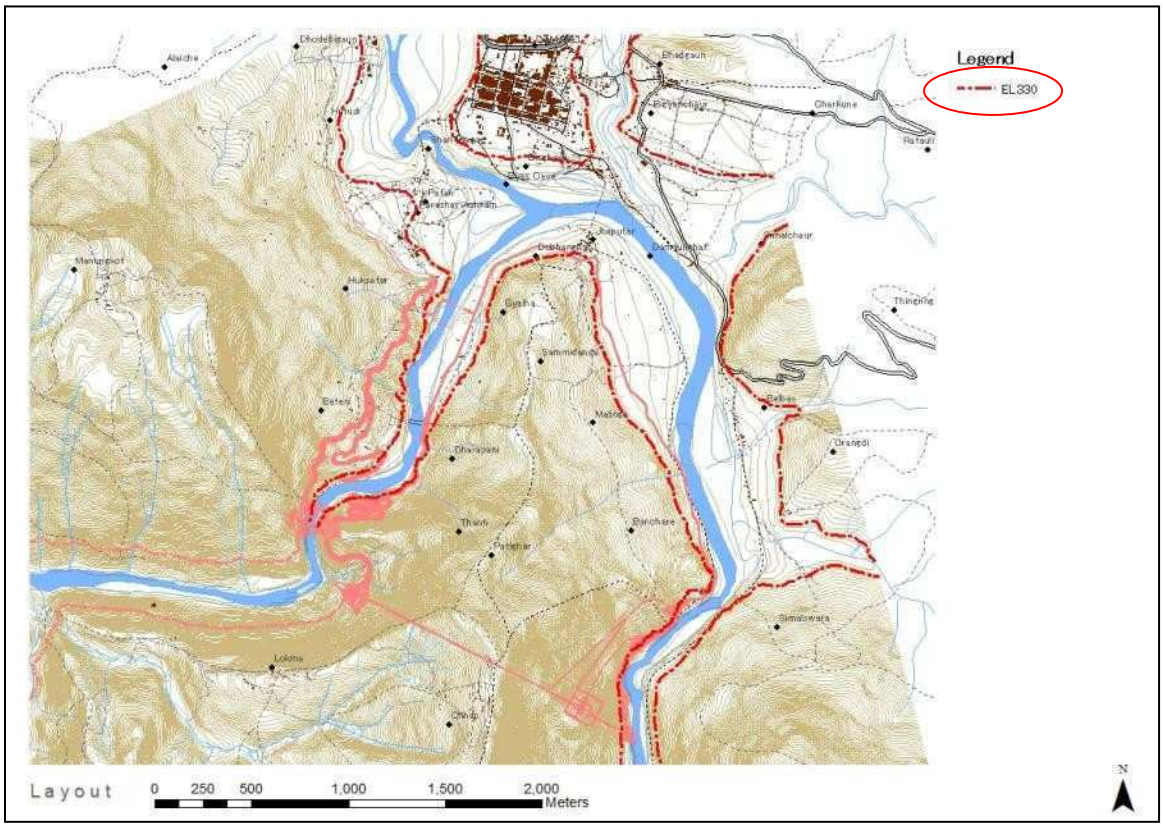
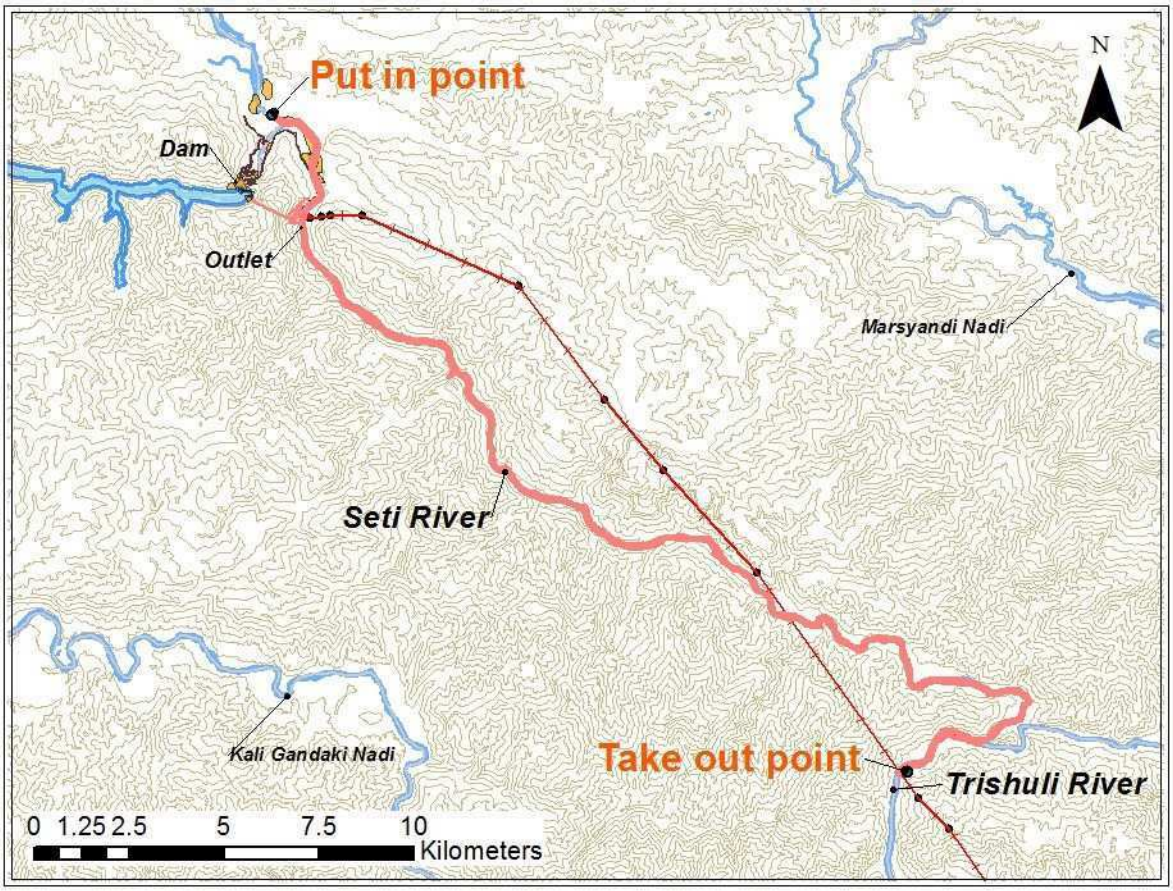


Figure 7.10. Location of rafting operations near the dam site.



110. The maximum daily flow variation will occur in January and February when the average flow rate will be 3.44 times the average monthly flow during the generation cycle which is 6 hours and reduced by around 50% during non-generation (18 hours), creating a substantial flow variation. The halving of the natural flow rate to as little as 22.5 m^3/s (the Madi flow plus the 2.4 m^3/s environmental release) will make this river less challenging, but this will have to be discussed in detail with rafting operators to determine the minimum flow necessary to operate. The morning release from 6-9 a.m. will provide a good flow for rafting, but the release is too early in the day to be used.

111. The greatest daily rise in the Seti River water level will be 1.66 m during peak generation in February, most likely between 6.00-6.30 am and 6.00-6.30 pm each day. Generation start-up will occur at a rate that creates an increase in downstream river depth of between 0.7-1.6 m over 30 minutes. As rafting is normally well downstream of the tailrace outlet by 4 pm and off the river by 5 pm each day, then generation in the late afternoon should not affect rafting (nevertheless, a warning system protocol will address the risk of stragglers still being on the river when water levels start to rise).

112. In addition to concerns about water level variations in the Seti-Madi River, there is also the issue of the quality of release water during the annual reservoir flushing. This is mostly a concern for aquatic habitats (for migrating fish, in particular), which is addressed in the Fish Conservation Management Plan, but nevertheless concerns are identified here, as they can be

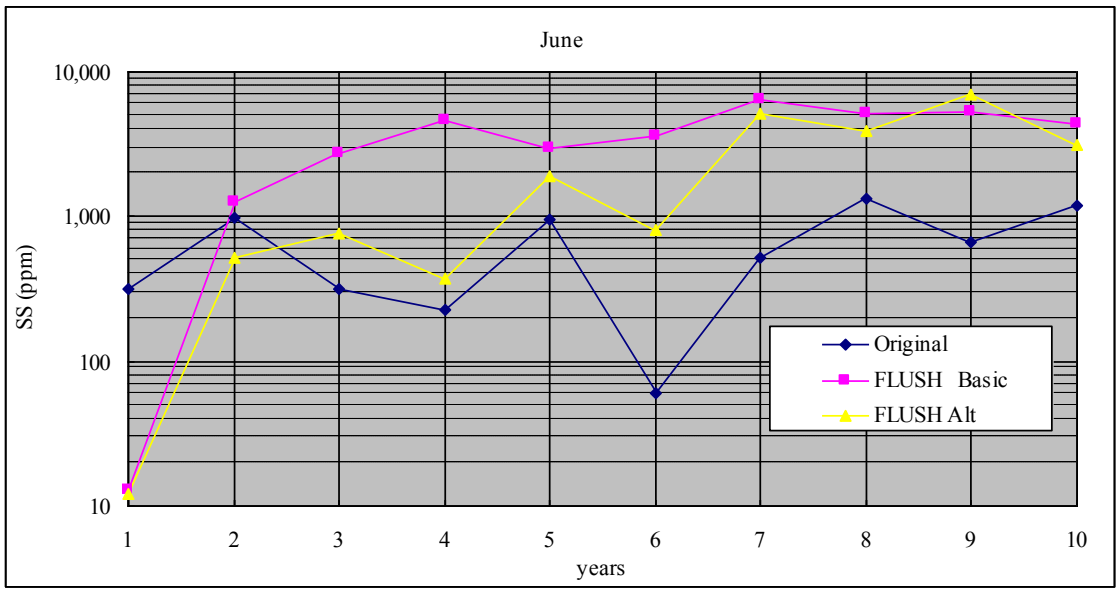
mitigated to some extent by managing water releases and engineering the areas immediately downstream from the water release points. The main changes expected in the quality of release water are due to the proposed annual emptying of the reservoir.

113. During the filling and storage of water in the reservoir, accumulated sediments and nutrients will build up in the reservoir, with a risk of low oxygen levels in deeper parts of the reservoir. In addition, during draining of the entire reservoir over 10 days in mid-to-late June, the released water will be cooler (possibly 4-7^{o}C) and will probably have lower dissolved oxygen levels than the natural Seti River flows expected in mid-June. The release water may also contain higher levels of phosphorus. These possible changes will occur in the context of current seasonal variability in the Seti River, in any case. For example, Seti River water quality is seasonally variable, ranging from highly turbid during the monsoon season (June-September), and relatively clear during the remainder of the year, apart from stormwater runoff that is usually turbid. Water temperature ranges from 15^{o}C in winter to a high of around 24-27^{o}C in the hot late dry season in May. The water is slightly alkaline, and biological oxygen demand and chemical oxygen demand values reflect relatively good water quality, with minimal organic and chemical inputs (which in turn reflects low population density in the watershed and lack of industrial activity).

114. The main result of emptying of the reservoir in June each year will be the possibly low levels of oxygen in the release water, which will then mix with more oxygenated water (from the Madi River, which will also be in monsoon flow), and the higher levels of suspended solids (from sediments that will have accumulated in the reservoir). Figure 7.11 shows the forecast concentrations of suspended solids in the release water in June (the average for the whole month, even though the pulse of release water will be only for ten days in the first ten years of operation of the dam). The suspended solids concentration might show an almost one order of magnitude increase in the immediate release area, but this material will remain suspended and will be widely distributed downstream until flow velocities are slow enough to allow the material to deposit[9]. This will occur at a time of year when the water is naturally turbid, due to high monsoon discharge rates.

[9]The exact locations of the various stages of sediment deposit, which depends on particle size and local velocities, are not known, and will vary with the overall discharge rates at any given time; this also depends on local bedforms which influence local velocities; some sediments will deposit and then be re-suspended during higher velocity events; monitoring will help determine sediment deposition rates and locations over time

Figure 7.11. Forecasted Suspended Solids Concentration (caused by flushing – June): monthly average over the initial 10 years.



115. To summarize, the main issues related to water releases from the Tanahu reservoir include:

- possible high suspended sediment load and low oxygen water released over 10-40 days during the annual reservoir flushing program, with the main impacts expected in the river section before the confluence with the Madi River, and then lesser impacts in river sections below that that are diluted with Madi River discharge;
- daily and monthly fluctuations in the water level in the Seti-Madi River, which could affect rafting operations and put people who are near the river at risk; in particular, a risk that the rafting season could be shortened somewhat, or rafting gear might be washed away in unexpected large discharge events; and,
- human safety issues associated with larger water releases and a rapid rise in water levels downstream from the dam (especially if these are unexpected, including the risk of a dam failure).

7.3.3 Objectives and Expected Outcomes of the Water Release and River Safety Management Plan

116. The main objective of the proposed Water Release and River Safety Management Plan is to establish a public awareness program and operational warning/notification system, ensuring the safety of all river users and adjacent residents, under all water release scenarios. The secondary objective is to optimize water quality, to the extent possible, in the release water during the annual reservoir flushing. This will be based on engineering applications, including a boulder field, for enhanced oxygenation of release water and ongoing suspension of sediments, in an 800-meter stretch of the Seti River immediately below the dam, until reaching the Madi River, where dilution can occur with the increased collective discharge of the two rivers.

117. The expected outcomes of the Water Release and River Safety Management Plan include:

- no loss of life, due to water level fluctuations associated with the Tanahu Hydropower Project, over its lifetime;
- no net loss in rafting business income over the life of the project;
- increased public understanding and acceptance of the operational aspects of the dam/reservoir (and also the benefits of the project); and,
- satisfactory water quality in the river system, downstream from the Seti-Madi confluence (the physical works will be covered by this Management Plan, but the downstream water quality monitoring, to verify its effectiveness, will be addressed by the Fish Habitat/Water Quality specialists within the Fish Conservation Management Plan).

7.3.4 Rationale for Proposed Approach

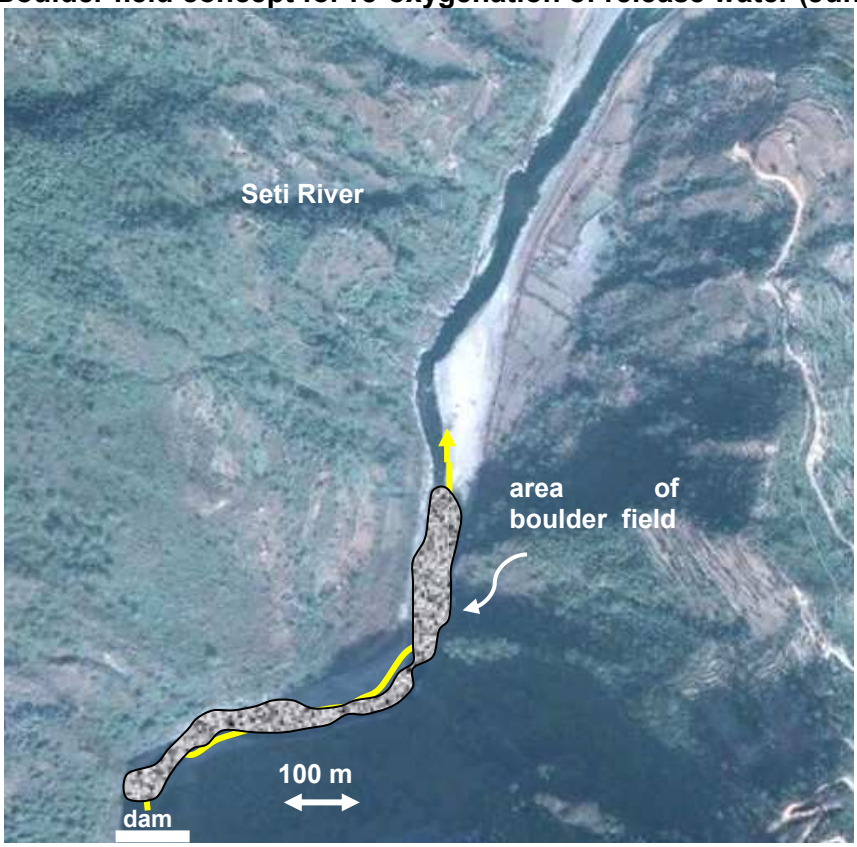
118. The main rationale for the proposed Water Release and River Safety Management Plan is simple: that a sound understanding of all possible water release scenarios (timing, frequency, river level changes, duration, impact areas), based on modeling that is subsequently verified with detailed field monitoring, can then inform an effective warning/notification system that is in place for all river users and residents within the zone of influence of the Tanahu Hydropower Project. Secondly, modifying the physical structure of the receiving riverbed below the dam can improve the water quality (specifically, increasing the rate of oxygenation of the release water and the suspension period of sediments). Proposed activities and methodologies are noted below.

7.3.5 Activities and Methodology

119. *Engineered outlet to improve water quality*: The proposal is to construct a boulder field in the 800-meter stretch of the Seti River below the dam (possibly using waste rock from the dam construction process), to create turbulent flow during the annual reservoir flushing, which will greatly increase the rate of re-oxygenation of possibly oxygen-depleted water from the reservoir[10], as well as maintaining sediments in suspension until the confluence with the Madi River, where the larger discharge will continue to maintain sediments in suspension. Figure 7.12 shows the concept. If the release water from the reservoir leaves the dam gates at sufficient velocity, there will be very turbulent flow and aeration of this release water. The possible positive impact of the boulder field can be modeled to determine the optimal size of boulders, the array, and density to create maximum turbulence for the expected discharge rate during reservoir emptying.

[10] Boulder fields at the outlet of relatively static waterbodies can greatly increase dissolved oxygen levels, by causing turbulent flow. National Coarse Fisheries Centre, England. 2012. De-oxygenation: practical self-help for fishery owners and managers.

Figure 7.12. Boulder field concept for re-oxygenation of release water (June discharge).



120. *Water level warning system*: Development and implementation of the proposed water level warning system will involve several steps, including:

- modeling and continuous monitoring of water releases under all conditions to allow ongoing adaptive management and fine-tuning of all water releases, especially the larger discharges during the annual reservoir flushing program;
- design and implementation of a public awareness program, to familiarize all river residents down to the confluence with the Trisuli River with the periodicity and scale of water releases (using brochures and radio programs);
- consultations with the river rafting industry to determine the scale of impact with rafting operations, and to determine scheduling of river activities to fit different water release scenarios; and,
- installation of signboards. community sirens, and light posts to forewarn of water level rises in the immediate impact area down to the confluence with the Trisuli.

121. These are described below.

122. *Modeling and continuous monitoring/adaptive management*: The behavior of the river system during the reservoir flushing period will continue to be modeled and re-adjusted, based on detailed monitoring of water levels during the first few years of operation of the dam/reservoir, and based on the continuous monitoring of the bed forms in terms of changes of the location, types and granular composition of gravel bars and bed materials. This will allow refinement of the water release rates to minimize any rapid changes in water level in downstream sections of the river. A safe water level rise rate (that people can realistically

adjust to) needs to be carefully determined (based on experience elsewhere, and also the physical reality of the hydraulics of emptying the Tanahu reservoir over a set period).

123. *Design and implementation of a public awareness program*: This activity will be initiated with a survey of all river residents and river users along the stretch from the Seti-Madi confluence to the confluence with the Trisuli, including clarification of riparian systems and agricultural uses along the river, to identify potentially vulnerable locations. This will also include a detailed survey of the residents of Damauli township, who would be the first impacted people in the event of a dam failure. The project will also survey rafting operators on the Seti River at Damauli from post-monsoon 2012- 2013 (late September-early October) to early June 2013-2014. Once the project generating hours are finalized, discussions will be held with the surveyed operators and NARA to clearly explain the likely daily and seasonal river flow volumes created by the project, identify when rafting cannot be undertaken due to project-altered river flows, and to develop mitigation measures and activity schedules that suit both the Tanahu Hydropower Project and the rafting industry, and perhaps take advantage of some increased flows during normal "shoulder" seasons. In any case, a mechanism for keeping rafting operators fully informed of daily water release schedules will be defined and implemented (rafting operators will also be in the vicinity of the siren system, as a back-up; see below). The option of establishing a rescue team for unexpected situations in which people may be trapped or isolated by rising waters will be considered.

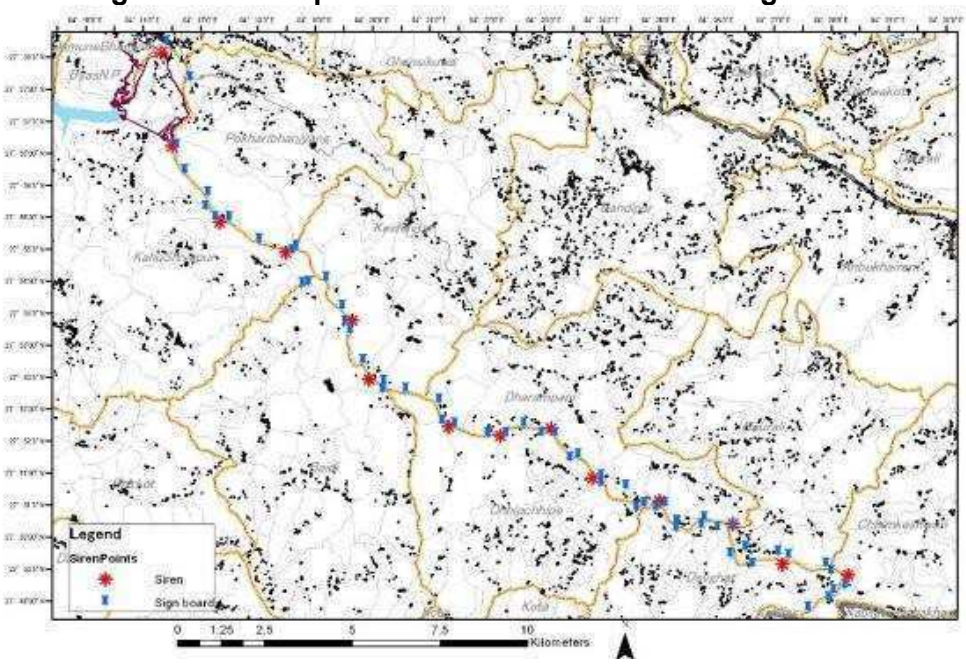
124. Once all the target communities between the dam and the Trisuli confluence are identified, the public awareness program can be initiated. This will involve development of a radio program, public meetings, as well as distribution of brochures, which will explain the operation of the dam, the use of signs, sirens, light posts. and the radio to warn of expected water level increases, identification of high risk areas along the river, and the contingency measures to be taken in the event of rapid water level increases.

125. *Installation of the warning system*: The warning system will include strategically located water gauge plates, to warn of unexpected water level increases, as well as signboards, sirens, and light posts. Figure 7.13 shows the proposed locations of the signboards and sirens along the river stretch from the dam to the confluence with the Trisuli. Regarding the risk of dam failure, if damage is identified that may lead to a dam failure, THL shall lower the reservoir water level after notifying downstream communities of an increase in the river water level, and shall issue an evacuation advisory to riverine communities. People living close to the river near Damauli township will be able to take safe refuge on land above 330 m asl in the event of catastrophic dam failure. An Emergency Response Plan shall be prepared by THL during project pre-construction that incorporates an evacuation plan in the event of dam failure (see below). The signboards will provide information of the frequency and scale of water level increases, as well as measures to be taken during highwater events (more specifically: daily water fluctuations (peaking and non-peaking operation periods) and potential river safety impacts; reservoir flushing and water discharge potentials and related potential river safety impacts; impacts of water fluctuations and reservoir flushing on aquatic ecology and dependent fisher communities; potential impacts of reservoir flushing on sedimentation and downstream water quality; potential impacts on the white water rafting operation; dam safety issues and potential downstream impacts). The sirens will be used to provide warning well in advance of river water level increases.

126. The signs will be installed at 55 locations between the dam site and the Trisuli River (see Figure 7.13). The siren system will be installed in each of 14 villages. Each siren will have mains power supply, as well as a battery and inverter in a secure fenced area. Sirens will be

sounded 30 minutes, 15 minutes and 5 minutes prior to the release of water from the dam and tailrace outlet. The sounding of sirens will be restricted to the daily hours of 6 am to 10 pm for generation flows, to avoid disrupting people at night, but flood flows will be sounded at any time of the day, given the potentially far greater and more sudden increase in downstream river flows and the related increased safety hazard of these events. Given that the timing of spill flows over the spillway is unknown, sirens will be sounded immediately prior to the spill or once it commences. In addition to the establishment of sirens at various locations, light posts will also be installed. The bulbs fitted on top of the light post will emit different colors of light, indicating different states of risk that one is exposed within the area along the bank at a given time of operation of the dam. The hazardous area on both sides of the banks will be delineated in the field, especially in the area where people are likely to come closer to the river for various activities, using sign boards and colored paints to warn them and facilitate them to keep out of the area, depending on the warning issued from sirens and/or the light posts.

Figure 7.13. Proposed locations of sirens and signboards.



127. During construction, the Seti River will be temporarily diverted around the dam site via an upstream coffer dam and two 6.6 m diameter diversion tunnels designed with a total capacity of 996.6 m^3/s. In the unlikely event that the coffer dam has the potential to breach due to a high flood flow prior to the base of the dam wall being constructed (Year 1), a warning of a possible flood between the dam and tailrace outlet will be broadcast on local radio, when the hazard is identified and project staff will notify nearby villages of this hazard. A similar broadcast will also be made during project operation each time a release is likely.

128. As noted above, the main area at risk in the event of a catastrophic dam failure is the town of Damauli, at the confluence of the Madi and Seti Rivers. All areas below 330 meters asl will potentially be at risk. An emergency evacuation plan will therefore be designed, communicated, and tested before the dam is operational. This plan will include a detailed map of “safe havens” (areas above 330 meters asl that are quickly accessible and that can accommodate the whole population of Damauli and adjacent communities on short notice). The shortest practical evacuation routes that can address all inhabited areas will be defined, and

these will be indicated on the map. A communication protocol and chain-of-command (within the municipal authorities) will then be defined, in which specific parts of Damauli have wardens identified, who would then ensure that all people in their specific areas are informed of a pending flood and starting to evacuate along the designated routes. This emergency evacuation plan would be activated upon a warning from the dam operators, as described previously. The emergency evacuation plan would be explained to all residents in the flood-prone areas, and would be tested on an annual basis. Details on the evacuation plan, warning signals, defined evacuation routes, and the expected duration of a flood event would be posted in various public places throughout Damauli.

7.3.6 Implementation Arrangements

129. Tanahu Hydropower Limited (THL) will be the Executing Agency for the Tanahu Hydropower Project and will also be responsible for all aspects of the Water Release and River Safety Management Plan, since all elements of the Plan are integral to daily operation and management of the reservoir and dam. Limited consultant support (disaster risk management consultant, hydrological engineer, and a communication specialist) will be needed for technical inputs to the design of the boulder field, the public awareness program, and the water level warning system, which will then be implemented by THL.

130. It is expected that the management plan will require 27 person-months (3 International and 24 National) during pre-construction and construction and 4 person-months (National) during the first two years of operation. The consultants will be engaged according to ADB Guidelines on the Use of Consultants. The equipment will be procured according to ADB's Procurement Guidelines. The study is expected to be implemented over 10 years, from 2013 to 2022. The disbursements will be made according to ADB's *Technical Assistance Disbursement Handbook.*[11] Consultant needs are listed below.

7.3.7 Terms of Reference for Consultants

131. The following consultants will be required to assist with design and testing of the Water Release and River Safety Management Plan:

- Disaster Risk Management Consultant (International and National, to work with THL counterparts): responsible for designing and testing all aspects of the water level warning system;
- Hydrological Engineer (International and National): responsible for designing the boulder field below the dam, and coordinating with the Fish Conservation Management Plan specialists on the subsequent monitoring of its effectiveness, as well as monitoring the river bed forms to determine changes during dam operation ; and,
- Communication Specialist (National): responsible for designing and testing the public awareness program.

132. The Disaster Risk Management Consultants will be responsible for the following tasks:

- Assessing the critical/vulnerable points along the river system where water level rises will create the greatest hazards for river residents and river users, and assisting THL to delineate in the field the hazardous areas, using paint and sign boards;

[11] ADB. 2008. *Technical Assistance Disbursement Handbook*, Manila.

- Assessing the technical aspects of water gauge plates and sirens (based on experiences elsewhere), and light posts, and selecting the most appropriate equipment;
- Determining the specific locations for installation of the plates, sirens, and light posts;
- Overseeing the procurement, installation, and testing of all equipment; and,
- Collaboration with the Communication Specialist regarding technical content for the public awareness program, including defining an evacuation plan in the event of a dam failure or other significant water release from the reservoir.

133. The Hydrological Engineers will be responsible for the following tasks:

- Assessing the daily water release rates during reservoir flushing and calculating required rugosity of the boulder field in the Seti River downstream from the dam, to achieve required oxygenation rates, and collaborating with THL to survey the present bed forms and morphological composition of bed materials in the river system;
- Designing the specific array of boulders in the proposed 800-meter stretch below the dam;
- Supervising the installation of the boulders; and,
- Collaborating with THL to conduct periodic surveys of the bed forms and morphological composition of bed materials inthe river system, preferably after the flushing operation of the dam, and to analyze the data to identify the changes that may have occurred.

134. The Communication Specialist will be responsible for the following tasks:

- Undertaking a survey of all river users and river residents between the dam and the confluence with the Trisuli River;
- Collaborating with THL and the Disaster Risk Management Consultant on the content for the signboards, the radio programs, and the brochures, as well as the design of the public meetings, and disseminating the meaning of the content of the sign boards, the signs marked in the field and the color of light being emitted by the light post and the action to be taken by individuals under different risk environments;
- Assisting with the design of an evacuation system in the event of dam failure (working with the Disaster Risk Management Consultant)
- Supervising the preparation and dissemination of materials; and,
- Supervising the installation of the signboards and the light posts.

7.3.8 Schedule

135. The consultancy services to support the Water Release and River Safety Management Plan are expected to start in the second half of 2013. The schedule for each of the activities in the Plan is shown below.

Activities	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Pre-constn		Construction						Operation	
Engineered outlet to improve water quality										
Design.										
Construction.										
Monitoring.										
Water level warning system										
Modeling and continuous monitoring/adaptive management.										
Design and implementation of a public awareness program.										

Activities	2013		2014		2015	2016	2017	2018	2019	2020	2021	2022
		Pre-constn			Construction						Operation	
Design, installation, and operation of the warning system.												

7.4 Proposed Wildlife Conservation and Awareness Management Plan

7.4.1 Introduction

136. The Tanahu Hydropower Project will result in loss of some riverine and forest habitat in the area that will be flooded by the reservoir, as well as the project facilities area and the camps. Several faunal studies have been undertaken to determine the habitat use and vulnerabilities of animals which may be exposed to the permanent change in habitats, as well as experiencing possible obstructions of movement, caused by the reservoir. These surveys focused on the wildlife which have a conservation concern in Nepal, including the Royal Bengal tiger (*Panthera tigris),* the clouded leopard *(Neofelis nebulosa),* the Himalayan black bear *(Ursus thibetanus),* sloth bear *(Melursus ursinus),* common leopard *(Panthera pardus),* common otter *(Lutra lutra),* Assamese monkey *(Macaca assamensis),* and striped hyena *(Hyaena hyaena)*. There is less concern about temporary construction effects, which will be managed by covenants in contracts that dictate construction best practices and restrictions on construction workers. There is also less concern about birds, reptiles, and amphibians, all of which have much smaller habitat size requirements and more scope and flexibility for compensatory movements (they are, therefore, not the focus of initiatives within this plan).

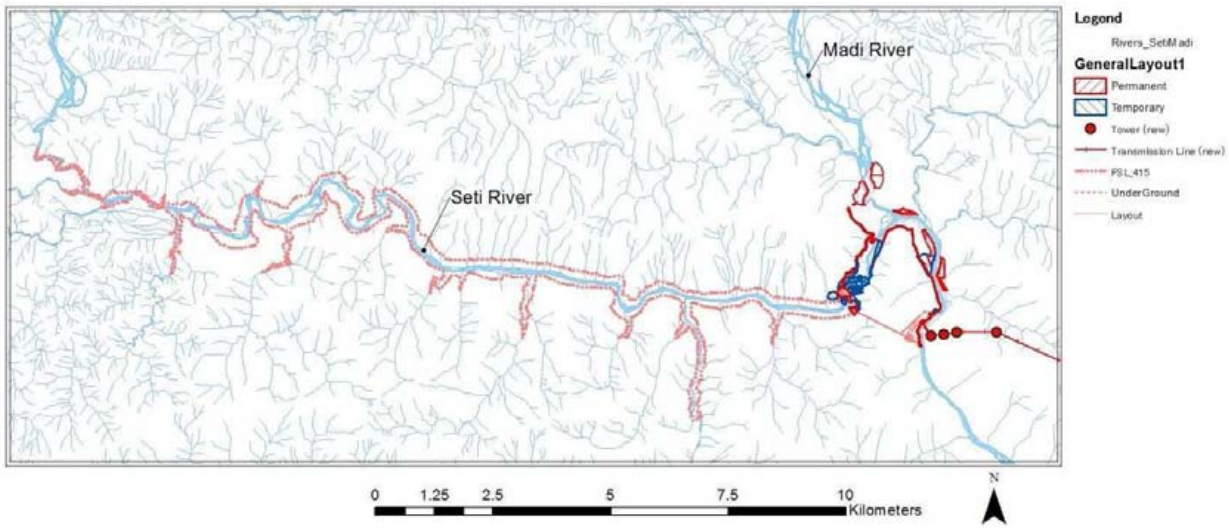
137. The purpose of the proposed Wildlife Conservation and Awareness Management plan is to increase the understanding of vulnerable wildlife in the reservoir area, project facilities area, and the camp sites, and to use the increased knowledge of vulnerable wildlife to develop and implement wildlife conservation measures which will reduce the potential negative effects of the Tanahu Hydropower Project. The plan includes description of the specific issues, the proposed objectives and outcomes of the wildlife conservation and awareness management plan, the approach and methodology, implementation arrangements, and schedule.

7.4.2 Context, Project Design and Activities, and Potential Issues Regarding Wildlife

138. Figure 7.14 shows the basic features of the Tanahu hydropower project, including the reservoir area, dam, and tailrace. The flooding of the reservoir will result in the loss of about 513 hectares of forest, shrub, and grassland habitat (as well as some cultivated area, and parts of the Seti River).

139. The concern is to understand to what extent the loss of habitat will affect vulnerable wildlife and then implementing suitable measures that will mitigate the vulnerability of important wildlife species. Initial wildlife survey data for the Tanahu project area are somewhat inconclusive, which is common to wildlife surveys in general (larger mammals are difficult to spot or find evidence of habitat use). Nevertheless, current observations are summarized below.

Figure 7.14. The Tanahu Hydropower Project; reservoir area, dam site, tailrace location.



140. Table 7.4 shows the observations and information for endangered, vulnerable, and near-threatened wildlife species in Nepal. The recent survey suggested the presence of at least five mammalian species in the project impact area based on habitat condition and level of human activity; however, only the Assamese monkey was actually observed. The anecdotal information for the other species in the table is questionable and possibly not reliable. For example, although the tiger was mentioned in the 2009 EIA as being present in the project area, most local residents now claim that that is not true, and it appears that the very specific habitat needs of some of the other species noted in Table 7.4 are not sufficiently present and contiguous to support these larger mammals. Furthermore, based on independent references, it seems that the tiger is not present in the area[12]. Figure 7.15 shows the tiger habitat in Nepal, indicating that the dam and reservoir lie approximately 28 km north of the nearest "*core area*" and at least 16 km north of the nearest identified "*tiger habitat corridor*"[13]. If tigers are present, they are not very prevalent at all, since no one sees them, nor is there loss of farm animals to tiger kills. Clearly, the main tiger habitat is to the south. Nevertheless, the Wildlife Conservation and Awareness Management Plan will confirm these details and adjust the project mitigation actions accordingly.

Table 7.4. Information on endangered, vulnerable, and near-threatened mammal species.

Common Name	Scientific Name	Local Name	EIA 2009	Addendum		Doubtful Presence	Conservation Status		
				Interview 2011	Survey 2011		CITES Annex	IUCN	GON
Royal Bengal tiger	*Pantheratigris*	Bagh	✓	✓		Yes	I	EN	P
Clouded leopard	*Neofelisnebulosa*	DhwanseChituwa	✓	✓			I	VU	P
Himalayan black bear	*Ursusthibetanus*	Kalobhalu	✓	✓			I	VU	
Sloth bear	*Melursusursinus*	KatheBhalu	✓	✓			I	VU	
Common leopard	*Pantherapardus*	Chituwa	✓	✓			I	NT	

[12]WWF Tigers Alive Landscape; Action Plan for Tx2, Draft Report, Terai Arc Landscape, 2012.

[13]Note: a "*core area*" is located in a protected area where tigers are known to occur, while "*tiger habitat corridor*" refers to a habitat link between core areas.

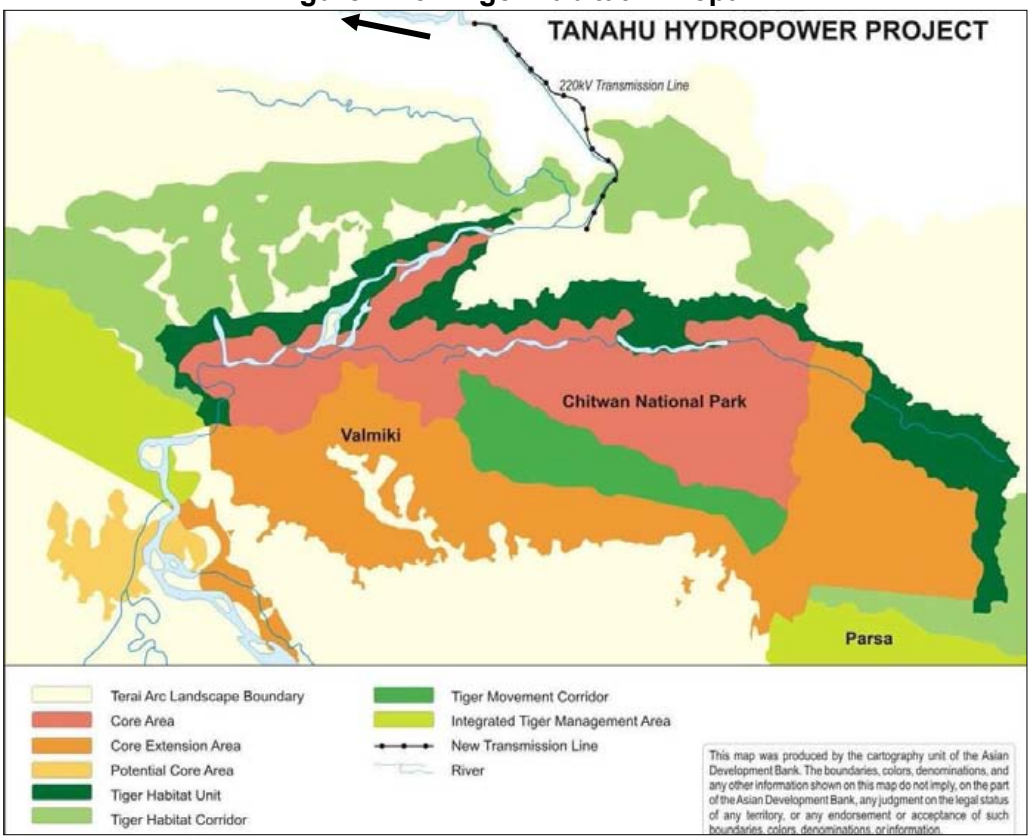
Common otter	*Lutra lutra*	Ontt	✓	✓		Yes	I	NT	
Assamese monkey	*Macacaassamensis*	Asami Bandar	✓	✓	✓		-	NT	P
Striped hyena	*Hyaenahyaena*	Hyaena / Bagh		✓		Yes		NT	

EN – endangered; VU – vulnerable; NT – near-threatened (IUCN).

141. All project sites are located outside nationally and locally designated protected areas. The nearest protected areas lie 30 km to the north of the reservoir area (Annapurna Conservation Area); see Figure 7.16. Although apparently not located in critical habitat for the eight classified mammal species shown in Table 7.4, the lingering concern is that the reservoir will widen the existing barrier to animal movement (whatever is there) that is currently created by the Seti River.

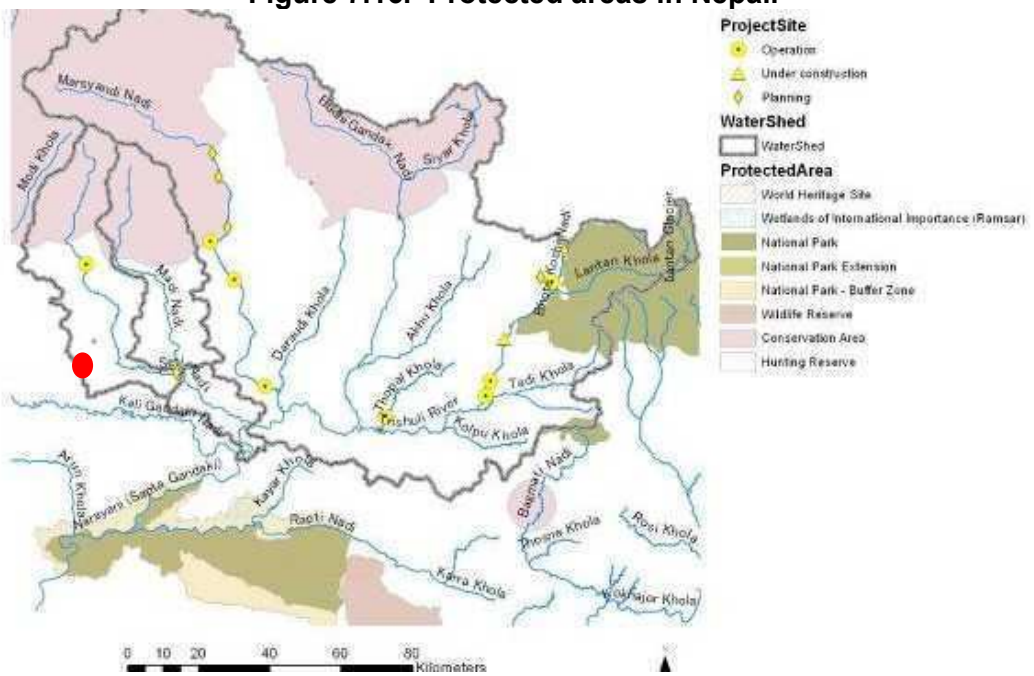
142. Given the lingering uncertainty about which near-threatened, vulnerable, and endangered species may actually occur in the reservoir area, a Wildlife Conservation and Awareness Management Plan is proposed to reduce the uncertainty and mitigate any potential effects of the project on important wildlife; this will especially provide certainty about the relative importance of the project area for tigers. Attention will also be given, during the initial surveys, to clarification of habitats that may be important for birds, bats, and butterflies, which were not addressed comprehensively in earlier surveys.

Figure 7.15. Tiger habitat in Nepal.



Note: Chitwan National Park is the bright red area on the northern side of the Nepal-India border.

Figure 7.16. Protected areas in Nepal.



7.4.3 Objectives and Expected Outcomes of the Wildlife Conservation and Awareness Management Plan

143. The main objective of the proposed Wildlife Conservation and Awareness Management Plan is to minimize the impact of habitat loss on important wildlife. A secondary objective to better understand the status of important wildlife in the project area, and to promote their conservation, through increased public awareness of their status and vulnerabilities. The plan will therefore involve further surveys in the project area, public education regarding wildlife in the area, and definition and implementation of measures that will allow important wildlife to continue to access and use habitats in the project area.

144. The expected outcomes of the Wildlife Conservation and Awareness Management Plan (addressing wildlife habitat issues in both the reservoir and dam areas) include:

- To the extent possible, integrity of wildlife habitats and removal of barriers to movement of important wildlife species; for example, animal movement (usually night-time) facilitated with "animal-appropriate" suspension bridges in critical habitat access areas; these might also facilitate daytime local resident movements across the reservoir;
- Increased understanding, amongst local residents and construction workers, regarding wildlife populations and habitat dependencies in the project area, such that human activities can be adjusted to not interfere with critical periods and locations (for example, not disturbing breeding/rearing areas/dens, etc.);
- Smaller mammals, amphibians, and reptiles encountered during land clearing and construction will be handled and moved according to a standard animal encounter protocol (catch-and-release), to minimize animal mortalities (a Standing Contract will be established with local experts, who will be called to address each situation, as needed); and,
- Increased awareness amongst the local population regarding the importance of protection of wildlife species, leading to less illegal hunting and trapping.

7.4.4 Rationale for Proposed Approach

145. As noted previously, there is still uncertainty regarding the status of near-threatened, vulnerable, and endangered wildlife species in the project area. The plan therefore involves a precautionary principle of increasing the understanding of wildlife populations and habitats in the project area, designing mitigation measures that will reduce impacts on vulnerable animals, and increasing public awareness to ensure compliance with wildlife protection guidelines. As noted previously, the primary focus is on the larger vulnerable mammal species, especially the Royal Bengal tiger, which is the focus of concern, being endangered. Insects, birds, amphibians, and reptiles are not believed to face serious habitat discontinuities, and they will therefore not receive the attention of specific initiatives, except to be dealt with on an "as-encountered" basis (a protocol will be developed for animal encounters during land clearing and construction). The geographical focus will be the reservoir area. Proposed activities and methodologies are noted below.

7.4.5 Activities and Methodology

146. *Wildlife Survey*: A local survey contractor will conduct wildlife surveys around the project site (reservoir area, project facilities area, and worker camp sites), during the wet and dry seasons, to help collect information on populations and habitat use for detailed mitigation planning and impact monitoring. The survey will involve the use of sensor cameras in the possible habitat/corridor areas used by important mammals. The sensor camera has an automatic shooting system triggered by a motion sensor and a heat sensor. It is proposed to use about 30 cameras in the dense forest around the reservoir site. Camera setting points, height, and direction will be carefully selected, based on large mammal surveys in other areas. The location will be recorded by GPS. The actual work includes setting the cameras, exchanging memory cards and batteries, and analysis of photographs. It is expected that the survey will be conducted once in the first three years (in dry and wet season) and then routinely during construction and operation. The photographic results will then be interpreted with regard to location, habitat type, and proximity to human habitations. Satellite photographs will also be used to classify habitat types, and secondary data from the Ministry of Forests, IUCN, and WWF will also be examined. The survey will need to be repeated again, during the construction period (in 2019) and then about one year after the hydropower project has been in operation (in 2022), to determine the effectiveness of the wildlife mitigation measures, and to solidify the understanding of wildlife habitat use in the project area. If the camera surveys indicate the presence of Royal Bengal tigers in the project area, then a special intervention will be required, which might involve trapping the tiger(s) and moving them to the tiger habitat in Chitwan National Park (advice will be taken from tiger experts, as needed).

147. *Design of Habitat and Species-Specific Mitigation Measures*: The results of the wildlife survey will be used to identify high-frequency wildlife areas that may be affected by the flooding of the reservoir. The intention will be to ensure habitat access, where there is a risk of habitat segmentation. The concept that is mentioned, for the Seti reservoir, is suspension bridges that can span the reservoir and not intimidate larger animals. Technical specifications will require very detailed assessment of experiences in other locations.

The locations of wildlife suspension bridges are listed below:

Existing Bridge			*Proposed Bridge*	
Name of Bridge	*Location VDC*	*Affected Bridge Length (m)*	*Length and Type*	*Location*
Bajogara to Bhagar (Bhagar Bridge)	Kahun Shivapur/Jamune (4 KM upstream from Dam Site)	135	Multi Span suspension bridge having length not less than 250 m.	200 m downstream (D/S) from the Bhagar Bridge
Bajogara to Chule (Chulesi Bridge)	Kotdurbar/Jamune (6 KM upstream from Dam Site)	125	Single Span suspension bridge having length not less than 160 m.	300 m upstream (U/S) from the Chulesi Bridge
Belkot to Machang Bhagar (Tunibote Bridge)	Kotdurbar/Jamune (10 KM upstream from Dam Site)	135	Multi Span suspension bridge having length not less than 260 m.	100 m U/S from the TuniboteBridge
Tutuwa to Belkot (Tutuwa Bridge)	Reesing Ranipokhari/Jamune (12 KM upstream from Dam Site)	110	Single Span suspension bridge having length not less than 160 m.	400 m U/S from the Tutuwa Bridge
Geruwatar to Kundale (Kundale Bridge)	Reesing Ranipokhari/Chhang (16 KM upstream from Dam Site)	110	Double span suspension bridge having length not less than 450 m.	300 m D/S from the Kundale Bridge
Reesing Patan to	Reesing	125	Single Span suspension	500 m U/S from the

Existing Bridge			*Proposed Bridge*	
Name of Bridge	*Location VDC*	*Affected Bridge Length (m)*	*Length and Type*	*Location*
Jhakas (Jhakas Bridge)	Ranipokhari/Chhang (20 KM upstream from Dam Site)		bridge having length not less than 300 m.	Jhakas Bridge
Kahun Shivapur/Kotdurbar (Additional Suspension Bridge in Limang Stream)			Single Span suspension bridge having length not less than 100 m.	1 KM U/S towards Limang stream from the confluence of Limang and Seti river.

148. *Coordination with the Forest Management Plan*: The Technical Assistance is also supporting a Forest Management Plan, to compensate for the trees that will be lost due to flooding of the reservoir. As that plan develops, it will be important to identify critical wildlife habitats and access areas that can be enhanced by planting of appropriate species. If degraded or fragmented habitats/corridors are found or created, then upgrading the vegetation through the Forest Management Plan can be very beneficial.

149. *Animal Encounter Protocol*: The construction contracts will specify the protocol for encountering and handling any animals that are encountered during land clearing and construction (within reason). Rather than ignoring or killing amphibians, birds and reptiles that are encountered during daily activities, workers will be encouraged to collect and deposit animals that are encountered (and can be captured and moved) in an appropriate area that will not be disturbed by future construction activity.

150. *Public awareness-raising and conservation education*: It is proposed to educate the workers and people living around the reservoir with regard to the importance of habitat management (trees and watersheds) and conservation of vulnerable animals (no illegal hunting and trapping). This will include awareness of the wildlife surveys and the need to leave the cameras undisturbed. The public awareness-raising will also include information on any habitat and access mitigation measures (such as wildlife suspension bridges), and the need to protect these. Public awareness-raising will be undertaken with brochures and public meetings.

7.4.6 Implementation Arrangements

151. Tanahu Hydropower Limited (THL) will be the Executing Agency for the Tanahu Hydropower Project and will build the required mitigation measures, as well as being responsible for management of construction workers. Consultant support will be needed to implement the wildlife surveys, undertake the public-awareness-raising, and design the wildlife mitigation measures, which will then be implemented by THL. Ministry of Forests will be engaged with several aspects of the wildlife activities (habitat identification and management).

152. It is expected that the management plan will require 32 person-months (4 International and 28 National) during pre-construction and construction and 3 person-months (National) during the first two years of operation. The consultants will be engaged according to ADB Guidelines on the Use of Consultants. The equipment will be procured according to ADB's Procurement Guidelines. The study is expected to be implemented over 10 years, from 2013 to

2022. The disbursements will be made according to ADB's *Technical Assistance Disbursement Handbook.*[14] Consultant needs are listed below.

7.4.7 Terms of Reference for Consultants

153. The following consultants will be required to assist with design and implementation of the Wildlife Conservation and Awareness Management Plan:

- Wildlife Management Specialists(International and National): responsible for undertaking the wildlife survey, identifying critical habitats and access points, designing the wildlife mitigation measures and animal encounter protocols, creating content for the public awareness-raising and delivering the sessions, repeating the survey to determine effectiveness of the mitigation measures, and coordination with the Forest Management Plan consultants.

154. Specifically, the Wildlife Management Specialists will be responsible for the following tasks:

- Review of the results of the previous surveys in the region, and all secondary data and satellite images;
- Design of the wildlife survey;
- Implementation of the wildlife survey, in the wet season and dry season (to be repeated at least once more after the dam/reservoir has been in operation for at least a year); weekly camera patrols;
- Identification of critical wildlife habitats and corridors in the reservoir area;
- Design of habitat access and wildlife movement mechanisms to ensure integrity of wildlife populations (important mammal species) in the project area (and monitoring through the second survey noted above);
- Definition of animal encounter protocols for construction workers (a Standing Contract will then be established with a local wildlife handling consultant, who will respond to all calls regarding animal encounters, including capture and transfer of animals to other suitable locations);
- Design and delivery of public awareness-raising and education programs related to wildlife conservation (including dissemination of the wildlife survey results and discussion of the interactions between the hydropower project and important wildlife; discussion of innovations in wildlife mitigation measures, collection of local anecdotal information on wildlife; discussion of concerns about illegal hunting and trapping, etc.); and,
- Coordination with the Forest Management Plan consultants regarding wildlife habitat needs (vegetation) at habitat access points.

7.4.8 Schedule

155. The consultancy services to support the Wildlife Conservation and Awareness Management Plan are expected to start in the second half of 2013. The schedule for each of the activities in the Plan is shown below.

Activities	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022

[14] ADB. 2008. *Technical Assistance Disbursement Handbook*, Manila.

		Pre-constn			Construction						Operation	
Wildlife Survey												
Design.												
Implementation.												
Design of Habitat and Species-Specific Mitigation Measures												
Design.												
Construction.												
Monitoring.												
Coordination with the Forest Management Plan												
Animal Encounter Protocol												
Public awareness-raising and conservation education												

7.5 Proposed Watershed/Forest Management Plan

7.5.1 Introduction

156. The Tanahu Hydropower Project will result in the loss of some forest habitat in the area that will be flooded by the reservoir, in the dam area and along access roads. Trees will obviously have to be cut down and scrub vegetation cleared, so that the construction of the project can proceed unencumbered. This is standard practice for hydropower projects and, as a result, there are relatively standard approaches to compensate for the loss of trees. These include regulatory approaches (discussed below) and what can be considered best practice in watershed/forest management related to hydropower projects (see Section 7.5.5). The overall objective is to replace the trees lost to the project and to enhance watershed functions, which include all the benefits associated with a properly functioning watershed, such as full vegetative cover, retention of soil, reduction of flashfloods, and provision of suitable habitat for a wide range of animal and plant species. With good planning, all these aspects can be properly addressed in a Watershed/Forest Management Plan; that is the intention of the Management Plan described below. The plan includes description of the specific issues, the proposed objectives and outcomes of the Watershed/Forest Management Plan, the approach and methodology, implementation arrangements, and schedule.

7.5.2 Context, Project Design and Activities, and Potential Issues Regarding Forest Cover

157. Figure 7.17 shows the basic features of the Tanahu hydropower project, including the reservoir area, dam, and tailrace. The flooding of the reservoir will result in the loss of about 422 hectares of forest habitat (as well as shrub and grassland, and some cultivated area, and parts of the Seti River). Figure 7.18 shows the nature of forests in the proposed reservoir area; forest cover is quite dense in places.

158. Due to the riverine habitat of the Seti River basin, the forest and forest tree species established in this habitat are more representative of the lower tropical Sal and mixed broad-leaved forest zone than anything else. Furthermore, tree density values indicate between 69.9 and 242.8 tonnes/ha, with an average of 131.31 tonnes of wood per hectare (details on growing stock are provided in the EIA Addendum, 2012). This value indicates that the forest status in the proposed reservoir area is much lower than the value found in matured natural forests in Nepal.

The affected forest area (the 422.6 ha in the reservoir area), contains approximately 162,000 trees (based on the recent surveys; see Tables 7.5 and 7.6; details on individual species are provided in the EIA Addendum, 2012). The forest that will be affected by reservoir inundation is located in a narrow riverine gorge, isolated from the nearest forest areas to the north, south, east and west by agricultural land and settlements. The existing break in forest habitat created by the Seti River will simply be widened by an average of around 150 m, once the trees are cut and the reservoir floods. There will be no new forest fragmentation, with the exception of permanent access roads to the dam and powerhouse that cross short sections of currently degraded forest. Furthermore, the project area is not located in any specially designated park or protected area (see Figure 7.19). As per the Forest Guideline 2006 (Guideline to Avail Forest Land for Other Development Purpose, 2063), the project is classified as a commercial venture, which means it has to comply with a number of provisions (seebelow). THL, in consultation with Ministry of Energy and the District Forest Office, will therefore seek to develop a fair and workable nursery and afforestation program for the reservoir area.

Figure 7.17. The Tanahu Hydropower Project; reservoir area, dam site, tailrace location.

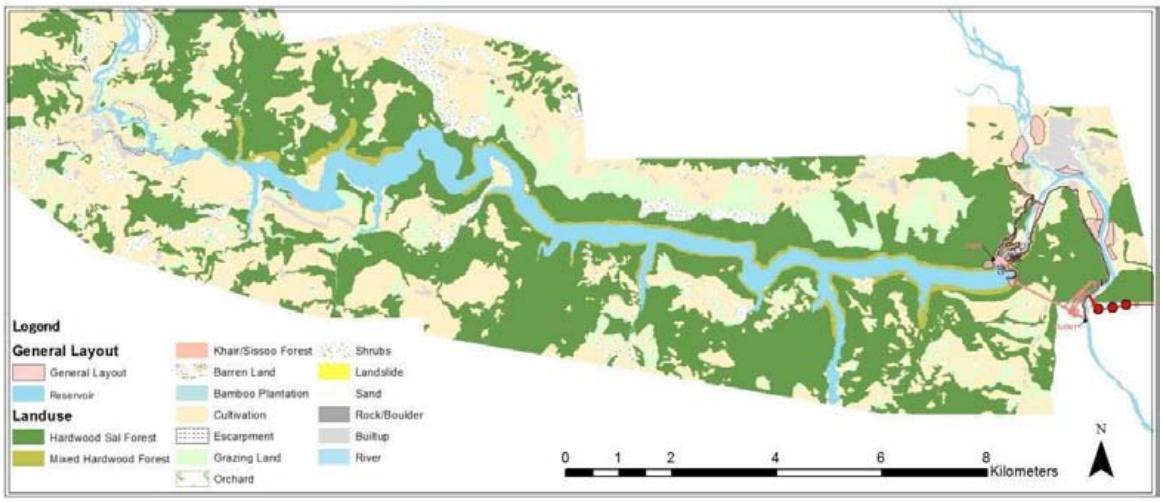


Figure 7.18. Forest cover in the Seti river area (within the proposed reservoir).

Table 7.5. Forest area affected by the project.

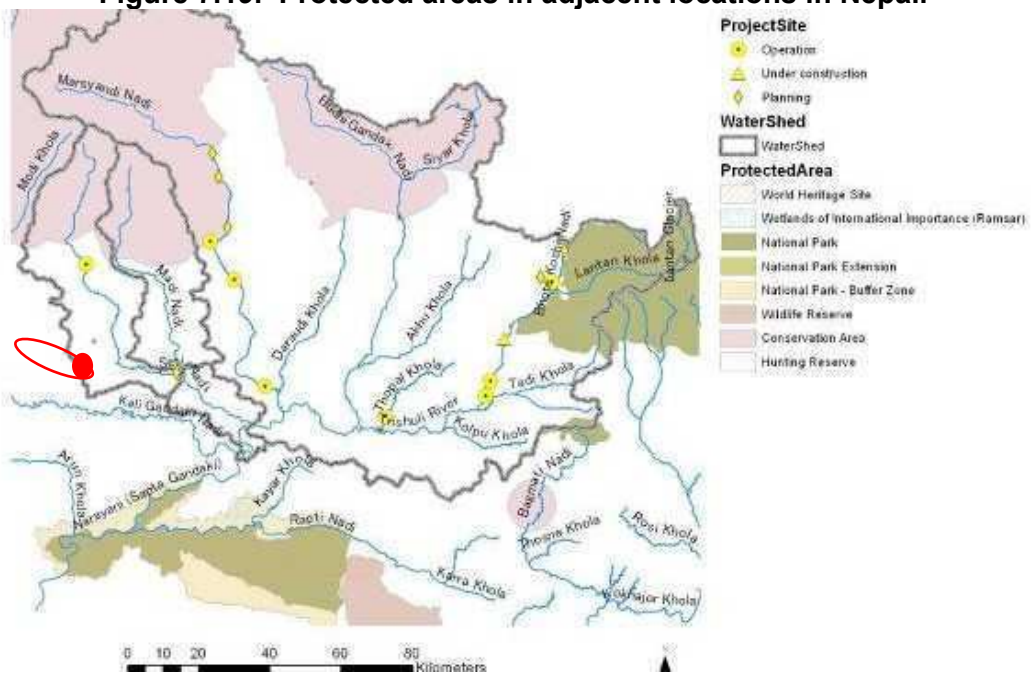
Forest Category	Reservoir (ha)	Project Facilities (ha)	Total Area (ha)
National Forest	259.84	51.91	**311.7**

Community Forest	88.77	16.79	**105.6**
Private forest	5.29	0.00	**5.3**
Total	**353.9**	**68.7**	**422.6**

Table 7.6. Loss of trees due to the project (estimated absolute number; details on the prevailing species are provided in the EIA Addendum, 2012).

Project Area	National Forest	Community Forest	Private Forest	Total
Reservoir	89,643	30,618	2,443	**122,704**
Project facilities	36,644	2,407	212	**39,263**
Total	**126,287**	**33,025**	**2,655**	**161,967**

Figure 7.19. Protected areas in adjacent locations in Nepal.



159. To meet the requirements of the Forest Guideline 2006 ("commercial venture"), the following mitigation measures are required to be implemented:

- survey of the forest area in the presence of a forest officer, numbering all trees above 10 cm dbh, by species;
- felling of the trees, branch cutting and stacking of the forest products within the felled areas;
- new nursery development;
- nursery seedling production for plantation development;
- acquisition of land area equivalent to the land area occupied by project structures;
- plantation and maintenance of seedlings for five years in a new area; and,
- lease compensation for project-occupied land as per the Forest Regulation.

160. As noted in the project EIA documents, there will be land-for-land compensation for project-occupied forest areas. The requirement for a planting ratio of 25 seedlings per lost tree will be discussed with the Ministry of Forests and Soil Conservation, once the application for the tree clearance is filed. The framework for the organizational structure for the Watershed/Forest

Management Plan will be developed in consultation with relevant authorities and stakeholders (see Table 7.7), to ensure that all expectations are understood and can be met in a reasonable manner. For instance, conservation of significant species will require propagation in the nursery from seed collected from the project-affected trees 6-12 months before they are removed. With regard to the wildlife habitat value of the forest area that will be cleared, this is addressed in the Wildlife Conservation and Awareness Management Plan.

161. To summarize, the required steps for developing the forest management plan, from the EIA stage through to design of the afforestation plan, include:

- Consultation with the concerned district forest officials and the Department of Forest Officials with regard to the project impact on forest land during the EIA study phase. The inputs of forest officials are normally on the process and procedures of the Forest Guidelines 2006. This includes i) forest area allocation to the national priority project only; ii) alternative analysis to explain that the project could not be realized without the acquisition of the forest land; iii) land-to-land replacement for the area occupied by the project structures in other areas; iv) afforestation of felled trees above 10cm dbh from the project occupied areas in a ratio of 1:25 in an area designated by the district forest office and then maintenance for 5 years, or pay the required amount, with costs as per forest norms 2003, to the district forest office.
- Submission of TML IEE (2010) and DAM EIA (2009) report as per the Forest Guideline measures.
- Approval of IEE/EIA report by the government.
- Issuance of the Project Generation License based on the approved TML IEE (2010) and DAM EIA (2009) by the Department of Electricity Development (DOED).
- Application to the Ministry of Energy and Ministry of Forests and Soil Conservation for forest land by the project with a copy of Project Generation License and approved TML IEE (2010) and DAM EIA (2009).
- Consultation with the Ministry of Forests and Soil Conservation and concerned Department of Forests and District Forest Offices on the various conditions of the Forest Guidelines in the presence of the concerned officials from DOED and the Ministry of Energy.
- Ministry of Energy and Ministry of Forests and Soil Conservation, after consultation, prepare a proposal for forest land allocation to the project with conditions (which include the provisions of forest guidelines (2006) and additional provisions) for cabinet approval.
- Cabinet of Ministers approve the proposal with or without conditions depending upon the project nature.
- Approval letter is forwarded to the project developer.
- Project developer then initiates consultation with the forest department and district forest office and the community forest user groups and prepares a plan for the afforestation, as per the approval letter conditions (the 5 ha of private forest can be handled in a similar consultative manner).

7.5.3 Objectives and Expected Outcomes of the Watershed/Forest Management Plan

162. The main objective of the proposed Watershed/Forest Management Plan is to ensure full forest compensation; that is, ensuring that the forest “function” and tree species composition lost to project activities (especially clearing the reservoir area) is replaced in another area (to be afforested), and that the optimal watershed functions in areas adjacent to the reservoir and in the afforested areas are fully recognized by local residents and maintained. Through the

proposed Watershed/Forest Management Plan, all regulatory requirements will be discussed and implemented, for full compliance.

163. The target planting area is the Seti River basin and the Madi River basin. The main target forest types to be included in the plan are: Montane Sal forest; *Schima-Castanopsis* forest; *Shorea-Schima* forest; mixed broadleaved forest; mixed patches of *Albizzia*, and *Acacia* and *Terminalia*. Target individual species are *Acacia catechu* (which has conservation status in Nepal), *Alstonia scholaris*, *Oroxylum indicum* (L.) Kurz., *Pandanus nepalensis* St. John, (which has conservation status in Nepal), *Shorea robusta* Gaertn (also with conservation status in Nepal) and *Vanda teres* Lindl. There are also three orchid species (*Coelogyne sp*.,*Dendrobium* sp., and *Cymbidium* sp.) and two shrubs and climbers (*Dioscorea deltoidea* Wall. ex Griseb and *Rauvolfia serpentina* (L.) Benth.) present in the project area which have a CITES conservation category; these will be moved to suitable habitat, as they are encountered.

164. The expected outcomes of the Watershed/Forest Management Plan include:

- replacement (over time, after seedlings have matured) of the forest area that will be reduced by the project, in areas that are as close to the project site as possible and suitable for afforestation;
- maintaining and/or improving the tree biodiversity in forested areas adjacent to the project site (no loss of tree species, especially the three that have conservations status in Nepal) and maintenance of habitat for other important plants, such as orchids; there are four orchid species in the project area which have special status in Nepal;
- maintaining a reasonable balance between the need for maintaining biodiversity and possible local interest in planting some stands of commercial trees; this will be done in consultation with District Forest Offices and local communities;
- reducing soil erosion in the Seti River basin (which will help with sedimentation issues in the reservoir); and,
- improving local community understanding of the importance of watershed and forest management, to support sustainability of the project mitigation measures.

7.5.4 Rationale for Proposed Approach

165. Most of the proposed Watershed/Forest Management Plan is actually specified in Nepali regulations and therefore becomes the backbone of the plan to compensate for forest losses in the project area. Furthermore, the activities proposed for forest and watershed management are based on international best practices, and recognized as effective in controlling vegetation cover and soil condition. All proposed activities will need to be sustained through continuous public awareness-raising and education programs, to maintain local community support for both the Watershed/Forest Management Plan and the project itself. Proposed activities and methodologies are noted below.

7.5.5 Activities and Methodology

166. *Clarification and compliance with required legal procedures*: Before the project land can be cleared and trees planted in adjacent locations, the following procedures need to be addressed by THL:

- issuance of the Project Generation License by the Ministry of Energy;

- cutting and Afforestation Application to the Ministry of Energy and Ministry of Forests and Soil Conservation;
- consultation with the Ministry of Forests and Soil Conservation and concerned Department of Forests and District Forest Offices regarding the planned cutting and planting;
- preparation of a proposal for forest land allocation to the project, for cabinet approval;
- Cabinet of Ministers approves the proposal with or without conditions; and,
- The approval letter is forwarded to THL.

167. The required forest permits and approvals are summarized in Table 7.7.

Table 7.7. Summary of required forest permits and approvals.

Permit/ Permission	Approval Authority	Information Required in Permit/Agreement	Suggested Timing of Application
Occupation of forest land	Cabinet, through the Ministry of Forests and Soil Conservation	EIA approval letter from MoEST, approved EIA report and detailed information on: o forest area (ha); o Government managed forest by type (District Forest, Community Forest, Leasehold Forest - by ha); o number of trees by species category in each forest type; o afforestation plan. Justification that forest land is required for project development (including an alternative analysis).	Application lodged at least 120 days prior to proposed occupancy of forest land.
'Felling permit' for trees on (cabinet permitted) public land 'Permission' to fell trees in Community Forests	DistrictForest Office (DFO), Department of Forests Forest User Group (and DFO)	Estimated number of trees to be felled / lopped; marking process; party responsible for cutting and transport of trees; monitoring process; involvement of DFO staff in tree clearance and construction monitoring; compensatory planting proposal and budget estimate.	Application lodged at least 60 days prior to proposed commencement of felling.

168. *Tree measurement*: After getting the approval letters, THL can start preparing the afforestation plan, following the condition of permits. The first step is measurement of trees in the National forest and Community forest. The local forest contractor of THL will start measurement of trees above 10cm dbh (tree diameter at breast height) in the affected forest area, in the presence of the forest officer. The measurement will include blaze marking, number writing, painting, and brushing, so that all trees are recorded. At the same time, conservation tree species should be marked and recorded by GPS. It is expected that the measurement work will continue until 2015. The tree measurement process will also be used to determine the required compensation for trees on private property that need to be felled for project purposes.

169. *Preparation of the afforestation plan*: The consultants for the Watershed/Forest Management Plan will prepare the afforestation plan, following the conditions of the cabinet approval letter. Preliminary activities will include the following:

(i) Exploration and measurements at the candidate site for afforestation, timber cutting, top soil storage, and land acquisition. The candidate planting site might be a high erosion area, open forest, illegal farm land, or derelict land (after excavation or mining) within the Seti and Madi River basins. A top soil storage site is needed, since top soil including

seeds should be used for the afforestation area. The seeds will promote the vegetation recovery, and removing soil will suppress eutrophication in the reservoir.

(ii) Identifying the planting species: The possible tree types for planting are i) Sissoo; ii) Khayar; iii) Fodder plants; iv) Timber trees; v) Fuelwood plants; vi) Medicinal plants; and, vii) Aromatic plants and any other Non-Timber Forest Products.

(iii) Identifying the planting methods: Planting methods can include creating seedlings from seeds; seedling transplantation; growing from branch cutting; and/or growing from stub cutting.

(iv) Identifying the important habitats for the wildlife: The areas of animal corridors, feeding areas, and other important habitats should be identified and planned as high priority planting areas. Very specific details will be needed for the afforestation plan.

170. After the activities listed above have been completed, the afforestation plan will be prepared. The afforestation plan will identify the utility and purpose of afforestation, the afforestation area [15], tree types, number of trees, nursery area, afforestation methods, afforestation schedule, and budget, as well as specific responsibilities and sustainability strategies.

171. *Public awareness-raising and watershed/forest management education program*: Public awareness-raising and forest education programs will be an important element of the overall watershed/forest management plan, to help sustain all activities. The target of this activity will be the construction workers and villagers around the various project sites. The program will involve workshops and dissemination through brochures. Education of the workers will include the following measures:

- forbidding access to the remaining forest around the project site;
- forbidding the disposal of soil in the river;
- overview of important species and exotic species in the forest habitat; and,
- forbidding the collection of firewood from the remaining forest.

172. Education of the villagers will include the following topics:

- the succession of forest vegetation and biodiversity;
- the importance of exotic species and required conservation actions;
- overview of the importance of soil cover; and,
- forbidding the cutting of important tree species and associated vegetation.

173. *Tree nursery*: Seedlings of the trees required for affected Natural forest, Community Forest, and Procured land will be produced in a nursery. This initiative will require the following actions:

(i) Development of new tree nurseries: following the completion of the afforestation plan, new nurseries will need to be developed in appropriate areas, as close as possible to the planting areas. Development of the nurseries (there may be more than one) will involve selection of sites, clearing land, earth works, fencing, setting up water supply, and of course establishing the nature of the land lease/acquisition.

(ii) Production of seedlings for the required plantation program: this will follow the details in the afforestation plan, in which the number of trees and tree types are clarified. For

[15] The forest guideline 2006 suggests "Afforestation in the land area equivalent to area occupied by the physical structures of the project, in a nearby area as directed by the District Forest of the Project Area and care taking for five years. Or pay the required amount to the Forest office calculated based on Forest Norms 2003." THL and NEA should follow this guideline or the condition of the approval by cabinet.

individual tree species, the appropriate seedling production and handling/grow-out methods will be defined. Indigenous tree species will be prioritized.

174. Tree cutting program: The local forest contractor will be responsible for cutting the trees in the project clearing areas, following the required protocol in the approvals. The steps in this initiative will involve the following:

(i) Transplanting important tree species: Identified conservation tree species, such as *Acacia catechu* and *Alstonia scholaris,* should be transplanted when encountered, before tree cutting (if they are not too big for transplanting). If the planting area is defined, these trees can be transplanted directly to the afforestation area (suitable soil conditions, such as sandy soil for *Acacia*, will be required, of course). If the area is not yet decided, conservation tree species that are uprooted will be kept in the tree nursery, which will be established before land clearing.
(ii) Extraction of available seedlings: If seedlings of appropriate species are encountered during land clearing and cutting, these will be taken out and kept in the nursery (this is known to work well with Sal trees). If the size of such trees is too big to reasonably carry, for some species that can handle coppicing, the upper part of the tree can be cut and the remaining stump kept and replanted.
(iii) Earth retaining work: In order to prevent soil erosion and loss to the river, earth retaining works will be needed in appropriate sloped areas.
(iv) Preparation of the work space: The active cutting areas will need to be carefully managed, which will include preparation of a timber cutting work space and a location for storing topsoil. The topsoil will need to be covered, to prevent dust and erosion. Truck routes will need to be identified and properly prepared. Truck routes and times will be provided to local residents.
(v) Tree felling: Tree felling work will need to be done carefully, starting with the upper canopy in the forest. As noted in the Wildlife Conservation and Awareness Management Plan, this work should be coordinated with the wildlife specialists, who will be available to rescue animals as encountered.
(vi) Branch cutting and stripping of leaves: Branches and leaves will be cut at the site. This material will be gathered and treated according to the covenants in the approvals, and might include mulching on site.
(vii) Collection of timber and branches: These will be carried to a storage area at the work site, prior to removal to a commercial operation, where they will be milled, or otherwise handled and dispersed. Chatta[16] (fuelwood) may be produced on-site, but will have to be strictly handled according to the conditions of approval. It will not be sold without permission from Department of Forests.
(viii) Storing of topsoil: Topsoil in the tree felling areas will be gathered and stored for the afforestation program. It will be excavated to a maximum depth of 30 cm in a manner that precludes erosion and soil loss.

175. *Afforestation and subsequent management*: The local forest contractor will plant tree seedlings as required in the new area, and look after the afforested area for a period of at least five years. Priority will be given to tree species with conservation significance, as much as possible (and if practical) and planting of large, continuous habitat areas, rather than strips, with

[16]In Nepal, fuel wood is measured in Chatta, its dimension being 20' ×5' ×5'.

due consideration of areas that might enhance habitat for critical wildlife (such as tigers)[17]. Steps required as this part of the program include:

(i) Clearing and layering of topsoil: Before planting at the afforestation site, exotic plants will be removed and earth works will be established to prevent topsoil erosion. Depending on the afforestation site, for example, if the slope is too steep, terraces may be needed.

(ii) Preparing the pits for plantation: This requires suitable sized pits (up to 30 x 30 x 30 cm) to be dug and fertilizer inputs (within reason and budget).

(iii) Seedling transportation and plantation: Seedlings will be brought from the nursery and planted at appropriate locations at the afforestation site. Planting will be undertaken in the appropriate season for maximum survival.

(iv) Maintenance: The planted seedlings will need maintenance for five years. The main work will involve fertilization, removing weeds, supplemental planting (as needed), and preventing erosion.

176. *Promotion of good watershed management principles*: Good watershed management practices will be promoted as part of this plan. The transfer of households and their farming activities from the reservoir area elsewhere will have actually have a positive impact on water quality in the reservoir, as the sewage and animal waste that would enter this part of the Seti River will be removed, and adjacent areas on the reservoir slopes will remain forested (at least at the eastern end of the reservoir). The main concern is inputs of pollution, fertilizers, sediments, wastewater, and sewage to the Seti River in the upper catchment west of the reservoir (which is already occurring according to local accounts). Soil management (terracing and bank stabilization) and tree planting associated with the replacement of trees cut in the reservoir area will help considerably, but additional promotion of soil and water management west of the reservoir will also be included in the plan. This will involve examination of options for sewage and wastewater management using constructed wetlands, reduction of fertilizer and pesticide inputs, and possible planting of green buffers along the river where soil erosion is a risk. These initiatives would come under the jurisdiction of the upper catchment municipalities, but nevertheless can be promoted as part of the THP Watershed/Forest Management Plan.

177. *Critical sequencing*: There needs to be good coordination between the land clearing process, during which species with conservation significance may be encountered, and establishment of the plant/tree nursery, The nursery should be established in an appropriate area prior to land clearing and inundation, so that collected materials (seeds and fertile propagative material of species with conservation significance; see Table C.15 of Volume 1) can be readily propagated and included in the afforestation program, rather than wasted.

7.5.6 Implementation Arrangements

178. Tanahu Hydropower Limited (THL) will be the Executing Agency for the Tanahu Hydropower Project. Technical expertise will be required to design and oversee the proposed Watershed/Forest Management Plan. However, the actual tree cutting and seedling planting will be undertaken by local contractors, selected with the help of the technical experts. Ministry of Forests and Soil Conservation will be heavily engaged with all aspects of the Management Plan, as required by the regulations.

[17] For example, within or adjacent to the Tiger Habitat Corridor in order to strengthen conservation benefits. This can be done in a manner consistent with the Nepal Tiger Conservation Action Plan 2008-2012 and in consultation with relevant experts, such as WWF

179. It is expected that the management plan will require 36 person-months (National) during pre-construction and construction and 4 person-months (National) during the first year of operation. The consultants will be engaged according to ADB Guidelines on the Use of Consultants. The equipment will be procured according to ADB's Procurement Guidelines. The study is expected to be implemented over 10 years, from 2013 to 2022. The disbursements will be made according to ADB's *Technical Assistance Disbursement Handbook.*[18] Consultant needs are listed below.

7.5.7 Terms of Reference for Consultants

180. The following consultants will be required to assist with design, oversight, and implementation of the Watershed/Forest Management Plan:

- Forest Management Specialist (National): responsible for providing technical advice to proper development of the tree cutting and afforestation plan, as well as providing public awareness and education content and delivery regarding watershed management, in support of healthy forests.

181. Specifically, the Forest Management Specialist will undertake the following tasks:

- Support the legal procedures required for forest compensation and acquisition of land for afforestation and the tree nurseries; maintain pacing and troubleshooting as required, to facilitate the process for THL. If the process behind the planned schedule, identify and solve the problems in cooperation with THL;
- Support THL in the preparation of the ToRs for the local contractor, who will handle tree cutting and planting of seedlings;
- Provide oversight for the measurement of trees in the affected areas (reservoir area, dam site and access roads);
- Prepare the afforestation plan, including specific instructions regarding cutting of trees, raising seedlings, planting, maintenance, and subsequent vegetation management (including planting locations, methods, schedule, and monitoring plan);
- Provide oversight for tree cutting in the affected areas, including establishing proper measures for erosion control and protection of important species;
- Design and provide technical oversight for all activities at the nurseries;
- Provide technical oversight for the planting and maintenance of seedlings, ensuring the transplanting of the most important tree species (ensuring that indigenous trees will be planted);
- Assist with management of lease payments and compensation, as needed; and,
- Design and implement public awareness and education activities addressing watershed and forest management.

7.5.8 Schedule

182. The consultancy services to support the Watershed/Forest Management Plan are expected to start in the second half of 2013. The schedule for each of the activities in the Plan is shown below.

[18] ADB. 2008. *Technical Assistance Disbursement Handbook*, Manila.

Activities	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
		Pre-constn	Construction						Operation	
Legal Aspects										
Tree Measurement										
Preparation of Afforestation Plan										
Watershed/Forest Awareness-Raising and Education										
Design and Establishment of Tree Nurseries										
Tree Cutting Program										
Seedling Planting Program and Maintenance										
Support to Lease Payments										

7.6 Phase-Specific Environmental Management Measures

7.6.1 Pre-Construction Phase

7.6.1.1 Commencement of Land and Building Acquisition and Leasing

183. 112 ha of private land and 86 households will be physically displaced in the pre-construction phase (see RP, 2012). The procedures for acquiring the land and buildings are described in the RP (including methods, timing, and compensation). Buildings will require dismantling/demolition; this process should follow the procedures outlined below for the Construction Phase. The costs of land and building acquisition are included in the budget for compensation.

7.6.1.2 Protection of Local Village Services

184. No temporary impact on village infrastructure and services is noted in the RP. If any infrastructure or services appear to be in the way of pre-construction work, and could therefore be constrained, alternative “makeshift” infrastructure will be installed by the CC before construction. Such local village services might be small foot passes, electricity lines, telephone lines, water pipes, and so on. The cost of protection of local village services is included in the construction budget.

7.6.1.3 Commencement of Resettlement Activities

185. The resettlement process for camp site, access roads, and temporary facilities will be prioritized to the resettlement process of reservoir area. However, as a general rule all resettlement activities will need to be completed prior to commencing any construction activities. It is expected that 49 structures will be affected for development of these areas. Table 7.8 shows the expected number of households that will be required to move during the pre-construction phase.

Table 7.8. Affected households in the construction area.

Project Component	Affected Assets	Affected Households
Access Road	Main Structure	28
Camp Site	Garden Area + Main structure + Backyard	1
	Main Structure	10
	Residential Land + Structure	3
	Residential Land + Garden Area + Main structure+ Backyard	2
Temporary Facility	Main Structure	5
	Grand Total	**49**

Source: Census Survey, 2011-2012 (Table 3.12: Part of Residential Asset getting affected)

186. THL will commence Displacement Assistance for all the affected households, which will include not only financial assistance, but also consulting assistance during the pre-construction stage. As per national legal provisions, the Compensation Determination Committee will be an integral part of RP implementation. A Local Consultative Forum (LCF) at each of the affected VDCs will facilitate the resettlement implementation at the village level. Involvement of local NGOs, CBOs and civil societies has been considered seriously and their support will be sought for development of community consensus. A Consulting firm/ national level NGO of repute and experience in RP implementation will be hired by the ESMU to implement the CDS. The assistance noted above should be finished by THL before construction starts.

187. The cost of pre-construction resettlement activities is summarized in Table 7.9, and includes compensation costs, housing displacement allowance, rental assistance, cultivation disruption allowance, transfer of materials allowance, special assistance for livelihood restoration for vulnerable households, and common property resources.

Table 7.9. Estimated compensation costs for affected residential structures in the pre-construction phase.

Project component	A total loss of residential structures in construction area	Budget in NRs
Camp Site, Betini	10	1,505,600
Camp Site, Jaruwa	9	3,245,000
Access Road – LB	4	602,240
Access Road – RB	24	7,664,016
Temporary facility (Hokse)	6	1,329,390
Total	**53**	**14,346,246 (US$ 167,000)**

Source: Census Survey, 2011-2012 (Table 8.2: Compensation for Structural losses)

188. Land acquisition and resettlement process for the main reservoir and its components are dealt in detail within the project Resettlement and Indigenous Peoples Plan.

7.6.1.4 Finalization of the Project Employment Strategy

189. Inequity in local project employment could cause serious conflicts among local people, especially if people from outside the affected area are engaged. In order to avoid such a conflict, a fair and reasonable employment strategy should be prepared and made clear to the public. THL will prepare the Project Employment Strategy during the pre-construction stage. Such strategies are expected to articulated and budgeted in the Community Development Plan (the budget will be assigned to construction costs).

7.6.1.5 Commencement of Staff Training

190. Construction employees will form the backbone of good environmental management practices during the construction phase and need to be well-exposed to environmental management principles and eventually all the details in this EMP. This especially applies to issues such as tree cutting around the project site for fuel, poaching, contamination of groundwater, illegal dumping of waste and hazardous materials, and so on.THL will explain all the required management principles, by working area, before the start of construction. Training material will be prepared by THL and the Advisory Organizations. The cost of this training is expected to be within the Project administration budget.

7.6.2 Construction Phase

7.6.2.1 Air Quality Control

191. Construction activities have the potential to cause short-term air quality impacts, especially at confined work sites such as within the headrace and tailrace tunnels and the power station cavern. Vehicle and machinery emissions and dust will be generated at Project sites. Adverse air quality can cause health problems, especially in these confined spaces. The CC will minimize air quality impacts and the potential of health-related problems by:

- providing ventilation in all confined areas (i.e., tunnels and power station cavern);
- providing breathing protection masks for employees where required;
- using dust suppression methods, such as water spraying;
- compacting stockpile surface retained for longer than one month, or during monsoon season;
- repairing gravel pavement of the main Project access roads and adjacent community roads;
- establishing on-site speed restrictions for construction traffic;
- frequent watering of project access roads each day when visible dust is generated, primarily during the dry season;
- erection of roadside fences near houses/villages on temporary construction access roads to reduce windborne dust movement;
- vehicle washing prior to leaving the site;
- careful handling and containment or damping of dusty materials on site, including the use of dust suppression/filtering on crushing and batching plants;
- frequent watering of spoil disposal areas during dry season;
- maintaining and operating equipment in accordance with the manufacturers' specifications (including emission controls);

- managing work sites and workforce camps to minimize odor generation; and,
- undertaking progressive site re-vegetation in accordance with contract as each landform is completed.

192. The CC will monitor air quality in tunnels and the power station cavern during construction on a daily basis. The ESU will visually inspect vehicle and equipment emissions and dust control measures during the weekly site inspections. The cost of air quality measures during construction is included in the construction budget.

7.6.2.2 Noise Control

193. Noise levels generated by construction activities will be significantly higher than current existing background noise levels. The main noise generating activities will include blasting and rock crushing. In addition, vibration and overpressure from construction blasting has the potential to affect local villages. The CC will inform local villages of construction schedules, likely commencement and completion dates of work at each site, and the dates and times when blasting and drilling will occur.

194. The CC will minimize noise and vibration impacts at construction sites by:
- locating stationary plants (e.g., generators) as far away as possible from local villages and workforce camps;
- maintaining all equipment to manufacturers' specifications;
- fitting mufflers on road vehicles and construction equipment; and,
- providing ear muffs to workers operating high decibel equipment or working in close proximity to this equipment.

195. The CC will only permit the use of air horns around villages for safety purposes. Blasting will be required at most construction sites. Uncontrolled blasting can cause extensive damage. Controlled blasting will be used during construction to limit the volume and extent of rock throw, and to reduce the disturbance to local villages. Maximum charge weights will be determined from test blasting or international practical metohds. The CC will seek approval for blasting from the ESU. The ESU will inspect proposed blasting sites prior to granting approval. The ESU will inspect blasting operations during the weekly site inspection. The CC will provide compensation to house owners, if structural damage occurs as a direct result of Project construction activities. The cost of noise control is included in the construction budget.

7.6.2.3 Water Quality Control

196. Project construction has the potential to adversely impact water quality in the Seti River and other local watercourses. Impacts on water quality will be minimized by setting up a settlement pond, treatment plant, or other relevant facilities at work sites, workforce camps, batching plants and other temporary facilities for construction works (spoil disposal areas measures for which are detailed in section 7.6.2.5 of this report). The exact width of buffer zone needed will be finalized by a survey done by CC. The CC will ensure that all wastewater is treated prior to being discharged to watercourses. The CC will regularly test and record the water quality in sedimentation tanks and settling ponds, prior to being discharged. The CC will obtain the ESU's approval for such waste water discharge system. Where possible, fence, entrance gate, or other relevant facility will be installed to prevent indiscriminate access or use.

197. Grease and waste oil will be prevented from entering waterways. Grease traps shall be installed at maintenance workshops and regularly cleaned out to ensure clean runoff from these sites, even during periods of rain. Oil separators will be set up at maintenance work shops. The CC will obtain ESU's approval for grease and waste oil trap/separator system. The field maintenance of machinery and equipment shall only be undertaken at sites approved by the ESU.

198. The CC shall store all fuels and chemicals in secure and protected areas, and in accordance with manufacturer's specifications. Protected areas shall have drainage valves to allow stormwater drainage. All rubbish and sewage disposal shall be undertaken at defined sites approved by the ESU.

199. The CC will implement the following mitigation measures:

- pit toilets at construction sites;
- standard toilets at camps with a central wetland type treatment facility;
- settlement pond or treatment plant for concrete batching plant;
- fraction fence installation work; and,
- sedimentation tanks to arrest the introduction of TSS in site drainage water, and regular maintenance of these (sediment removal).

200. If poor water quality is detected, the CC shall immediately recommend mitigation measures to the ESU for approval. The ESU shall approve these measures and/or specify other measures, and direct the CC to implement them immediately. The costs for water quality management related to construction activities are included in the construction budget.

7.6.2.4 Land Stability Management

201. Project construction has the potential to cause erosion and sedimentation in the work areas, potentially causing land degradation and increased turbidity in local watercourses. The operation of the reservoir also has the potential to cause erosion, slumpage, and landslides along the foreshore, primarily where the overlying soil structure is weak; a landslide instability and erosion mapping study of the reservoir foreshore was therefore completed in 2012, and informs the measures required to be implemented during the construction phase (there is also likely to be river level variation below the dam, but there is less concern about erosion here, as this will occur within the current water level fluctuation range of the river, unlike the reservoir, which will affect land that has not been immersed before).

202. The study identified that the main instability near project sites occurs in the upper reaches of the proposed reservoir area, especially between Bhimad and Rising Patan (Figure 7.20 and 7.21). The steep cliffs of soft sand and gravel composing both banks of the Seti River, as well as the JyagdiKhola, WantengKhola, and PhediKhola, are highly vulnerable to failure. Another source of instability is the highly weathered colluvium located on steep banks of various streams and gullies. The anticipated points are shown in the sequence of Figures 7.20 to 7.24.

203. Four project-induced processes could create foreshore erosion:

- **Wave action** – small wind-generated waves on the reservoir surface will cause minor soil erosion along the foreshore. Erosion is likely to be greatest at FSL because water will remain at this level for 3-4 months each year. A lower rate of

erosion is likely in the zone between FSL and MOL, as the water level will slowly decrease over six dry season months from the start of December through to May, with little to no wave action likely below MOL.

- **River undercutting** – the creation of the reservoir has the potential to redirect river flows onto foreshore banks and cause stream flow erosion. This is most likely to occur along the uppermost 500-1,000 m of the reservoir, where sediment deposited into the reservoir backwater and the raised water level may direct the river flow onto reservoir foreshore banks (e.g., onto the riverbank directly below Bhimad village).
- **Rapid drawdown** – the rapid draining of the reservoir over a 10-day period in June each year, reducing the water level by 53 m from MoL (378 m asl) to almost empty (325 m asl), will result in an average daily drawdown rate of 5.3 m, equivalent to 1 m every 4.5 hours. This rapid rate of drawdown will result in rapid drainage of the saturated foreshore profile. Where soils have a low shear strength, the drainage rate is unlikely to release the hydrostatic pressure unless slumpage of the banks is occurring.
- **Gully erosion** – side watercourses that are not stable due to exposed rock are likely to be destabilized by undercutting where they meet the reservoir, leading to gully erosion progressing upslope.

204. The majority of foreshore instability is likely to result from the rapid drawdown of the reservoir, with the next most destructive processes likely to be river undercutting and gully erosion. The foreshore ground surface along the lower 12 km of the reservoir between MOL and FSL will generally be stable due to shallow underlying rock. Approximately 50% of the foreshore along the upper 5-6 km of the reservoir consists of poorly consolidated alluvial deposits that are prone to erosion and landslip from Project-induced processes. River undercutting is expected to be greatest at the rear of the reservoir, where deposited sediment will form a delta that will have a meandering river channel cutting through it that will undercut foreshore banks at different points.

Figure 7.20. High risk landslide area #1.

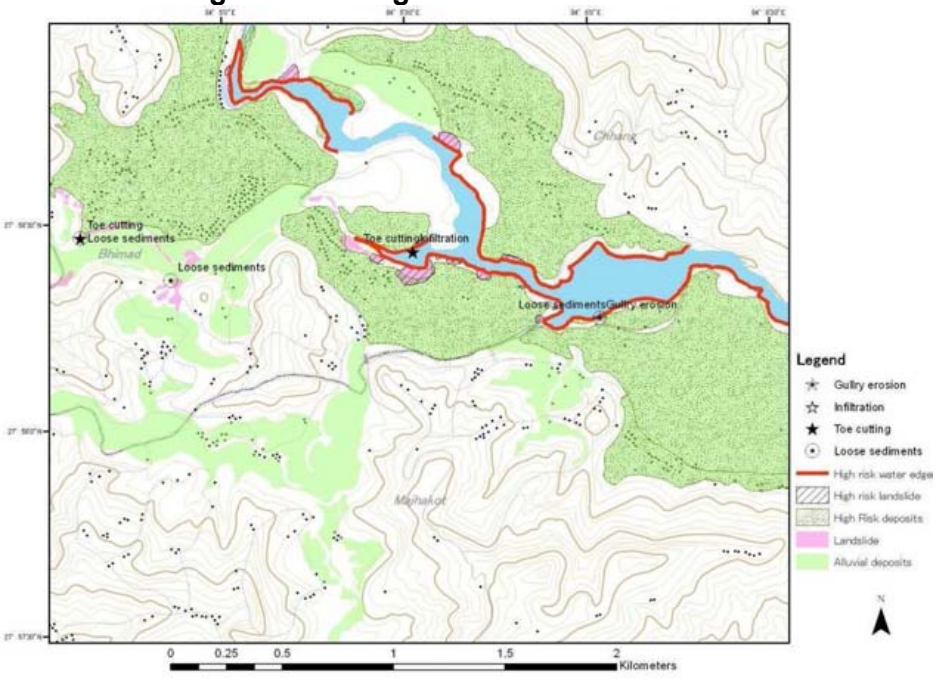


Figure 7.21. High risk landslide area #2.

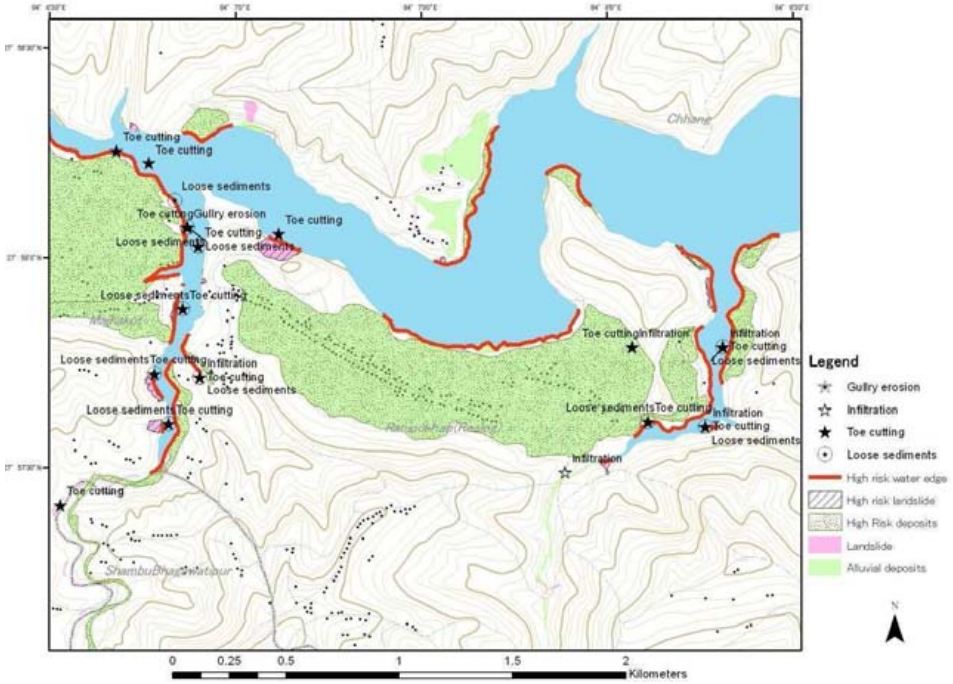


Figure 7.22. High risk landslide area #3.

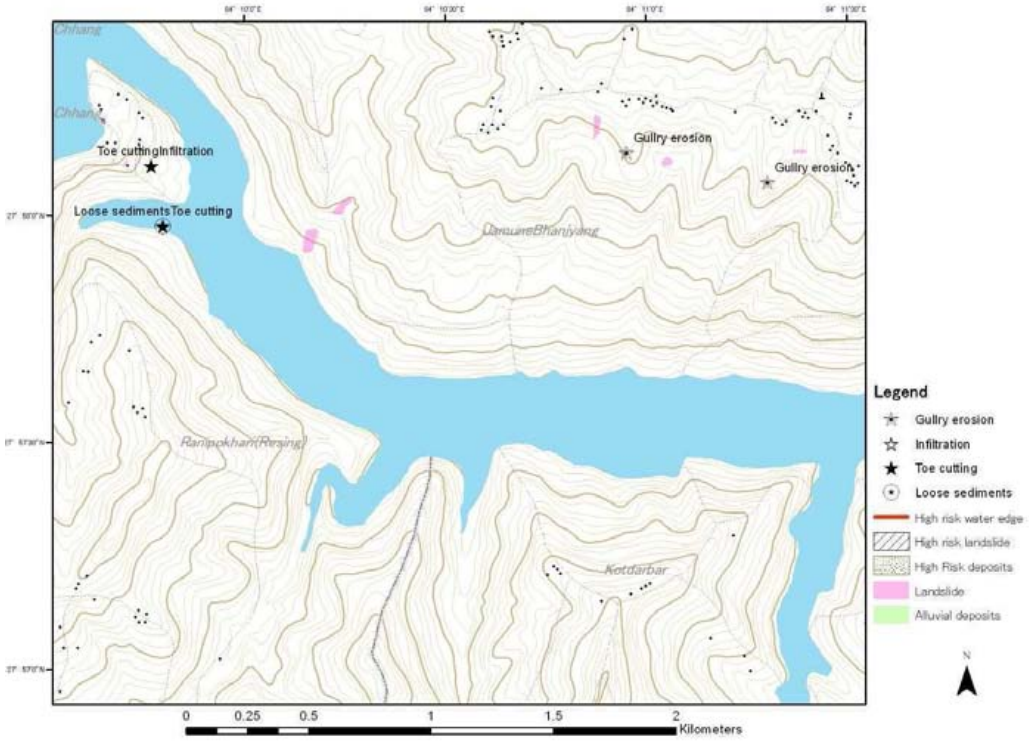


Figure 7.23. High risk landslide area #4.

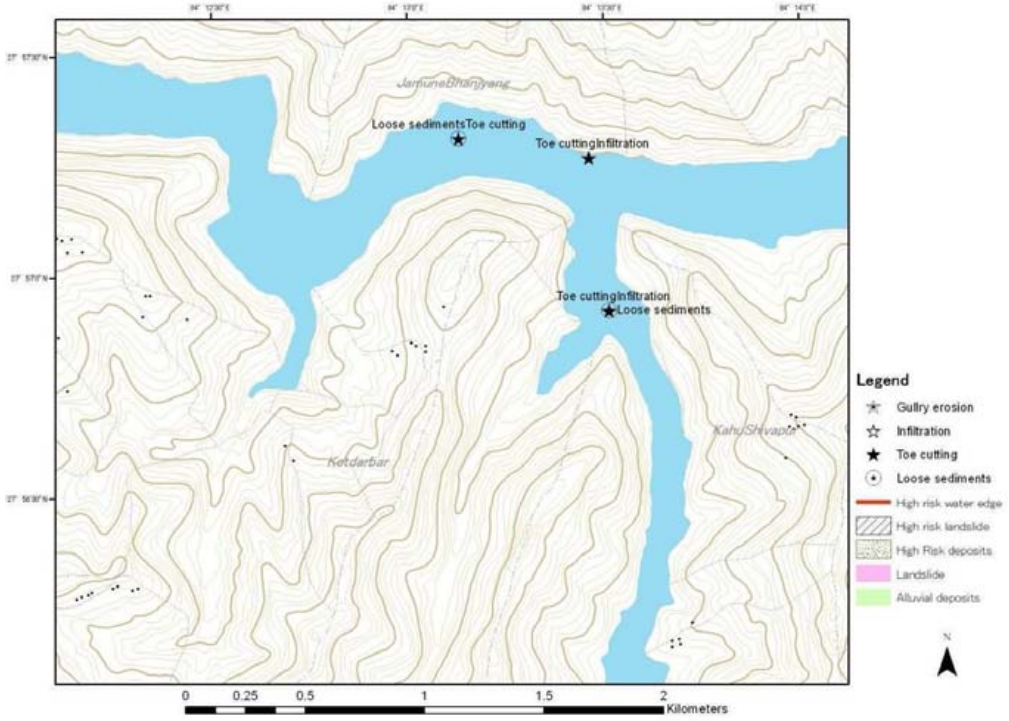
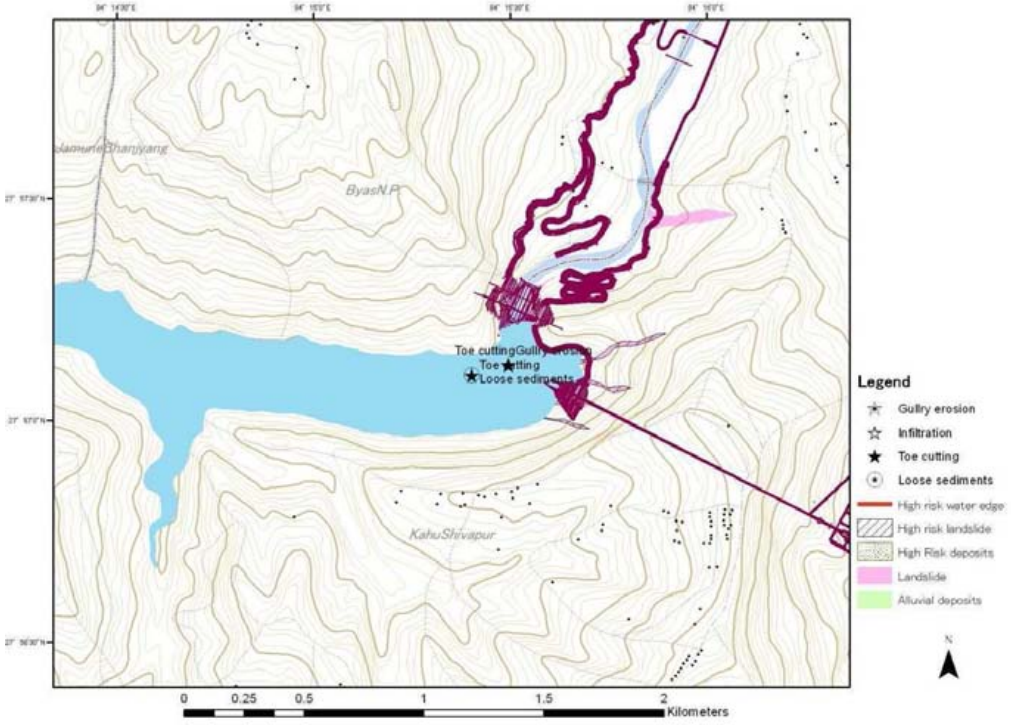


Figure 7.24. High risk landslide area #5.



205. The CC shall minimize erosion and sedimentation during Project construction by implementing an approved Erosion and Sediment Control Plan (ESCP) and following the general principles outlined below.

206. Drains and Erosion and Sediment Control Measures: Adequate surface drainage is essential to ensure that stormwater runoff from Project sites does not cause significant erosion. Catch drains will be installed on the top side of Project sites, where the slope permits, to divert run-off water around sites. Wherever possible, drains will have outlets into stable drainage lines. Where this is not possible, the ESU shall consult with adjoining downslope landowners on mutually acceptable locations for drain outlets. Sediment basins shall be installed at tunnel entrances and on the downslope side of all main construction sites and stockpile areas. The CC shall survey and peg all designed drainage works prior to the commencement of bulk earthworks. The ESU and CC shall then jointly inspect all pegged drainage works. Once approval has been granted by the ESU, the CC shall install site drains prior to, during, or immediately following road excavation in order to minimize the erosion hazard.

207. During Project construction, the CC shall inspect surface drains, sediment basins and sediment traps each week, or after any storm events, and undertake regular maintenance and repair (e.g., de-silting of sediment basins). The ESU shall also inspect the efficiency of all drains and erosion and sediment control measures during weekly site inspections and after storm events.

208. *Saving Topsoil*: Topsoil is a valuable resource, required for the re-vegetation of disturbed areas. Accordingly, it shall be saved from all disturbed sites during Project construction and re-spread during rehabilitation, when Project sites are no longer required. The CC will strip all topsoil from each Project site where slopes permit (i.e., on slopes less than 25^{o}) prior to site activities, including excavation, stockpiling, and camp establishment. Topsoil will be stockpiled separately from other materials in designated areas approved by the ESU. If the topsoil stockpile is to be retained for more than one month or during the monsoon season, the CC will cover or seed the stockpile to minimize the erosion potential.

209. *Excavation*: The CC shall minimize erosion by forming excavated and filled landforms at stable batter slopes. The CC will construct any required retaining walls prior to bulk excavation of hill slopes, so that backfilling of the wall can occur at the time of excavation, thus minimizing the double handling of fill. All disturbed areas shall be rehabilitated as soon as possible following the completion of construction activities on that site. The CC shall seek permission from the ESU to commence site rehabilitation.

210. *Stockpiling*: The stockpiling of topsoil, sub-soil, rock and other material will be required during the construction of roads, the dam and other Project features. These materials shall be stockpiled to prevent damage to local features, from diverted runoff and sedimentation. Stockpiled materials shall be stored on non-hazardous sites, away from both habitation and drainage lines, to minimize off-site sedimentation and protect nearby features. The CC shall locate and peg stockpile sites in accordance with the following criteria:

- at least 10 m away from drainage lines and above flood level;
- on land with less than a 10° slope;
- on sites already clear of trees and shrubs;
- not above houses or other structures; and,
- further than 5 m away from vegetation that is being retained.

211. The CC shall seek approval from the ESU for the use of areas as stockpile sites prior to commencing the associated extraction operations. The ESU shall inspect and approve all correctly located sites. If stockpiling is planned on private land, the CC shall obtain written

permission from the landowner for use of the site prior to using the area. The stockpiling of fill material shall not be permitted during the monsoon season, unless it is appropriately covered or protected. Where a soil stockpile is to be retained for longer than one month the stockpile shall be seeded with an appropriate cover crop.

212. *Gabion at High Risk Landslide Areas*: The CC will be required to undertake protection works along the high risk slopes, as follows:

- Protection works will be installed along the toe of identified high risk slopes that are at or below FSL and above MOL, prior to reservoir filling to assist these areas to stabilize over time. These locations will include unstable slopes lying directly below houses.
- Additional slope stabilization works will include slope shaping and bioengineering.
- Where private land is identified as being at risk of landslip or severe erosion, the existing physical land boundary will be surveyed onto cadastral sheets and photographed, so that any Project-induced land loss can be accurately compensated after it has occurred.

213. The costs of land stability management will be included within the construction budget. In addition, there will be a monitoring program during the operation period which will involve visual inspections of the reservoir slopes every six months by an experienced geologist, and then recommendations made, as needed, for remedial works (coming from the Project operations budget). If private land along the reservoir foreshore is eroded, the landowner will be fairly compensated, in accordance with the resettlement plan.

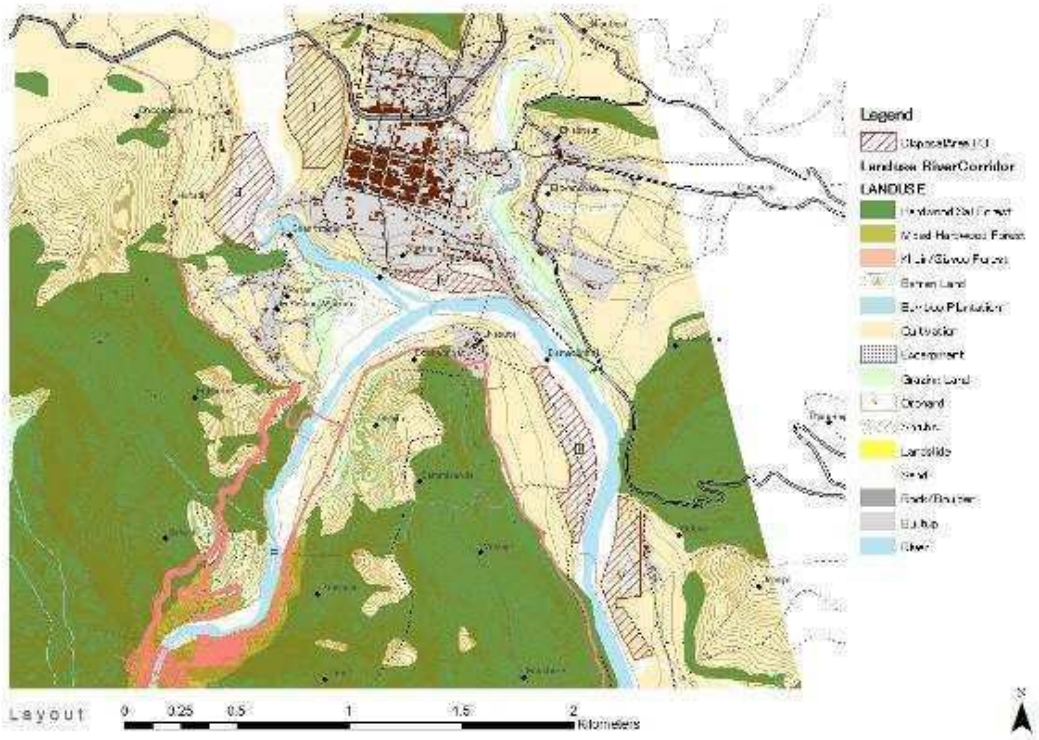
7.6.2.5 Spoil Bank Management

214. An estimated 2,267,000 million m^3 of spoil will be generated during Project construction, from tunneling and excavation, consisting of 1,970,000 m^3 of rock and 297,000 m^3 of soil. An estimated 911,000 m^3 of rock spoil will be used in construction, leaving 1,356,000 m^3 of excess spoil that will be disposed.

215. Improper spoil disposal has the potential to result in the loss of productive land resources, induce slope instability, raise water turbidity, adversely impact on aquatic life and create a visual impact. Five disposal areas with a total capacity of 2.44 million m^3have been identified in relatively close proximity (within 6-7 km) to the Project sites where excess material will be generated (Figure 7.25), providing sufficient capacity for the disposal of the excess material. These sites were selected on the basis of:

- proximity to spoil generation sites;
- available capacity;
- land ownership;
- existing land cover and use;
- landowner willingness to sell or lease private land for spoil disposal (sell the land to the Project, retain it for future use, etc);
- minimal potential to create future environmental and social impacts; and,
- potential uses of the final landform.

Figure 7.25. Potential spoil disposal sites.



216. Spoil disposal site selection has emphasized the avoidance of environmental and social impacts (short and long term). This includes the use of low value land such as riverine deposits and degraded land in preference to shrub-land and cultivation in that order. Where riverine landforms are to be used, the potential for river re-direction, flooding, and erosion has been considered, along with the potential to create usable landforms (e.g. playing fields) from the final spoil landform.

217. The disposal site land types consist of:

- riverine government and private land adjoining the main river banks, where disposal will not unduly restrict flood flows; and,
- riverside land with low production value (e.g., recent alluvial deposits, grassland, poor quality occasionally cropped land).

218. Spoil management measures (costs to be included in the construction budget) to be implemented will include:

- disposal of excess spoil at designated and pegged spoil disposal areas that have been approved by the ESU;
- no sidecasting of excess spoil over the edge of excavation sites or placing spoil in drainage lines or watercourses, above houses or at other sites where it is likely to cause damage to structures or natural features;
- the CC shall instruct the construction workforce on the approved fill disposal locations and supervise the correct placement of fill at sites;
- topsoil (where present) stripping and stockpiling prior to spoil placement;
- progressive installation of retaining structures, benches and drains to ensure landform stability and minimize erosion and sedimentation. This will include stabilizing the toe of the spoil disposal sites that front onto the Madi and Seti rivers

using rock gabion walls, and benching the fill batters of each disposal area that exceeds 7 m in height;
- layering and compaction of spoil as the material is placed, with daily inspection by the ESU;
- topsoil spreading and site re-vegetation of the final landform; and,
- the ESU shall inspect and approve the final land shaping at each designated spoil disposal site prior to and following top-soiling.

7.6.2.6 Waste Management

219. Construction and domestic waste will be generated during Project construction. Construction waste will primarily be composed of cleared vegetation, tunneling sludge, waste oils, and material packaging. Domestic waste, predominantly generated at workforce camps, will include perishable and non-perishable domestic rubbish, sewage, oils and surplus fuels.

220. The CC will be responsible for the management, collection, and disposal of all construction and domestic waste generated at construction sites, work sites and workforce camps. The CC shall manage waste disposal at Project sites by providing:
- separate containers for the collection of recyclable/reusable construction material waste and non-recyclable waste at work sites;
- waste disposal containers for the collection of domestic rubbish generated at work sites and workforce camps; and,
- collection and storage of waste oils, fuels and chemicals in sealed containers in bunded areas for subsequent on-site recycling or safe disposal.

221. The CC shall ensure rubbish collection and disposal does not encourage scavenging by animals and birds. Waste materials shall be reused or recycled on-site where possible, to minimize the generation of waste. In particular:
- excavated rock and spoil material shall be used where possible as an aggregate in concrete, in dam wall construction, as road base and for road maintenance; and,
- cleared vegetation shall be made available to local communities or stockpiled for use during re-vegetation.

222. Waste materials that cannot be reused or recycled shall be burned or land-filled in designated areas on-site. The burning of waste shall be favored over land-filling where feasible, to reduce the potential for groundwater contamination. If waste is to be land-filled, it shall be covered with a layer of soil at the end of each day to reduce odors and prevent scavenging. Following the completion of filling, the landfill shall be capped with a 600 mm layer of soil, then top-soiled and re-vegetated. The ESU shall inspect waste management procedures at each Project site during the weekly site inspection. Costs related to waste management are included in the Project construction budget.

7.6.2.7 Hazards Management

223. The Project has the potential to be affected by natural and Project induced hazards. Potential natural hazards in the catchment area include floods, landslides and earthquakes.
223. Project induced hazards during Project construction include chemical spills, explosions, the collapse of structures, and other common construction site hazards.

224. *General Hazards*: The CC shall minimize worker and community exposure to hazards during Project construction by providing:

- safety training for each employee as it relates to his/her job at the commencement of employment and refresher workshops as required;
- appropriate relevant safety equipment for each employee;
- safety equipment at each work site, including fire-fighting equipment;
- first aid facilities at all Project sites;
- security fences around all work sites and workforce camps, and hazardous locations on construction sites; and,
- designated and signed paths around and through construction sites, work sites and workforce camps.

225. The CC shall conduct regular safety audits at all Project sites. As soon as activities have been completed at each construction site, work site and workforce camp, the CC shall clean up and leave the site in a safe condition. This shall include the removal of all wastes and excess building materials, and the stabilization of all cut faces and fill embankments.

226. *Hazardous Materials*: The mis-handling and incorrect storage of explosives, combustible and toxic materials (such as petrol, diesel, oil and lubricants) can lead to explosions, spills and leaks that pose safety hazards to workers and may cause soil and water contamination. The CC shall safely handle and store hazardous materials. Hazardous materials shall be stored in secure and bunded areas, and in accordance with manufacturer's specifications. Explosives shall be stored in police-guarded bunkers, in strict accordance with GoN regulations.

227. The CC shall immediately contain and mop up any chemical spill. The CC shall seek direction from the ESU regarding the disposal of any hazardous material. The costs of hazardous materials management will be included in the Project construction budget.

7.6.2.8 Workforce Management and Safety

228. A significant number of local people will be employed for Project construction, but a large number of people will move into the local area and live in temporary workforce camps, potentially creating additional demands on natural resources. The CC shall minimize pressure on the surrounding environment by developing and enforcing workforce management conditions. Workers shall act in a responsible manner during and after working hours, respecting the rights and property of local people. The CC shall establish rules to prevent:

- illegal felling of trees and use of other forest resources;
- illegal fishing and hunting;
- alcohol consumption;
- employment of under-aged employees;
- defecation in open areas and waterways; and,
- harvesting or taking the personal resources of others.

229. The CC shall ensure that no wood is burned by workers on or off the site, and shall provide alternative fuel sources for all cooking, heating and lighting needs at workforce camps. The large construction workforce will increase pressure on existing health facilities in the area.
229. To minimize the potential for disease and ensure camp safety, the following shall be provided by the CC at workforce camps:

- potable water and sanitation facilities;
- rubbish bins for waste disposal;
- health care facilities (clinic); and,
- on-going safety and health-related education programs.

230. The CC shall ensure that all service facilities are supplied with sufficient capacity to service the maximum proposed workforce size at each camp and that the facilities are actively maintained in good, clean order, by workers specifically appointed for the task. The cost of this program is included in the Project construction budget.

7.6.2.9 Traffic and Access Control

231. A considerable increase in traffic will occur in the Project area during construction. The CC shall clearly define and mark Project roads to prevent indiscriminate vehicle access. Speed limits determined by the ESU shall be established on Project roads and enforced by the CC. The CC shall install speed humps on internal Project roads to minimize safety hazards. The cost of this program is included in the Project construction budget.

7.6.2.10 Archaeology Management

232. Archaeological assets might be found during excavation and/or earth work. The CC shall report the discovery of any archaeological, cultural, or religious sites to the ESU, and work at the site shall cease, until a plan of action has been developed and implemented. The ESU shall seek the advice of the relevant VDC Chairman to determine appropriate action. Related costs are included in the Project construction budget. The protocol for "chance finds" is described in Appendix 3 in Volume 1 of the Environmental Addendum.

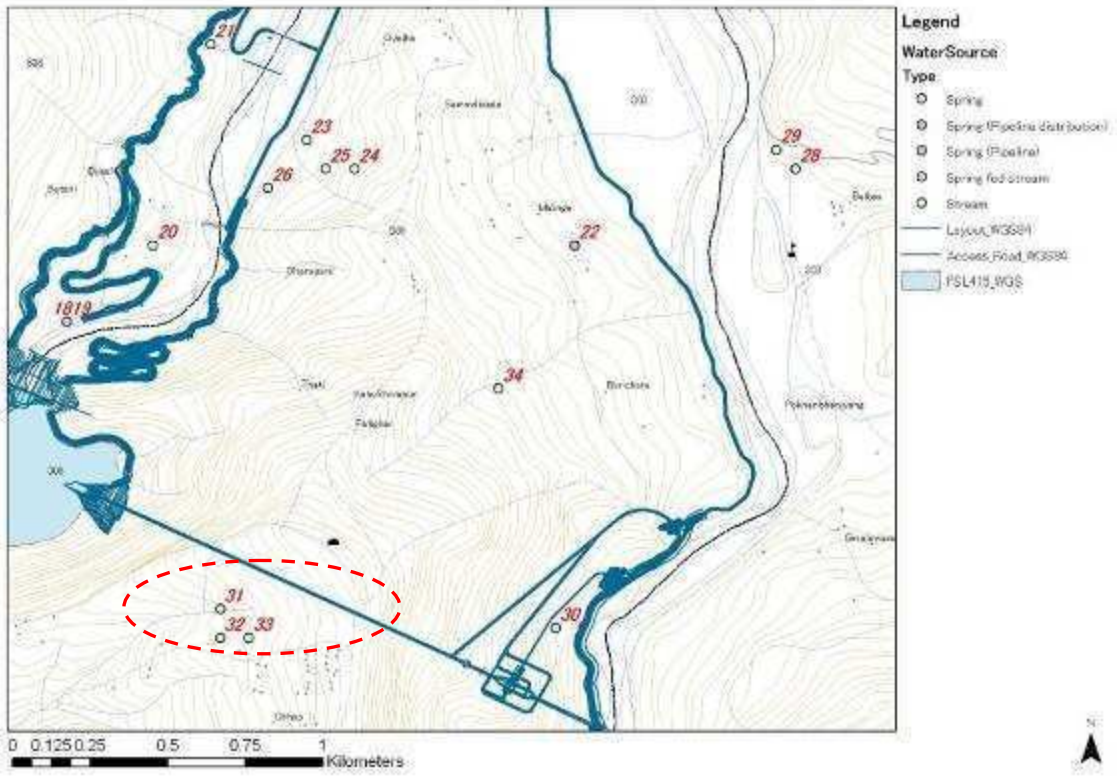
7.6.2.11 Water Supply

233. The water table above the headrace tunnel, tailrace tunnel, and other associated tunnels may fall due to Project-induced changes in subsurface rock conditions. Four existing springs used for domestic water supply by an estimated 236 households are located above the headrace and tailrace as summarized in Table 7.10 and illustrated in Figure 7.26. One of these springs is close to the alignment of the tailrace tunnel, while the other three springs are offset at least 250 m from the headrace tunnel alignment.

Table 7.10. High risk springs.

Well No.	Name of Water Source / Supply System	Type of Water Source	Owner	Use	Beneficiary Households	Discharge Rate (l/min.)
30	MukurlukKhanepaniMuhan	Spring	Jhaputar village	Household purpose only	152	31
31	HulmadiKhanepaniMuhan	Spring	Chhap and Jikhabari villages	Household purpose only	30	12
32	JhirudiKhanepani Muhan	Spring	Lokma village	Household purpose only	10	16
33	SimaldiKhanepaniMuhan	Spring	Chhap and Jikhabari villages	Household purpose only	24	13

Figure 7.26. Location of high risk springs.



234. The flow rate of the four springs that are at risk of being affected by Project tunneling will be measured every quarter: (i) for one year prior to tunneling; and, (ii) for three years following tunneling. If a perceptible decrease in the flow rate of any of the springs occurs, then a solution to reinstate the water supply will be developed in consultation with the affected households. Options that will be considered include: (i) gravity reticulation of water from an upslope source using a polyethylene pipeline; and, (ii) trucking in water.

235. THL shall provide the necessary funds and support to establish and maintain the water supply system/s, and shall monitor the effectiveness of the supply system/s over the Project life. The provisional compensation cost for drying of spring water is 4,000,000 NRs.

7.6.2.12 Demobilization Management

236. After construction, any residual materials left on site might cause water pollution or waste problems. The CC will be responsible for removing all temporary buildings, refuse, stockpiles, and excess construction materials from Project sites after the Supervising Consultant deems that they are no longer required. Construction materials from demolished temporary structures shall be recycled where possible and made available to the local community. Materials that cannot be recycled shall be burned or land-filled. Related costs will be included in the Project construction budget.

7.6.2.13 Site Rehabilitation

237. Temporary work sites will have to be returned to the land owners. If the areas are given back without any treatment, there may be some recurring problems, such as erosion, soil contamination, and so on. All temporary work sites and workforce camps, and any disturbed areas around permanent Project sites, shall be re-vegetated by the CC as soon as possible after the completion of construction or use of these sites, in order to minimize the erosion hazard and to provide long term stabilization. The CC shall spread all stockpiled topsoil across sites and plant a cover crop and locally indigenous tree species on non-agricultural land. The ESU shall ensure that sites are fully rehabilitated within one month of final site use and shall regularly monitor the effectiveness of re-vegetation measures during the weekly site inspections.

238. Land leased during Project construction shall be rehabilitated in accordance with the lease agreements, returning the land to an equal or better condition than it was in prior to Project use. Related costs will come from the Project construction budget.

7.6.2.14 Reinstatement of Services

239. If there are any trails or local services temporarily cut during Project construction and not replaced with permanent alternatives after construction, people using such services might have some difficulty in the future. All trails and local services temporarily cut during Project construction and not replaced with permanent alternatives shall be reinstated by the CC as soon as possible. Trails and local services are required by local villages for access, crop production, and drinking water supply. The ESU shall inspect and certify that all previously inventoried services have been adequately reinstated. Related costs will come from the Project construction budget.

7.6.3 Operational Phase

7.6.3.1 Training

240. Environmental management during Project operation will involve training of employees and the monitoring of bio-physical features that will either be potentially affected by the Project or may impact upon the Project. All Project staff employed during the operational phase will attend an environmental induction and training workshop conducted by the THL at the commencement of employment. Induction and training will aim to raise the level of environmental awareness and will be tailored to different staff roles. It will variously cover:

- relevant legislation/licences/approvals;
- site environmental and safety procedures;
- incident management and emergency response procedures; and,
- complaint handling procedures.

241. Training costs will come from the Project operations budget.

7.6.3.2 River Water Quality

242. Water quality in the reservoir and the quality of released water from the power station and dam will be measured on a monthly basis throughout the year, for at least the initial five years of project operation. Downstream flow quality will be compared with the inflowing natural Seti River flow, to identify changes in water quality. If a significant change is identified, the concept of a mixing apparatus will be considered at the intake, to improve the quality of generation releases. In addition to the details provided below, water quality in the release water is also addressed in the Water Release and River Safety Management Plan (specifically, the concept of a boulder field near the dam, to create aerated turbulent flow).

243. Development within the Pokhara and LekhaNath Municipalities of Kaski District is rapid. Based on further urban development and an increased use of agricultural fertilizer in the watershed over time, the phosphorus loading in the Seti River is expected to increase. The reservoir is predicted to show increasing eutrophic conditions, based on the current phosphorus levels in the Seti River flows, but annual flushing (in June, at the beginning of the monsoon) will ensure that there is no nutrient accumulation over time.

244. *Adaptive Management*: At the commencement stage of reservoir flushing, adaptive management will be implemented. Figure 7.27 shows the concept of adaptive management, with cycles composed of "plan", "implement", "monitor", and "evaluate" applied over the initial years of project operation, with each year's findings fed back into the management cycle the following year. Thus it could be recommended that implementation of flushing be raised gradually to establish an effective operation pattern that minimizes the adverse impacts(low DO, high SPM, DSS, etc.) on the downstream river ecosystem as much as possible. Table 7.11 provides examples of adaptive management activities for each step in the cycle.

Figure 7.27.Adaptive management applied to reservoir releases.

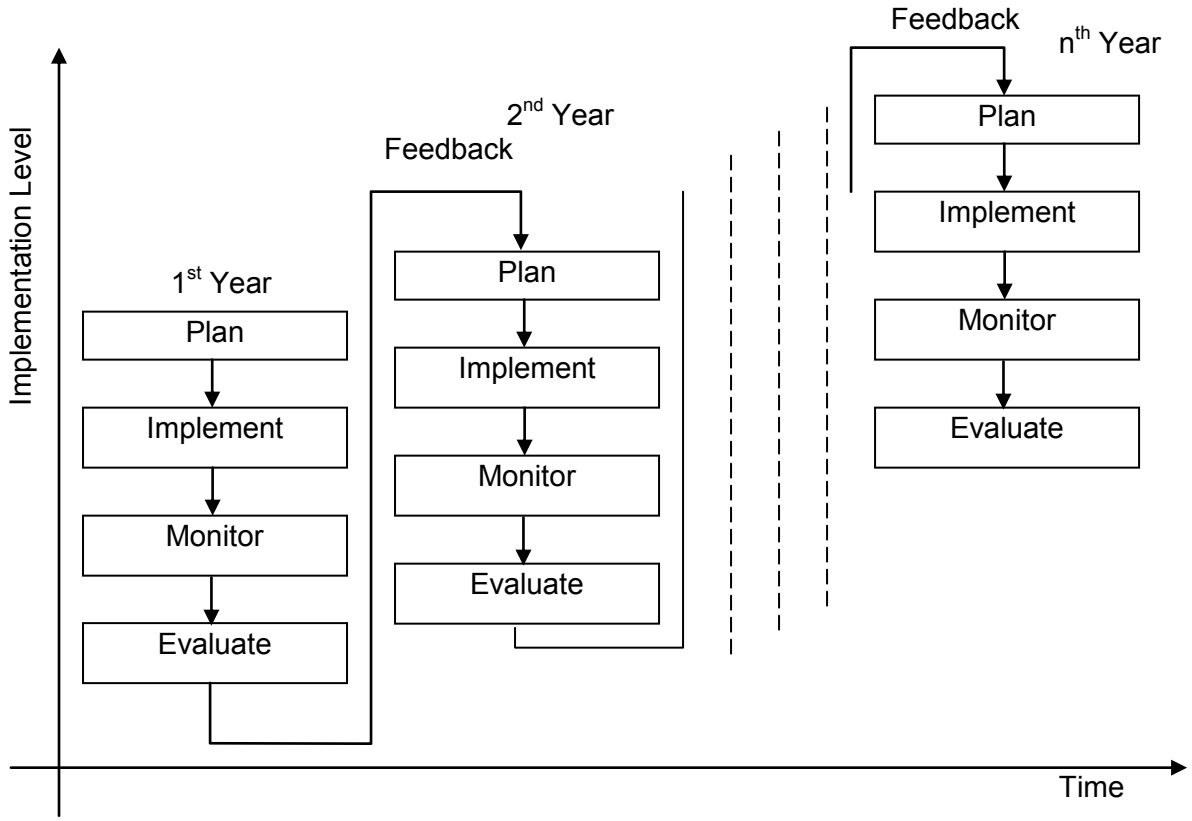


Table 7.11. Examples of adaptive management activities.

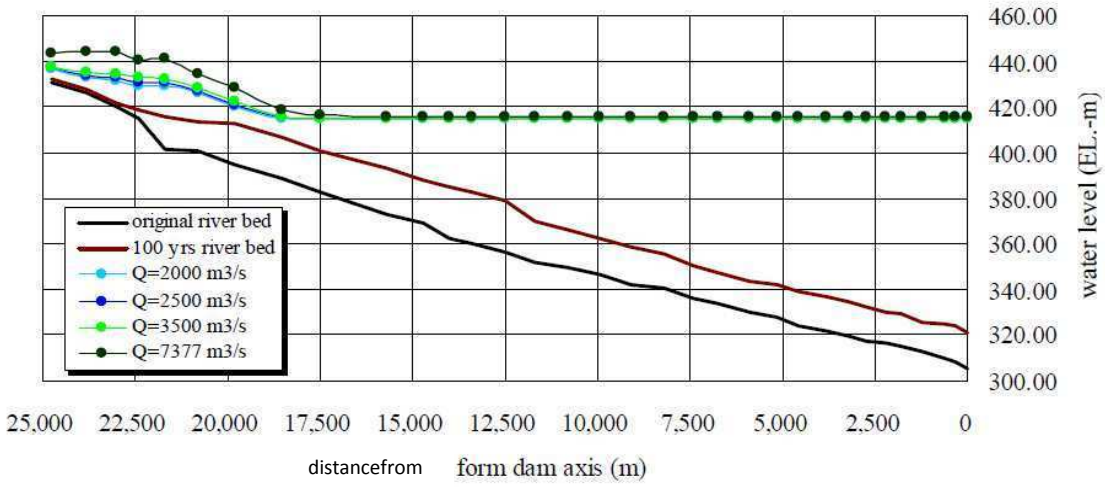
Step	Activities
Plan	Establishing: 1) Flushing operation plan, including forecasting performance of sediment ejection by mathematical model; 2) Auxiliary measures planning such as partial mechanical sediment removal; 3) Monitoring plan; 4) Facilities maintenance plan; etc.
Implement	Annual flushing operation as per the plan.
Monitor	1) Data collection on environmental impacts: physical - particle distribution of riverbed, SS concentration, water temperature, dissolved oxygen, etc; and biological - fish, benthic organism, aquatic plant, etc; in the reservoir and downstream river. 2) Sedimentation survey (at fixed cross-sections) in the reservoir. 3) Degradation (abrasion) of facilities.
Evaluate	Evaluating: 1) Performance of sediment ejection from the reservoir compared to the forecasted rate, and review of the mathematical model; 2) Positive and negative environmental impacts caused by flushing operation; 3) Soundness of facilities after flushing operation; 4) Backwater risk based on the sedimentation survey data; etc.
Feedback/Adjust	The flushing operation plan for the flowing year is based on the results of the evaluation.

245. *Mixing Apparatus*: If the monitoring indicates water quality problems in the reservoir, one option is to install a fraction fence, at the rear of the reservoir. The fence will be suspended from floats, installed to send inflowing nutrient-rich water from the surface to deeper in the reservoir. As a consequence, it is expected to decrease phytoplankton growth by controlling photosynthesis. As the transparency of Seti River is low, the fraction fence is expected to be effective. By sending higher nutrient inflows to a deeper depth, this nutrient-rich water is more likely to be drawn off via the intake and released downstream. The water monitoring cost is included in the budget for monitoring. The cost of the fraction fence (if needed) will be included in the Project construction budget.

7.6.3.3 Sedimentation Management

246. Simulations have indicated that the river bed could be raised up from the original river bed in the upstream zone of the reservoir, even though sediment flushing operations are planned on an annual basis. In general, it is known from other hydropower operations that the river bed tends to be raised in the upstream zone of the reservoir, where the velocity of river flow is reduced due to rapidly increasing water depth (a higher volume of water absorbing a smaller incoming volume). Accordingly, the simulation results for the Seti River and reservoir reflect this. Storage reservoirs also have the typical issue called the "backwater problem", in which the height of the water surface can be raised, due to the river bed increasing with deposited sediments. The study results are noted below (see Figure 7.28).

Figure7.28. Estimated river bed level after 100 years of project operation.



247. The conditions for the water level calculations include:
1) water level at the dam axis set asEL. 415.00 (FSL) for all discharges;
2) calculated discharges of 2,000, 2,500, 3,500, and 7,377 m^3/s are approximately equivalent to discharge return periods of 10 years, 20 years, 50 years, 100 years, and PMF, respectively.

248. According to Figure 7.28, it is understood that the reservoir water level is affected (raised) in the downstream zone at 17,500 m distance from the dam axis. THL will conduct river cross section measurements at the end of the reservoir every year. If there is any sedimentation observed through monitoring, deposited sediments at the upper end of the reservoir will be bulldozed into the incised river channel, thereby promoting its downstream

transport by river flows. The cost of this operation could be 117,520 NRp/year, which is included in the Project construction budget.

7.6.3.4 Hazards Risk Management

249. Natural hazards may occur in the Project catchment. These hazards have the potential to cause damage to Project structures, and loss of life and property. Hazard risks are discussed below.

250. *Flood damage caused by precipitation*: The capacity of the spillway is designed to cope with the probable maximum flood (PMF) (this is the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the catchment). The PMF has been estimated at 7,377 m^3/s. The dam spillway has been designed to safely discharge this flow; therefore there is no possibility that the dam will overtop due to catchment runoff (however, this will contribute flood flows expected elsewhere in the whole basin).

251. *Flood damage caused by a glacier lake outburst flood*: According to the *Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods* (International Centre for Integrated Mountain Development: ICIMOD, 2001), there were (in 2001) ten glacial lakes in the headwaters of the Seti River basin and none of these lakes are potentially dangerous. ICIMOD more recently reported that the number of glacial lakes had decreased to six. Based on this information, it is assumed that there is little possibility that a GLOF (glacier lake outburst flood) could cause the dam wall to fail.

252. *Earthquake damage to dam and subsequent flood*: According to the *Seismic Hazard Map of Nepal*, the maximum acceleration at the project site is evaluated as 230 gal and the horizontal seismic coefficient is estimated at 0.15. The dam has been designed with pseudo-static seismic analysis under the conditions noted below. For the estimated earthquake, the dam should have the following safety factors:

- the dam foundation should have the minimum safety factor of 4.0 against shear force caused by seismic acceleration; and,
- the tensile force should not act at the upstream side of the dam body against seismic acceleration.

253. A concrete gravity dam designed in accordance with modern technical requirements will not immediately collapse due to the severest earthquake, even if cracks develop in the dam wall. Accordingly, there is no possibility that the probable earthquake will cause complete failure of the dam. If an earthquake occurs, immediately after the occurrence of a severe earthquake, THL shall conduct an emergency inspection of the dam involving;

- inspection of the outside appearance of the dam body, to determine whether conspicuous cracks are induced by earthquake, or not;
- inspection of displacement of the dam body, to determine whether conspicuous change in displacement of the dam body is observed, or not; and,
- inspection in the galleries to determine whether water leakage from joints and/or drainage holes has increased or not, whether there are uplift changes or not, and any other significant changes in measured values of instruments installed in the dam body.

254. If damage is identified that may lead to a dam failure, THL shall lower the reservoir water level, after notifying downstream communities of an expected increase in the river water level

and shall issue an evacuation advisory to riverine communities. The maximum rise in the river water level, assuming that the Tanahu dam disappears instantaneously and stored water with the full supply level flows down the Seti River is estimated as a flood of 47,500 m^3/s occurring for about 90 minutes. In this case, the maximum water level at the confluence of the Seti and Madi Rivers is estimated at 330 m asl (this is addressed in the Water Release and River Safety Management Plan. As noted in that Plan, people living close to the river (near Damauli township) would be able to take safe refuge on land above 330 m asl, in the event of catastrophic dam failure.

255. *Flood risk enhanced by spoil bank*: The potential for spoil disposal to increase river levels, and thereby alter the path of river flows, and in turn cause downstream riverbank erosion, has been assessed by modeling upstream flow depth increases that are likely to result from the use of the two main spoil disposal sites, I to V. This is discussed below.

256. *Influence on upstream areas*: The relationship between river discharge rate and water level was calculated for: (i) existing conditions; and, (ii) following disposal of spoil at sites I to V. Thirty-six river sections were established along a predetermined stretch of the Madi River and Seti River, to determine the possible rise in water levels due to the use of spoil disposal areas (the details are provided in the Environmental Addendum, 2012).The main findings of the estimation of Madi River and Seti River level changes with the use of spoil disposal sites I toV are:

(i) the use of spoil disposal sites I and II will only increase river depth slightly for river discharges of 1,000 m^3/s and less, equal to a 2-year probable flood event, as the spoil disposal landforms will only marginally constrict the river at these depths;
(ii) a 2,000 m^3/s river discharge, equal to a 20-year probable flood, will raise the river water level next to the disposal areas by up by 2m, but the water level at the upstream end of disposal site I will not rise;
(iii) a 3,000 m^3/s river discharge, equal to a 50-year probable flood, will raise the river water level next to the disposal sites and at the upstream end of disposal site I by 3m and 1m, respectively;
(iv) a 5,000 m^3/s river discharge, equal to 300-year probable flood, will raise the river water level next to the disposal sites and at the upstream end of disposal site I by 6m and 4m, respectively.
(v) use of the disposal areas III-V hardly affects river water levels adjacent to the disposal areas;
(vi) slopes of disposal areas III-V will be protected with rock gabions up to the water level corresponding to a 100-year probable flood; and,
(vii) disposal area IV will not be submerged for a flood of 13,000 m^3/s, corresponding to PMF, at the confluence of the Seti and Madi Rivers (converted from the ratio of catchment area at the Tanahu dam site and the confluence).

257. *Influence on downstream areas*: The use of spoil disposal sites I and II will narrow the Madi River cross-section as described above, thereby obstructing larger river flood flows. This restriction in the river section will elongate the flood duration and peak flow a bit.

258. The ESMU will develop Incident Management and Emergency Response Procedures for review by THL. Once the procedures have been approved by THL, the ESMU will implement the procedures, and will undertake monthly safety audits of all major Project structures and sites (the costs covered by the Project operations budget). Furthermore, the ESMU shall minimize potential Project induced hazards by:

- developing and implementing a comprehensive dam safety surveillance program;

- developing and implementing an ongoing public education program warning local communities of changed hydrological conditions below the dam wall and tailrace outlet and the dangers associated with electricity;
- installing warning sirens and erecting warning signs between the dam and Trisuli River warning of fluctuating river levels (see the Water Release and River Safety Management Plan described previously); and,
- prohibiting public access to the dam wall, power station, switching yard, and tailrace outlet.

7.6.3.5 Workforce Safety

259. Workers might be injured by electrical equipment, dam equipment, or vehicles. The ESMU will minimize the potential for worker accidents by providing (costs included in the Project operations budget):

- safety training to employees;
- appropriate protective clothing to employees (e.g. hard hats, boots, gloves, goggles, and ear muffs); and,
- first-aid kits and fire extinguishers at all work sites.

8. Complaint Handling and Grievance Redress

8.1 Complaint Handling

8.1.1 Project Construction - CC

260. The CC will maintain a "*Complaints Register*", recording all complaints received from individuals or groups within the community, either written or verbal. Each record shall detail:

- the name of the complainant;
- the time and date the complaint was received;
- an explanation of the specific complaint;
- the signature of the complainant;
- the signature of the employee who recorded the complaint;
- the person assigned to manage resolution of the complaint;
- the response action taken to resolve the complaint; and,
- the outcome.

261. The CC shall advise the ESMU of a significant complaint within 24 hours of receiving the complaint, and report minor complaints to the ESMU on a weekly basis. The CC, in conjunction with the ESMU and THL when necessary, shall deal appropriately with all complaints to resolve them in a timely manner.

8.1.2 Project Construction - ESMU

262. The ESMU will maintain a "*Complaints Register*", recording all complaints received from individuals or groups within the community, either written or verbal, providing the same details as listed in Section 8.1.1 above. The ESMU will inform THL of a significant complaint (i.e. affecting safety, livelihoods, or creating/potentially creating a significant bio-physical impact on the environment) within 48 hours of receiving the complaint, and report minor complaints to THL on a weekly basis. The ESMU, in conjunction with THL when necessary, shall deal appropriately with all complaints to resolve them in a timely manner.

8.2 Grievance Redress Mechanism

263. A grievance redress mechanism (GRM) will be established to receive and facilitate the resolution of affected people's (AP) concerns, complaints, and grievances on social and environmental issues. The GRM aims to be proactive and accessible to APs for an effective way to address their concerns. The GRM will have three levels with time-bound schedules to function, as noted below.

264. *First level of GRM*: The Public Information Centre (PIC) at the VDC level will be the first level of intervention to address the grievance. Many grievances can be resolved by providing correct and complete information. The PIC will have full-time staff representing the EA and IA, with full authority to listen and provide information to APs and resolve their issues. The PIC officer may seek the assistance of the supervision consultant safeguards specialists to help resolve the issue. The PIC will fully document the complaint, including: (i) name of the person; (ii) date the complaint was received; (iii) nature of the complaint; (iv) location; and, (v) how the complaint was resolved. These reports will be submitted to the PMO and to the ESMU each month.

265. *Second level of GRM*: Should the grievance remain unresolved, the PIC officer will forward the complaint to the ESMU. The person filing the grievance will be notified by the officer that his/her grievance was forwarded to the ESMU. Grievances will be resolved through on-going interaction with the affected persons, with the ESMU answering queries and resolving grievances regarding various issues such as social and livelihood impacts and environmental issues. The ESMU will undertake corrective measures at the field level for environmental, social and livelihood issues. The ESMU staff will fully document the following information: (i) name of the person; (ii) date the complaint was received; (iii) nature of the complaint; (iv) location; and, (v) how the complaint was resolved.

266. *Third level of GRM*: Should the grievance remain unresolved, the issue will be referred to the Grievance Redressal Committee (GRC). The GRC will be headed by ESMU and shall consist of members of the concerned VDC, affected persons, NGOs and local area committee. The affected person can present his or her concerns/issues to the GRC. All relevant costs of GRC will be borne by the project. The GRC will meet, as necessary, when there are grievances to be addressed. The GRC will suggest corrective measures at the field level and assign clear responsibilities for implementing its decision in a timely manner as decided. The ESMU will be responsible for processing and placing all papers before the GRC, recording decisions, issuing minutes of the meetings, and taking follow-up action to ensure that formal orders are issued and decisions are carried out.

267. If each of the above measures fails, the affected person can seek legal redress of the grievance in the appropriate courts, which is the formal legal court system.

9. Supervision, Monitoring, and Reporting

9.1 Site Supervision

268. Strict supervision of Project construction activities is required to ensure that works are undertaken in accordance with the detailed Project design, environmental plans, permits,

approvals, contract conditions, and the principles outlined in this EMP. A system of reviews, approvals, and reporting shall be implemented, as described below.

9.1.1 Pre-construction Phase

269. Pre-construction inspections of each Project site shall be jointly undertaken by the ESMU and CC, once the CC has surveyed and pegged each site. These inspections will serve to:

- confirm the location of Project sites;
- identify site specific construction and environmental issues;
- identify trails and services that will be temporarily cut during construction and shall be temporarily connected during construction and/or reinstated upon the completion of construction;
- identify stockpile sites and spoil and waste disposal areas; and,
- plan construction phasing at Project sites.

270. During the inspection, the ESMU and CC shall discuss and agree upon the above issues. In particular, the ESMU will document the type and location of all trails and services that are to be temporarily disconnected, and provide a copy of this to the CC. The CC shall sign off on the trails and services that are to be reinstated, and return a signed copy of the description of services to the ESMU.

9.1.2 Construction Phase

271. The ESMU shall undertake daily, weekly and monthly inspections of construction sites and work areas, and monthly inspections of workforce camps during the construction period. This will involve the protocols described below.

272. *Daily Environmental Inspections*: The ESMU will inspect the following works in progress:

- vegetation clearance;
- excavation activities;
- stockpiling; and,
- spoil disposal.

273. If any activities are not being undertaken in accordance with the contract and EMP conditions, the CC shall be instructed by the ESMU to rectify the situation, and the ESMU shall undertake a follow-up inspection to ensure that it has been rectified. Blasting and rock crushing activities will also be inspected when they are occurring. All drainage works and erosion and sediment controls will be inspected after each major storm event.

274. *Weekly Environmental Inspections*: The ESMU will undertake weekly inspections, accompanied by the CC, of all the sites and activities inspected during the daily inspections, as well as the following Project components, sites and activities:

- drainage works;
- erosion and sediment controls;
- tunneling;
- chemical, fuel and explosive storage;
- oil separators;
- refueling areas; and,
- site rehabilitation works.

275. If any of these sites or activities are not in accordance with the contract and EMP conditions, the ESMU will document these and specify corrective measures in the Weekly Report. The ESMU will provide a copy of the Weekly Report to the CC within two days of the inspection, for appropriate action, and the CC shall undertake all actions as specified.

276. *Monthly Environmental Inspections*: The ESMU shall undertake a monthly inspection of all workforce camps and work sites in use over the preceding month. The adequacy of services provided at work sites and workforce camps will be inspected, as well as any on-site or off-site environmental degradation caused by camp or workforce activities. If any activities are not being undertaken in accordance with the contract and EMP conditions, the ESMU shall document these activities and specify corrective measures in the Monthly Report. The ESMU will provide a copy of the Monthly Report to the CC within two days of the inspection, and the CC shall undertake all actions as specified.

277. *Pre-monsoon Drainage Inspection*: The ESMU will undertake a joint pre-monsoon inspection of Project sites, in conjunction with the CC, to review monsoon drainage controls in the last two weeks of May each year. The ESMU shall specify the locations and types of any additional drainage and erosion and sediment controls that are required, and provide a written copy of these to the CC. The CC shall install the specified works prior to June 10.

9.1.3 Post-Construction Phase

278. The ESMU shall undertake a post-construction certification inspection of each completed Project site. The ESMU shall inspect all reinstated access and local services and the re-vegetation of all temporarily disturbed land. The ESMU shall certify each Project site if it is in accordance with all contract and EMP conditions, or provide a written list of remedial actions to the CC to be completed prior to certification.

9.2 Routine Environmental Monitoring

279. Environmental monitoring will occur during Project design/pre-construction, construction and operation, to provide baseline data, confirm project compliance and to detect any adverse impacts/non-compliances. The environmental monitoring will also provide valuable new insights into the natural operation of the Seti-Madi River system and related habitats, and the effectiveness of mitigation measures (especially those that are innovative); this particular environmental monitoring is described and budgeted within the four key Management Plans (Sections 7.2 – 7.5). The focus of routine environmental monitoring will be ensuring that construction activities strictly comply with management plan provisions and minimizing any direct and indirect Project environmental impacts. Proposed monitoring during each Project phase is summarized in Table 9.1; this routine environmental monitoring program will require careful coordination with the dedicated monitoring in the four main Management Plans, to ensure synergy between both programs, and to avoid any duplication.

9.2.1 Baseline and On-going Monitoring

280. Environmental parameters at or near Project sites will be monitored by the ESMU through CC. Parameters that will be monitored will include water quality, air quality and noise levels. Baseline monitoring will be conducted during the design/pre-construction phase to fill in baseline data gaps. Monitoring of these parameters will continue over the duration of construction to identify any changes. Regular reports identifying non-compliance with

government standards during Project construction will be prepared by CC and submitted to the ESMU for review.

9.2.2 Internal Monitoring

281. Regular internal environmental monitoring of construction works, associated activities and the implementation of environmental management measures will be undertaken by the CC during project design/pre-construction and construction, as per the frequency set out in Table 9.1. The CC will prepare fortnightly monitoring reports and submit these to the ESMU during project design/pre-construction and construction.

9.2.3 External Monitoring

282. External environmental monitoring of CC activities will be formally undertaken by the ESMU once a month during Project design and construction, although some works will be closely monitored on a daily basis, particularly in the early stages of construction. Monthly monitoring reports will be prepared by the ESMU and submitted to the CC, including directions on what activities require improvement to achieve compliance. MoEST will conduct external monitoring of CC activities if it sees fit, to ensure Project compliance with the EMP, specific project environmental management plans, Project approval conditions and statutory requirements. The ESMU will provide MoEST with all necessary environmental records and arrange for ESMU and CC staff to be available during MoEST site inspections.

9.2.4 Panel of Experts

283. A Panel of Experts will be appointed to provide guidance to the ESMU. The Panel, including an environmental specialist with significant expertise in site environmental management, will provide independent evaluations of Project environmental management during the construction and initial operational phases. Evaluations will entail:

- *Design/Pre-construction*: reviewing detailed Project designs and SEPs; and,
- an inspection of the main Project sites;
- *Construction*: reviewing CC's fortnightly internal monitoring reports;
- reviewing ESMU's monthly and quarterly monitoring reports;
- inspecting all operational construction sites and associated facilities; and,
- liaising with GoN authorities.

9.3 Records

284. Full environmental management records will be kept on site by the CC and ESMU for the full respective periods of their activities. Details are provided below.

9.3.1 Construction Phase

285. The CC will keep records demonstrating environmental compliance during Project construction. The following records shall be kept:

- all necessary permits and approvals;
- proof of employee environmental and safety training;
- a daily record of mitigation measure implementation;
- all environmental monitoring results;
- a record of all maintenance of environmental controls;
- all written instructions and reports provided by the ESMU, including Weekly Reports, Monthly Reports and Audit Reports;
- a register of non-conformances and corrective actions; and,

- all correspondence on environmental management matters, including any complaints received.

286. All records shall be kept at site premises and maintained in a legible state for the full period of construction. Environmental records will be made available to THL, ESMU, DoED, and MoPE, upon request.

9.3.2 Operation Phase

287. The project operation office will keep records demonstrating environmental compliance during the operation of the Project. The following records shall be kept:

- all necessary approvals and permits, including permission for activities on private land;
- proof of employee environmental and safety training;
- results of all environmental monitoring;
- maintenance undertaken;
- all written instructions and reports provided by the ESMU, including Weekly Reports, Monthly Reports and Audit Reports;
- a register of non-conformances and corrective actions; and,
- correspondence.

288. A database of environmental monitoring results will be established. If monitoring results indicate non-conformance, the project operation office shall inform THL immediately, and appropriate remedial action shall be taken. Records shall be kept at site premises and maintained in a legible state. Records will be made available to THL and MoEST, upon request.

Table 9.1. Routine environmental monitoring requirements (Hydropower Plant).

Feature / Issue	Methods and Scope	Parameter	Location	Respons-ibility	Time/ Frequency
Pre-Construction Phase					
Climate	Baseline monitoring (measurement)	Rainfall, temperature	Dam site	CC	Daily
Air Quality	Baseline Monitoring (sampling, measurements and tests)	PM 10 and PM 2.5	three sites (Beltar, Jhapu Tar, Benitar)	CC	Dry Season (2013-2014)
Noise	Baseline Monitoring (measurements at the site)	noise pressure level in dBA	three sites (Beltar, Jhapu Tar, Benitar)	CC	Once (2013-2014)
Water Quality	Baseline Monitoring (sampling and tests)	Ambient Temperature (^{o}C), pH, Conductivity (µmhos / cm), Total Suspended Solids (mg/l), Total Phosphorus (mg/l), Total Kjeldahl Nitrogen (mg/l), Ammoniacal Nitrogen, (NH_3 – N) (mg/l), Nitrate Nitrogen (NO_3 – N) (mg/l), Nitrite Nitrogen, (NO_2 – N) (mg/l) Dissolved Oxygen (mg/l), Biological Oxygen Demand (BOD5 @ 20^{o}C) (mg/l), Chemical Oxygen Demand (CODCr) (mg/l), Total Sulphate (mg/l), Fecal Coliform Count	W1-W9 (9 points) and 3 on Madi River (potential habitat offset)	CC	4 times / year

Feature / Issue	Methods and Scope	Parameter	Location	Respons-ibility	Time/ Frequency
		(MPN Index / 100ml)			
Construction Phase					
Statutory Responsibilities	Compliance monitoring for licence and permit conditions		All Project sites	ESMU(THL)	Weekly
Climate	Baseline monitoring (measurement)	Rainfall, temperature	Dam site	ESMU(THL)	Daily
Noise	Impact Monitoring (measurement)	Noise pressure Level in dBA	three points - Beltar, Benitar and Jhaputar	CC	3 times/year x 5 years
Air Quality	Impact Monitoring (sampling, measurements and tests)	PM 10 and PM 2.5	three sites (Beltar, Jhapu Tar, Benitar)	CC	Three times a year (Dry season) x 5 years
Water Quality	Compliance monitoring for effluent discharge (sampling and test)	Ambient Temperature (^{o}C), pH, Conductivity (µmhos / cm), Total Suspended Solids (mg/l), Total Phosphorus (mg/l), Total Kjeldahl Nitrogen (mg/l), Ammoniacal Nitrogen, (NH_3 – N) (mg/l), Nitrate Nitrogen (NO_3 – N) (mg/l), Nitrite Nitrogen, (NO_2 – N) (mg/l) Dissolved Oxygen (mg/l), Biological Oxygen Demand (BOD5 @ 20^{o}C) (mg/l), Chemical Oxygen Demand (CODCr) (mg/l), Total Sulphate (mg/l), Fecal Coliform Count (MPN Index / 100ml)	6 points (Effluent points at the construction site)	CC	4 times / year x 5 years
	Compliance monitoring for drinking water (sampling and test)	Ditto	6 points (Drinking water source and tap water)	CC	3 times / year x 5 years
Spring	Impact Monitoring (visual observation and hearing)	Water Volume, Photo	5 Springs	CC	4 times/ year x 5 years
Building Survey	Impact Monitoring (visual observation)	Damage condition	Buildings near the construction site	CC	4 times/ year x 5 years
Waste Management	Compliance Monitoring (visual observation)	· Waste materials reused or recycled on-site where possible · Non-recyclable wastes disposed of appropriately	All Project sites	ESMU(THL)	Weekly

Feature / Issue	Methods and Scope	Parameter	Location	Respons-ibility	Time/ Frequency
Hazards/Risk	Compliance Monitoring (visual observation)	· Workers provided with appropriate safety equipment and regular safety training · Use of hazardous goods according to manufacturers' specifications · Explosives stored in guarded bunkers · Storage of hazardous goods in bunded areas or in secure sheds · Maintenance of downstream warning signs and sirens	All Project sites	ESMU(THL)	Weekly
Workforce Management and Safety	Compliance Monitoring (visual observation)	· Enforcement of workforce rules and regulations · Provision of adequate and well maintained services and facilities · Provision of alternative fuels for cooking, heating and light	All Project sites	ESMU(THL)	Weekly
Traffic/Access	Compliance Monitoring (visual observation)	· Enforcement of speed limits on Project roads	All Project roads	ESMU(THL)	Weekly
Vegetation	Baseline monitoring (quadrat survey) prior to inundation	Protected species, Number of species, invasion species	8 locations	ESMU(THL)	one time/year x 2 years (1st year and 3rd year)
Terrestrial fauna	Baseline monitoring (visual observation and sampling for mammals, reptiles, birds, and butterflies) prior to inundation	Protected species, Number of species, invasion species	8 locations	ESMU(THL)	one time/year x 2 years (1st year and 3rd year)
Aquatic Ecology	Baseline monitoring (fish net)	Protected species, Number of species, invasive species	F1-F9 and 3 on Madi River	ESMU(THL)	2 times/year x 2 years (1st year and 3rd year)
Land Use	Baseline Monitoring (Satellite Image analysis, , 0.6m/pixel, color)	Forest area, illegal logging, land slide etc.	2km around the reservoir area	ESMU(THL)	1 time (5th year)
Operation Phase					
Statutory Responsibilities	· Compliance with licence and permit conditions		All Project sites	ESMU(THL)	Every 6 months
Climate	Baseline monitoring	Rainfall, temperature	Established catchment	ESMU(THL)	Daily

Feature / Issue	Methods and Scope	Parameter	Location	Respons-ibility	Time/ Frequency
	(measurement)		monitoring stations		
Hydrology	Baseline Monitoring	River flow volume	Seti River – upstream of the reservoir, between Madi confluence and tailrace outlet, downstream of tailrace outlet; reservoir – in the water column near the headrace intake; riparian flow immediately below the riparian outlet	ESMU(THL)	Daily
Reservoir Foreshore Stability	Impact monitoring	· Landslides and slope stability	Reservoir foreshore	ESMU(THL)	Every six months (first 5 years)
Water Quality	Baseline Monitoring (sampling and tests)	Ambient Temperature (^{o}C), pH, Conductivity (µmhos / cm), Total Suspended Solids (mg/l), Total Phosphorus (mg/l), Total Kjeldahl Nitrogen (mg/l), Ammoniacal Nitrogen, (NH_3 – N) (mg/l), Nitrate Nitrogen (NO_3 – N) (mg/l), Nitrite Nitrogen, (NO_2 – N) (mg/l) Dissolved Oxygen (mg/l), Biological Oxygen Demand (BOD5 @ 20^{o}C) (mg/l), Chemical Oxygen Demand (CODCr) (mg/l), Total Sulphate (mg/l), Fecal Coliform Count (MPN Index / 100ml)	W1-W9 (9 points) and 3 on Madi River (potential habitat offset)	ESMU(THL)	4 times / year
Vegetation	Baseline monitoring (quadrat survey)	Protected species, Number of species, invasion species	8 locations	ESMU(THL)	1 time/2 years
Terrestrial fauna	Baseline monitoring (visual observation and sampling for mammals, reptiles, birds, and butterflies)	Protected species, Number of species, invasion species	8 locations	ESMU(THL)	1 time/2 years
Aquatic Ecology	Baseline monitoring (fish	Protected species, Number of species, invasion species	F1-F9 and 3 on Madi	ESMU(THL)	1 time/2 years

Feature / Issue	Methods and Scope	Parameter	Location	Respons-ibility	Time/ Frequency
	net)		River		
Land Use	Baseline Monitoring (Satellite Image analysis, , 0.6m/pixel, color)	Forest area, illegal logging, land slide etc.	2km around the reservoir area	ESMU(THL)	1 time /5 years
Sedimentation	Impact monitoring (River cross section measurement)	Sedimentation condition	2 points (upper end of the reservoir) and 5 points (downstream of the outlet)	ESMU(THL)	1 time/year

10. Auditing

10.1 Site Audits

289. Site audits will be undertaken, to independently verify the compliance of Project activities and controls with Government standards and the conditions set out in Project environmental plans.

10.1.1 Construction Phase

290. *Compliance audit*: The EMSU, acting as an Auditor, shall conduct a full compliance audit of the CC's operations and all construction and ancillary sites once every three months. Environmental compliance will be audited against the conditions contained in the construction contract, EMP, IMPs, SEPs and permit and approval conditions. The CC shall assign a representative to attend the audit and be responsible for implementing corrective actions.

291. The audit will involve a review of all sites in use or used since the previous audit, any construction and related activities in progress, and the site records. An Audit Report describing the results of the audit shall be prepared by the ESMU and submitted to the CC within two days of audit completion. The Audit Report shall specify any non-conformances and recommend corrective action/s, with dates for completion. The ESMU will follow up on any corrective actions within a reasonable time frame, either signing out the corrective action or requesting completion of the action.

292. *External compliance audit*: The Panel of Experts will undertake an external compliance audit at least once a year during the construction phase to assess the project's compliance with the EMP, the effectiveness of mitigation measures and institutional development, and whether or not any unanticipated effects occurred as a result of project activities.

10.1.2 Operational Phase

293. *Compliance audit*: THL will undertake a compliance audit of all Project sites every six months over the initial three years of Project operation, then annually over the life of the private generation period. Sites and operation activities shall be audited against contract conditions and the EMP. The project operation office shall accompany and assist THL during the audit. An

Audit Report describing the results of each audit shall be prepared by THL and submitted to the project operation office within five days of audit completion. The Audit Report will specify any non-conformances and recommend corrective action/s with dates for completion.

294. *External compliance audit*: MoEST will undertake an external compliance audit after two years of Project operation, to assess the project's compliance with the EMP, the effectiveness of mitigation measures and institutional development, and whether or not any unanticipated effects occurred as a result of project activities. The audit shall be based on a site inspection and the monitoring reports and baseline data prepared/gathered by the CC, ESMU, etc.

10.2 Corrective Action

295. Environmental non-conformances usually require the implementation of corrective actions specified in non-conformance reports. The requirements for these are described below.

10.2.1 Construction Phase

296. The CC will implement the corrective action/s recommended by the ESMU in the time specified. The CC shall then notify the ESMU of the completion of the corrective action/s. The ESMU will verify the satisfactory implementation of corrective actions during the following Weekly Inspection and sign off on the non-conformance/s if satisfactorily rectified, or make a further request, if unsatisfactory.

10.2.2 Operation Phase

297. During Project operation, THL will implement the corrective action/s recommended by the auditing, in the time specified. THL shall then notify the auditor of the completion of the corrective action/s so that the satisfactory implementation can be verified. The THL will verify the satisfactory implementation of corrective actions and sign off on the non-conformance/s, if satisfactorily rectified, or make a further request if unsatisfactory.

10.3 Incident Management Procedures

298. The CC and the THL will prepare Incident Management Procedures for their respective Project phases. During employee environmental training, the CC / THL shall emphasize the importance of documenting all environmental incidents. The CC shall immediately report all incidents to the ESMU. These incidents may include:

- theft or misplacement of explosives;
- construction activities undertaken outside approved sites;
- damage to private or Government structures or land;
- hazardous material spills; and,
- forest or grass fires.

299. The CC / THL shall investigate and act on all incidents by:

- identifying the cause of the incident;
- identifying and implementing necessary corrective action(s);
- identifying personnel responsible for carrying out corrective action(s);
- implementing or modifying controls necessary to avoid repetition; and,
- recording any changes required in written procedures.

10.4 Emergency Response Procedures

300. The CC and THL will develop and implement *Emergency Response Procedures* for the Project for their respective construction and operation phases. The following steps shall be included in the procedures.

Define the Problem:

- The immediate problem is established, to facilitate a review of available options for short-term action.

Manage the Situation:

- The safety of any persons, either workers or others involved in Project construction or operation, is to be ensured as a first priority.
- Environmental damage is to be quickly minimized. All emergency action should take place as soon as possible after the event.

After the Event:

- The EMSU/THL shall be contacted immediately, once all persons are safe and any possible immediate actions to control damage and manage the situation have been taken.

301. A rectification plan will be developed by the ESMU/THL, detailing how any remaining environmental effects will be remedied.

References

Ministry of Environment, Science and Technology, 2006. *A Guide to Environmental Management Plan of Hydropower Projects*. Ministry of Environment, Science and Technology, Kathmandu.

Nepal Electricity Authority, 2012. *Upper Seti (Tanahu) Hydroelectric Project Environmental Addendum*. Prepared by Nepal Electricity Authority for the Asian Development Bank.

Nepal Electricity Authority, 2009. *Environmental Impact Assessment of the Upper Seti Storage Hydroelectric Project: Final Report*. Environmental and Social Studies Department, Engineering Services, NEA.

Appendix A: Summary of Environmental Management Measures for the Dam and Reservoir.

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
Main Issue Management Plans (spanning pre-construction and construction)						
Fish Conservation Management Plan	Loss of fish habitat and obstruction of migrating fish.	S,P	• Establish the hatchery techniques. • Field Survey and identification of hatchery site. • Physical facility construction. • Operation hatchery. • Distribution of fingerlings to the reservoir. • Hatchery capacity building. • Experimentation with a "catch-and-haul" program. • Habitat survey and management. • Identification of compensating fish habitat for protection. • Public awareness-raising and education. • Fishing controls: establish a reporting system for fishing methods such as electrical fishing and/or dynamite fishing in the Madi and Seti basin. • Water pollution control: check the river water quality regularly and if any pollution is detected, identify the source and take action for them in cooperation with other agencies (biomass clearing of reservoir area before flooding will help address low oxygen concerns and methane production in reservoir). • Solid waste control: establish a reporting system of disposal of solid waste into the river or on the river bank. If any problems are detected, take action with other	$539,718 (consulting services) $1,322,440 (fish hatchery)	THL-ESMU NARC NGO (IUCN, WWF, etc.)	Audit condition

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
			responsible organization. • River bed mining control: patrol the Madi and Seti basin periodically and check whether it might cause serious effects on fish. • Examine the technical feasibility of a "switchback" fish pass.			
Water Release and River Safety Management Plan	Risk to downstream communities and river users, due to rapid water level changes. Risk of deteriorated water quality below dam.	S, but difficult to predict (T)	• Survey of downstream water users and critical points along river. • Technical assessment of equipment (e.g. types of lights and sirens)options and preparation of river safety program. • Installation/testing of equipment. • Prepare and broadcast local radio programs and disseminate information materials. • Hold explanation meetings. • Operation and testing of water gauge plates, sirens, light posts; routine use. • Design and construction of a boulder field immediately below the dam for aeration of release water and suspension of sediments. • Related monitoring of effectiveness. • Detail consultation with rafting associations and prepare mitigation measures for any potential impacts	$337,980 (consulting services)	THL-ESMU	Audit condition; site inspections
Wildlife Conservation and Awareness Management Plan	Wildlife habitat loss, possible segmentation of potential wildlife corridors.	MS, T	• Wildlife survey. • Identification of possible habitats. • Environmentally sound design of habitat access arrangements (for example, suspension bridges). • Animal encounter protocol (standing contract for animal rescue). • Coordination with forest management planning. • Monitoring of effectiveness of measures. • Public awareness-raising and education.	$504,780 (consulting services)	THL-ESMU NGO (IUCN, WWF, etc.)	Audit condition

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
Watershed/Forest Management Plan	Forest loss; impact of habitat loss on terrestrial fauna.	MS, P	• Support to legal aspects of forest compensation. • Tree measurements in reservoir. • Preparation of the afforestation plan. • Land acquisition for nursery. • Monitor the tree cutting program. • Nursery/ supervision of tree planting. • Coordination with wildlife habitat plan. • Monitoring. • Public awareness-raising and education regarding watershed management.	$357,679 (consulting services) $18,034,600 (compensation and afforestation)	THL/ESMU NGO (IUCN etc.)	Audit condition
Phase-Specific Actions						
1. Pre-Construction Period						
Commencement of land and building acquisition and leasing	112 ha and 86 households affected.	MS, P	• Identified and negotiated resettlement plan and compensation.	Part of construction cost	THL	Resettlement agreement/ compensation
Protection of local village services	None observed in reservoir area, but contingency if identified.	NS	• Temporary replacement of services.	Part of construction cost	THL	Resettlement agreement/ compensation
Commencement of resettlement activities	Positive action.	+	• As identified in Project Resettlement and Indigenous Peoples Plan	Part of construction cost	THL	Resettlement agreement/ compensation
Finalization of the project employment strategy	Positive action.	+	• Local hiring, to the extent possible.	Part of construction cost	THL	THL strategy
Commencement of staff training	Positive action.	+	• Construction staff aware of all environmental requirements.	Part of construction cost	THL	THL strategy
2. Construction Period						
Air quality control	Dust impact around the land clearing areas and all construction sites. Air pollution by construction vehicles	MS, T	• Providing ventilation in all confined areas (i.e. tunnels and power station cavern). • Providing breathing protection masks for employees, where required. • Using dust suppression methods such as water spraying.	Part of construction cost	CC	Condition of the Construction contract/ site inspections

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
	and transporter vehicle.		• Covering or seeding stockpiles retained for longer than one month, or during monsoon season. • Gravelling the main Project access roads and adjacent community roads. • On-site speed restrictions for construction traffic. • Frequent watering of project access roads each day when visible dust is generated, primarily during the dry season. • Erection of roadside fences near houses/villages to reduce windborne dust movement. • Vehicle washing prior to leaving the site; • Careful handling and containment or damping of dusty materials on site, including the use of dust suppression/filtering on crushing and batching plants. • Maintaining and operating equipment in accordance with manufacturers' specifications. • Managing work sites and workforce camps to minimize odor generation. • Progressive site re-vegetation as each tower base is completed.			
Noise control	Noise generated from cut-and-cover activities, excavation, back filling and construction of above ground structures, as well as construction vehicles. Vibration generated from and drill & blast	MS, T	• Locating stationary plant (e.g., generators) as far away as possible from local villages and workforce camps. • Maintaining all equipment to manufacturers' specifications. • Fitting mufflers to road vehicles and construction equipment. • Providing ear muffs to workers operating high decibel equipment or working in close proximity to this equipment.	Part of construction cost	CC	Condition of the construction contract/ site inspections

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
	activities in the dam, tunnel and powerhouse.					
Water quality control	Water pollution from siting of all land based construction activities including temporary facilities	MS, T	• Set up a settlement pond, treatment plant, or other relevant facilities at work sites, workforce camps, batching plants and other temporary facilities for construction works	Part of construction cost	CC	Condition of the construction contract/ site inspections
	Eutrophication in the reservoir.	MS, T	• Fraction fence (deflecting high nutrient water to deeper depths in reservoir) and installation work.	Part of construction cost	CC	Condition of the construction contract/ site inspections
	Water pollution from construction sites and camp site.	MS, T	• Pit toilets at construction sites and temporary camp sites around the dam and reservoir locations. • Standard toilets at camps with a central wetland type treatment facility.	Part of construction cost	CC	Condition of the Construction contract/ site inspections
	Drains and erosion and sediment control. Turbid water from construction site.	MS, T	• Topsoil saving. • Excavation controls. • Stockpiling of materials. • Settlement pond for aggregate washing. • Sedimentation tanks to arrest the TSS; regular maintenance.	Part of construction cost	CC	Condition of the Construction contract/ site inspections
Land stability	Landslides associated with the terrace materials in the upper reservoir area.	S, P	• Gabion at the high risk landslide areas. • Drain and erosion and sediment control measures. • Topsoil saving. • Excavation. • Stockpiling.	Part of construction cost	CC	Condition of the Construction contract/ site inspections

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
Spoil bank management	Soil erosion, flooding around the spoil bank.	MS, T	• Disposal of excess spoil at designated and pegged spoil disposal areas that have been approved by the ESU. • No side-casting of excess spoil over the edge of excavation sites or placing spoil in drainage lines or watercourses, above houses or at other sites where it is likely to cause damage to structures or natural features. • The CC shall instruct the construction workforce on the approved fill disposal locations and supervise the correct placement of fill at sites. • Topsoil (where present) stripping and stockpiling prior to spoil placement. • Progressive installation of retaining structures, benches and drains to ensure landform stability and minimize erosion and sedimentation. This will include stabilizing the toe of the spoil disposal sites that front onto the Madi and Seti rivers using rock gabion walls, and benching the fill batters of each disposal area that exceeds 7 m in height. • Layering and compaction of spoil as the material is placed, with daily inspection by the ESU. • Topsoil spreading and site re-vegetation of the final landform. • The ESU will inspect and approve the final land shaping at each designated spoil disposal site prior to and following top-soiling.	Part of construction cost	CC	Condition of the Construction contract/ site inspections

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
Waste management	Water pollution from construction waste and aesthetic concerns from solid waste.	MS, T	▪ Regular solid waste collection with vehicles, to approved land fill sites. ▪ Proper storage and handling of all construction materials and waste.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Hazards management	Worker safety risks from accidents and chemicals.	MS, T	• Safety training to each employee as it relates to his/her job at the commencement of employment and refresher workshops as required. • Appropriate relevant safety equipment to each employee. • Safety equipment at each work site, including fire-fighting equipment. • First aid facilities at all Project sites. • Security fences around all work sites and workforce camps, and hazardous locations on construction sites. • Designated and signed paths around and through construction sites, work sites and workforce camps.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Workforce management and safety	As above.	+	• As above.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Traffic and access control	Vehicle congestion on small rural roads.	NS, T	• Identification of project access roads, vehicle types, and schedules.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Archaeology management	Potential loss of cultural heritage.	NS, P	• Work stoppage in the event of archaeological remains or other cultural heritage being found along the right-of-way.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Water Supply	Building and pipe damage caused by	MS, T	• Provisional cost for house repairs near the construction site.	Part of construction cost	CC	Condition of the

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
	construction vehicles and blasting. Spring drying (impact on tourism).		• Provisional compensation cost for drying of spring water.			Construction contract/ site inspections
Demobilization management	Positive action.	+	• Organized retreat and clean-up after construction of all dam facilities, powerhouse, and related structures.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Site rehabilitation	Positive action.	+	• Soil management and re-vegetation around all construction sites.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Reinstatement of services	Positive action.	+	• Replacement/ improvement of all displaced village services.	Part of construction cost	CC	Condition of the construction contract/ site inspections
3. Operations and Maintenance Period						
Sedimentation management	Backwater effects of the reservoir.	NS, T	• Dozer work for sedimentation removal.	Part of operation cost	THL-ESMU	Audit condition
Hazards	Dam failure by earthquake, floods, landslides (natural disasters).	S, R	• Preparation Disaster Action Manual for the workers. • Preparation Disaster Action Plan for people in the possible affected area. • Information disclosure to the people in the possible affected area.	Part of operation cost	THL-ESMU	Regular checking of DAP.
Training	Positive action.	+	• Ongoing training of workers regarding safety and environmental management measures (but few staff during operational phase).	Part of operation cost	THL-ESMU	Audit condition
Workforce safety	Positive action.	+	• As above.	Part of operation cost	THL-ESMU	Audit condition

S - Significant impact, MS - Moderately significant impact, NS - Not significant impact, T - Temporary impact, P - Permanent impact, R – Rare, + - Positive Impact.

Appendix B: Statutory Requirements

Environmental Legislation

302. The Environmental Protection Act, 1996, and Environmental Protection Rules is the main umbrella Act and Rules in Nepal, which covers almost all aspects of environment. Ministry of Environment, Science and Technology is the lead agency, which administers the environmental matters emphasising on environmental conservation and management through internalising environmental assessment system, pollution control and prevention, conservation of natural heritage sites, compensation for environmental damages etc. However, there are several other policies, guidelines, acts and rules which relate to construction and operation of TANAFU HEP and should comply with the provisions by the involved parties during the period. The relevant Government of Nepal legislation and government policies and guidelines affecting and applicable to the project are listed below:

- Environment Protection Act, 2053 (1997)
- Environment Protection Regulations, 2054 (1997)
- National Environmental Assessment Guidelines, 2050 (1993)
- EIA Guidelines for Forestry Sector, 2052 (1995)
- Draft EIA Guidelines for Water Resources Sector, 2052 (1995)
- Forest Act, 2049 (1993) and Forest Regulations, 2052 (1995)
- Forestry Sector Policy, 2054 (1997)
- Soil & Water Conservation Act, 2039 (1982)
- National Parks & Wildlife Conservation Act, 2029 (1973)
- Aquatic Animals Protection Act, 2039 (1982) & Amendment, 2055(1999)
- Electricity Act & Regulations, 2050 (1992)
- Land Acquisition Act, 2034 (1977)
- Water Resources Regulations, 2049 (1993)
- Local Self Governance Act, 2055 (1999) & Regulations, 2056 (2000).
- Explosives Act, 1961;
- Vehicle and Transportation Management Act, 1992;
- Labor Act, 1991;
- Solid Waste (Management and Resource Mobilization), Act, 1986;
- Public Roads Act, 1974;
- Hydropower Development Policy, 2002
- Electricity Development and Management Act 2062 (2005)

303. Since Tanahu HEP study will be financed by ADB and JICA, it also requires compliance with the ADB safeguards and JICA guidelines for environmental and social considerations.

Environmental Standards

304. There are very few environmental standards endorsed by MOEST and other GON line agencies. Except for vehicular emissions standards and tolerance limits for inland effluent discharge, most of the environmental pollution standards, are in the formulation process. Considering the above situation following environmental standards are proposed for TANAFU HEP construction and operation. These environmental standards shall be treated as other acts and regulations until GON enforces standards in the specified sector for the project environmental compliance propose.

Table A1. Standards for Effluents Discharged into Inland Waters from the Construction Sites and Camps.

SN	Parameters	Tolerance Limits
1.	Total Suspended solids, mg/L, Max	30-200
2.	Particle size of total suspended particles	Shall pass 850-micron Sieve.
3.	pH	5.5 to 9.0
4.	Temperature	Shall not exceed 40 degree C in any section of the stream within 15 meters down-stream from the effluent outlet
5.	Biochemical oxygen demand (BOD) for 5 days at 20 degree C, mg/L, Max	30-100
6.	Oils and grease, mg/L, Max	10
7.	Phenolic compounds, mg/L, Max	1
8.	Cynides (as CN), mg/L, Max	0.2
9.	Sulphides (as S), mg/L, Max	2
10.	Radioactive materials:	
11.	a. Alpha emitters, c/ml, Max	7 OCT
12.	b. Beta emitters, c/ml, Max	8 OCT
13.	Insecticides	Absent
14.	Total residual chlorine, mg/L	1
15.	Fluorides (as F), mg/L, Max	2
16.	Arsenic (as As), mg/L, Max	0.2
17.	Cadmium (as, Cd), mg/L, Max	2
18.	Hexavalent chromium (as Cr), mg/L, Max	0.1
19.	Copper (as Cu), mg/L, Max	3
20.	Lead (as Pb), mg/L, Max	0.1
21.	Mercury (as Hg), mg/L, Max	.01
22.	Nickel (as Ni), mg/L, Max	3
23.	Selenium (as Se), mg/L, Max	0.05
24.	Zinc (as Zn), mg/L, Max	5
25.	Ammonical nitrogen, mg/L, Max	50
26.	Chemical Oxygen Demand, mg/L, Max	250
27.	Silver, mg/L, Max	0.1

Source: Standards adopted from MOEST

Table A2. Drinking Water Quality Standards for Construction Camps and Construction Sites.

SN	Parameters	Desirable Limits	Maximum Tolerable Limit
1.	Colour, Hazen units, Max	10	15
2.	Odour	Unobjectionable	
3.	Taste	Agreeable	
4.	Turbidity, NTU, Max	5	10
5.	Total Dissolved Solids, mg/l , Max	500	1500
6.	pH value	6.5 – 8.5	May be relaxed up to 5.5 on the lower and up to 9 on higher side.
7.	Total Hardness (as $CaCO_3$) mg/l, Max	250	
8.	Calcium (as Ca), mg/l, Max	75	
9.	Magnesium (as Mg), mg/l, Max	30	
10.	Copper (as Cu), mg/l, Max	1	may be extended up to 1.5
11.	Iron (as Fe), mg/l, Max	0.3	
12.	Manganese (as Mn), mg/l, Max	0.1	may be extended up to 0.5
13.	Chlorides (as Cl), mg/l, Max	250	
14.	Sulphate, (as SO_4), mg/l, Max	150[20]	
15.	Nitrate (as NO_3), mg/l, Max	45	No relaxation
16.	Fluoride (as F), mg/l, Max	1.5	

[19] Value for turbidity is 5 in FAR(for mineral water), PFA, BS, WHO
[20] Value for Sulphate BS:200, FAR(for mineral water) and PFA:250

SN	Parameters	Desirable Limits	Maximum Tolerable Limit
17.	Phenolic compounds, (as C_6H_5OH), mg/l, Max	0.001	May be relaxed up to 0.002
18.	Mercury (as Hg), mg/l, Max	0.001	No relaxation
19.	Cadmium (as Cd), mg/l, Max	0.01	No relaxation
20.	Selenium (as Se), mg/l, Max	0.01	No relaxation
21.	Lead (as Pb), mg/l, Max	0.01	No relaxation
22.	Arsenic (as As), mg/l, Max	0.05	No relaxation
23.	Cyanide (as CN), mg/l, Max	0.05	No relaxation
24.	Chromium (as Cr^{6+}), mg/l, Max	0.05	No relaxation
25.	Residual free Chlorine, (as Cl), mg/l, Min	0.2	
26.	Ammonia, mg/l, Max	1.5	
27.	Aluminium, mg/l, max	0.2	
28.	Boron mg/l, max	0.3	
29.	Nickel, mg/l, max	0.02	
30.	Hydrogen sulphide, mg/l, max	0.1	
31.	Zinc, mg/l, max	3	

Source: Standards adopted from Department of Water Supply & Sewerage

Table A3. Ambient Air Quality Standards in the Project Area.

Parameters	Units	Averaging Time	Concentration in Ambient Air, maximum
TSP (Total Suspended Particulates)	$\mu g/m^3$	Annual	-
		24-hours*	230
PM_{10}	$\mu g/m^3$	Annual	-
		24-hours*	120
Sulphur Dioxide	$\mu g/m^3$	Annual	50
		24-hours**	70
Nitrogen Dioxide	$\mu g/m^3$	Annual	40
		24-hours**	80
Carbon Monoxide	$\mu g/m^3$	8 hours**	10,000
		15 minute	100,000
Lead	$\mu g/m^3$	Annual	0.5
		24-hours	-
Benzene	$\mu g/m^3$	Annual	20****
		24-hours	-

Source: National Ambient Air Quality Standards adopted from MOEST

**Note: 24 hourly values shall be met 95% of the time in a year. 18 days per calendar year the standard may be exceeded but not on two consecutive days.*

***Note: 24 hourly standards for NO_2 and SO_2 and 8 hours standard for CO are not to be controlled before MOPE has recommended appropriate test methodologies. This will be done before 2005.*

****Note: If representativeness can be proven, yearly averages can be calculated from PM10 samples from selected weekdays from each month of the year.*

*****Note: To be re-evaluated by 2005.*

Table A4. Emissions Standards for 'in-use' Vehicles.

Fuel	*Wheelers Type*	*Manufacturing Date*	*Emissions*
Petrol	Four-Wheelers	Up to 1980	• 4.5% CO • 1,000 ppm HC*
	Four-Wheelers	After 1981	• 3.0% CO • 1,000 ppm HC*
	Three-Wheelers	Up to 1991	• 4.5% CO • 7,800 ppm HC*
	Three-Wheelers	After 1991	• 3.0% Co • 7,800 ppm HC*

Fuel	*Wheelers Type*	*Manufacturing Date*	*Emissions*
	Two-Wheelers		• 4.5% CO • 7,800 ppm HC*
Diesel	-	Up to 1994	• 75 HSU
		After 1994	• 65 HSU
LPG/CNG	All categories		• 3.0% CO* • 1,000 ppm HC*

Source

Nepal Gazette, BS 2054-9-8, Ministry of Works and Transport

* *Nepal Gazette, BS 2057-7-7, Ministry of Population and Environment*

CO – carbon monoxide; HC – Hydrocarbon; HSU – Hertridge Smoke Unit

Table A5. Proposed Noise Exposure Limits for the Work Environment.

(Adopted from Occupational Safety and Health Administration (OSHA).

SN	Noise Exposure (dBA)	Permissible exposure (Hours and Minutes)
1.	85	16 hrs.
2.	87	12 hrs. –18 min.
3.	90	8 hrs.
4.	93	5 hrs – 18 min.
5.	96	3 hrs.-30 min.
6.	99	2 hrs. – 18 min.
7.	102	1 hr. – 30 min.
8.	105	1 hr.
9.	108	40 min.
10.	111	26 min.
11.	114	17 min.
12.	115	15 min.
13.	118	10 min.
14.	121	6.6 min.
15.	124	4 min.
16.	127	3 min.
17.	130	1 min.

Source: Marsh, 1991.

Table A6. Proposed Average Equivalent Sound Levels Recommended to Protect the Public Health and Welfare of the Project Site Communities.

S.N.	Land Use	Measure	To Protect Against Activity Interference and Hearing Loss Effects (dBA)
1.	Residential including farm residences	Leq (24)	55
2.	Commercial	Leq (24)	70
3.	Hospitals	Leq (24)	55
4.	Industrial	Leq (24)	70
5.	Educational	Leq (24)	55
6.	Recreational Areas	Leq (24)	70
7.	Farmland and general unpopulated land	Leq (24)	70

Source: U.S, Environmental Protection Agency, 1974
Note: Leq (24)= Equivalent Sound Level in decibels for 24 hours.

Environmental Permits and Approvals

Permits and Approvals relevant to the TANAFU HEP are presented in Table A.7 below.

Table A7. Permits and Approvals Required.

Issues	Authority	Approval and permits
Tree clearing and Government owned land	District Forest Office, Ministry of Forests and Soil Conservation	Permits
Tree clearing in Community Forest	District Forest Office and Forest User Groups	Permit and Approval
Relocation of archaeological , cultural and religious sites	Village Development Committee and Department of Archaeology	Approval
Works on private land and property	Compensation Fixation Committee, Village Advisory Group and Landowner	Approval
Relocation or disturbance to infrastructures such as irrigation canals, water supply, foot trails and tracks, suspension bridges, etc	Respective user committees/Village Development Committee and Ward Office	Approval
Construction of access roads	Department of Roads	Approval

Volume 2b. Environmental Management Plan: Transmission Line Component

Prepared by Nepal Electricity Authority for the Asian Development Bank.

List of Abbreviations

AP	Affected People
CBO	Community Based Organization
CC	Construction Contractor
CDS	Community Development Strategy
CLO	Community Liaison Officer
DDC	District Development Committee
DFO	District Forest Office
DOED	Department of Electricity Development
DOR	Department of Roads
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environment Protection Act
EPR	Environment Protection Rules
ESCP	Erosion and Sediment Control Plan
ESMU	Environmental and Social Management Unit (THL)
ESSD	Environmental and Social Study Department (NEA)
ESU	Environmental Sub-Unit (THL-ESMU)
FSL	Full Supply Level
GESI	Gender Equality & Social Inclusion Plan
GoN	Government of Nepal
GRC	Grievance Redressal Committee
GRM	Grievance Redress Mechanism
IEE	Initial Environmental Examination
IMERP	Incident Management and Emergency Response Procedures
IMP	Issue Management Plans
IUCN	International Union for Conservation of Nature
MoE	Ministry of Energy
MoEST	Ministry of Environment, Science and Technology
MoFSC	Ministry of the Forests and Soil Conservation
MoPE	Ministry of Population and Environment
NARA	Nepal Association of Rafting Agents
NARC	National Agricultural Research Council
NEA	Nepal Electricity Authority
NGO	Non-Governmental Organizations
PIC	Public Information Center
PMO	Project Manage Office
PSC-EMC	Environmental Management Consultant (PSC)
PSC-SMC	Social Management Consultant (PSC)
PSC	Project Supervision Consultant
RoW	Right-of-Way
RP	Resettlement Plan
RSASU	Resettlement and Social Action Sub-Unit (THL-ESMU)
SEP	Site Environmental Plans
THL	Tanahu Hydropower Limited
THP	Tanahu Hydropower Project
USHEP	Upper Seti Hydropower Project
VDC	

PREFACE

The Tanahu Hydropower Project (Nepal) has been in development since at least 2009, at which time a detailed Environmental Impact Assessment (EIA) was prepared for the dam and reservoir on the Seti River in the Western Region. In 2010, an Initial Environmental Examination was also completed for the Transmission Line component of the project (by the Nepal Electricity Authority). Since some technical details and environmental considerations were still unclear in 2010, more detailed surveys and technical assessments were undertaken, with ADB support, in 2011 and 2012. As a result of this consolidating activity, there is now a need to update both the EIA and the Environmental Management Plans (EMPs) that were prepared as part of the original work in 2009 and 2010. These volumes have been prepared, and include the following:

- Volume 1: Updated Tanahu Hydropower Project **Addendum to EIA 2009 and IEE 2010** (for both the dam/reservoir component and the transmission line);
- Volume 2a: Updated **Environmental Management Plan** for the **Dam/Reservoir** Component and,
- Volume 2b: Updated **Environmental Management Plan** for the **Transmission Line** Component (this document);

.

Table of Contents

Tables

Figures

Foreword

The Upper Seti Hydroelectric Project (USHEP) was changed to Tanahu Hydropower Project (THP), to avoid confusion with the proposed West Seti Hydroelectric Project in far western Nepal. The name is derived from Tanahu District, in which all proposed Project structures are located. To avoid confusion, the project is therefore referred to as the “THP” in this report.

1. Introduction

1.1 Background

1. This Environmental Management Plan (EMP) has been prepared for the THP to define project environmental management measures and procedures, thereby helping to ensure that all mitigation measures and monitoring requirements specified in the *Environmental Impact Assessment* (EIA, 2009), the *Transmission Line IEE* (2010) and *Environmental Addendum* (2012) are implemented during each phase of project development and operation. There are two components to the EMP:

- the EMP for the dam/reservoir component; and,
- the EMP for the transmission line.

2. This document is the **transmission line component** and pertains to the activities of NEA (there is a separate document for the THL environmental management of the dam/reservoir component; Environmental Addendum Volume 2a).

3. The EMP outlines the organizational structure of the Environmental and Social Study Department (ESSD) within the National Electricity Authority (NEA) and describes the main roles and responsibilities of the parties involved in project environmental management. This EMP updates and supersedes the EMP contained in the project IEE (2010) and incorporates the management measures contained in the project *Environmental Addendum* (2012); see EIA, Volume 1. All environmental management measures previously proposed in the 2010 IEE are included in this EMP. The EMP also takes into account the findings of the Community Development Strategy (CDS), Resettlement Plan (RP), and the Gender Equality & Social Inclusion Plan (GESI), although such related issues are much less significant for the transmission line, compared to the dam and reservoir.

1.2 Aims of the EMP

4. This EMP has been prepared by the NEA to specify the opportunities for environmental design and the environmental management requirements in the final design, pre-construction, construction, operation and de-commissioning phases of the transmission line component of the THP. This plan clarifies the environmental responsibilities of all parties that will be involved in Project environmental management, and the environmental mitigation measures, monitoring, auditing and reporting that shall be undertaken.

5. The primary aims of the EMP are to:

- define environmental management principles and guidelines for the design, construction and operation of the transmission line, including statutory requirements;
- establish the roles and responsibilities of all parties involved in the environmental management of the transmission line;
- describe measures that shall be implemented to avoid or mitigate adverse environmental impacts;
- establish a supervision, monitoring, auditing and reporting framework for Project environmental management;
- clarify the sequence of EMP activities; and,
- estimate the resources required to implement the EMP.

6. The EMP should be considered as an environmental operations manual for use by transmission line management and staff, contractors, and regulatory authorities. It reflects the commitment to environmental management by NEA. As such, for major Management Plans within the overall EMP (for example, addressing wildlife concerns, and forest management), these plans are presented as *programs* that span the design, pre-construction, construction, and operation phases, to maintain coherence and the integrity of the overall objectives and expected outcomes, rather than presenting elements of these plans separately for each phase of the Project. Nevertheless, the specific sequence of activities within each major Management Plan is clear with regard to the design, pre-construction, construction, and operation of the Project (evident within the schedules and budgets).

2. Statutory Requirements

7. The acts, regulations, rules, policies, guidelines and conventions relevant to the planning, design, construction and operation of the Project are described in this section. NEA will be responsible for fulfilling the provisions of all relevant acts while implementing the project; these are also elaborated within individual Management Plans, where relevant.

2.1 Environmental Legislative Framework

8. Nepal's environmental legislation is multi-sectoral in nature and enables the Ministry of Environment, Science and Technology (MoEST) to specify the mitigation of all potential sources of air, land and water degradation that may adversely affect natural and social environments. In this capacity, MoEST is responsible for updating and revising national legislation relating to environmental impact, and has jurisdiction to develop, and coordinate the development of, additional sectoral guidelines.

9. The *Environment Protection Act 1997* (EPA) is a comprehensive, umbrella-type environmental act enforced through appropriate regulatory measures. It provides a legal basis for authorities to regulate an Environmental Impact Assessment (EIA) and/or Initial Environmental Examination (IEE). Section 3 of the EPA requires the project proponent to conduct an EIA or IEE for the prescribed proposal. Section 6 (1) of the EPA empowers the relevant agency to grant approval of an EIA report, only if it finds that the implementation of the proposal will have no significant adverse effects on the environment. The *Environment Protection Rules 1997* (EPR) provides a legal basis for concerned authorities to regulate an EIA and/or an IEE.The Act and Rules are administered by the MoEST, emphasising environmental conservation and management through internalizing of the environmental assessment system, pollution control and prevention, conservation of natural heritage sites, compensation for environmental damages, etc.

10. All activities carried out as part of Project construction and operation must comply with the relevant provisions of all Acts and Regulations, including:

- *Aquatic Animals Protection Act 2017 (1960)* &*Amendment 2055 (1999);*
- *District Development Committee (Working Agreements) Regulations 2050 (1993);*
- *Electricity Act 2049 (1992)* and *Electricity Regulation 2050 (1993);*
- *Environment Protection Act 2053 (1997)* and *Environment Protection Regulations 2054 (1997);*
- *Explosives Substances Act 2018 (1961);*
- *Forest Act 2049* (*1993* and *1995* amendments) and *Forest Regulation 2052 (1995);*

- *Hydropower Development Policy 2056 (2001);*
- *Labor Act 2048 (1992);*
- *Land Administration Act 2024 (196);*
- *Land Acquisition Act 2034 (1977)* and *Land Acquisition Guidelines 2049(1993);*
- *Local Self Governance Act 205 (1999)* and *Local Self Governance Regulation 2057 (2000);*
- *National Parks and Wildlife Conservation Act 2029 (1973)* and *National Parks and Wildlife Conservation Regulation 2030 (1974);*
- *Public Roads Act 2030 (1974);*
- *Soil and Watershed Conservation Act 2039 (1982);*
- *Solid Waste (Management and Resource Mobilization) Act 2044 (1987), 2067 (2010);*
- *Village Development Committee (Working Procedures) Rules 2050 (1994);* and,
- *Water Resources Act 2049 (1992)* and *Water Resources Regulation 2049 (1993).*

2.2 Environmental Policies and Guidelines

11. Relevant Government policies and guidelines that apply to the Project include:
- *Hydropower Development Policy 2056(2001);*
- *National Environmental Impact Assessment Guidelines 2049 (1993);*
- *Draft EIA Guidelines for Water Resources Sector 2050 (1994);*
- *EIA Guidelines for Forestry Sector 2050 (1995);* and,
- *Forestry Sector Policy 2057 (2000).*

2.3 Project Conditions of Approval

12. The Upper Seti (now Tanahu) Hydroelectric Project *Environmental Impact Assessment* (EIA, 2009) was approved by the Government of Nepal (GoN) in July 2009 (Vikram2066/07/05), and the associated *Initial Environmental Examination Bharatpur 220 kV* (IEE, 2010)was approved in April 2010 (Vikram2067/04/26). There are no conditions associated with these approvals.

2.4 Environmental Permits and Approvals

13. The key permits and approvals required for Project development that must be obtained, after the Generation Licence has been granted, are listed in Table 2.1.

Table 2.2. Environmental Permits and Approvals.

Permit/Permission	Approval Authority	Information Required in Permit/Agreement	Suggested Timing of Application[1]
Occupation of forest land	Cabinet, through the Ministry of Forests and Soil Conservation	EIA approval letter from MoEST, approved EIA report and detailed information on: o forest area (ha); o Government managed forest by type (District Forest, Community Forest, Leasehold Forest - by ha); o number of trees by species category in each forest type; o afforestation plan. Justification that forest land is required for project development (including an alternative analysis).	Application lodged at least 120 days prior to proposed occupancy of forest land

Permit/Permission	Approval Authority	Information Required in Permit/Agreement	Suggested Timing of Application[1]
'Felling permit' for trees on (cabinet permitted) public land 'Permission' to fell trees in Community Forests	District Forest Office (DFO), Department of Forests Forest User Group (and DFO)	Estimated number of trees to be felled / lopped; marking process; party responsible for cutting and transport of trees; monitoring process; involvement of DFO staff in tree clearance and construction monitoring; compensatory planting proposal and budget estimate.	Application lodged at least 60 days prior to proposed commencement of felling
Permit to upgrade DoR road, bridge, culvert, etc	Department of Roads (DoR)	Site location, proposed upgrading works, program of works.	Application lodged at least 60 days prior to proposed commencement of upgrading works
Permission to relocate archaeological, religious, cultural sites	VDC	Party/s responsible for relocation – NEA and VDC (or traditional religious or cultural community (Guthi, etc.) of respective site (the Department of Archaeology is not involved as no significant sites will be affected).	Agreement at least 30 days prior to proposed relocation
Permit to extract material	District Development Committee (DDC)	Site location, extraction area dimensions and volume, timing of extraction.	Application lodged at least 60 days prior to the proposed commencement of extraction
Written permission from private landowner (or bilateral agreement) for temporary use of leased land	Landowner	Information about land use negotiation.	Agreement at least 15 days prior to land occupation
Relocation or disturbance of community infrastructure (e.g. irrigation canals, water supply lines, foot trails, suspension bridges)	Respective user committees/Village Development Committee and Ward Office	.	prior to

1 There are no set lead-in times for applications. These application times are suggested to avoid construction being delayed.

14. The ESSD of NEA will apply for the necessary permits and permissions, including reaching a M

. As noted previously, many of these are incorporated directly into the specific Management Plans that are intended to address the most vulnerable environmental attributes in the Project area.

3. Project Description

3.1 Location

15. The Project origin (the western terminus of the transmission line) is located near the township of Damauli, in Tanahu District in the Western Development Region of Nepal (Figures 3.1 and 3.2); in fact, at the powerhouse below the dam. The transmission line will run east and cross the Mahabharat range at around 1,400 m and then will extend down to the Teraito terminate at around 230 m asl, near the confluence of the Seti-Madi River and the Trisuli, in Chitwan District.

Figure 3.1.Location of the Tanahu Hydropower Project in Nepal.

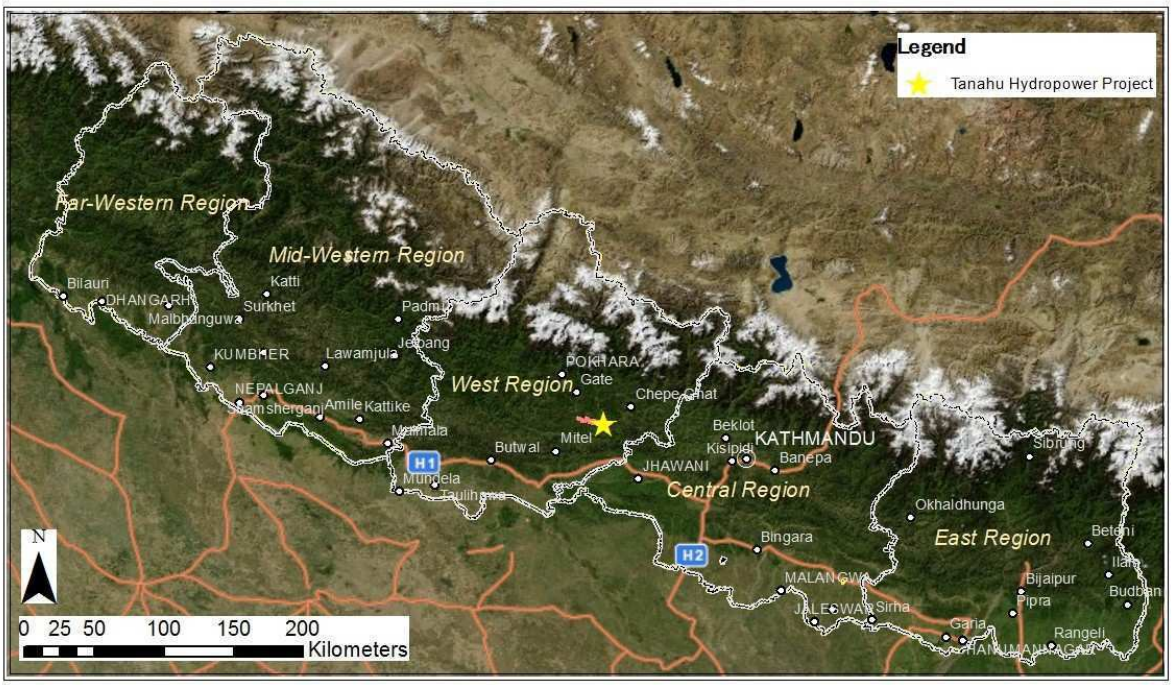
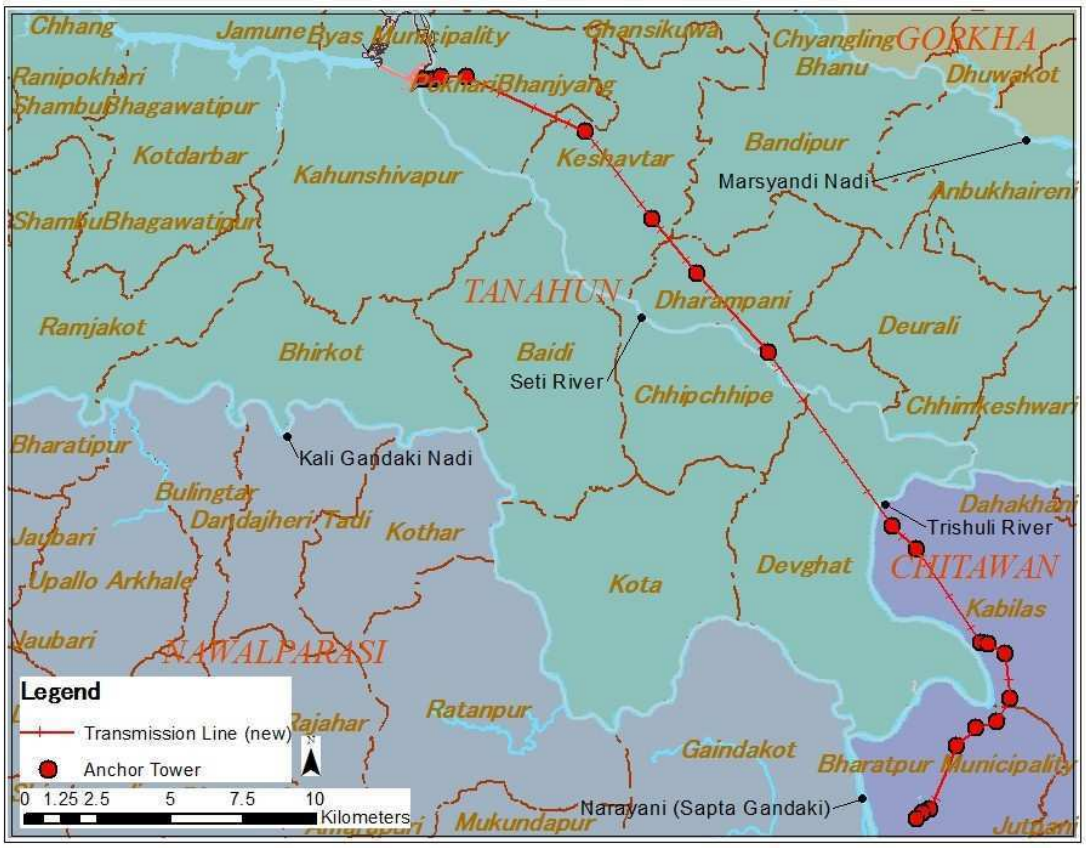


Figure 3.2.The proposed transmission line route.



3.2 Project Components

16. Although this EMP is confined to the transmission line, the whole project design is described below, to set a proper context for environmental management measures. The THP is a storage type hydropower project with a rated capacity of 140 MW, with estimated average annual energy generation of 587.7 GWh (Years 1-10) and 489.9 GWh (Year 11 onwards). THP is designed to supply power to the Nepalese grid. The main features of the Project are:

- **Dam and spillway**: a 140 m high concrete gravity dam, with a crest length of 175 m will be constructed on the Seti River, approximately 2 km upstream of the confluence with the Madi River. The spillway will have three gates, each sized at 16.5 m width by 16.5 m height, designed to safely discharge the probable maximum flood estimated at 7,377m^3/s. There will also be two mid-level gates for reducing reservoir levels during annual reservoir flushing.
- **Reservoir:** a reservoir with a total surface area of 7.26 km^2 at FSL (EL 415 m) will be created. The reservoir will have a minimum operating level (MOL) of EL 378 m, providing a 37 m available drawdown (fluctuation zone) between MOL and FSL. The total storage volume of the reservoir at FSL will be 295.1 million m^3, with 200.3 million m^3 (68%) of this being effective storage at the date of completion.
- **Waterway**: a 7.4 m (diameter) by 1,203 m long headrace tunnel will be constructed on the right bank of the reservoir. This will connect to a 160 m long penstock that divides into two (going from 7.4 m in diameter to 2 x 3.1 m in diameter) near its end. A 190 m long tailrace tunnel will be constructed to discharge the flow used for power generation back into the Seti River.
- **Powerhouse:** an underground powerhouse will be constructed 6 km downstream of the dam. Two units of vertical axis Francis turbines, three phase synchronous generator and transformer will be installed. The powerhouse dimensions are 27 m wide by 46 m high by 97 m long. Surface facilities will include an outgoing terminal and administrative buildings.
- **Access roads:** two permanent access roads (totaling 7.3 km) and a number of temporary access roads will be constructed at the Project site.
- **Workforce camps, work areas and administration buildings:** a permanent operation and maintenance workforce camp will be established near the powerhouse site at Kahunshivapur. During Project construction, this camp will serve as the Project management staff camp. Temporary workforce camps are also likely to be established near the dam and powerhouse sites.
- **Transmission line:** a 37 km long 220 kV transmission line of double circuits will be constructed from the Tanahu Hydropower Plant to the new Bharatpur substation in Chitwan District (managed by NEA).The transmission line will follow the alignment identified in 2010, except for a 300 meter variation right at the power plant and some other very small variations along the proposed route, to account for local topography and avoid disturbance of houses. About half of the transmission line will share a right-of-way with an existing 132 kV line, which helps to minimize disturbance to land use and habitats. The width of the right-of-way will be 30 m.

4. Summary of Environmental/Social Impacts

4.1 Potential Environmental and Social Impacts

17. The transmission line (being a linear project) will occupy a very small "footprint" compared to the dam and reservoir, and will be constructed over a much shorter period (the substation in Chitwan District being constructed for 1.5 years at the beginning of the fifth year of

the project; the transmission line will be started in Year 6 and will also take 1.5 years). Given the short duration of the project (construction phase), its small footprint, and the relatively innocuous effects during the operational phase, there are in fact very few significant environmental impacts expected to be associated with the transmission line. They are summarized below and provide the focus for the relatively limited EMP.

18. As noted above, most of the expected small and temporary impacts associated with the transmission line relate to the small land area required for this project. Table 4.1 shows the land requirement. 93.5 hectares will be taken up temporarily for the right-of-way (which will require access and then clearing of the 30-meter swath, along the 37 km of the route). Most of this right-of-way will occur in agricultural land, and about 35 hectares will be taken from forest land. Although the right-of-way will be cleared for construction of the tower pads and stringing the cables, this cleared swath will be allowed to re-grow somewhat (to a maximum of 3 meters), and local communities will have access, although limited use of this right-of-way (but cultivation allowed, which is a benefit, although no house construction or planting of trees). 4.4 hectares of land along the transmission line will be a permanent loss, with about 2 ha from agricultural land and about 2.4 ha from forests. These permanent losses are extremely small compared to adjacent agricultural land and forests, and impacts on land use and use of forest habitat would be difficult to measure with any statistical veracity.

Table 4.1.Land Requirement for the Transmission Line

Project Component	Land Types			Total Land Take		Total (ha)
	Agricultural land (ha)	Forest (ha)	Barren Land (ha)	Temporary (ha)	Permanent (ha)	
Land required along right-of-way	40.8	35.1	17.6	93.5	0	93.5
Land to be acquired for Tower Pads	2.02	2.38	0	0	4.4	4.4
Camps	3	0	0	3	0	3
Total	**45.82**	**37.48**	**17.6**	**96.5**	**4.4**	**100.9**

19. Some forest clearing is required (within the 37.5 ha); it has been estimated that 8,948 trees of various species and sizes will be felled (a wood volume of 9,070 m^3). This area of clearing is limited and the remaining adjacent forest area is large and contiguous, so it not expected that there will be significant impacts on wildlife use of the cleared (but somewhat re-grown) right-of-way, nor in adjacent forest areas. In any case, the 2010 surveys did not indicate any significant or unique forest habitats or significant numbers of important or protected wildlife (although there was anecdotal reference to tigers and single-horned rhinoceros in the southern parts of the transmission line area).The southern 7.5 km section of the proposed transmission line right-of-way occurs in the "*tiger habitat corridor*" (WWF, 2012), but this is already fragmented by the existing transmission RoW and the Muglin – Narayanghat highway. The new line is therefore not considered likely to impart additional impact to any tiger movements from the "*core areas*" of Chitwan National Park, which is 15 km further to the south.

20. Some households will be affected temporarily during the clearing of the right-of-way, mostly reflecting a one-time loss of 303 tonnes of agricultural production (and possibly a permanent annual loss of 5 tonnes per year). These losses will require compensation.

21. During land clearing and construction of the tower bases, there is a risk of land disturbance and soil loss, depending on the prevailing weather/rain conditions and local drainage, and adjacent farming activities could also be disrupted.

4.2 Other Temporary and Spatially-Limited Construction Impacts

22. General construction impacts, typical of land clearing, earthmoving, framing, and concrete works, will occur and have to be effectively managed over the construction phase (1.5 years). The impacts will include:

- limited erosion and sedimentation;
- noise and vibration at individual work sites;
- possible air quality decline;
- water quality decline (if work occurs in the vicinity of watercourses); and
- safety hazards.

5. Implementation Responsibilities

23. Project environmental management will involve the following main designated parties: the NEA Environmental & Social Study Department (NEA-ESSD); NEA-appointed contractors; GoN agencies; and an independent Panel of Experts (Table 5.1). In addition, consultation will occur with local communities and non-governmental organizations (NGOs) during implementation of the EMP (see Figure 5.1).

Table 5.1.Project Environmental Management Organizations

Category	Organization/Contractor
Project Owners	National Electricity Authority (NEA): Environmental and Social Study Department (ESSD): Environmental Sub-Unit(ESU) Resettlement and Social Action Sub-Unit (RSASU) Community Liaison Officer (CLO)
Construction and Operation Supervision	Project Supervision Consultant (PSC): Environmental Management Consultant (PSC-EMC) Social Management Consultant (PSC-SMC)
Advisory Organizations	International NGOs (for example, IUCN, WWF)
Contractor	Construction Contractor (CC) Other Local Contractors for Forest and Wildlife activities
Independent Monitoring	Panel of Experts
GoN	Ministry of Environment, Science and Technology (MoEST) Ministry of Energy (MoE)

5.1 NEA

24. NEA will be directly responsible for the implementation, management and supervision of the transmission line environmental management plan, through the ESSD. NEA will hire a number of consultants to design and oversee, and contractors to implement, the environmental management measures, as well as an independent Panel of Experts to provide periodic review and advice.

25. *Environmental and Social Study Department (ESSD)*: The Environmental and Social Study Department (ESSD) under the NEA will have four major roles:

(i) implementing and administering planned actions in the EMP, RP, CDS, and GESI;
(ii) monitoring the environmental and social impact and compliance as per EMP, RP, CDS and GESI;
(iii) revising the EMP, RP, CDS and GESI, based on the monitoring results; and,
(iv) disseminating information to project stakeholders and coordinating with the different line agencies.

26. The ESSD will consist of the Environmental Sub-Unit (ESU), the Resettlement and Social Action Sub-Unit (RSASU)and Community Liaison Officer (CLO). The ESU will coordinate with PSC-EMC, whereas the RSASU will coordinate with other stakeholders such as Local VDCs, DDCs, NGOs, CBOs, affected parties, DoED, MoE, and MoEST.

27. *Environmental Sub-Unit (ESU)*: The ESU will be responsible for: (i) mitigation measures planned in the EMP; (ii) environmental baseline monitoring and environmental compliance monitoring; and, (iii) corrective action and reviewing the EMP during pre-construction, construction and operation. ESU duties will include:

Pre-construction:

- acquiring all necessary permits and approvals for Project construction and operation (for land and forest-based activities);
- ensuring that EMP design recommendations are included in the final Project design;
- preparing Issue Management Plans (IMPs);
- reviewing and approving CC's Site Environmental Plans (SEPs) and Incident Management and Emergency Response Procedures (IMERP);
- monitoring mitigation measures as per EMP and recommending corrective actions;
- preparing regular monitoring reports to ADB/JICA; and,
- reviewing and approving surveyed and pegged Project sites prior to construction activities.

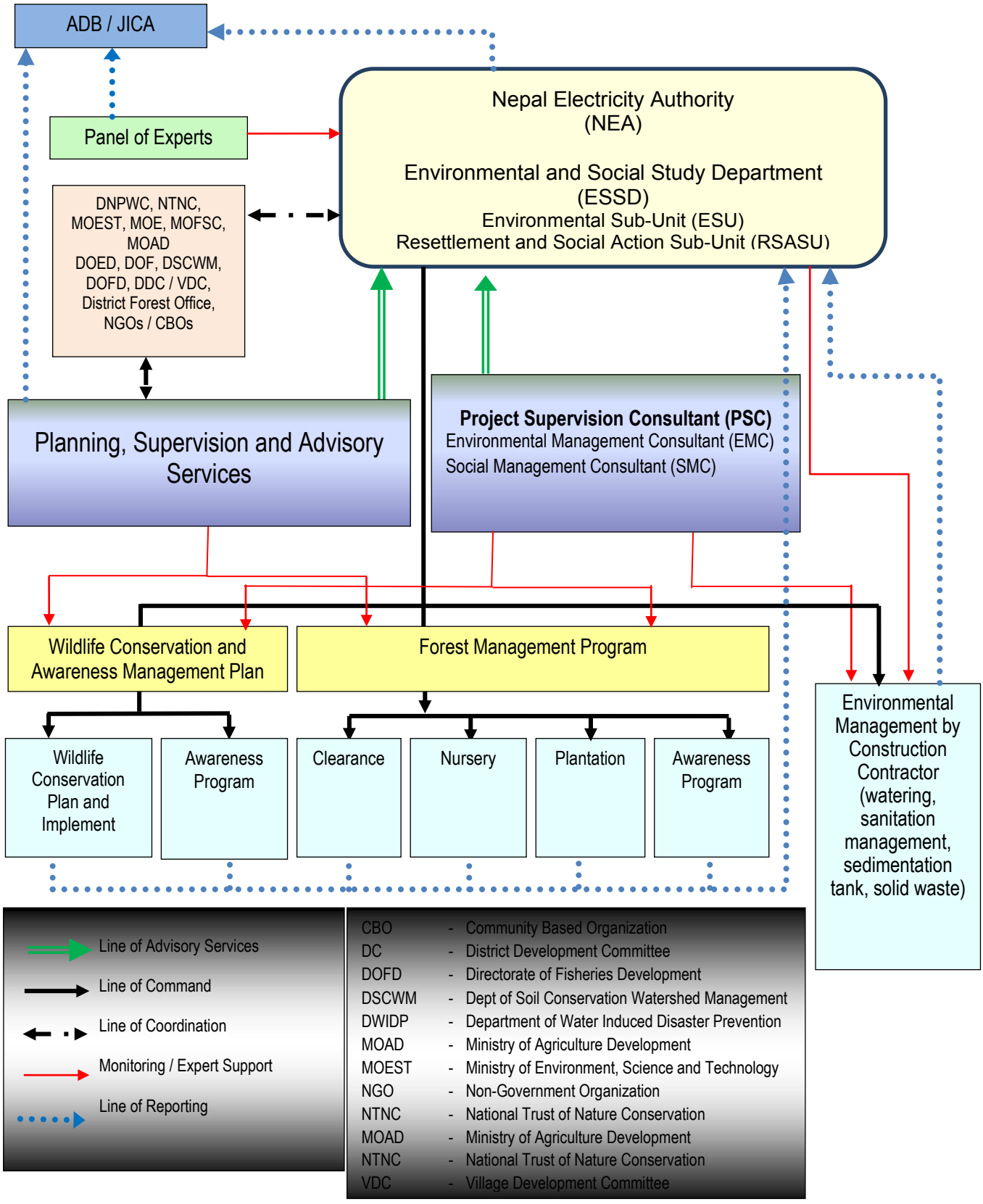
Construction:

- monitoring baseline conditions and compliance of the CC;
- preparing regular monitoring reports to ADB/JICA;
- publishing monitoring results on the Project web site;
- implementing mitigation and monitoring actions in the EMP;
- monitoring and reviewing CC's activities and other mitigation programs;
- auditing CC compliance with the EMP, IMPs, SEPs, Project approval and permit conditions and any other statutory requirements;
- issuing corrective action requests and conduct follow-up inspections and evaluation of corrective actions; and,
- liaising with MoEST, MoE and other GoN agencies to ensure that they have access to environmental documentation and Project personnel, and responding to their comments and directives.

28. *Resettlement and Social Action Sub-Unit (RSASU)*: The RSASU will be responsible for implementing the RP, GESI and CDS and liaison with the government and non-governmental organizations on related issues. As these works require official responsibilities, the members of this sub-unit can be deputed members of NEA, with experience in the implementation of such plans. The sub-unit will also be responsible for the operation of the Public Information Center (PIC) and handling grievances, as well as the following:

- implementing, supervising and recording the land acquisition, compensation and resettlement program as per the RP (if resettlement is required);
- implementing and supervising the CDS and GESI as per CDS and GESI;
- liaising with other Government authorities on environmental management and resettlement;
- disseminating information through PICs and other media, and collecting feedback through regular consultation with various stakeholders; and,
- distributing ESSD's bimonthly monitoring reports to central and local level stakeholders.

Figure 5.1.Organizational Structure for Implementation of the EMP.



5.2 Project Supervision Consultant

29. The Project Supervision Consultant (PSC) will be hired by and shall directly assist the ESSD with its duties. The PSC will include the Environmental Management Consultant (PSC-EMC) and Social Management Consultant (PSC-SMC). PSC duties shall include:

Pre-construction/Construction Phase:

- preparing the final Project design to minimize adverse impacts, consistent with the technical and economic objectives of the transmission line, engineering designs prepared to date, EIA/EMP design recommendations and Project conditions of consent;
- monitoring of all the mitigation measures taken by NEA and monitoring survey results by contractors; and,
- submitting half-yearly environmental management reports, including monitoring record sheets, to NEA.

Operation Phase:

- developing and submitting *Incident Management and Emergency Response Procedures* to NEA for approval;
- operating the Project and undertaking all associated activities in accordance with the measures set out in this EMP, the IMPs and any additional measures required to meet Project approval conditions and statutory requirements;
- environmental monitoring and carrying out any necessary repairs and maintenance of Project components, including implementation of any necessary environmental safeguards;
- submitting half-yearly environmental management reports, including monitoring record sheets, to NEA;
- implementing corrective actions as directed by NEA or any government agency with legislative or permit responsibilities; and,
- liaising with the local community regarding any environmental issues that they feel concerned about; and,
- maintaining an EMS in full compliance with the International Organization of Standardization standard 14001 (ISO 14001).

5.3 Construction Contractor

30. The Construction Contractor (CC) shall be primarily responsible for the implementation and internal monitoring of all environmental management measures associated with Project design, pre-construction and construction. The CC shall have sole responsibility for all activities on sites under its control for the duration of construction. This includes the activities of all sub-contractors, whether employed or contracted directly or indirectly by the CC. Accordingly, it shall be the CC's responsibility to ensure that all activities are compliant with Project plans, permit and approval conditions, and any other statutory requirements.

31. CC duties will include:

Pre-construction:

- preparing SEPs for each construction and ancillary site that the CC is responsible for, and *Incident Management and Emergency Response Procedures* covering all activities;

- providing environmental training to all staff and sub-contractors, to ensure personnel have a clear understanding of environmental requirements relevant to their scope of work and can meet their environmental responsibilities; and,
- surveying and pegging all Project sites where works are due to commence within the next six months.

Construction:

- constructing the Project and undertaking all associated activities in accordance with the measures set out in this EMP, the IMPs, the SEPs and any additional measures required to meet Project approval and permit conditions and other statutory requirements;
- regularly maintaining environmental protection measures;
- participating in and assisting with ESU's site inspections and audits, and following ESU directions to ensure that all works are conducted to specified standards;
- environmental monitoring, recording and reporting as specified in the EMP, IMPs, SEPs, etc;
- coordinating emergency response procedures;
- implementing corrective actions as directed by the ESSD, MoEST, MoE and any other government agency with legislative responsibilities; and,
- maintaining an environmental management system (EMS) in full compliance with the International Organization of Standardization standard 14001 (ISO 14001).

5.4 Panel of Experts

32. A Panel of Experts, including the environmental experts who will be appointed to provide guidance to the ESSD, will be established for the entire Project. The environmental experts in the Panel will comprise an environmental specialist, and a resettlement and social development specialist. The panel will undertake overall evaluation of the environmental management and resettlement/ livelihood restoration work planned and undertaken for the transmission line component. The Panel will be appointed early in the pre-construction phase. The Panel will convene once in the first year during installation of the transmission line and once thereafter.

33. The scope of work of the Panel will include:

Pre-construction:

- reviewing the adequacy of this EMP, the Issue Management Plans (IMPs),Site Environmental Plans (SEPs), RP, CDS, and GESI and the provision of recommendations for improvements; and,
- reviewing Project design and Tenders, and provision of any recommended design changes and other improvements if any.

Construction:

- assessing the adequacy of, and providing advice to improve, the environmental management system, CC performance, environmental supervision, monitoring and auditing, and the effectiveness of remedial actions;
- reviewing internal monitoring data and reports and audit reports, as well as quantitative and qualitative socioeconomic monitoring reports;
- evaluating Project institutions, including capacity and operating constraints;
- analyzing budgets and expenditure in relation to milestones and site realities; and,
- advising on any emerging issues and providing recommendations on how to address issues related to land use and compensation.

5.5 Government Agencies

5.5.1 Ministry of Environment, Science and Technology (MoEST)

34. MoEST, the government agency responsible for environmental management and development approval, will monitor Project environmental management as it sees fit during Project design and construction, and audit the Project after completion of line installation, to assess compliance against Project approval, license and permit conditions, statutory standards and Project environmental management plans (EMP, etc). MoEST will provide formal feedback to NEA on non-complying aspects of the Project.

5.5.2 Ministry of Energy (MoE)

35. The Department of Electricity Development (DoED), within the Ministry of Energy (MoE), is responsible for monitoring Project environmental management during Project design, construction and operation to assess compliance against Project approval and license conditions, statutory standards and Project environmental management plans. This will be undertaken on an as-required basis during construction and operation phase. DoED duties will include:

- reviewing the final Project design, providing approval if acceptable;
- providing formal feedback to NEA on non-complying aspects of the Project;
- inspecting Project sites at any time during construction to assess if construction activities are being undertaken in accordance with licence requirements; and,
- inspecting Project sites and operational activities at any time to ensure that Project activities are in accordance with licence requirements.

5.6 Community

36. Community participation is an important component of effective environmental management and will be fundamental during Project design, construction and operation for the formulation and updating of the Community Development Strategy (CDS). Initially, community participation will occur through consultation between the ESSD, CC, directly affected landowners and local communities during the design and pre-construction phase. Negotiations will occur with affected landowners where land is to be acquired or leased, with details provided on the intended use of the land, construction activities and environmental management measures (including site rehabilitation of temporarily used land in the right-of-way).

37. Consultation with local communities will commence during the pre-construction phase and continue throughout the construction and immediate operation phases. A community forum of local representatives will be established, including elected VDC representatives, and shall meet on a regular basis with NEA, ESSD and CC representatives to discuss local environmental and social issues. The forum will commence with a detailed Project briefing, covering such issues as the construction program, major construction activities, local employment on the Project, the extent of construction sites and the maintenance of services during construction. Individual community members will have the right to present issues to the forum.

38. The ESSD shall employ a Community Liaison Officer (CLO) to manage community relations during Project construction, including sitting on the community forum. The key tasks of the CLO will include:

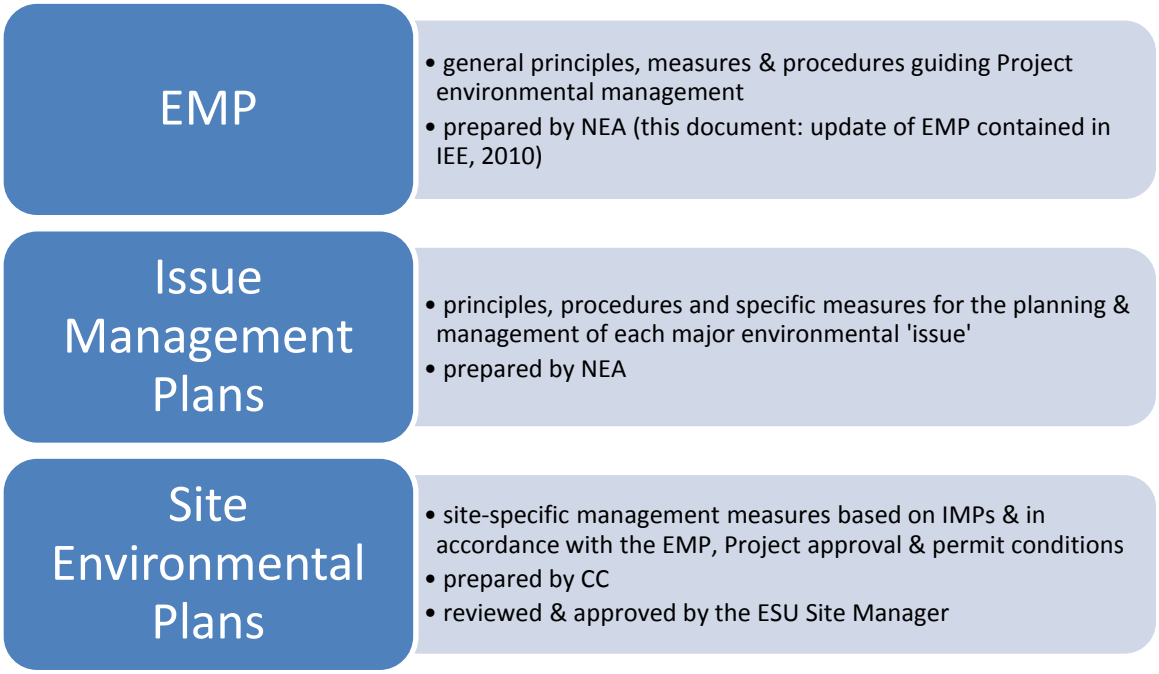
- ensuring that the community is well informed;

- ensuring that the CC understands community concerns;
- providing a clear point of contact for individuals and community groups regarding environmental issues, with a formalized complaint procedure and grievance mechanism; and,
- liaising with individuals, community groups and the CC to resolve local environmental issues.

6. Environmental Planning

39. Three levels of environmental management plans will guide and control site environmental management (Figure 6.1). This EMP, incorporating the measures approved in the EMP contained in the approved IEE (20109) prepared by NEA will establish the guiding principles, responsibilities and main mitigation measures for environmental management.

Figure 6.1.Levels of Project Environmental Management Plans



40. The overall EMP will be supported by Issue Management Plans (IMPs) that will be prepared by the NEA, providing detail on the planning requirements, management principles and mitigation measures for each major environmental issue (Section 6.2). The EMP and IMPs provide the CC with references for the preparation of Site Environmental Plans (SEPs). A SEP will be prepared by the CC for each transmission line work site, converting the IMP principles and generic measures into workable, site-specific measures. In addition, the CC shall prepare its own ISO-14001 EMS that incorporates the above plans, and *Incident Management and Emergency Response Procedures*.

6.1 EMP

41. This EMP provides a single-source, overarching environmental framework for all implementing parties, government agencies and stakeholders. All environmental management measures previously proposed in the IEE (2010) are included in this EMP.

6.2 Issue Management Plans (IMPs)

42. A set of IMPs will be prepared by NEA, covering each major Project environmental issue. The IMPs will build upon the general principles of environmental management set out in the EMP, providing a greater level of detail on responsibilities, proposed mitigation and management measures, implementation of measures, and monitoring and reporting procedures for each major environmental issue. The proposed IMPs are:

Plan No.	Issue Management Plan/Program
IMP 1	Environmental Training
IMP 2	Forest Management Program
IMP 3	Wildlife Conservation and Awareness Program
IMP 4	Air Quality Control
IMP 5	Noise Control
IMP 6	Water Quality Control
IMP 7	Waste Management
IMP 8	Hazards management
IMP 9	Workforce Management and Safety
IMP 10	Archaeology management
IMP 11	Demobilization management
IMP 12	Site Rehabilitation
IMP 13	Reinstatement of Services
IMP 14	Emergency Response Plan

43. IMPs may be updated by the ESU from time to time, in response to government requirements or to clarify management responsibilities, planning, permits and approvals, mitigation measures, and monitoring and reporting procedures. This EMP document contains the first framework for the IMPs (see Section 7), which will then be verified and provided with more detail as the Project proceeds through the approval process.

6.3 Site Environmental Plans

44. A SEP shall be prepared by the CC for each transmission line work site and the substation, converting the principles and generic measures contained in the EMP and IMPs into site-specific controls. Each SEP shall contain a layout map(s) of the main measures and describe:

- construction activities and associated works that will occur over the construction life;
- environmental features that have the potential to be impacted by construction activities;
- the environmental mitigation measures that will be implemented over the duration of construction and illustrate these on a plan(s); and,
- operation and maintenance of mitigation measures.

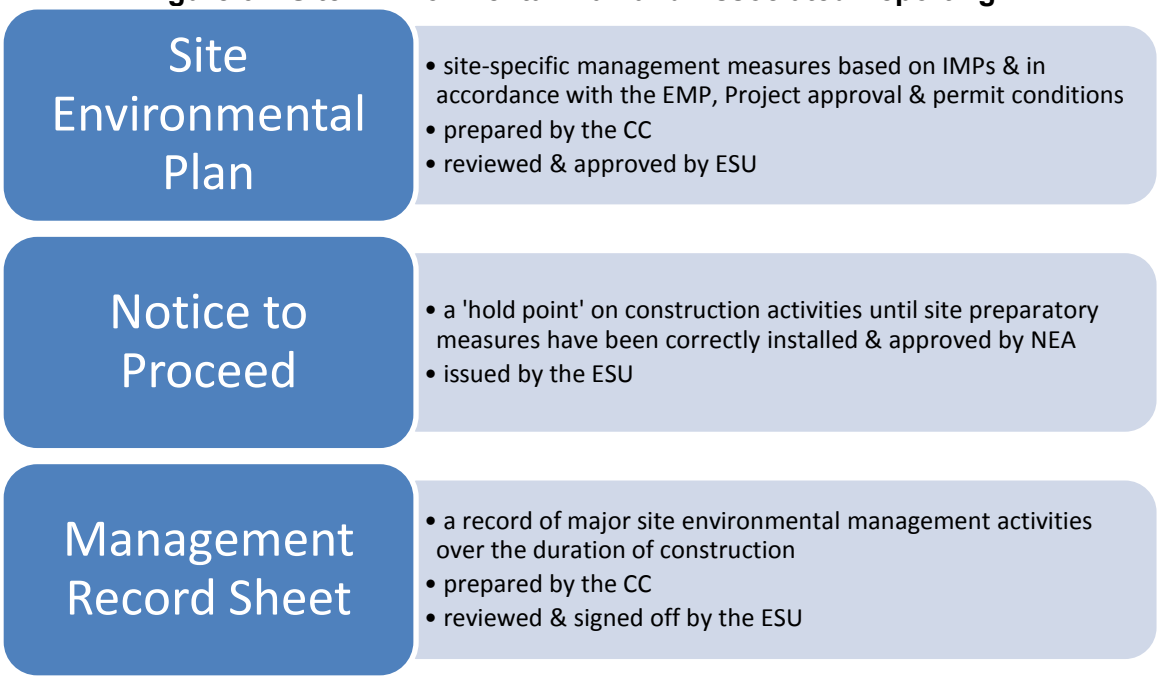
45. The level of detail contained in a SEP will be relative to the potential environmental impact of site activities, varying according to the site and proposed activities. For example, the SEP for land clearing through dense/hilly forest areas will be a detailed plan, whereas the SEP

for a separate materials storage area will be simple. Sub-components of a SEP will normally, but not always, include:

- Vegetation Management Plan;
- Erosion and Sediment Control Plan;
- Earthworks Plan;
- Waste Management Plan; and,
- Site Rehabilitation Plan.

46. SEPs will be living documents (see Figure 6.2), subject to revision as construction proceeds. Each SEP shall contain a *Pre-Commencement Checklist* that will be completed by the CC and reviewed by the ESU prior to construction activities being permitted to commence on that site. Each SEP shall be submitted to the ESU at least two weeks prior to the proposed commencement of site activities. The outcome of the review will either be ESU approval of the SEP in the form of a *Notice to Proceed* or the provision of instructions to the CC to revise the plan and resubmit it for approval. The CC must obtain a formal *Notice to Proceed* for each site from the ESU before any construction activities can commence. Each SEP will also contain a *Record of Mitigation Measures*, summarizing the measures contained in the plan that shall be used as a checklist.

Figure 6.2.Site Environmental Plan and Associated Reporting.



7. Management Measures

7.1 Overview

47. Environmental management measures will be implemented over two Project phases: (i) pre-construction; and, (ii) construction, with some monitoring and maintenance expected during the operational phase to ensure the integrity of the right-of-way. Some of the proposed

measures are very specific to the Project phases, and are described accordingly; many of these reflect routine practices that are usually encoded within construction contracts, or are reflected in design adjustments to minimize environmental impacts, and are increasingly assumed as "standard" practices for transmission line installation, based on extensive global experience. In addition to those, there are two key Management Plans (which provide a frame for IMP #s 2 and 3) that address site specific concerns associated with this project. These include the following:

- the Wildlife Conservation and Awareness Management Plan; and,
- the Forest Management Plan.

48. Given that the issues associated with wildlife and forests (although spatially limited) span all the Project phases, and will need fairly routine oversight, linking of activities, and continuity over a three-year period spanning the end of construction and the first year of operation, these two main Management Plans are described as coherent programs; that is, **they are articulated once as seamless management measures (rather than being repeated three times, for each of the Project phases)**. However, within each of the two main Management Plans, the scheduling clearly shows the duration and sequence of activities through the various phases, and the allocation of Plan resources has been separated into pre-construction/construction and operation phases (however, note that the consulting services budget covers up to the end of the construction phase; the operational phase budget has been filed for the information of the Government of Nepal). The two main Management Plans are explained first, followed by the Project phase-specific environmental management measures.

49. The estimated total costs of the mitigation measures and the associated monitoring are shown below (this shows both the dam/reservoir component and the transmission line). These costs include the Government of Nepal expenses related to the forestry management plan, as well as the costs associated with the consulting services required for each of the two main Management Plans, which are then described below. Several proposed mitigation measures will be finalized prior to construction, depending on further technical design and feasibility studies. If necessary, additional budget will be allocated from the project contingency.

Item			NRs
Mitigation	Hydropower Plant	Tree planting and watershed management	1,564,631,138
		Wildlife conservation and awareness program	42,941,635
		Fish conservation and awareness program	158,413,810
		Rivers safety program	28,751,959
		Provisional cost for House repair and drying spring	4,000,000
		Sub total	**1,798,738,541**
	Transmission Line	Tree planting and watershed management	130,411,347
		Wildlife conservation and awareness program	20,777,497
		Sub total	**151,188,844**
Monitoring	Hydropower Plant	Spring water	500,000
		House Crack	500,000
		Vegetation	3,720,000

Item			NRs
		Terrestrial fauna	3,720,000
		Aquatic fauna	18,432,000
		Land use	313,060
		Sub total	**27,185,060**
	Transmission Line	Frontline environmental monitoring	3,500,000
		Third party monitoring	1,000,000
		Sub total	**4,500,000**
Grand Total (Rp.)			**1,981,612,445**
Grand Total (USD)			**23,293,904**

7.2 Proposed Wildlife Conservation and Awareness Management Plan

7.2.1 Introduction

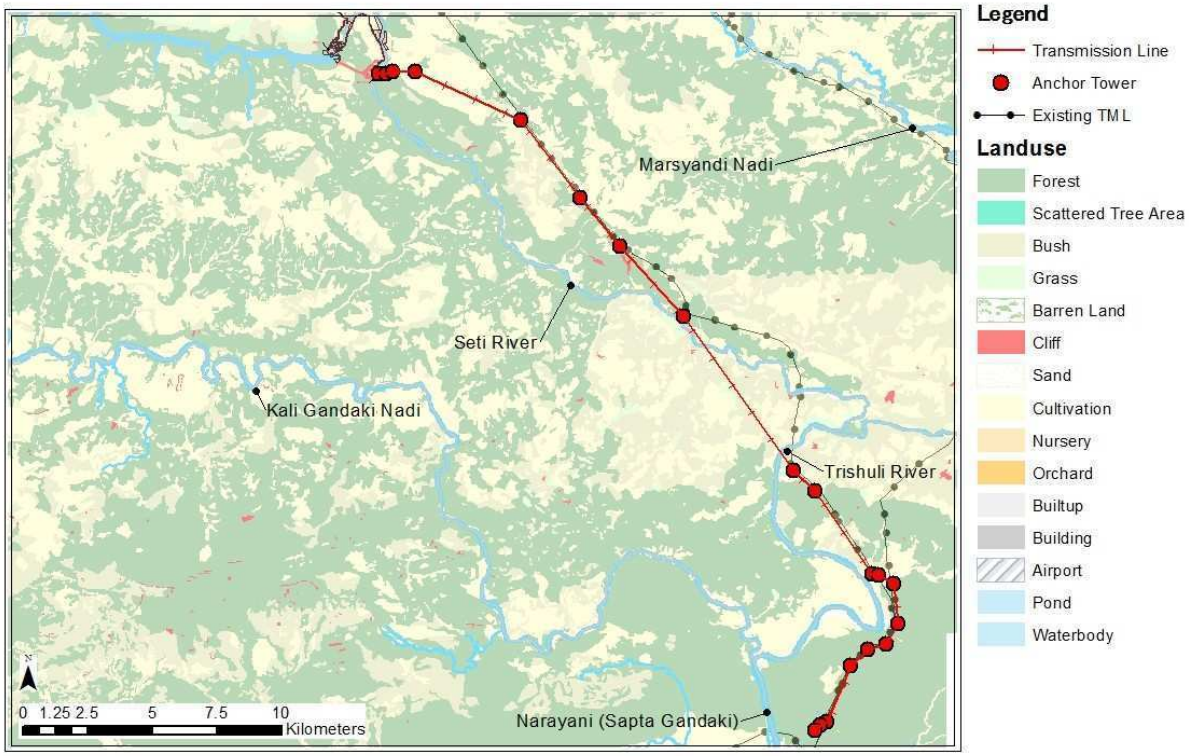
50. As noted previously, the transmission line will result in the loss of some forest habitat along the proposed transmission line route; a total of about 38 ha, with about 2.4 of this being permanent (at the tower bases), and 33 ha (along the right-of-way) being converted to tall grass/shrub understory (but never exceeding 3 meters in height). Detailed faunal studies have *not* been undertaken to determine the habitat use and vulnerabilities of animals which may be exposed to any permanent change in habitats or alteration in habitat (given the small area affected), but the assessment done in 2010 did examine the expected wildlife use of the right-of-way (there is only a minor reference to proximity to tiger habitat, and possibly one-horned rhinoceros crossing through this area). Regardless of these apparently limited wildlife uses of the right-of-way, the precautionary approach addresses the concern for wildlife which have a conservation concern in Nepal, including the Royal Bengal tiger (*Panthera tigris),* the clouded leopard *(Neofelis nebulosa),* the Himalayan black bear *(Ursus thibetanus),* sloth bear *(Melursus ursinus),* common leopard *(Panthera pardus),* common otter *(Lutra lutra),* Assamese monkey *(Macaca assamensis),* and striped hyena *(Hyaena hyaena)*. There is less concern about temporary construction effects, which will be managed by covenants in contracts that dictate construction best practices and restrictions on construction workers. There is also less concern about birds, reptiles, and amphibians, all of which have much smaller habitat size requirements and more scope and flexibility for compensatory movements (they are, therefore, not the focus of initiatives within this plan).

51. The purpose of the proposed Wildlife Conservation and Awareness Management plan is to increase the understanding of vulnerable wildlife along the transmission line right-of-way, and to use the increased knowledge of vulnerable wildlife to develop and implement appropriate wildlife conservation measures which will reduce the potential negative effects of the transmission line (but with the effort reflecting the relatively small scale of expected effects). The plan includes description of the specific issues, the proposed objectives and outcomes of the wildlife conservation and awareness management plan, the approach and methodology, implementation arrangements, and schedule.

7.2.2 Context, Project Design and Activities, and Potential Issues Regarding Wildlife

52. Figure 7.1 shows the proposed route of the transmission line. As noted above, the right-of-way will be 30 m wide and will cross patches of forest for a total footprint of 38 ha. The concern is to understand to what extent the loss of forest habitat (trees being cut, and secondary re-growth being restricted in height) will affect vulnerable wildlife and then to implement suitable measures that will mitigate the vulnerability of important wildlife species. Wildlife data for the right-of-way are inconclusive, based mostly on anecdotal information, which suggests relatively low importance of the right-of-way for wildlife. About half of the right-of-way will track along the right-of-way for another power line, which means there will be little change in existing forest habitat (and therefore wildlife use) in those particular areas (see Figure 7.1).

Figure 7.1.The Proposed Transmission Line Route



53. Table 7.1 shows the status information for endangered, vulnerable, and near-threatened wildlife species in Nepal. Figure 7.2 indicates that the transmission line is located outside nationally and locally designated protected areas. The nearest protected areas lie 30 km to the north of the powerhouse (Annapurna Conservation Area), and about 15 km to the south of the transmission line terminus (Chitwan National Park). Figure 7.3 shows the tiger habitat in Nepal, indicating that the southern 7.5 km of the proposed transmission line crosses "*tiger habitat corridor*", although on the western periphery of it, in an area that is already transected by the existing high tension power line and the highway. If tigers are present, they are not very prevalent at all, since no one sees them, nor is there reported loss of farm animals to tiger kills. Clearly, the main tiger habitat is further to the south. Nevertheless, the Wildlife Conservation and Awareness Management Plan will confirm these details and adjust the project mitigation actions accordingly. The main intention is to reduce the uncertainty and mitigate any potential effects of the transmission line on important wildlife; this will especially provide certainty about the relative importance of the right-of-way for tigers.

Table 7.1.Information on Endangered, Vulnerable, and Near Threatened Mammal Species.

Common Name	Scientific Name	Local Name	Conservation Status		
			CITES Annex	IUCN	GON
Royal Bengal tiger	*Panthera tigris*	Bagh	I	EN	P
Clouded leopard	*Neofelis nebulosa*	DhwanseChituwa	I	VU	P
Himalayan black bear	*Ursus thibetanus*	Kalobhalu	I	VU	-
Sloth bear	*Melursus ursinus*	KatheBhalu	I	VU	-
Common leopard	*Panthera pardus*	Chituwa	I	NT	-
Common otter	*Lutra lutra*	Ontt	I	NT	-
Assamese monkey	*Macaca assamensis*	Asami Bandar	-	NT	P
Striped hyena	*Hyaena hyaena*	Hyaena / Bagh	-	NT	-

EN – endangered; VU – vulnerable; NT – near-threatened (IUCN).

Figure 7.2.Protected areas in Nepal

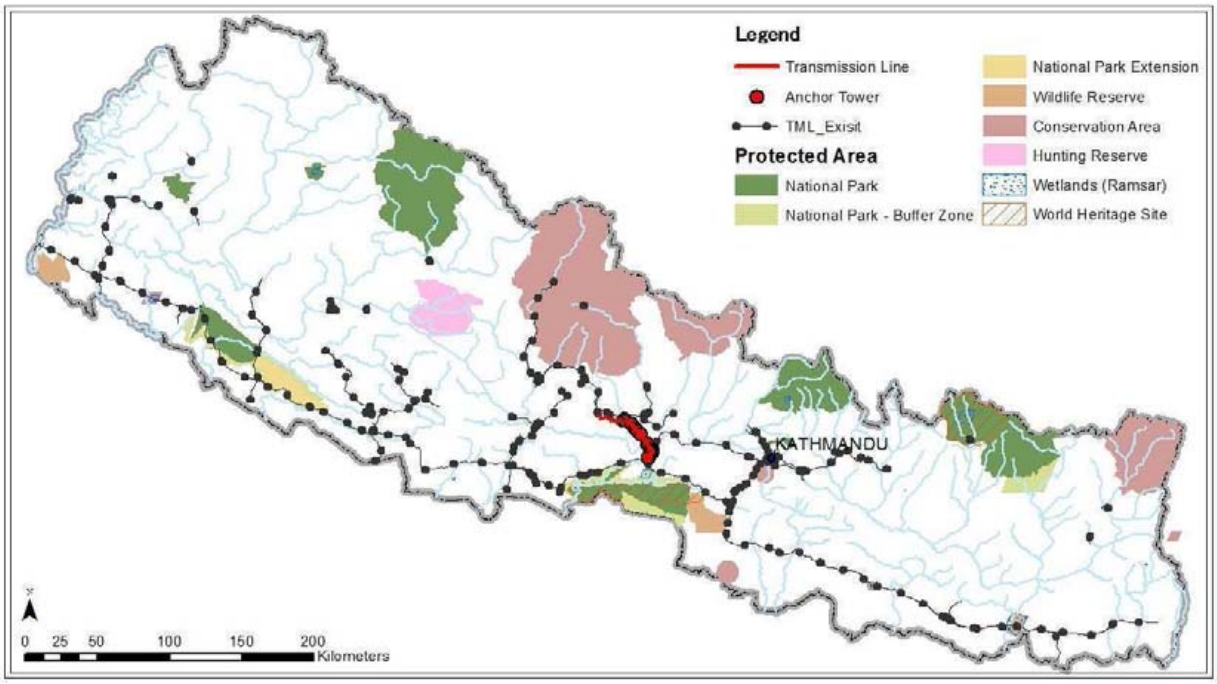
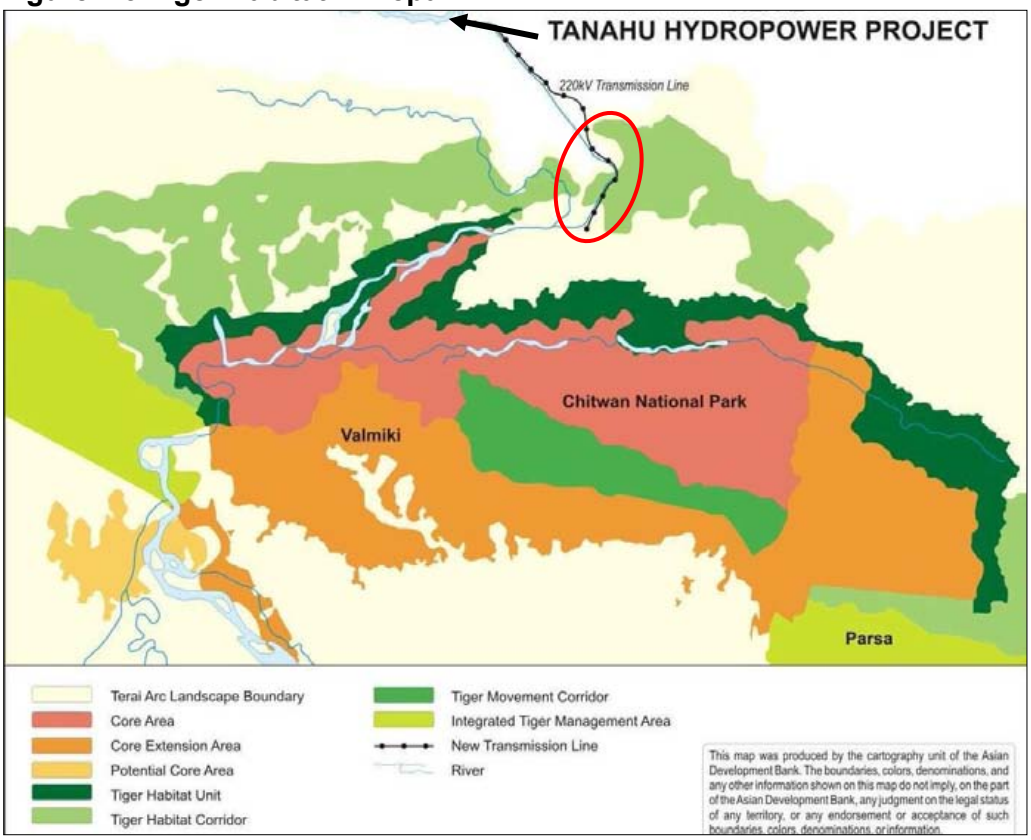


Figure 7.3.Tiger Habitat in Nepal



Note: Chitwan National Park is the bright red area on the northern side of the Nepal-India border.

7.2.3 Objectives and Expected Outcomes of the Wildlife Conservation and Awareness Management Plan

54. The main objective of the proposed Wildlife Conservation and Awareness Management Plan is to minimize the impact of habitat loss (38 ha) on important wildlife. A secondary objective to better understand the status of important wildlife in the transmission line right-of-way, and to promote their conservation, through increased public awareness of their status and vulnerabilities. The plan will therefore involve further surveys in the project area (although limited), public education regarding wildlife in the area, and definition and implementation of measures that will allow important wildlife to continue to access and use habitats adjacent to the transmission line right-of-way.

55. The expected outcomes of the Wildlife Conservation and Awareness Management Plan (addressing wildlife habitat issues along the transmission line) include:

- To the extent possible, integrity of wildlife habitats is maintained, or compensated for, along the path of the transmission line right-of-way;
- Increased understanding, amongst local residents and construction workers, regarding wildlife populations and habitat dependencies along the right-of-way, such that human activities can be adjusted to not interfere with critical periods and locations (for example, not disturbing breeding/rearing areas/dens, if these are encountered, etc.);
- Smaller mammals, amphibians, and reptiles encountered during land clearing and tower base construction will be handled and moved according to a standard animal encounter

protocol (catch-and-release), to minimize animal mortalities (a Standing Contract will be established with local experts, who will be called to address each situation, as needed); and,

- Increased awareness amongst the local population regarding the importance of protection of wildlife species, leading to less illegal hunting and trapping.

7.2.4 Rationale for Proposed Approach

56. As noted previously, there is still uncertainty regarding the status of near-threatened, vulnerable, and endangered wildlife species along the transmission line right-of-way. The plan therefore involves a precautionary principle of increasing the understanding of wildlife populations and habitats along the line, designing mitigation measures that will reduce impacts on vulnerable animals, and increasing public awareness to ensure compliance with wildlife protection guidelines. As noted previously, the primary focus is on the larger vulnerable mammal species, especially the Royal Bengal tiger, which is the focus of concern, being endangered. Two possible measures were considered, including: increasing the tower heights, so that not many trees have to be cut (except at the tower sites); and, minimizing the clearance of vegetation clearance along the right-of-way (the latter is considered to be the most cost-effective).

57. The main approach, then, is as follows:

- Strictly controlling vegetation clearance and pruning, by marking out areas prior to vegetation removal and limiting clearance to areas essential to establish line electrical safety. Vegetation removal will be supervised by the DFO of each concerned district.
- Re-vegetating all right-of-way areas disturbed during construction. This will include top-soiling and seeding around tower foundations and bio-engineering measures where slopes have to be stabilized (e.g. planting of broom grass *Thysanolaema maxima* in erosion prone areas).
- During line operation, the central 15 m of the right-of-way will be allowed to regenerate to a height of between 1.5-3 m, except within 8 m of towers, where vegetation will be kept to a height of 30-50 cm. All other right-of-way areas will be maintained by pruning vegetation.

58. Given that vegetation up to 3 m height within the right-of-way may increase the grazing habitat for species that are the prey of tigers, the right-of-way should provide a benefit to tigers, if in fact they occur in the area.

59. Insects, amphibians, and reptiles are not believed to face serious habitat discontinuities, especially given the narrowness of the right-of-way, and they will therefore not receive the attention of specific initiatives, except to be dealt with on an “as-encountered” basis (a protocol will be developed for animal encounters during land clearing and construction). However, attention will be given, during the initial surveys, to clarification of habitats that may be important for birds, bats, and butterflies, which were not addressed comprehensively in earlier surveys. The geographical focus will be the forest areas along the proposed transmission line route. Proposed activities and methodologies are noted below.

7.2.5 Activities and Methodology

60. *Wildlife Survey*: A local survey contractor will conduct wildlife surveys along the transmission line route, during the wet and dry seasons, to help collect information on

populations and habitat use for detailed mitigation planning and impact monitoring. The survey will involve the use of sensor cameras in the possible habitat/corridor areas used by important mammals. The sensor camera has an automatic shooting system triggered by a motion sensor and a heat sensor. It is proposed to use about 10 cameras in the dense forest patches along the transmission line route. Camera setting points, height, and direction will be carefully selected, based on large mammal surveys in other areas. The location will be recorded by GPS. The actual work includes setting the cameras, exchanging memory cards and batteries, and analysis of photographs. It is expected that the survey will be conducted once in Year 4 of the project (about a year before transmission line work will begin; in the dry and wet season) and then once during operation (within the first two years), to determine the effectiveness of the wildlife mitigation measures, and to solidify the understanding of wildlife habitat use along the route. The photographic results will then be interpreted with regard to location, habitat type, and proximity to human habitations. Satellite photographs will also be used to classify habitat types, and secondary data from the Ministry of Forests, IUCN, and WWF will also be examined. If the camera surveys indicate the presence of Royal Bengal tigers along the route, then a special intervention will be required, which might involve trapping the tiger(s) and moving them to the tiger habitat in Chitwan National Park (advice will be taken from tiger experts, as needed).

61. *Design of Habitat and Species-Specific Mitigation Measures*: The results of the wildlife survey will be used to identify high-frequency wildlife areas that may be affected by forest cutting along the route. The intention will be to ensure habitat access, where there is a risk of habitat segmentation. This might involve specific vegetation channels (up to 3 m high) that will along predators to cross the right-of-way, without being intimidated or exposed; some creativity will be required here to select the most appropriate species, should this need arise[1]. With regard to the transmission towers, the exact location of each tower can be adjusted to suit local wildlife movements (for example, there is some scope, in tens of meters, one way or the other along the alignment, if such specific siting of towers is required).

62. *Coordination with the Forest Management Plan*: The Technical Assistance is also supporting a Forest Management Plan, to compensate for the trees that will be lost due to cutting along the transmission line route. As that plan develops, it will be important to identify critical wildlife habitats and access areas that can be enhanced by planting of appropriate, but short, species (as noted above).

63. *Animal Encounter Protocol*: The construction contracts will specify the protocol for encountering and handling any animals that are encountered during land clearing and tower base construction (within reason). Rather than ignoring or killing amphibians, birds and reptiles that are encountered during daily activities, workers will be encouraged to collect and deposit animals that are encountered (and can be captured and moved) in an appropriate area that will not be disturbed by future construction activity, or these can be reported and collected by a special contractor.

64. *Public awareness-raising and conservation education*: It is proposed to educate the workers and people living along the transmission line right-of-way with regard to the importance of habitat management (trees and watersheds) and conservation of vulnerable animals (no illegal hunting and trapping). This will include awareness of the wildlife surveys and the need to leave the cameras undisturbed. The public awareness-raising will also include information on

[1]Tree species of medium height like *Aporusa octandra, Hoarrhena pubescens, Casearia elliptica* and small climbers like *Dioscora bulbifera, D. Pubera and Dioscorea hamiltonii* under the transmission line could provide fodder for herbivores, which would also maintain habitat for the predator species (but heights need to be restricted to 3 m).

any habitat and access mitigation measures (such as wildlife vegetation tracks), and the need to protect these. Public awareness-raising will be undertaken with brochures and public meetings.

7.2.6 Implementation Arrangements

65. The National Electricity Authority (NEA) will be the Executing Agency for the transmission line component and will implement the required mitigation measures, as well as being responsible for management of construction workers. Consultant support will be needed to implement the wildlife surveys, undertake the public-awareness-raising, and design the wildlife mitigation measures, which will then be implemented by NEA. Ministry of Forests will be engaged with several aspects of the wildlife activities (habitat identification and management).

66. It is expected that the Management Plan will require 19.5 person-months (2.5 International and 17 National) during pre-construction and construction and 4 person-months (National) during the first two years of operation. The consultants will be engaged according to ADB Guidelines on the Use of Consultants. The equipment will be procured according to ADB's Procurement Guidelines. The study is expected to be implemented over 5 years, from 2017 to 2022. The disbursements will be made according to ADB's *Technical Assistance Disbursement Handbook.*[2] Consultant needs are listed below.

7.2.7 Terms of Reference for Consultants

67. The following consultants will be required to assist with design and implementation of the Wildlife Conservation and Awareness Management Plan for the transmission line:

- Wildlife Management Specialists (International and National): responsible for undertaking the wildlife survey, identifying critical habitats and access points, designing the wildlife mitigation measures and animal encounter protocols, creating content for the public awareness-raising and delivering the sessions, repeating the survey to determine effectiveness of the mitigation measures, and coordination with the Forest Management Plan consultants.

68. Specifically, the Wildlife Management Specialists will be responsible for the following tasks:

- Review of the results of any previous surveys in the region (near the proposed transmission line route), and all secondary data and satellite images;
- Design of the wildlife survey;
- Implementation of the wildlife survey, in the wet season and dry season (once before installation of the line, and then once during operation); weekly camera patrols;
- Identification of critical wildlife habitats and corridors in the reservoir area;
- Design of habitat access mechanisms (low vegetative cover) to ensure integrity of wildlife populations (important mammal species) along the route (and monitoring through the second survey noted above);
- Definition of animal encounter protocols for construction workers (a Standing Contract will then be established with a local wildlife handling consultant, who will respond to all calls regarding animal encounters, including capture and transfer of animals to other suitable locations);
- Design and delivery of public awareness-raising and education programs related to wildlife conservation (including dissemination of the wildlife survey results and

[2] ADB. 2008. *Technical Assistance Disbursement Handbook*, Manila.

discussion of the interactions between the transmission line and important wildlife; discussion of innovations in wildlife mitigation measures, collection of local anecdotal information on wildlife; discussion of concerns about illegal hunting and trapping, etc.); and,

- Coordination with the Forest Management Plan consultants regarding wildlife habitat needs (vegetation) at habitat access points.

7.2.8 Schedule

69. The consulting services to support the Wildlife Conservation and Awareness Management Plan for the transmission line is expected to start in the 2017. The schedule for each of the activities in the Plan is shown below.

Activities	2013		2014		2015	2016	2017	2018	2019	2020	2021	2022
		Pre-constn			Construction						Operation	
Wildlife Survey												
Design.												
Implementation.												
Design of Habitat and Species-Specific Mitigation Measures												
Design.												
Implementation.												
Monitoring.												
Coordination with the Forest Management Plan												
Animal Encounter Protocol												
Public awareness-raising and conservation education												

7.3 Proposed Forest Management Plan

7.3.1 Introduction

70. As noted previously, the proposed transmission line will result in the loss of some patches of forest habitat along the route, totaling 37.5 ha, 2.4 of which will be a permanent loss, and about 35 of which will be converted to low grass/scrub habitat. Trees will obviously have to be cut down and scrub vegetation cleared, so that the installation of the line and the construction of the towers can proceed unencumbered. This is standard practice for transmission line projects and, as a result, there are relatively standard approaches in Nepal to compensate for the loss of trees. These include regulatory approaches (discussed below) and what can be considered best practice in forest management related to such projects (see Section 7.3.5). The overall objective is to replace the trees lost to the project, and provide the best possible habitat (up to 3 m height in the right-of-way) for as wide a range of animal and plant species as possible, without hindering maintenance of the right-of-way. With good planning, all these aspects can be properly addressed in a Forest Management Plan; that is the intention of the Management Plan described below. The plan includes description of the specific issues, the proposed objectives and outcomes of the Forest Management Plan, the approach and methodology, implementation arrangements, and schedule.

7.3.2 Context, Project Design and Activities, and Potential Issues Regarding Forest Cover

71. Figure 7.4 shows the proposed transmission line route. Figure 7.5 shows the forest cover in one area where the line will approach the Seti-Madi River. It has been estimated that 8,948 trees of various species (none unique) and sizes will be felled (a wood volume of 9,070 m^3). This area of clearing is limited and the remaining adjacent forest area is large and contiguous, so it not expected that there will be significant impacts on forest cover in the two districts impacted by the project. Most of the right-of-way, however, will be converted to high grass/low scrub vegetated habitat. As per the Forest Guideline 2006 (Guideline to Avail Forest Land for Other Development Purpose, 2063), the transmission line project will be classified as a commercial venture, which means it has to comply with a number of provisions (see below). NEA, in consultation with Ministry of Energy and the District Forest Office, will therefore seek to develop a fair and workable nursery and afforestation program as compensation for the trees lost along the right-of-way.

Figure 7.4.The Proposed Transmission Line Route

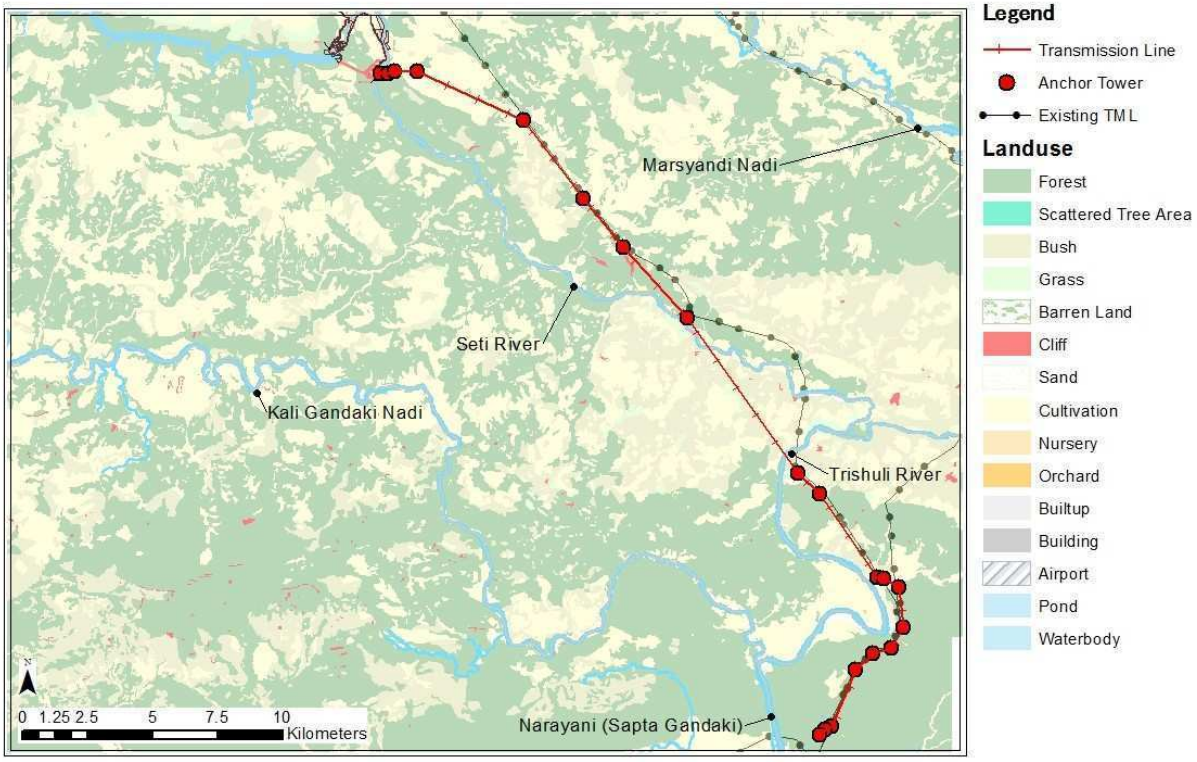


Figure 7.5.Forest Cover Where the Proposed Transmission Line Approaches the Seti-Madi River.

72. To meet the requirements of the Forest Guideline 2006 ("commercial venture"), the following mitigation measures are required to be implemented:

- survey of the forest area in the presence of a forest officer, numbering all trees above 10 cm dbh, by species;
- felling of the trees, branch cutting and stacking of the forest products within the felled areas;
- new nursery development;
- nursery seedling production for plantation development;
- acquisition of land area equivalent to the land area occupied by project structures;
- plantation and maintenance of seedlings for five years in a new area; and,
- lease compensation for project-occupied land as per the Forest Regulation.

73. There has been reference to a land-for-land compensation for project-occupied forest areas, and a requirement for a planting ratio of 25 seedlings per lost tree. This will be discussed with the Ministry of Forests and Soil Conservation, once the application for the tree clearance is filed. The framework for the organizational structure for the Forest Management Plan will be developed in consultation with relevant authorities and stakeholders (see Table 7.2), to ensure that all expectations are understood and can be met in a reasonable manner. For instance, conservation of significant species will require propagation in the nursery from seed collected from the project-affected trees 6-12 months before they are removed. With regard to the wildlife habitat value of the forest area that will be cleared, this is addressed in the Wildlife Conservation and Awareness Management Plan. Note, however, that the impact on forest cover caused by the transmission line route is quite small, so that efforts to establish institutional structures and processes to establish a Forest Management Plan should be scaled to this small impact.

74. To summarize, the required steps for developing the forest management plan, from the EIA stage through to design of the afforestation plan, include:

- Consultation with the concerned district forest officials and the Department of Forest Officials with regard to the project impact on forest land during the EIA study phase. The inputs of forest officials are normally on the process and procedures of the Forest Guidelines 2006. This includes i) forest area allocation to the national priority project only; ii) alternative analysis to explain that the project could not be realized without the acquisition of the forest land; iii) land-to-land replacement for the area occupied by the project structures in other areas; iv) afforestation of felled trees above 10cm dbh from the project occupied areas in a ratio of 1:25 in an area designated by the district forest office and then maintenance for 5 years, or pay the required amount, with costs as per forest norms 2003, to the district forest office.
- Submission of TML IEE (2010) and DAM EIA (2009) report as per the Forest Guideline measures.
- Approval of IEE/EIA report by the government.
- Issuance of the Project Generation License based on the approved TML IEE (2010) and DAM EIA (2009) by the Department of Electricity Development (DOED).
- Application to the Ministry of Energy and Ministry of Forests and Soil Conservation for forest land by the project with a copy of Project Generation License and approved TML IEE (2010) and DAM EIA (2009).
- Consultation with the Ministry of Forests and Soil Conservation and concerned Department of Forests and District Forest Offices on the various conditions of the Forest Guidelines in the presence of the concerned officials from DOED and the Ministry of Energy.
- Ministry of Energy and Ministry of Forests and Soil Conservation, after consultation, prepare a proposal for forest land allocation to the project with conditions (which include the provisions of forest guidelines (2006) and additional provisions) for cabinet approval.
- Cabinet of Ministers approve the proposal with or without conditions depending upon the project nature.
- Approval letter is forwarded to the project developer.
- Project developer then initiates consultation with the forest department and district forest office and the community forest user groups and prepares a plan for the afforestation, as per the approval letter conditions.

7.3.3 Objectives and Expected Outcomes of the Forest Management Plan

75. The main objective of the proposed Forest Management Plan is to ensure full forest compensation; that is, ensuring that the forest "function" and tree species composition lost to the transmission line installation and maintenance are replaced in another area (to be afforested). Through the proposed Forest Management Plan, all regulatory requirements will be discussed and implemented, for full compliance.

76. The target planting area is expected to be near the Seti River (before the Trisuli), along which much of the transmission line will pass. The main target forest types to be included in the plan are: Montane Sal forest and *Schima-Castanopsis* forest (in Tanahu District); Tropical Sal forest in Chitwan District; and mixed patches of *Acacia* and *Terminalia*. Target individual species are *Acacia catechu* (which has conservation status in Nepal) and *Shorea robusta* Gaertn (also with conservation status in Nepal).

77. The expected outcomes of the Forest Management Plan include:

- replacement (over time, after seedlings have matured) of the forest area that will be reduced by the transmission line, in areas that are as close to the project site as possible and suitable for afforestation;
- maintaining and/or improving the tree biodiversity in forested areas adjacent to the project site (no loss of tree species, especially the three that have conservations status in Nepal);
- maintaining a reasonable balance between the need for maintaining biodiversity and possible local interest in planting some stands of commercial trees (although only a small area is impacted, so this may not be such a big issue); this will be done in consultation with District Forest Offices and local communities; and,
- improving local community understanding of the importance of watershed and forest management, to support sustainability of the mitigation measures associated with the transmission line.

7.3.4 Rationale for Proposed Approach

78. Most of the proposed Forest Management Plan is actually specified in Nepali regulations and therefore becomes the backbone of the plan to compensate for forest losses along the transmission line right-of-way. All proposed activities will need to be sustained through continuous public awareness-raising and education programs, to maintain local community support for both the Forest Management Plan and the project itself. Proposed activities and methodologies are noted below.

7.3.5 Activities and Methodology

79. *Clarification and compliance with required legal procedures*: Before the project land can be cleared and trees planted in adjacent locations, the following procedures need to be addressed by NEA:

- issuance of the Project Generation License by the Ministry of Energy;
- cutting and Afforestation Application to the Ministry of Energy and Ministry of Forests and Soil Conservation;
- consultation with the Ministry of Forests and Soil Conservation and concerned Department of Forests and District Forest Offices regarding the planned cutting and planting;
- preparation of a proposal for forest land allocation to the project, for cabinet approval;
- Cabinet of Ministers approves the proposal with or without conditions; and,
- The approval letter is forwarded to NEA.

80. The required forest permits and approvals are summarized in Table 7.2.

Table 7.2.Summary of Required Forest Permits and Approvals.

Permit/ Permission	Approval Authority	Information Required in Permit/Agreement	Suggested Timing of Application
Occupation of forest land	Cabinet, through the Ministry of Forests and Soil Conservation	EIA approval letter from MoEST, approved EIA report and detailed information on: o forest area (ha); o Government managed forest by type (District Forest, Community Forest, Leasehold Forest - by ha); o number of trees by species category in each forest type;	Application lodged at least 120 days prior to proposed occupancy of forest land.

Permit/ Permission	Approval Authority	Information Required in Permit/Agreement	Suggested Timing of Application
		○ afforestation plan. Justification that forest land is required for project development (including an alternative analysis).	
'Felling permit' for trees on (cabinet permitted) public land 'Permission' to fell trees in Community Forests	District Forest Office (DFO), Department of Forests Forest User Group (and DFO)	Estimated number of trees to be felled / lopped; marking process; party responsible for cutting and transport of trees; monitoring process; involvement of DFO staff in tree clearance and construction monitoring; compensatory planting proposal and budget estimate.	Application lodged at least 60 days prior to proposed commencement of felling.

81. *Tree measurement*: After getting the approval letters, THL can start preparing the afforestation plan, following the condition of permits. The first step is measurement of trees in the National forest and Community forest. The local forest contractor of THL will start measurement of trees above 10cm dbh (tree diameter at breast height) in the affected forest area, in the presence of the forest officer. The measurement will include blaze marking, number writing, painting, and brushing, so that all trees are recorded. At the same time, conservation tree species should be marked and recorded by GPS. It is expected that the measurement work will continue until 2015. The tree measurement process will also be used to determine the required compensation for trees on private property that need to be felled for project purposes.

82. *Preparation of the afforestation plan*: The consultants for the Forest Management Plan will prepare the afforestation plan, following the conditions of the cabinet approval letter. Preliminary activities will include the following:

(i) Exploration and measurements at the candidate site for afforestation, timber cutting, top soil storage, and land acquisition. The candidate planting site might be a high erosion area, open forest, illegal farm land, or derelict land (after excavation or mining) somewhere along the Seti-Madi River. A top soil storage site is needed, since top soil including seeds should be used for the afforestation area. The seeds will promote the vegetation recovery.

(ii) Identifying the planting species: The possible tree types for planting are i) Sissoo; ii) Khayar; iii) Fodder plants; iv) Timber trees; v) Fuelwood plants; vi) Medicinal plants; and, vii) Aromatic plants and any other Non-Timber Forest Products.

(iii) Identifying the planting methods: Planting methods can include creating seedlings from seeds; seedling transplantation; growing from branch cutting; and/or growing from stub cutting.

(iv) Identifying the important habitats for the wildlife: The areas of animal corridors, feeding areas, and other important habitats should be identified and planned as high priority planting areas. Very specific details will be needed for the afforestation plan.

83. After the activities listed above have been completed, the afforestation plan will be prepared. The afforestation plan will identify the utility and purpose of afforestation, the afforestation area [3], tree types, number of trees, nursery area, afforestation methods,

[3]The forest guideline 2006 suggests "Afforestation in the land area equivalent to area occupied by the physical structures of the project, in a nearby area as directed by the District Forest of the Project Area and care taking for five years. Or pay the required

afforestation schedule, and budget, as well as specific responsibilities and sustainability strategies.

84. *Public awareness-raising and forest management education program*: Public awareness-raising and forest education programs will be an important element of the overall forest management plan, to help sustain all activities. The target of this activity will be the construction workers and villagers along the proposed transmission line route. The program will involve workshops and dissemination through brochures. Education of the workers will include the following measures:

- forbidding access to the remaining forest along the right-of-way;
- forbidding the disposal of soil in the river;
- overview of important species and exotic species in the forest habitat; and,
- forbidding the collection of firewood from the remaining forest.

85. Education of the villagers will include the following topics:

- the succession of forest vegetation and biodiversity;
- the importance of exotic species and required conservation actions;
- overview of the importance of soil cover; and,
- forbidding the cutting of important tree species and associated vegetation.

86. *Tree nursery*: Seedlings of the trees required for affected Natural forest, Community Forest, and Procured land will be produced in a nursery. This initiative will require the following actions:

(i) Development of new tree nurseries: following the completion of the afforestation plan, new nurseries will need to be developed in appropriate areas, as close as possible to the planting areas. Development of the nurseries (there may be more than one) will involve selection of sites, clearing land, earth works, fencing, setting up water supply, and of course establishing the nature of the land lease/acquisition.

(ii) Production of seedlings for the required plantation program: this will follow the details in the afforestation plan, in which the number of trees and tree types are clarified. For individual tree species, the appropriate seedling production and handling/grow-out methods will be defined. Indigenous tree species will be prioritized.

87. *Tree cutting program*: The local forest contractor will be responsible for cutting the trees in the right-of-way clearing areas, following the required protocol in the approvals. The steps in this initiative will involve the following:

(i) Transplanting important tree species: Identified conservation tree species, such as *Acacia catechu* and *Alstonia scholaris,* should be transplanted when encountered, before tree cutting (if they are not too big for transplanting). If the planting area is defined, these trees can be transplanted directly to the afforestation area (suitable soil conditions, such as sandy soil for *Acacia*, will be required, of course). If the area is not yet decided, conservation tree species that are uprooted will be kept in the tree nursery.

(ii) Extraction of available seedlings: If seedlings of appropriate species are encountered during land clearing and cutting, these will be taken out and kept in the nursery (this is known to work well with Sal trees). If the size of such trees is too big to reasonably carry, for some species that can handle coppicing, the upper part of the tree can be cut and the remaining stump kept and replanted.

---

amount to the Forest office calculated based on Forest Norms 2003." NEA and NEA should follow this guideline or the condition of the approval by cabinet.

(iii) Earth retaining work: In order to prevent soil erosion and loss to the river, earth retaining works will be needed in appropriate sloped areas.

(iv) Preparation of the work space: The active cutting areas will need to be carefully managed, which will include preparation of a timber cutting work space and a location for storing topsoil. The topsoil will need to be covered, to prevent dust and erosion. Truck routes will need to be identified and properly prepared. Truck routes and times will be provided to local residents.

(v) Tree felling: Tree felling work will need to be done carefully, starting with the upper canopy in the forest. As noted in the Wildlife Conservation and Awareness Management Plan, this work should be coordinated with the wildlife specialists, who will be available to rescue animals as encountered.

(vi) Branch cutting and stripping of leaves: Branches and leaves will be cut at the site. This material will be gathered and treated according to the covenants in the approvals, and might include mulching on site.

(vii) Collection of timber and branches: These will be carried to a storage area at the work site, prior to removal to a commercial operation, where they will be milled, or otherwise handled and dispersed. Chatta[4] (fuelwood) may be produced on-site, but will have to be strictly handled according to the conditions of approval. It will not be sold without permission from Department of Forests.

(viii) Storing of topsoil: Topsoil in the tree felling areas will be gathered and stored for the afforestation program. It will be excavated to a maximum depth of 30 cm in a manner that precludes erosion and soil loss.

87. *Afforestation and subsequent management*: The local forest contractor will plant tree seedlings as required in the new area, and look after the afforested area for a period of at least five years. Steps required as this part of the program include:

(i) Clearing and layering of topsoil: Before planting at the afforestation site, exotic plants will be removed and earth works will be established to prevent topsoil erosion. Depending on the afforestation site, for example, if the slope is too steep, terraces may be needed.

(ii) Preparing the pits for plantation: This requires suitable sized pits to be dug (up to 30 x 30 x 30 cm) and fertilizer inputs (within reason and budget).

(iii) Seedling transportation and plantation: Seedlings will be brought from the nursery and planted at appropriate locations at the afforestation site. Planting will be undertaken in the appropriate season for maximum survival.

(iv) Maintenance: The planted seedlings will need maintenance for five years. The main work will involve fertilization, removing weeds, supplemental planting (as needed), and preventing erosion.

7.3.6 Implementation Arrangements

88. The National Electricity Authority (NEA) will be the Executing Agency for the transmission line component. Some technical expertise will be required to design and oversee the proposed Forest Management Plan. However, the actual tree cutting and seedling planting will be undertaken by local contractors, selected with the help of the technical experts. Ministry of Forests and Soil Conservation will be heavily engaged with all aspects of the Management Plan, as required by the regulations.

[4] In Nepal, fuel wood is measured in Chatta, its dimension being 20' ×5' ×5'.

89. It is expected that the Management Plan will require 23 person-months (National) during pre-construction and construction and 2 person-months (National) during the first year of operation. The consultants will be engaged according to ADB Guidelines on the Use of Consultants. The equipment will be procured according to ADB's Procurement Guidelines. The study is expected to be implemented over 6 years, from 2016 to 2022. The disbursements will be made according to ADB's *Technical Assistance Disbursement Handbook.*[5] Consultant needs are listed below.

7.3.7 Terms of Reference for Consultants

90. The following consultant will be required to assist with design, oversight, and implementation of the Forest Management Plan:

- Forest Management Specialist (National): responsible for providing technical advice to proper development of the tree cutting and afforestation plan, as well as providing public awareness and education content, in support of healthy forests.

91. Specifically, the Forest Management Specialist will undertake the following tasks:

- Support the legal procedures required for forest compensation and acquisition of land for afforestation and the tree nurseries; maintain pacing and troubleshooting as required, to facilitate the process for NEA. If the process behind the planned schedule, identify and solve the problems in cooperation with NEA;
- Support NEA in the preparation of the ToRs for the local contractor, who will handle tree cutting and planting of seedlings;
- Provide oversight for the measurement of trees in the affected areas (in forest patches along the transmission line right-of-way);
- Prepare the afforestation plan, including specific instructions regarding cutting of trees, raising seedlings, planting, maintenance, and subsequent vegetation management (including planting locations, methods, schedule, and monitoring plan);
- Provide oversight for tree cutting in the affected areas, including establishing proper measures for erosion control and protection of important species;
- Design and provide technical oversight for all activities at the nurseries;
- Provide technical oversight for the planting and maintenance of seedlings, ensuring the transplanting of the most important tree species (ensuring that indigenous trees will be planted);
- Assist with management of lease payments and compensation, as needed; and,
- Design and implement public awareness and education activities addressing forest management.

7.3.8 Schedule

92. The consulting services to support the Forest Management Plan are expected to start in 2016. The schedule for each of the activities in the Plan is shown below.

Activities	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
		Pre-constn	Construction						Operation	
Legal Aspects										
Tree Measurement										

[5] ADB. 2008. *Technical Assistance Disbursement Handbook*, Manila.

Activities	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
		Pre-constn	Construction						Operation	
Preparation of Afforestation Plan										
Forest Awareness-Raising and Education										
Design and Establishment of Tree Nurseries										
Tree Cutting Program										
Seedling Planting Program and Maintenance										
Support to Lease Payments										

7.4 Phase-Specific Environmental Management Measures

7.4.1 Pre-Construction Phase

7.4.1.1 Commencement of Land and Building Acquisition and Leasing

93. Some households will be affected temporarily during the clearing of the right-of-way**.** It is expected that there will be a one-time loss of 303 tonnes of agricultural production and a permanent annual loss of 5 tonnes per year. These losses will require compensation

7.4.1.2 Protection of Local Village Services

94. No temporary impact on village infrastructure and services is noted in the RP. If any infrastructure or services appear to be in the way of pre-construction work, and could therefore be constrained, alternative "makeshift" infrastructure will be installed by the CC before construction. Such local village services might be small foot passes, electricity lines, telephone lines, water pipes, and so on. The cost of protection of local village services is included in the construction budget.

7.4.1.3 Finalization of the Project Employment Strategy

95. Although installation of the transmission line and substation is not expected to create much employment, perceived inequity in local project employment could cause serious conflicts among local people, especially if people from outside the affected area are engaged. In order to avoid such a conflict, a fair and reasonable employment strategy should be prepared and made clear to the public. NEA will prepare the Project Employment Strategy during the pre-construction stage. Such strategies are expected to articulated and budgeted in the Community Development Plan (the budget will be assigned to construction costs).

7.4.1.4 Commencement of Staff Training

96. The transmission line construction employees will form the backbone of good environmental management practices during the construction phase and need to be well-exposed to environmental management principles and eventually all the details in this EMP. This especially applies to issues such as tree cutting along the line route for fuel, poaching, contamination of groundwater, illegal dumping of waste and hazardous materials, and so on. NEA will explain all the required management principles, by working area, before the start of

construction. Training material will be prepared by NEA and the Advisory Organizations. The cost of this training is expected to be within the Project administration budget.

7.4.2 Construction Phase

7.4.2.1 Air Quality Control

97. Construction activities have the potential to cause short-term air quality impacts, but most of the transmission line work will be occurring in open areas, so the risks are low. Vehicle and machinery emissions and dust will be generated along the right-of-way, but especially at the tower bases. Adverse air quality can cause health problems. The CC will minimize air quality impacts and the potential of health-related problems by:

- providing breathing protection masks for employees where required;
- using dust suppression methods, such as water spraying;
- compacting stockpile surface retained for longer than one month, or during monsoon season;
- repairing gravel pavement of any access roads and community roads adjacent to the right-of-way;
- establishing on-site speed restrictions for construction traffic;
- frequent watering of project access roads each day when visible dust is generated, primarily during the dry season;
- erection of roadside fences near houses/villages on temporary construction access roads to reduce windborne dust movement;
- vehicle washing prior to leaving work sites;
- careful handling and containment or damping of dusty materials on site, including the use of dust suppression/filtering;
- frequent watering of spoil disposal areas during dry season;
- maintaining and operating equipment in accordance with the manufacturers' specifications (including emission controls);
- managing work sites and workforce camps to minimize odor generation; and,
- undertaking progressive site re-vegetation in accordance with contract as the work at tower base is completed.

98. The ESU will visually inspect vehicle and equipment emissions and dust control measures during the weekly site inspections. The cost of air quality measures during construction is included in the construction budget.

7.4.2.2 Noise Control

99. Noise levels generated by construction activities will be significantly higher than current existing background noise levels, although it is not expected that there will be blasting and rock crushing, which would be the main concern. The CC will inform local villages of transmission line work schedules, including likely commencement and completion dates of work at each site.

100. The CC will minimize noise and vibration impacts at construction sites by:

- locating stationary plants (e.g., generators) as far away as possible from local villages and workforce camps;
- maintaining all equipment to manufacturers' specifications;
- fitting mufflers on road vehicles and construction equipment; and,

- providing ear muffs to workers operating high decibel equipment or working in close proximity to this equipment.

101. The CC will only permit the use of air horns around villages for safety purposes. The cost of noise control is included in the construction budget.

7.4.2.3 Water Quality Control

102. Transmission line land clearing and construction of the tower bases have the potential to adversely impact water quality in local watercourses. Impacts on water quality will be minimized by setting up a settlement pond, treatment plant, or other relevant facilities at work sites, workforce camps, batching plants and other temporary facilities fofr construction work. The exact width of buffer zone needed will be finalized by a survey done by CC.. The CC will ensure that all wastewater is treated prior to being discharged to watercourses. The CC will regularly test and record the water quality in sedimentation tanks and settling ponds, prior to being discharged. Given the moving nature of the work with the tower bases, these measures will have to be reasonable and temporary. The CC will obtain the ESU's approval for such waste water discharge system. Where possible, fence, entrance gate, or other relevant facility

103. Grease and waste oil will be prevented from entering waterways. Grease traps shall be installed at maintenance workshops and regularly cleaned out to ensure clean runoff from these sites, even during periods of rain. Oil separators will be set up at maintenance work shops. The CC will obtain ESU's approval for grease and waste oil trap/separator system. The field maintenance of machinery and equipment shall only be undertaken at sites approved by the ESU.

104. The CC shall store all fuels and chemicals in secure and protected areas, and in accordance with manufacturer's specifications. Protected areas shall be lined and have a capacity equivalent to 125% of the total liquid storage capacity, and shall have drainage valves to allow stormwater drainage. All rubbish and sewage disposal shall be undertaken at defined sites approved by the ESU.

105. The CC will implement the following mitigation measures:
- pit toilets at construction sites;
- standard toilets at camps with a central wetland type treatment facility;
- settlement pond or treatment plant for concrete batching plant; and,
- sedimentation tanks to arrest the introduction of TSS in site drainage water, and regular maintenance of these (sediment removal); to the extent that these may be required at the work camp.

106. If poor water quality is detected, the CC shall immediately recommend mitigation measures to the ESU for approval. The ESU shall approve these measures and/or specify other measures, and direct the CC to implement them immediately. The costs for water quality management related to construction activities are included in the construction budget.

7.4.2.4 Waste Management

107. Construction and domestic waste will be generated during transmission line construction work. Construction waste will primarily be composed of cleared vegetation, waste oils, and

material packaging. Domestic waste, predominantly generated at workforce camps, will include perishable and non-perishable domestic rubbish, sewage, oils and surplus fuels.

108. The CC will be responsible for the management, collection, and disposal of all construction and domestic waste generated at construction sites, work sites and workforce camps. The CC shall manage waste disposal at Project sites by providing:

- separate containers for the collection of recyclable/reusable construction material waste and non-recyclable waste at work sites;
- waste disposal containers for the collection of domestic rubbish generated at work sites and workforce camps; and,
- collection and storage of waste oils, fuels and chemicals in sealed containers in bunded areas for subsequent on-site recycling or safe disposal.

109. The CC shall ensure rubbish collection and disposal does not encourage scavenging by animals and birds. Waste materials shall be reused or recycled on-site where possible, to minimize the generation of waste. In particular:

- excavated spoil material (for example, at the tower bases and the substation) shall be used where possible as an aggregate in concrete, or as a road base and for road maintenance; and,
- cleared vegetation shall be made available to local communities or stockpiled for use during re-vegetation.

110. Waste materials that cannot be reused or recycled shall be burned or land-filled in designated areas on-site. The burning of waste shall be favored over land-filling where feasible, to reduce the potential for groundwater contamination. If waste is to be land-filled, it shall be covered with a layer of soil at the end of each day to reduce odors and prevent scavenging. Following the completion of filling, the landfill shall be capped with a 600 mm layer of soil, then top-soiled and re-vegetated. The ESU shall inspect waste management procedures at each Project site during the weekly site inspection. Costs related to waste management are included in the Project construction budget.

7.4.2.5 Hazards Management

111. The Project has the potential to be affected by natural and Project induced hazards. Potential natural hazards along the transmission line right-of-way include floods, landslides and earthquakes. Project induced hazards during Project construction include chemical spills, explosions, the collapse of structures, and other common construction site hazards.

112. *General Hazards*: The CC shall minimize worker and community exposure to hazards during Project construction by providing:

- safety training for each employee as it relates to his/her job at the commencement of employment and refresher workshops as required;
- appropriate relevant safety equipment for each employee;
- safety equipment at each work site, including fire-fighting equipment;
- first aid facilities at all Project sites;
- security fences around all work sites and workforce camps, and hazardous locations on construction sites; and,
- designated and signed paths around and through construction sites, work sites and workforce camps.

113. The CC shall conduct regular safety audits at all Project sites. As soon as activities have been completed at each construction site, work site and workforce camp, the CC shall clean up and leave the site in a safe condition. This shall include the removal of all wastes and excess building materials, and the stabilization of all cut faces and fill embankments.

114. *Hazardous Materials*: The mis-handling and incorrect storage of explosives, combustible and toxic materials (such as petrol, diesel, oil and lubricants) can lead to explosions, spills and leaks that pose safety hazards to workers and may cause soil and water contamination. The CC shall safely handle and store hazardous materials. Hazardous materials shall be stored in secure and bunded areas, and in accordance with manufacturer's specifications. Explosives shall be stored in police-guarded bunkers, in strict accordance with GoN regulations.

115. The CC shall immediately contain and mop up any chemical spill. The CC shall seek direction from the ESU regarding the disposal of any hazardous material. The costs of hazardous materials management will be included in the Project construction budget.

7.4.2.6 Workforce Management and Safety

116. Some local people will be employed for land clearing and tower base and substation construction, but more outside people will move into the local area and live in temporary workforce camps, potentially creating additional demands on natural resources (although limited by the small workforce and the moving nature of the transmission line work).The CC shall minimize pressure on the surrounding environment by developing and enforcing workforce management conditions. Workers shall act in a responsible manner during and after working hours, respecting the rights and property of local people. The CC shall establish rules to prevent:

- illegal felling of trees and use of other forest resources;
- illegal fishing and hunting;
- alcohol consumption;
- employment of under-aged employees;
- defecation in open areas and waterways; and,
- harvesting or taking the personal resources of others.

117. The CC shall ensure that no wood is burned by workers on or off the site, and shall provide alternative fuel sources for all cooking, heating and lighting needs at workforce camps. The construction workforce could also increase pressure on existing health facilities in the area. To minimize the potential for disease and ensure camp safety, the following shall be provided by the CC at workforce camps:

- potable water and sanitation facilities;
- rubbish bins for waste disposal;
- health care facilities (clinic); and,
- on-going safety and health-related education programs.

118. The CC shall ensure that all service facilities are supplied with sufficient capacity to service the maximum proposed workforce size at each camp and that the facilities are actively maintained in good, clean order, by workers specifically appointed for the task. The cost of this program is included in the Project construction budget.

7.4.2.7 Traffic and Access Control

119. There will be temporary increases in traffic at specific work areas along the right-of-way. The CC shall clearly define and mark Project roads to prevent indiscriminate vehicle access. Speed limits determined by the ESU shall be established on Project roads and enforced by the CC. The CC shall install speed humps on internal Project roads to minimize safety hazards. The cost of this program is included in the Project construction budget.

7.4.2.8 Archaeology Management

120. Archaeological assets might be found during excavation and/or earth work for the tower bases and for the substation. The CC shall report the discovery of any archaeological, cultural, or religious sites to the ESU, and work at the site shall cease, until a plan of action has been developed and implemented. The ESU shall seek the advice of the relevant VDC Chairman to determine appropriate action. Related costs are included in the Project construction budget. Appendix 3 in the Environmental Addendum (Volume 1) provides details on the protocol in the event of "chance finds".

7.4.2.9 Demobilization Management

121. After construction, any residual materials left on site might cause water pollution or waste problems. The CC will be responsible for removing all temporary buildings, refuse, stockpiles, and excess construction materials from Project sites after the Supervising Consultant deems that they are no longer required. Construction materials from demolished temporary structures shall be recycled where possible and made available to the local community. Materials that cannot be recycled shall be burned or land-filled. Related costs will be included in the Project construction budget.

7.4.2.10 Site Rehabilitation

122. Temporary work sites will have to be returned to the land owners. If the areas are given back without any treatment, there may be some recurring problems, such as erosion, soil contamination, and so on. All temporary work sites and workforce camps, and any disturbed areas around the tower bases and the substation, shall be re-vegetated by the CC as soon as possible after the completion of construction or use of these sites, in order to minimize the erosion hazard and to provide long term stabilization. The CC shall spread all stockpiled topsoil across sites and plant a cover crop (grass is proposed, to minimize the height of vegetation in the right-of-way) on non-agricultural land. The ESU shall ensure that sites are fully rehabilitated within one month of final site use and shall regularly monitor the effectiveness of re-vegetation measures during the weekly site inspections.

123. Land leased during Project construction shall be rehabilitated in accordance with the lease agreements, returning the land to an equal or better condition than it was in prior to Project use. Related costs will come from the Project construction budget.

7.4.2.11 Reinstatement of Services

124. If there are any trails or local services temporarily cut during Project construction and not replaced with permanent alternatives after construction, people using such services might have some difficulty in the future. All trails and local services temporarily cut during Project construction and not replaced with permanent alternatives shall be reinstated by the CC as soon as possible. Trails and local services are required by local villages for access, crop production, and drinking water supply. The ESU shall inspect and certify that all previously inventoried

services have been adequately reinstated. Related costs will come from the Project construction budget.

7.4.3 Operational Phase

7.4.3.1 Training

125. Environmental management during Project operation will involve training of employees and the monitoring of bio-physical features that will either be potentially affected by the Project or may impact upon the Project. All Project staff employed during the operational phase (expected to be just at the substation) will attend an environmental induction and training workshop conducted by the NEA at the commencement of employment. Induction and training will aim to raise the level of environmental awareness and will be tailored to different staff roles. It will variously cover:

- relevant legislation/licences/approvals;
- site environmental and safety procedures;
- incident management and emergency response procedures; and,
- complaint handling procedures.

126. Training costs will come from the Project operations budget.

7.4.3.2 Workforce Safety

127. Workers might be injured by electrical equipment, or vehicles. The ESSD will minimize the potential for worker accidents by providing (costs included in the Project operations budget):

- safety training to employees;
- appropriate protective clothing to employees (e.g. hard hats, boots, gloves, goggles, and ear muffs); and,
- first-aid kits and fire extinguishers at all work sites.

8. Complaint Handling and Grievance Redress

8.1 Complaint Handling

8.1.1 Project Construction - CC

128. The CC will maintain a "*Complaints Register*", recording all complaints received from individuals or groups within the community, either written or verbal. Each record shall detail:

- the name of the complainant;
- the time and date the complaint was received;
- an explanation of the specific complaint;
- the signature of the complainant;
- the signature of the employee who recorded the complaint;
- the person assigned to manage resolution of the complaint;
- the response action taken to resolve the complaint; and,
- the outcome.

129. The CC shall advise the ESSD of a significant complaint within 24 hours of receiving the complaint, and report minor complaints to the ESSD on a weekly basis. The CC, in conjunction

with the ESSD and NEA when necessary, shall deal appropriately with all complaints to resolve them in a timely manner.

8.1.2 Project Construction - ESSD

130. The ESSD will maintain a "*Complaints Register*", recording all complaints received from individuals or groups within the community, either written or verbal, providing the same details as listed in Section 8.1.1 above. The ESSD will inform NEA of a significant complaint (i.e. affecting safety, livelihoods, or creating/potentially creating a significant bio-physical impact on the environment) within 48 hours of receiving the complaint, and report minor complaints to NEA on a weekly basis. The ESSD, in conjunction with NEA when necessary, shall deal appropriately with all complaints to resolve them in a timely manner.

8.2 Grievance Redress Mechanism

131. A grievance redress mechanism (GRM) will be established to receive and facilitate the resolution of affected people's (AP) concerns, complaints, and grievances on social and environmental issues. The GRM aims to be proactive and accessible to APs for an effective way to address their concerns. The GRM will have three levels with time-bound schedules to function, as noted below.

132. *First level of GRM*: The Public Information Centre (PIC) at the VDC level will be the first level of intervention to address the grievance. Many grievances can be resolved by providing correct and complete information. The PIC will have full-time staff representing the EA and IA, with full authority to listen and provide information to APs and resolve their issues. The PIC officer may seek the assistance of the supervision consultant safeguards specialists to help resolve the issue. The PIC will fully document the complaint, including: (i) name of the person; (ii) date the complaint was received; (iii) nature of the complaint; (iv) location; and, (v) how the complaint was resolved. These reports will be submitted to the PMO and to the ESSD each month.

133. *Second level of GRM*: Should the grievance remain unresolved, the PIC officer will forward the complaint to the ESSD. The person filing the grievance will be notified by the officer that his/her grievance was forwarded to the ESSD. Grievances will be resolved through on-going interaction with the affected persons, with the ESSD answering queries and resolving grievances regarding various issues such as social and livelihood impacts and environmental issues. The ESSD will undertake corrective measures at the field level for environmental, social and livelihood issues. The ESSD staff will fully document the following information: (i) name of the person; (ii) date the complaint was received; (iii) nature of the complaint; (iv) location; and, (v) how the complaint was resolved.

134. *Third level of GRM*: Should the grievance remain unresolved, the issue will be referred to the Grievance Redressal Committee (GRC). The GRC will be headed by ESSD and shall consist of members of the concerned VDC, affected persons, NGOs and local area committee. The affected person can present his or her concerns/issues to the GRC. All relevant costs of GRC will be borne by the project. The GRC will meet, as necessary, when there are grievances to be addressed. The GRC will suggest corrective measures at the field level and assign clear responsibilities for implementing its decision in a timely manner as decided. The ESSD will be responsible for processing and placing all papers before the GRC, recording decisions, issuing minutes of the meetings, and taking follow-up action to ensure that formal orders are issued and decisions are carried out.

135. If each of the above measures fails, the affected person can seek legal redress of the grievance in the appropriate courts, which is the formal legal court system.

9. Supervision, Monitoring, and Reporting

9.1 Site Supervision

136. Strict supervision of Project construction activities (land clearing, and construction of the tower bases and the substation) is required to ensure that works are undertaken in accordance with the detailed Project design, environmental plans, permits, approvals, contract conditions, and the principles outlined in this EMP. A system of reviews, approvals, and reporting shall be implemented, as described below.

9.1.1 Pre-construction Phase

137. Pre-construction inspections of each Project site shall be jointly undertaken by the ESSD and CC, once the CC has surveyed and pegged each site. These inspections will serve to:

- confirm the location of Project sites;
- identify site specific construction and environmental issues;
- identify trails and services that will be temporarily cut during construction and shall be temporarily connected during construction and/or reinstated upon the completion of construction;
- identify stockpile sites and spoil and waste disposal areas; and,
- plan construction phasing at Project sites.

138. During the inspection, the ESSD and CC shall discuss and agree upon the above issues. In particular, the ESSD will document the type and location of all trails and services that are to be temporarily disconnected, and provide a copy of this to the CC. The CC shall sign off on the trails and services that are to be reinstated, and return a signed copy of the description of services to the ESSD.

9.1.2 Construction Phase

139. The ESSD shall undertake daily, weekly and monthly inspections of construction sites and work areas, and monthly inspections of workforce camps during the construction period. This will involve the protocols described below.

140. *Daily Environmental Inspections*: The ESSD will inspect the following works in progress:

- vegetation clearance;
- excavation activities;
- stockpiling; and,
- spoil disposal.

141. If any activities are not being undertaken in accordance with the contract and EMP conditions, the CC shall be instructed by the ESSD to rectify the situation, and the ESSD shall undertake a follow-up inspection to ensure that it has been rectified. Blasting and rock crushing activities will also be inspected when they are occurring. All drainage works and erosion and sediment controls will be inspected after each major storm event.

142. *Weekly Environmental Inspections*: The ESSD will undertake weekly inspections, accompanied by the CC, of all the sites and activities inspected during the daily inspections, as well as the following Project components, sites and activities:

- drainage works;
- erosion and sediment controls;
- chemical, fuel and explosive storage;
- oil separators;
- refueling areas; and,
- site rehabilitation works.

143. If any of these sites or activities are not in accordance with the contract and EMP conditions, the ESSD will document these and specify corrective measures in the Weekly Report. The ESSD will provide a copy of the Weekly Report to the CC within two days of the inspection, for appropriate action, and the CC shall undertake all actions as specified.

144. *Monthly Environmental Inspections*: The ESSD shall undertake a monthly inspection of all workforce camps and work sites in use over the preceding month. The adequacy of services provided at work sites and workforce camps will be inspected, as well as any on-site or off-site environmental degradation caused by camp or workforce activities. If any activities are not being undertaken in accordance with the contract and EMP conditions, the ESSD shall document these activities and specify corrective measures in the Monthly Report. The ESSD will provide a copy of the Monthly Report to the CC within two days of the inspection, and the CC shall undertake all actions as specified.

145. *Pre-monsoon Drainage Inspection*: The ESSD will undertake a joint pre-monsoon inspection of Project sites, in conjunction with the CC, to review monsoon drainage controls in the last two weeks of May each year. The ESSD shall specify the locations and types of any additional drainage and erosion and sediment controls that are required, and provide a written copy of these to the CC. The CC shall install the specified works prior to June 10.

9.1.3 Post-Construction Phase

146. The ESSD shall undertake a post-construction certification inspection of each completed Project site. The ESSD shall inspect all reinstated access and local services and the re-vegetation of all temporarily disturbed land. The ESSD shall certify each Project site if it is in accordance with all contract and EMP conditions, or provide a written list of remedial actions to the CC to be completed prior to certification.

9.2 Routine Environmental Monitoring

147. Environmental monitoring will occur during Project design/pre-construction, construction and operation, to provide baseline data, confirm project compliance and to detect any adverse impacts/non-compliances, although it will be very limited, given the linear nature of the project and minimal disturbance during its operational phase. The focus of routine environmental monitoring will be ensuring that construction activities strictly comply with management plan provisions and minimizing any direct and indirect Project environmental impacts. Proposed monitoring during each Project phase is summarized in Table 9.1. Some coordination with the monitoring expected as part of Forest Management Plan and the Wildlife Conservation and Awareness Management Plan will be required, to avoid duplication.

9.2.1 Baseline and On-going Monitoring

148. Environmental parameters at or near Project sites will be monitored by the ESSD through CC. Parameters that will be monitored could include water quality (depending on proximity to watercourses), air quality and noise levels. Baseline monitoring will be conducted during the design/pre-construction phase to fill in baseline data gaps. Monitoring of these parameters will continue over the duration of construction to identify any changes. Regular reports identifying non-compliance with government standards during Project construction will be prepared by CC and submitted to the ESSD for review. As noted above, given the linear nature of the project during construction, and the relatively static nature during operation, environmental parameters will be selected to match the relatively "light" impact of the transmission line.

9.2.2 Internal Monitoring

149. Regular internal environmental monitoring of construction works, associated activities and the implementation of environmental management measures will be undertaken by the CC during project design/pre-construction and construction, as per the frequency set out in Table 9.1. The CC will prepare fortnightly monitoring reports and submit these to the ESSD during project design/pre-construction and construction.

9.2.3 External Monitoring

150. External environmental monitoring of CC activities will be formally undertaken by the ESSD once a month during Project design and construction. Monthly monitoring reports will be prepared by the ESSD and submitted to the CC, including directions on what activities require improvement to achieve compliance. MoEST will conduct external monitoring of CC activities if it sees fit, to ensure Project compliance with the EMP, specific project environmental management plans, Project approval conditions and statutory requirements. The ESSD will provide MoEST with all necessary environmental records and arrange for ESSD and CC staff to be available during MoEST site inspections.

9.2.4 Panel of Experts

151. The option is in place for a Panel of Experts, although it may not really be necessary, given the nature of transmission line impacts. Nevertheless, if deemed necessary, a Panel of Experts will be appointed to provide guidance to the ESSD. The Panel, including an environmental specialist with significant expertise in site environmental management, will provide independent evaluations of Project environmental management during the construction and initial operational phases. Evaluations will entail:

- *Design/Pre-construction*: reviewing detailed Project designs and SEPs; and,
- an inspection of the main Project sites;
- *Construction*: reviewing CC's fortnightly internal monitoring reports;
- reviewing ESSD's monthly and quarterly monitoring reports;
- inspecting all operational construction sites and associated facilities; and,
- liaising with GoN authorities.

9.3 Records

152. Full environmental management records will be kept on site by the CC and ESSD for the full respective periods of their activities. Details are provided below.

9.3.1 Construction Phase

153. The CC will keep records demonstrating environmental compliance during Project construction. The following records shall be kept:

- all necessary permits and approvals;
- proof of employee environmental and safety training;
- a daily record of mitigation measure implementation;
- all environmental monitoring results;
- a record of all maintenance of environmental controls;
- all written instructions and reports provided by the ESSD, including Weekly Reports, Monthly Reports and Audit Reports;
- a register of non-conformances and corrective actions; and,
- all correspondence on environmental management matters, including any complaints received.

154. All records shall be kept at site premises and maintained in a legible state for the full period of construction. Environmental records will be made available to NEA, ESSD, DoED, and MoPE, upon request.

9.3.2 Operation Phase

155. The project operation office will keep records demonstrating environmental compliance during the operation of the Project. The following records shall be kept:

- all necessary approvals and permits, including permission for activities on private land;
- proof of employee environmental and safety training;
- results of all environmental monitoring;
- maintenance undertaken;
- all written instructions and reports provided by the ESSD, including Weekly Reports, Monthly Reports and Audit Reports;
- a register of non-conformances and corrective actions; and,
- correspondence.

156. A database of environmental monitoring results will be established. If monitoring results indicate non-conformance, the project operation office shall inform NEA immediately, and appropriate remedial action shall be taken. Records shall be kept at site premises and maintained in a legible state. Records will be made available to NEA and MoEST, upon request.

Table 9.1.Routine Environmental Monitoring Requirements (Transmission Line)

Feature / Issue	Methods and Scope	Parameter	Location	Responsibility	Time /Frequency
CONSTRUCTION PHASE					
Frontline environmental monitoring by the project proponent as per approved IEE	Compliance monitoring (visual observation)	Vegetation clearance area, landslide protection, water management, waste management	Along the transmission line and substation	ESSD (NEA)	Daily

Third Party monitoring /Auditing	Impact monitoring	Vegetation clearance area, landslide protection, water management, waste management	Along the transmission line and substation	ESSD (NEA)	Once a month

10. Auditing

10.1 Site Audits

157. Site audits will be undertaken, to independently verify the compliance of Project activities and controls with Government standards and the conditions set out in Project environmental plans.

10.1.1 Construction Phase

158. *Compliance audit*: The ESSD, acting as an Auditor, shall conduct a full compliance audit of the CC's operations and all construction and ancillary sites once every three months. Environmental compliance will be audited against the conditions contained in the construction contract, EMP, IMPs, SEPs and permit and approval conditions. The CC shall assign a representative to attend the audit and be responsible for implementing corrective actions.

159. The audit will involve a review of all sites in use or used since the previous audit, any construction and related activities in progress, and the site records. An Audit Report describing the results of the audit shall be prepared by the ESSD and submitted to the CC within two days of audit completion. The Audit Report shall specify any non-conformances and recommend corrective action/s, with dates for completion. The ESSD will follow up on any corrective actions within a reasonable time frame, either signing out the corrective action or requesting completion of the action.

160. *External compliance audit*: The Panel of Expert(if deemed to be necessary) will undertake an external compliance audit at least once a year during the construction phase to assess the project's compliance with the EMP, the effectiveness of mitigation measures and institutional development, and whether or not any unanticipated effects occurred as a result of project activities.

10.1.2 Operational Phase

161. *Compliance audit*: NEA will undertake a compliance audit of the transmission line once in the first year of Project operation. Right-of-way and tower sites shall be audited against contract conditions and the EMP. The project operation office shall accompany and assist NEA during the audit. An Audit Report describing the results of each audit shall be prepared by NEA and submitted to the project operation office within five days of audit completion. The Audit Report will specify any non-conformances and recommend corrective action/s with dates for completion.

162. *External compliance audit*: MoEST will undertake an external compliance audit also in the first year of Project operation, to assess the project's compliance with the EMP, the effectiveness of mitigation measures and institutional development, and whether or not any unanticipated effects occurred as a result of project activities. The audit shall be based on a site

inspection and the monitoring reports and baseline data prepared/gathered by the CC, ESSD, etc.

10.2 Corrective Action

163. Environmental non-conformances usually require the implementation of corrective actions specified in non-conformance reports. The requirements for these are described below.

10.2.1 Construction Phase

164. The CC will implement the corrective action/s recommended by the ESSD in the time specified. The CC shall then notify the ESSD of the completion of the corrective action/s. The ESSD will verify the satisfactory implementation of corrective actions during the following Weekly Inspection and sign off on the non-conformance/s if satisfactorily rectified, or make a further request, if unsatisfactory.

10.2.2 Operation Phase

165. In the first year of Project operation, NEA will implement the corrective action/s recommended by the auditing, in the time specified. NEA shall then notify the auditor of the completion of the corrective action/s so that the satisfactory implementation can be verified. The NEA will verify the satisfactory implementation of corrective actions and sign off on the non-conformance/s, if satisfactorily rectified, or make a further request if unsatisfactory.

10.3 Incident Management Procedures

166. The CC and the NEA will prepare Incident Management Procedures for their respective Project phases. During employee environmental training, the CC / NEA shall emphasize the importance of documenting all environmental incidents. The CC shall immediately report all incidents to the ESSD. These incidents may include:

- theft or misplacement of explosives;
- construction activities undertaken outside approved sites;
- damage to private or Government structures or land;
- hazardous material spills; and,
- forest or grass fires.

167. The CC / NEA shall investigate and act on all incidents by:

- identifying the cause of the incident;
- identifying and implementing necessary corrective action(s);
- identifying personnel responsible for carrying out corrective action(s);
- implementing or modifying controls necessary to avoid repetition; and,
- recording any changes required in written procedures.

10.4 Emergency Response Procedures

168. The CC and NEA will develop and implement *Emergency Response Procedures* for the Project for their respective construction and operation phases. The following steps shall be included in the procedures.

Define the Problem:

- The immediate problem is established, to facilitate a review of available options for short-term action.

Manage the Situation:

- The safety of any persons, either workers or others involved in Project construction or operation, is to be ensured as a first priority.
- Environmental damage is to be quickly minimized. All emergency action should take place as soon as possible after the event.

After the Event:

- The ESSD/NEA shall be contacted immediately, once all persons are safe and any possible immediate actions to control damage and manage the situation have been taken.

169. A rectification plan will be developed by the ESSD/NEA, detailing how any remaining environmental effects will be remedied.

References

Ministry of Environment, Science and Technology, 2006.*A Guide to Environmental Management Plan of Hydropower Projects*. Ministry of Environment, Science and Technology, Kathmandu.

Nepal Electricity Authority, 2012.*Upper Seti (Tanahu) Hydroelectric Project Environmental Addendum*. Prepared by Nepal Electricity Authority for the Asian Development Bank.

Nepal Electricity Authority, 2010.*Initial Environmental Examination (IEE) of Upper Seti (Damauli) – Bharatpur 220 kV Transmission Line Project*. *Final Report. Volume 1: Main Report*. Environmental and Social Studies Department, Engineering Services, NEA.

Appendix A: Summary of Environmental Management Measures for the Transmission Line.

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
Main Issue Management Plans (spanning pre-construction and construction)						
Wildlife Conservation and Awareness Management Plan	Wildlife habitat loss, possible segmentation of potential wildlife corridors.	MS, T	• Wildlife survey. • Identification of possible habitats. • Environmentally sound design of right-of-way. • Animal encounter protocol. • Coordination with forest management planning. • Monitoring. • Education.	$244,240 (consulting services)	NEA-ESSD NGO (IUCN, WWF, etc.)	Audit condition
Forest Management Plan	Forest loss; impact of habitat loss on terrestrial fauna.	MS, P	• Tree measurement. • Preparation of afforestation plan. • Land acquisition. • Nursery/ supervision of tree planting. • Coordination with wildlife habitat plan. • Monitoring. • Education.	$164,040 (consulting services) $1,368,949 (land compensation and afforestation)	NEA/ESSD NGO (IUCN etc.)	Audit condition
Phase-Specific Actions						
1. Pre-Construction Period						
Commencement of land and building acquisition and leasing	Just land leasing and some acquisition required.	NS, T/P	• Identified and negotiated compensation.	Part of construction cost	NEA	Compensation agreement
Protection of local village services	None observed in right-of-way, but contingency if identified.	NS	• Temporary replacement of services.	Part of construction cost	NEA	Resettlement agreement/ compensation
Finalization of the project employment strategy	Positive action.	+	• Local hiring, to the extent possible.	Part of construction cost	NEA	NEA strategy
Commencement of staff training	Positive action.	+	• Construction staff aware of all environmental requirements.	Part of construction cost	NEA	NEA strategy
2. Construction Period						
Air quality control	Dust impact around	MS, T	• Providing breathing protection masks for	Part of	CC	Condition of

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
	the land clearing and tower base construction sites. Air pollution by construction vehicles and transporter vehicle.		employees, where required. • Using dust suppression methods such as water spraying. • Covering or seeding stockpiles retained for longer than one month, or during monsoon season. • Gravelling the main Project access roads and adjacent community roads. • On-site speed restrictions for construction traffic. • Frequent watering of project access roads each day when visible dust is generated, primarily during the dry season. • Erection of roadside fences near houses/villages to reduce windborne dust movement. • Vehicle washing prior to leaving the site; • Careful handling and containment or damping of dusty materials on site, including the use of dust suppression/filtering on crushing and batching plants. • Maintaining and operating equipment in accordance with manufacturers' specifications. • Managing work sites and workforce camps to minimizeodor generation. • Progressive site re-vegetation as each tower base is completed.	construction cost		the Construction contract/ site inspections
Noise control	Noise generated from land clearing and construction activities, as well as construction vehicles.	MS, T	▪ Locating stationary plant (e.g., generators) as far away as possible from local villages and workforce camps. ▪ Maintaining all equipment to manufacturers' specifications. ▪ Fitting mufflers to road vehicles and construction equipment. ▪ Providing ear muffs to workers operating	Part of construction cost	CC	Condition of the construction contract/ site inspections

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
			high decibel equipment or working in close proximity to this equipment.			
Water quality control	Water pollution from siting of all land based construction activities including temporary facilities	MS, T	• setting up a settlement pond, treatment plant, or other relevant facilities at work sites, workforce camps, batching plants and other temporary facilities fofr construction work.	Part of construction cost	CC	Condition of the construction contract/ site inspections
	Water pollution from construction sites and camp site.	MS, T	• Pit toilets at construction sites and temporary camp sites along the right-of-way.	Part of construction cost	CC	Condition of the Construction contract/ site inspections
	Drains and erosion and sediment control.	NS, T	▪ Topsoil saving. ▪ Excavation controls. ▪ Stockpiling of materials.	Part of construction cost	CC	Condition of the Construction contract/ site inspections
Waste management	Water pollution from construction waste and aesthetic concerns from solid waste.	MS, T	▪ Regular solid waste collection with vehicles, to approved land fill sites. ▪ Proper storage and handling of all construction materials and waste.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Hazards management	Worker safety risks from accidents and chemicals.	MS, T	• Safety training to each employee as it relates to his/her job at the commencement of employment and refresher workshops as required. • Appropriate relevant safety equipment to each employee. • Safety equipment at each work site, including fire-fighting equipment. • First aid facilities at all Project sites. • Security fences around all work sites and workforce camps, and hazardous locations on construction sites. • Designated and signed paths around and through construction sites, work sites and workforce camps.	Part of construction cost	CC	Condition of the construction contract/ site inspections

Impact Items/ Project Activities	Potential Environmental Impacts	Degree /type of Impact	Mitigation/Enhancement Measure	Cost	Responsible Institution	Guarantees/ Agreements
Workforce management and safety	As above.	+	• As above.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Traffic and access control	Vehicle congestion on small rural roads.	NS, T	• Identification of project access roads, vehicle types, and schedules.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Archaeology management	Potential loss of cultural heritage.	NS, P	• Work stoppage in the event of archaeological remains or other cultural heritage being found along the right-of-way.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Demobilization management	Positive action.	+	• Organized retreat and clean-up after right-of-way clearing and construction of tower bases and tower installation and line stringing.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Site rehabilitation	Positive action.	+	• Soil management and re-vegetation around tower bases.	Part of construction cost	CC	Condition of the construction contract/ site inspections
Reinstatement of services	Positive action.	+	• Replacement/ improvement of all displaced village services.	Part of construction cost	CC	Condition of the construction contract/ site inspections
3. Operations and Maintenance Period						
Training	Positive action.	+	• Ongoing training of workers regarding safety and environmental management measures (but few staff during operational phase).	Part of operation cost	NEA-ESSD	Audit condition
Workforce safety	Positive action.	+	• As above.	Part of operation cost	NEA-ESSD	Audit condition

S - Significant impact, MS - Moderately significant impact, NS - Not significant impact, T - Temporary impact, P - Permanent impact, R – Rare, + - Positive Impact.

Appendix B: Statutory Requirements

Environmental Legislation

1. The Environmental Protection Act, 1996, and Environmental Protection Rules is the main umbrella Act and Rules in Nepal, which covers almost all aspects of environment. Ministry of Environment, Science and Technology is the lead agency, which administers the environmental matters emphasising on environmental conservation and management through internalising environmental assessment system, pollution control and prevention, conservation of natural heritage sites, compensation for environmental damages etc. However, there are several other policies, guidelines, acts and rules which relate to construction and operation of TANAFU HEP and should comply with the provisions by the involved parties during the period. The relevant Government of Nepal legislation and government policies and guidelines affecting and applicable to the project are listed below:

- Environment Protection Act, 2053 (1997)
- Environment Protection Regulations, 2054 (1997)
- National Environmental Assessment Guidelines, 2050 (1993)
- EIA Guidelines for Forestry Sector, 2052 (1995)
- Draft EIA Guidelines for Water Resources Sector, 2052 (1995)
- Forest Act, 2049 (1993) and Forest Regulations, 2052 (1995)
- Forestry Sector Policy, 2054 (1997)
- Soil & Water Conservation Act, 2039 (1982)
- National Parks & Wildlife Conservation Act, 2029 (1973)
- Aquatic Animals Protection Act, 2039 (1982) & Amendment, 2055(1999)
- Electricity Act & Regulations, 2050 (1992)
- Land Acquisition Act, 2034 (1977)
- Water Resources Regulations, 2049 (1993)
- Local Self Governance Act, 2055 (1999) & Regulations, 2056 (2000).
- Explosives Act, 1961;
- Vehicle and Transportation Management Act, 1992;
- Labor Act, 1991;
- Solid Waste (Management and Resource Mobilization), Act, 1986;
- Public Roads Act, 1974;
- Hydropower Development Policy, 2002
- Electricity Development and Management Act 2062 (2005)

2. Since Tanahu HEP study will be financed by ADB and JICA, it also requires compliance with the ADB safeguards and JICA guidelines for environmental and social considerations.

Environmental Standards

3. There are very few environmental standards endorsed by MOEST and other GON line agencies. Except for vehicular emissions standards and tolerance limits for inland effluent discharge, most of the environmental pollution standards, are in the formulation process. Considering the above situation following environmental standards are proposed for TANAFU HEP construction and operation. These environmental standards shall be treated as other acts and regulations until GON enforces standards in the specified sector for the project environmental compliance propose.

Table A1. Standards for Effluents Discharged into Inland Waters from the Construction Sites and Camps.

SN	Parameters	Tolerance Limits
1.	Total Suspended solids, mg/L, Max	30-200
2.	Particle size of total suspended particles	Shall pass 850-micron Sieve.
3.	pH	5.5 to 9.0
4.	Temperature	Shall not exceed 40 degree C in any section of the stream within 15 meters down-stream from the effluent outlet
5.	Biochemical oxygen demand (BOD) for 5 days at 20 degree C, mg/L, Max	30-100
6.	Oils and grease, mg/L, Max	10
7.	Phenolic compounds, mg/L, Max	1
8.	Cynides (as CN), mg/L, Max	0.2
9.	Sulphides (as S), mg/L, Max	2
10.	Radioactive materials:	
11.	a. Alpha emitters, c/ml, Max	7 OCT
12.	b. Beta emitters, c/ml, Max	8 OCT
13.	Insecticides	Absent
14.	Total residual chlorine, mg/L	1
15.	Fluorides (as F), mg/L, Max	2
16.	Arsenic (as As), mg/L, Max	0.2
17.	Cadmium (as, Cd), mg/L, Max	2
18.	Hexavalent chromium (as Cr), mg/L, Max	0.1
19.	Copper (as Cu), mg/L, Max	3
20.	Lead (as Pb), mg/L, Max	0.1
21.	Mercury (as Hg), mg/L, Max	.01
22.	Nickel (as Ni), mg/L, Max	3
23.	Selenium (as Se), mg/L, Max	0.05
24.	Zinc (as Zn), mg/L, Max	5
25.	Ammonical nitrogen, mg/L, Max	50
26.	Chemical Oxygen Demand, mg/L, Max	250
27.	Silver, mg/L, Max	0.1

Source: Standards adopted from MOEST

Table A2.Drinking Water Quality Standards for Construction Camps and Construction Sites.

SN	Parameters	Desirable Limits	Maximum Tolerable Limit
1.	Colour, Hazen units, Max	10	15
2.	Odour	Unobjectionable	
3.	Taste	Agreeable	
4.	Turbidity, NTU, Max	5	10
5.	Total Dissolved Solids, mg/l , Max	500	1500
6.	pH value	6.5 – 8.5	May be relaxed up to 5.5 on the lower and up to 9 on higher side.
7.	Total Hardness (as $CaCO_3$) mg/l, Max	250	
8.	Calcium (as Ca), mg/l, Max	75	
9.	Magnesium (as Mg), mg/l, Max	30	
10.	Copper (as Cu), mg/l, Max	1	may be extended up to 1.5
11.	Iron (as Fe), mg/l, Max	0.3	
12.	Manganese (as Mn), mg/l, Max	0.1	may be extended up to 0.5
13.	Chlorides (as Cl), mg/l, Max	250	
14.	Sulphate, (as SO_4), mg/l, Max	150[7]	
15.	Nitrate (as NO_3), mg/l, Max	45	No relaxation

[6] Value for turbidity is 5 in FAR(for mineral water), PFA, BS, WHO
[7] Value for Sulphate BS:200, FAR(for mineral water) and PFA:250

SN	Parameters	Desirable Limits	Maximum Tolerable Limit
16.	Fluoride (as F), mg/l, Max	1.5	
17.	Phenolic compounds, (as C_6H_5OH), mg/l, Max	0.001	May be relaxed up to 0.002
18.	Mercury (as Hg), mg/l, Max	0.001	No relaxation
19.	Cadmium (as Cd), mg/l, Max	0.01	No relaxation
20.	Selenium (as Se), mg/l, Max	0.01	No relaxation
21.	Lead (as Pb), mg/l, Max	0.01	No relaxation
22.	Arsenic (as As), mg/l, Max	0.05	No relaxation
23.	Cyanide (as CN), mg/l, Max	0.05	No relaxation
24.	Chromium (as Cr^{6+}), mg/l, Max	0.05	No relaxation
25.	Residual free Chlorine, (as Cl), mg/l, Min	0.2	
26.	Ammonia, mg/l, Max	1.5	
27.	Aluminium, mg/l, max	0.2	
28.	Boron mg/l, max	0.3	
29.	Nickel, mg/l, max	0.02	
30.	Hydrogen sulphide, mg/l, max	0.1	
31.	Zinc, mg/l, max	3	

Source: Standards adopted from Department of Water Supply & Sewerage

Table A3.Ambient Air Quality Standards in the Project Area.

Parameters	Units	Averaging Time	Concentration in Ambient Air, maximum
TSP (Total Suspended Particulates)	$\mu g/m^3$	Annual	-
		24-hours*	230
PM_{10}	$\mu g/m^3$	Annual	-
		24-hours*	120
Sulphur Dioxide	$\mu g/m^3$	Annual	50
		24-hours**	70
Nitrogen Dioxide	$\mu g/m^3$	Annual	40
		24-hours**	80
Carbon Monoxide	$\mu g/m^3$	8 hours**	10,000
		15 minute	100,000
Lead	$\mu g/m^3$	Annual	0.5
		24-hours	-
Benzene	$\mu g/m^3$	Annual	20****
		24-hours	-

Source: National Ambient Air Quality Standards adopted from MOEST

**Note: 24 hourly values shall be met 95% of the time in a year. 18 days per calendar year the standard may be exceeded but not on two consecutive days.*

***Note: 24 hourly standards for NO_2 and SO_2 and 8 hours standard for CO are not to be controlled before MOPE has recommended appropriate test methodologies. This will be done before 2005.*

****Note: If representativeness can be proven, yearly averages can be calculated from PM10 samples from selected weekdays from each month of the year.*

*****Note: To be re-evaluated by 2005.*

Table A4.Emissions Standards for 'in-use' Vehicles.

Fuel	*Wheelers Type*	*Manufacturing Date*	*Emissions*
Petrol	Four-Wheelers	Up to 1980	• 4.5% CO • 1,000 ppm HC*
	Four-Wheelers	After 1981	• 3.0% CO • 1,000 ppm HC*
	Three-Wheelers	Up to 1991	• 4.5% CO • 7,800 ppm HC*
	Three-Wheelers	After 1991	• 3.0% Co • 7,800 ppm HC*

	Two-Wheelers		• 4.5% CO • 7,800 ppm HC*
Diesel	-	Up to 1994	• 75 HSU
		After 1994	• 65 HSU
LPG/CNG	All categories		• 3.0% CO* • 1,000 ppm HC*

Source

Nepal Gazette, BS 2054-9-8, Ministry of Works and Transport

* *Nepal Gazette, BS 2057-7-7, Ministry of Population and Environment*

CO – carbon monoxide; HC – Hydrocarbon; HSU – Hertridge Smoke Unit

Table A5. Proposed Noise Exposure Limits for the Work Environment.

(Adopted from Occupational Safety and Health Administration (OSHA).

SN	Noise Exposure (dBA)	Permissible exposure (Hours and Minutes)
1.	85	16 hrs.
2.	87	12 hrs. –18 min.
3.	90	8 hrs.
4.	93	5 hrs – 18 min.
5.	96	3 hrs.-30 min.
6.	99	2 hrs. – 18 min.
7.	102	1 hr. – 30 min.
8.	105	1 hr.
9.	108	40 min.
10.	111	26 min.
11.	114	17 min.
12.	115	15 min.
13.	118	10 min.
14.	121	6.6 min.
15.	124	4 min.
16.	127	3 min.
17.	130	1 min.

Source: Marsh, 1991.

Table A6. Proposed Average Equivalent Sound Levels Recommended to Protect the Public Health and Welfare of the Project Site Communities.

S.N.	Land Use	Measure	To Protect Against Activity Interference and Hearing Loss Effects (dBA)
1.	Residential including farm residences	Leq (24)	55
2.	Commercial	Leq (24)	70
3.	Hospitals	Leq (24)	55
4.	Industrial	Leq (24)	70
5.	Educational	Leq (24)	55
6.	Recreational Areas	Leq (24)	70
7.	Farmland and general unpopulated land	Leq (24)	70

Source: U.S, Environmental Protection Agency, 1974
Note: Leq (24)= Equivalent Sound Level in decibels for 24 hours.

Environmental Permits and Approvals

4. Permits and Approvals relevant to the TANAFU HEP are presented in Table A.7 below.

Table A7. Permits and Approvals Required.

Issues	Authority	Approval and permits
Tree clearing and Government owned land	District Forest Office, Ministry of Forests and Soil Conservation	Permits
Tree clearing in Community Forest	District Forest Office and Forest User Groups	Permit and Approval
Relocation of archaeological , cultural and religious sites	Village Development Committee and Department of Archaeology	Approval
Works on private land and property	Compensation Fixation Committee, Village Advisory Group and Landowner	Approval
Relocation or disturbance to infrastructures such as irrigation canals, water supply, foot trails and tracks, suspension bridges, etc	Respective user committees/Village Development Committee and Ward Office	Approval
Construction of access roads	Department of Roads	Approval