Environmental Assessment Report

Summary Environmental Impact Assessment
Project Number: 41904
August 2007

India: NTPC Capacity Expansion Financing II (Tapovan–Vishnugad Hydroelectric Project and Loharinag–Pala Hydroelectric Project)

Prepared by NTPC Limited for the Asian Development Bank (ADB).

CURRENCY
(as of August 2007)

Currency Unit	–	Indian rupee/s (Rs)
Rs1.00	=	$0.02273
$1.00	=	Rs44.0

ABBREVIATIONS

ADB	–	Asian Development Bank
CO_2	–	carbon dioxide
EIA	–	environmental impact assessment
FRL	–	full reservoir level
HEP	–	hydroelectric project
IEE	–	initial environmental examination
MDDL	–	minimum draw down level
MOEF	–	Ministry of Environment and Forests
NH	–	national highway
NOx	–	nitrogen oxides
PTCUL	–	Power Transmission Corporation of Uttaranchal Limited
ROW	–	right-of-way
RP	–	resettlement plan
SEIA	–	summary environmental impact assessment
SO_2	–	sulfur dioxide
VDAC	–	village development advisory committee

WEIGHTS AND MEASURES

GWh	–	gigawatt-hour
ha	–	hectare
km	–	kilometer
km^2	–	square kilometer
kV	–	kilovolt
kWh	–	kilowatt-hour
m	–	meter
MCM	–	million cubic meters
mm	–	millimeter
m^3	–	cubic meter
m^3/s	–	cubic meter per second
MT	–	metric ton
MW	–	megawatt
MWh	–	megawatt-hour

NOTES

(i) In this report, "$" refers to US dollars.

(ii) In 2006, the Indian state of Uttaranchal officially changed its name to Uttarakhand. For the sake of consistency, Uttarakhand is used throughout this document.

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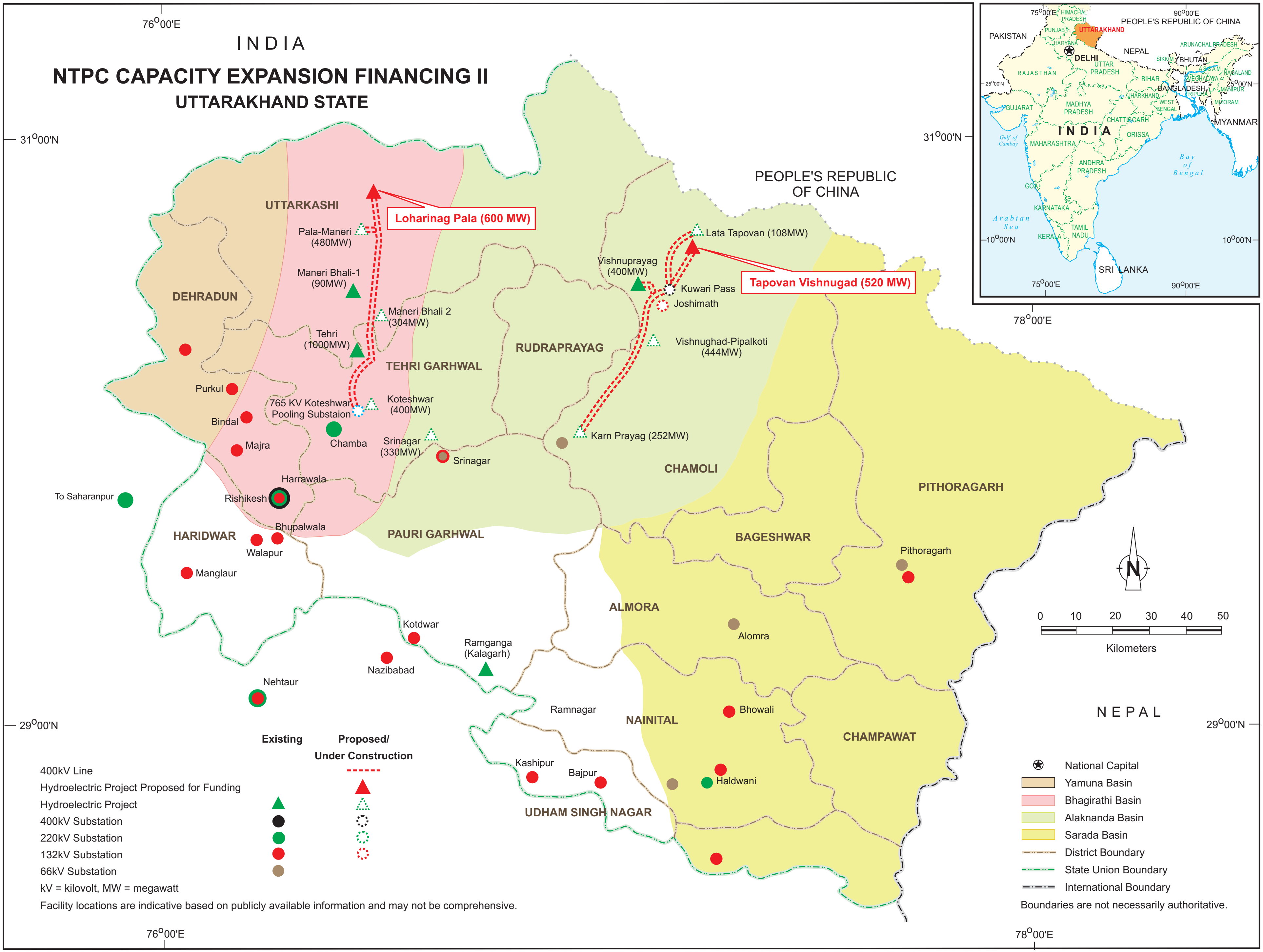

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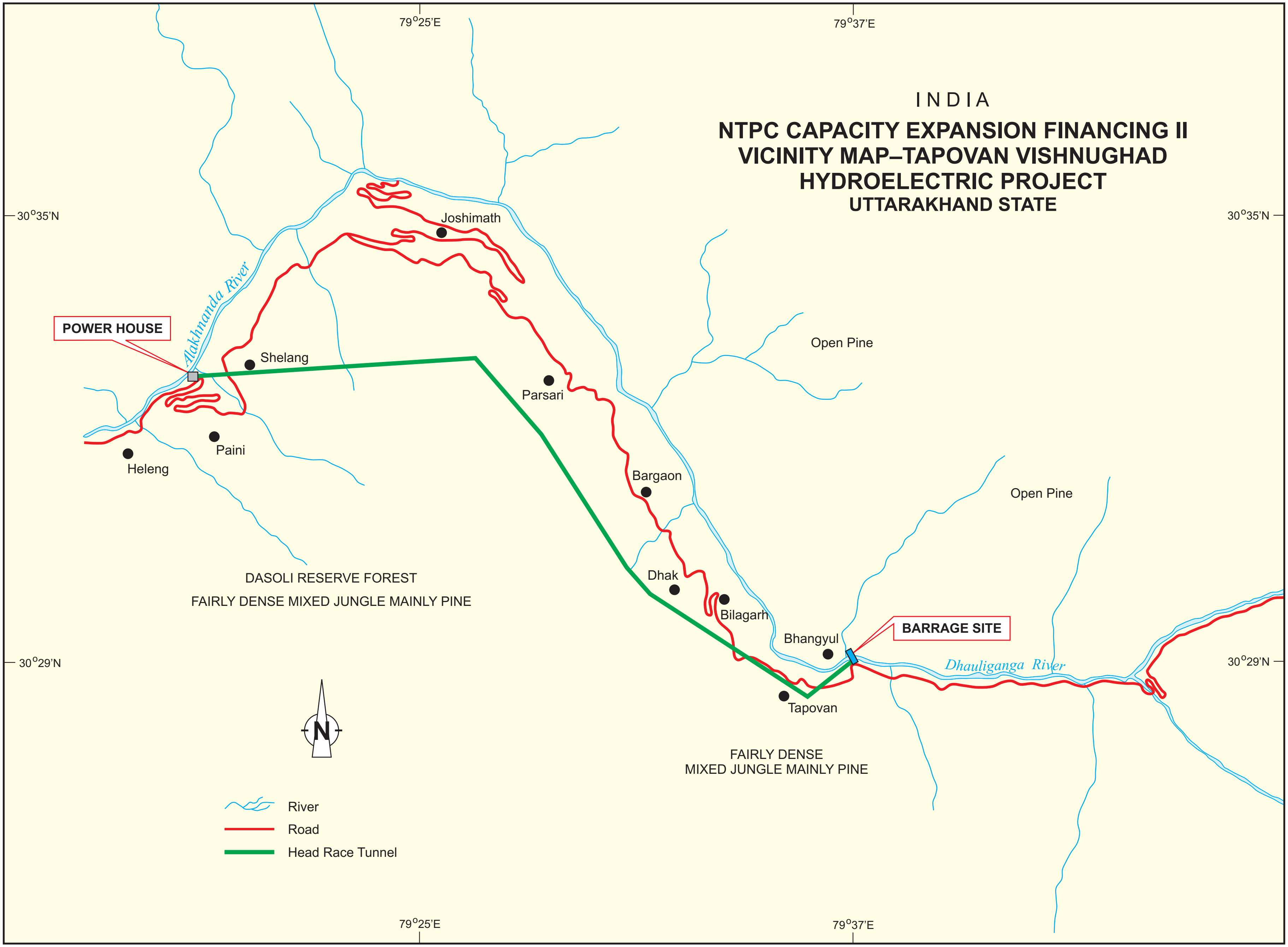
Map 1



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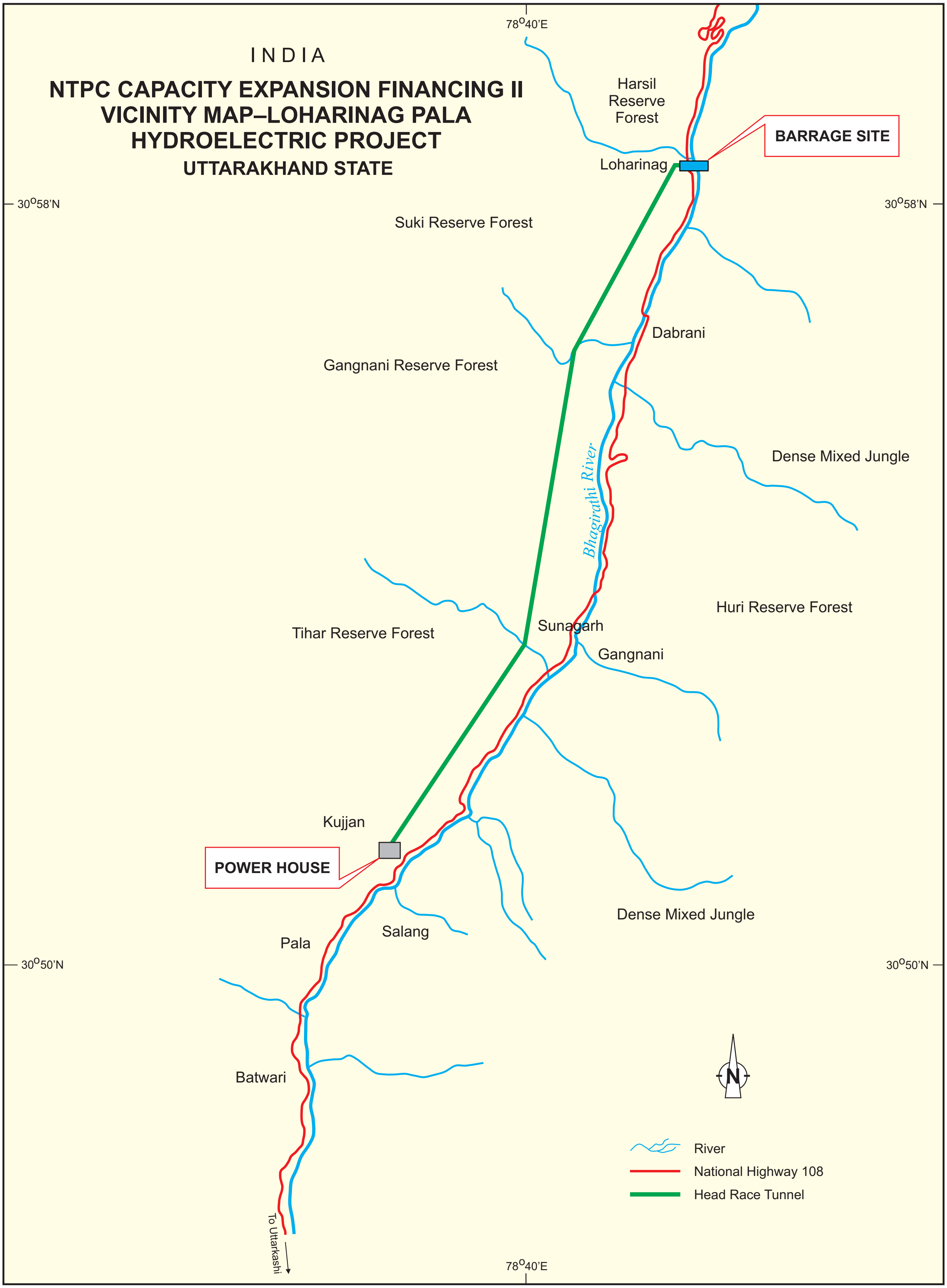
Map 2

Map 3



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I. INTRODUCTION

1. Demand for electricity in India outstrips supply. Inadequate generation, transmission, and distribution, and less-than-optimum use of electricity, lead to shortages, particularly at peak times. In 2006–2007, India had a peak power deficit of 13.5% and a power supply deficit of 9.9%; the corresponding deficits in the Northern region were 11.3% and 10.9%, respectively.[1] The total national shortfall in 2006 was estimated to be 8.3% of demand.[2] According to the 2001 census, about 44% of households in India have no access to electricity. Recognizing that electricity is a key driver of rapid economic growth and poverty reduction, the Government aspires to meet electricity demand in full by 2012.[3] Other objectives include providing all households with access to electricity within 5 years, and increasing the per capita availability of electricity to over 1,000 kilowatt-hours (kWh) by 2012.

2. India generates about 83% of its electricity from thermal power plants and about 14% from hydroelectric plants.[4] Installing a combination of generation types would enable the country to meet the substantial demand for electricity, but the Government is seeking to increase the share of hydropower generation to 50,000 megawatts (MW) of hydroelectric projects to deliver renewable energy benefits. Uttarakhand, now a net importer of electricity, plans to be a net exporter by 2010. The state has little or no fossil fuel resources, but has abundant hydropower potential, given its river resources and range of elevation. Of its assessed hydropower potential of 18,175 MW, only 6% had been developed by 2004.

3. NTPC Limited is implementing the 520 MW Tapovan–Vishnugad Hydroelectric Project (HEP) and the 600 MW Loharinag–Pala HEP, run-of-river schemes in Uttarakhand with some similar features. The construction of the Loharinag–Pala HEP began in July 2006; the first turbine is scheduled to be commissioned in April 2011 and the final turbine will come online in October 2011. The construction of the Tapovan–Vishnugad HEP began in November 2006; the first turbine is scheduled to be commissioned in September 2012 and the final turbine in March 2013, but efforts are being made to commission the Project by March 2012. These projects will add 1,120 MW of installed capacity to the Indian grid—a substantial contribution to meeting the shortfall in supply.

4. As required by the Government, environmental impact assessments (EIAs), covering the construction and operation of the projects, were prepared. A rapid EIA (March 2004) and a comprehensive EIA (September 2004) were prepared for each project. Detailed project reports were also prepared in March 2004 for the Loharinag–Pala HEP, and in April 2004 for the Tapovan–Vishnugad HEP. A detailed socioeconomic survey of all project-affected families, consisting of a village survey and a household survey, was completed in August 2005 for the Loharinag–Pala HEP, and in December 2005 for the Tapovan–Vishnugad HEP.

5. All necessary national and state government approvals for both projects have been obtained. The Ministry of Environment and Forests (MOEF) granted NTPC final site clearance (Stage II) for the Loharinag–Pala HEP in January 2004, and for the Tapovan–Vishnugad HEP in February 2004. These clearances permitted NTPC to carry out a site survey and investigation and to collect environmental data for the EIA and the Environmental Management Plan. Site clearances also permitted the construction of roads and temporary residences. However, if the area affected by these developments was on forest land, then prior clearance was required under the Forest (Conservation) Act, 1980.

[1] Central Electricity Authority. Available: http://www.cea.nic.in
[2] Ministry of Power. 2006. Available: http://powermin.nic.in
[3] Ministry of Power. 2005. National Electricity Policy. *The Gazette of India*. Extraordinary Part 1 Section 1–12. February. New Delhi.
[4] ADB. 2005. *Summary Environmental Impact Assessment: Uttaranchal Power Sector Project in India*. Manila.

6. Public hearings were held—in July 2004 for the Loharinag–Pala HEP, and in August 2004 for the Tapovan–Vishnugad HEP—and no-objection certificates for the projects were issued by the Uttaranchal Environment Protection and Pollution Control Board in September 2004.

7. The environmental assessment of transmission lines for the projects was completed separately by Power Grid Corporation of India Limited as part of the Asian Development Bank (ADB) multitranche financing facility for the Uttaranchal Power Investment Program (No. 003 and Loan No. 2309-IND, approved by the ADB Board in March 2006).

8. This summary EIA (SEIA) has been prepared by NTPC and will be posted on ADB's website 120 days before the requested loan is considered by ADB's Board of Directors. The proposed developments are classified as ADB environmental category A because the substantially reduced river flows will result in degradation in the river section between the weir and tailrace outlet, and because some resettlement will take place. Each HEP, its features and impacts, is described separately in this SEIA—the Tapovan–Vishnugad HEP in Part II, and the Loharinag–Pala HEP in Part III.

II. TAPOVAN–VISHNUGAD HYDROELECTRIC PROJECT

9. The description of the Tapovan–Vishnugad HEP in this SEIA is based on the information contained in the comprehensive EIA (2004) and on more recent documentation obtained by NTPC.

A. Description of the Project

10. The Tapovan–Vishnugad HEP, shown in Maps 1 and 2, will consist of four 130 MW turbines, for an installed capacity of 520 MW. It will feature a 200 meter (m) long and 22 m high barrage across the Dhauliganga River in Chamoli District, Uttarakhand. The barrage will have four gates, each one 14 m wide and 12 m high. The barrage pond will have a maximum depth of 22 m and a live storage of 13 m (between a minimum draw down limited [MDDL] elevation of 1,790.5 m and a full reservoir level [FRL] of 1,803.5 m) with a capacity of 0.57 million cubic meters (MCM). The pond will have a small submergence area confined to a gorge (about 10 hectares [ha]), providing some short-term daily storage (to allow peaking power generation for up to about 4 hours).

11. River flows will be diverted into an 11.77 kilometer [km] long head-race tunnel via a desilting basin and intake 234 m upstream of the barrage on the left bank. The intake sill level will be 5 m above the riverbed at an elevation of 1,787 m to prevent the entry of bed load. The head-race tunnel will divert the majority of river flow around an 18 km section of the combined Dhauliganga (11 km) and Alaknanda (7 km) rivers, creating a gross head of 523 m. The maximum head-race tunnel discharge will be 122.2 cubic meters per second (m^3/s). The underground powerhouse will be at Animathgad (Shelong), about 200 m upstream of the Animathgad and Alaknanda River confluence. The tailrace tunnel is 7 m in diameter and 439 m long.

12. The Tapovan–Vishnugad HEP will be operated as a run-of-river scheme with peaking generation in the dry season. During the monsoon it will operate as a base-load station, running at the design capacity of 520 MW all day when the river flow exceeds 147.2 m^3/s (the maximum head-race tunnel discharge plus the flushing flow). In the dry season the power plant will operate as a peaking station, with inflows detained to fill the storage then used to generate at full capacity over short periods, most likely over two cycles per day. A maximum time of 6.83 hours will be needed to fill the storage, and provide enough water for 1.46 hours of peak generation. Peaking generation is likely to occur once in the morning and

once in the evening. The rest of the day in the dry season the plant is likely to operate as a base-load station, with inflows directly used for power generation. Throughout the year the minimum release from the barrage will be 1.1 m^3/sec, according to the environmental clearance from MOEF.

13. Project tunneling and other project works are estimated to generate about 3.10 million cubic meters (m^3) of spoil. An estimated 900,000 m^3 of this material (from underground excavation) will be used in construction. Additional construction materials will be obtained from Government approved quarries. Ancillary works will include the construction of 4.5 km of road and the widening and upgrading of some existing roads.

14. Transport to the site will be via the Joshimath Malari road. The total project workforce is estimated to peak at 2,600 during the 7-year construction period; up to 8,200 additional people (project workforce, service people, and families) will be residing in the valley during construction. Power from the plant will be evacuated via a new 20 km long 400 kilovolt (kV) transmission line to be built by the Power Transmission Corporation of Uttaranchal Limited (PTCUL). This line will run to a substation at Kuvari Pass, to connect into the existing 400 kV system.

15. The Tapovan–Vishnugad HEP began construction in November 2006 and is scheduled to be commissioned in 2012–2013, with the first unit coming online in September 2012. The total cost of the Project is estimated to be Rs29,785 million ($677 million). The main site works begun as of January 2007 are:

(i) barrage site preparation works, including the main access road and facility sites; and
(ii) adit works near the intake.

B. Description of the Environment

1. Physical Resources

16. The project site is on the Dhauliganga and Alaknanda rivers in the Garhwal Himalaya. The barrage site is adjacent to Tapovan village, about 11 km upstream of the confluence of the Dhauliganga and Alaknanda rivers near Joshimath, next to the Joshimath Malari road 15 km southeast of Joshimath.

17. The Project has a 3,100 square kilometer (km^2) mountainous catchment area that includes the Nanda Devi Basin (20% of the total catchment), which drains into the Rishiganga, a major tributary of the Dhauliganga; 1,483 km^2 (46%) of the catchment is covered in snow that extends up to Nanda Devi, the second-highest mountain in India at 7,817 m. About 90 km of the Dhauliganga occurs above the barrage.

18. The mean annual river flow at the barrage site is 113.7 m^3/s (Appendix 1, Table A1.1). Most river flows occur during the monsoon season, from June to October (70%), peaking at a mean monthly flow of 310 m^3/s in July. The lowest monthly flow occurs in February (19.5 m^3/s).

19. Rainfall occurs mainly during the monsoon season, with around 60% being received from July to September. The average annual rainfall in the project area is 1,250 mm. Temperatures peak just before the monsoon season at a daily maximum of 26–27^{o}C in June, decreasing with the onset of the monsoon. In winter temperatures drop to a mean daily minimum of 2–3^{o}C in December and January. Average non-monsoon humidity is 61%. The ambient air quality in the area is good because of the absence of pollution sources and low population density.

20. The site topography consists of a steep-sided valley with the occasional riverside alluvial deposit next to the Dhauliganga River. The barrage pond is largely contained within a gorge, with the main affected land-use types being riverine features and rocks. The tailrace outlet site is in a steep-sided valley, while the access to this site and the power station occupies cultivation terraces and grazing land.

21. The project site is in the Uttarakhand Himalayas in the central part of the Himalayan folded belt. The geology of the project site is classified as Central Himalayan crystalline, composed of medium- to high-grade metamorphics. Surface soils in the project area, as in other regions of the Himalayas, are young. Soils on slopes above 30^{o} are generally shallow because of erosion and mass wasting, with medium to coarse texture. Valley soils are developed from colluvium and alluvium derived from the upper slopes. In general, north-facing slopes support deep, moist, and fertile soils, while south-facing slopes are too precipitous and exposed to denudation. Soil pH decreases with increasing elevation.

22. Land cover in the surrounding area is dominated by grassland, with cultivation occurring on lower-slope land with better soils. Secondary land cover types include forest (5.6%), and water bodies (1.5%). Site land use before construction consisted of barren land, rocky areas, riverine features, and private agricultural land (cropping and grazing).

23. Uttarakhand is a seismically active state classed under seismic zones IV and V on the Seismic Zoning Map of India, corresponding to zone factors of 0.24 and 0.36 for effective peak ground acceleration in terms of gravitational acceleration, g. This area is very susceptible to earthquakes: the earthquake hazard class for a large area of Uttarakhand is rated as high. The project area is also prone to landslides.

24. Apart from hydroelectricity generation, water use in local rivers and canals by volume is mainly for irrigation, conveyed to terraced fields via gravity-fed canals. Small volumes of water are extracted for domestic use. Water quality in the Dhauliganga and Alaknanda near the tailrace outlet site is good and fit for drinking apart from raised coliform levels (Appendix 2 and 3). The quality of the water is a function of the low population level and lack of industry in the catchment.

2. Ecological Resources

25. Although the Project is in an ecologically sensitive region and dense forest occurs on the left bank near the barrage site, there is low vegetation diversity and density at the barrage site and in the reservoir area. Site vegetation cover mainly consists of grassland; areas of cultivation and light shrubland are also present.

26. The barrage site is about 5 km downstream of the Nanda Devi Biosphere Reserve (200,000 ha), which extends down to the right bank of the Dhauliganga. The reserve includes Nanda Devi National Park (63,033 ha) as the core area, with the nearest boundary about 9 km from the barrage site. The national park was on the World Heritage List in 1988 and is in the World Conservation Union (IUCN) management category Ia (strict nature reserve).

27. The dominant forest types in the project area are Himalayan moist temperate forest and Himalayan dry temperate forest. Chir pine (*Pinus roxburghii*) is the dominant tree species 750–1,600 m above sea level. Above 1,500 m above sea level, Chir pine grows in association with species such as Banj, Buransh, Anyar, and Kaphal. A floristic survey of the area found 191 plant species before the monsoon and 155 species after the monsoon, dominated by herb and shrub species. Species diversity and density at the barrage site is

very low. Little undergrowth exists because of annual fires and livestock grazing. The main local forest reserves are Dasoli, Dunagiri, and Paikhadalla.

28. Wildlife in the area is reported to include leopard, jungle cat, civet, wild dog, and Indian fox, and at higher elevations bharal, thar, musk deer, snow leopard, and brown bear. Local bird species include partridge, pheasants, pigeons, woodpeckers, and cuckoos. Five species of fish are known to occur in the Dhauliganga River: spotted snow trout (*Schizothorax richardsonii*), *Neomacheilus montanas*, sucker head (*Garra gotyla*), torrent minnow (*Barilius sps.*), and point-snouted snow trout (*Schizothorax progastus*). The fish-catch survey of the National Research Centre was dominated by *Schizothorax* species, which composed 90–95% of the catch on the Alaknanda River and 60% on the Dhauliganga River. The planktonic population in the Dhauliganga River is low. Benthic microfauna and microflora have an important role in the propagation of benthic fauna and fish life.

3. Economic Development

29. Livestock grazing and cultivation are the dominant land-use activities in the area. The two cropping seasons are *kharif* (monsoon season, from April to October) and *rabi* (winter, from October to April). The major *kharif* crops are maize and pulses, while the main *rabi* crops are wheat, barley, mustard, and peas. Dryland cultivation is the dominant form of cropping, accounting for 85% of cultivated land in the area. Irrigation is practiced on terraced fields, where water is available. Fruit is also grown in small orchards in the area, as well as house garden crops.

30. Forest products harvested in the area include wood for construction, furniture, and implements; fodder; fuelwood; fruits and berries; medicines; and essential oils. Fishing is only a part-time activity; some of the catch is sold locally.

4. Social and Cultural Resources

31. Twelve villages with a combined estimated population of 3,500 people are in the project area. The population consists of general caste (50.4%), scheduled tribes (39.2%), and scheduled castes (10.4%). The literacy rate is 43%. The main occupation is crop cultivation (78.3%); other agricultural activities (labor, livestock rearing) make up 3.5% and a range of occupations compose the remaining 18.2%. However, land is being acquired only from eight villages.

32. The local settlement pattern is characterized by the 12 small rural villages, plus the district center of Joshimath with its population of about 13,204. Eight of the local villages are accessible via *kutchha* road, three via *pucca* road, and three via foot tracks only. Medical facilities in the project area villages are poor; they are limited to a health center/hospital in Tapovan and child welfare centers in Tapovan and Lata. But the villages have well-developed educational facilities: a primary school in each village, middle schools in five villages, and a pre-university college in Tapovan. The major town of Joshimath is on National Highway (NH) 58, 12 km downstream of the barrage site. This town is the local service center, providing a base station for pilgrims/tourists visiting Shri Badrinathji, Hemkunt Sahib, and the Valley of Flowers.

33. There are no historic or religious sites in the project area. Apart from village temples, the nearest site of historic and religious importance is Badrinath Temple, on the Alaknanda River at 3,133 m above mean sea level. This site is 55 km from the barrage site on NH 58A. Badrinath shrine was established as a pilgrimage site in the 8th century. A temple was first built in the 9th century, and the current structure is around 400 years old. About 600,000 pilgrims visit the temple every year between May and October. Additionally, the Joshimath

Temple, established 1,200 years ago at Joshimath, is a notable pilgrimage site in the vicinity of the Project.

C. Alternatives

34. **No Project**. Without the Project, the significant energy deficit in the Northern region (9.9% deficit in 2006–2007) would not be reduced by 2,418 GWh per year from this renewable energy source. The expansion of industry would be stifled and residential consumption of electricity curbed. An equal amount of power would have to be generated by alternative means, most likely from a fossil fuel–powered plant.

35. **Fuel Type**. India currently has a hydropower-to-thermal-power-generation ratio of 25:75. Given its limited coal reserves and untapped hydroelectricity potential (primarily in the Himalayas), as well as the global shift to renewable energy, the Government is supporting hydropower development to meet the power deficit and achieve a ratio of 40:60. NTPC has a corporate aim of diversifying generation, to reduce dependence on fossil fuels. In addition, the state of Uttarakhand does not have fossil fuel reserves, but has an estimated hydropower potential of 18,175 MW, of which only 6% has been developed. The installed capacity of the state is about 1,109 MW, consisting almost entirely of hydropower.

36. **Location**. Three alternative barrage sites were considered for the Project. The initial site considered was 1.5 km downstream of the Dakh Nala–Dhauliganga confluence (2.5 km downstream of the current site) but it was rejected because of its unacceptable geology. The current site, 1 km upstream of the Dakh Nala–Dhauliganga confluence, was then proposed. Another site considered was about 2.88 km below the current site (400 m below the initial site) to avoid striking hot water springs when tunneling for the current scheme. This option was rejected because it was concluded that there was no certainty of avoiding the hot-water springs with this site and 68 m of head would be lost at this lower location, substantially reducing annual power generation. The favorable features of the selected barrage site include a relatively straight section of river, a small submergence area, reasonable space for the intake and desilting structures, space for construction activities, no areas of dense forest affected, and no ecologically sensitive sites within 5 km.

37. Four alternative power station sites were considered. Sites at Pipalkoti and Gulabkoti were rejected because the tunnels would cross the central Himalayan thrust and the tunnel dimensions were too large. A site near the confluence of the Karam Nasa river was also rejected, as no suitable surface location existed for the switchyard and other structures. The selected site is suitable because it is on a spur with a rocky outcrop along the entire alignment of the pressure shaft, and two adits can be installed to shorten the construction period.

38. **Project Type**. The proposed project configuration, consisting of a run-of-river scheme with provision for minor peaking power generation (a maximum of 4 hours’ storage) was selected over a storage HEP because the valley cross-section at lower elevations upstream of the barrage site is not large enough to economically store water, and the project location is constrained by the upstream tail-water level of the proposed Lata–Tapovan HEP and the downstream Vishnugad–Pipalkoti FRL. The storage capacity of the Project of 0.57 MCM (to pond-level elevation of 0.5 m) is enough for storing the diurnal variation in river flows, allowing greater utilization of the available water. In addition, this run-of-river project will have considerably less impact than a storage project because the submergence area is limited and there will be no alteration of the seasonal river flow pattern.

D. Anticipated Environmental Impacts and Mitigation Measures

39. The likely primary adverse environmental impacts of the Project, based on type, duration, extent, and severity, will be changes in the river hydrology, loss of agricultural and forest land, a decline in the quality of aquatic ecosystems, and resettlement (Table 1). Most of the likely primary project impacts will occur during project operation, with the most significant impact being altered river hydrology between the barrage and the tailrace outlet.

Table 1: Likely Primary Adverse Environmental and Social Impacts of the Tapovan–Vishnugad HEP

Issue/Feature	Impact	Extent	Duration
Hydrology	• Reduced river flows between barrage and tailrace outlet • Decline in river water quality	Along an 18 km stretch of river	Permanent Permanent
Aquatic ecosystems	• Altered river ecosystem • Prevention of upstream fish movement	11 km Dhauliganga, 7 km Alaknanda, pondage inundation area Up to 90 km of the Dhauliganga plus tributaries	Permanent Permanent
Land resources	• Loss of agricultural and forest land	144.6 ha total land conversion	Permanent
Social	• Resettlement of households	57 households, predominantly self-relocated	Permanent

ha = hectare, km = kilometer.
Source: Adapted from WAPCOS. 2004. *EIA Study for Tapovan–Vishnugad Hydroelectric Project*. Gurgaon.

1. Altered River Flow Volumes

40. A substantial reduction in river flows will occur along an 18 km stretch of river below the barrage (11 km Dhauliganga and 7 km Alaknanda), particularly during the dry season, when flows along the Dhauliganga will be reduced to a minimum release of 1.1 m^3/s from the barrage. The monsoon season flow will also be reduced along this section of river, restricted to a 25 m^3/s sediment flushing flow down the Dhauliganga when river flows do not exceed 147 m^3/s (the turbine capacity plus the flushing flow), and reduced by 122 m^3/s (the turbine capacity) when river flows exceed 147 m^3/s. The decreased flow will occur in the Dhauliganga River down to its confluence with the Alaknanda River. The reduced flow released from the barrage will increase in volume farther downstream as intermediate catchment inflows from Dhauliganga tributaries enter the river and the Dhauliganga flows into the Alaknanda River 11 km downstream. In addition, the daily distribution of flows below the barrage, particularly in the dry season, will change from a high diurnal variation produced by greater daytime snow melt to a more constant flow released from the barrage (particularly when the flow is reduced to the minimum dry season release). The Project's effect on the Alaknanda will be pronounced over the initial 1–2 km downstream of the Dhauliganga confluence in the dry season, up to the tailrace outlet of the Vishnuprayag HEP, a 400 MW run-of-river project that began generation in 2006. This short stretch of river will be largely dewatered in the dry season.

41. Peaking power generation by the Project in the dry season for up to 4 hours per day will create variable river flows below the tailrace outlet. The generation discharge from the tailrace outlet will vary by as much as 122 m^3/s, from no generation up to full generation, up to twice a day. This variable discharge will vary Alaknanda River flows by up to 122 m^3/s in the dry season, but only over less than 1 km of river downstream of the tailrace outlet, as the proposed Vishnugad–Pipalkoti HEP (444 MW) dam site is about 2.5 km below the tailrace outlet. This 65 m high dam will have an FRL of 1,267 m above sea level and gross storage of 3.63 MCM, which will be utilized for peaking power generation in the dry season; hence, this project will regulate dry season flows farther downstream.

2. Decline in Water Quality

42. A decline in water quality will occur along the 11 km reach of the Dhauliganga below the barrage during project operation because of a higher concentration of sediment during the monsoon and when intermittent sediment flushing is undertaken in the transition period between the monsoon and dry seasons. The impact of the increased sediment load is unlikely to be significant because the river has a naturally high sediment load during these periods**.** Water quality is also likely to deteriorate in the Dhauliganga downstream of the barrage because of the reduced dilution of runoff from the intermediate sub-catchment between the barrage and the Alaknanda confluence.

43. River flows discharged from the barrage will be reduced to a minimum release of 1.1 m^3/s in the dry season. This flow is equivalent to 9.2% of the lowest flow observed at the barrage site (12 m^3/s in February); therefore, the dry-season flow will be equal to or less than 9.2% of flows in October–May. Intermediate catchment flows between the barrage and the tailrace outlet will increase this river flow, particularly once the Dhauliganga enters the Alaknanda.

3. Disruption of Fish Migration

44. The migration of two species of snow trout found in the Alaknanda and Dhauliganga rivers, *Schizothorax richardsonii* and *Schizothorax progastus*, may be affected by the construction of the barrage. This potential adverse impact will be mitigated by the annual river stocking with snow trout 10 km upstream and downstream of the barrage. The effect of the Project on fish migration is likely to lessen over time, as several hydroelectric projects are planned on the Alaknanda River below the project tailrace and mid- to longer-range migratory species are therefore unlikely to reach the project area.

45. The Project proposes supplementary stocking of the Dhauliganga River annually with snow trout, 10 km upstream of the barrage. Each year, the State Fisheries Department will stock the river with about a hundred 30 mm fingerlings for every kilometer. The department will develop and operate for this purpose a fish hatchery and rearing nursery, consisting of a hatchery building, hatching troughs, nursery ponds, and rearing tanks, estimated to cost Rs6.5 million. The supply of seeds from this facility may be supplemented by collection from natural sources.

4. Land Acquisition and Land Use Conversion

46. The Project will require the conversion of 144.6 ha of land to permanent and temporary project features (barrage, pond, switchyard, etc.) and ancillary sites (camps, storage areas, workshops, etc.). The land consists of 82.73 ha of government land (classified as forest and revenue land) and 61.86 ha of private land owned by 630 landowners in eight villages (Tapovan, Ravigram, Selang, Dhak, Paini, Paiya Chormi, Chamtoli, and Bhengul) (Table 2). Most of the government land is forest land not under tree cover, while most of the private land is under terraced cultivation. The Uttarakhand state government has acquired some private land as provided in the Land Acquisition Act, 1894. An additional 2.2 ha of land—1.12 ha of private land and 1.15 ha of forest land—is being acquired. The additional private land is being acquired from previously affected households in Tapovan and Selang villages.

47. The impacts of the project include: loss of land (agricultural and residential), structures (residential and community), income and livelihood (owners), and community and cultural sites. Compensation based on the market replacement value of the asset will be provided to the affected households. Additional support in the form of livelihood training and

shifting/transit support will also be provided to the affected households to restore lives and livelihoods.

Table 2: Land Acquisition and Affected Structures, by Village

Village	Land Acquisition (ha)		Affected Structures		No. of Affected Farmers
	Private	Government	Private	Community	
Tapovan	14.037	15.792	6	3 temples, 1 school, 1 ayurvedic hospital, 1 cremation ground	152
Bhengul		3.200	-	1 cremation ground, grazing land and 1 ashram	-
Dhak	7.950	14.637	-	1 cremation ground, grazing land	106
Chamtoli	1.249	1.965	-	-	35
Paiya Chormi		5.124	-	Grazing land	-
Ravigram	15.817	2.024	8	-	136
Shelong	19.018	24.836	41	2 schools, 1 cremation ground, grazing land	168
Paini	2.666	14.001	2	-	33
Total					**630**

ha = hectare.
Source: NTPC estimates.

48. To compensate for the loss of vegetation from project sites, and in accordance with the Forest (Conservation) Act, 1980, the State Forest Department will undertake afforestation on a total of 163.518 ha at 20 locations identified by the department. The cost of this compensatory forest program is covered by the land price paid by NTPC.

5. Resettlement

49. A total of 57 households are being resettled from the area being acquired for the Project (Table 2). The affected households have expressed a preference to resettle within the vicinity of their present locations, to minimize disruption and to benefit from mutual support from kin groups, as well as new development opportunities generated by the Project. The Project will facilitate completion of relocation activities within a reasonable time frame.

50. Resettlement is under way. Some affected households have resettled locally, using the compensation provided by NTPC. Assistance in relocation is to be provided to the affected households by the Project. A resettlement plan (RP) for the Project, detailing the impacts and measures to be taken to mitigate various project losses, is being prepared. The RP is based on the general findings of the census/social survey, field visits, and meetings with various project-affected persons.

51. Community development plans are under preparation in consultation with the stakeholders. The initiatives include: relocation of common property resources such as schools and temples; creation and augmentation of community infrastructure with a focus on health and education, basic amenities, capacity building, etc.

6. Reduction of Greenhouse Gas Emissions

52. The 2,418 gigawatt-hours (GWh) of electricity to be generated per year by the Project will offset the electricity now generated from other sources. According to the Central Electricity Authority's database on carbon dioxide (CO_2) emissions in the Indian power

sector, the combined margin for the Northern grid is 0.75 tons of CO_2 emission per MWh (based on a 75:25 thermal-power-to-hydropower generation mix). The CO_2 emission reduction from the Project is therefore estimated to be 1.805 million metric tons (MT) per year. In addition, the Project is expected to offset the emission of 64.02 MT/day of sulfur dioxide (SO_2) and 32.47 MT/day of nitrogen oxides (NOx), given the emissions from an equivalent amount of electricity generated from the NTPC Sipat Thermal Power Plant, a modern coal-fired plant.

7. Secondary Impacts

53. Standard construction impacts will occur. These will mainly relate to specific construction activities, site disturbance, spoil disposal, river flow disruption, and the influx of workers into the area. These types of construction impacts, common to most hydropower projects, are described below, together with the associated mitigation measures.

54. **Impact on Nanda Devi Biosphere Reserve and Nanda Devi National Park.** Adverse effects associated with forest harvesting and hunting by the project workforce and associated service providers in these protected areas are unlikely because of the distance of these areas from the nearest project site (5 km and 9 km, respectively) and the difficulty of access to these protected areas. In addition, the Project will provide alternative fuel to employees during construction to obviate the need for fuel wood harvesting.

55. **Decline in Water Quality.** River water quality could substantially decline during construction from sewage discharge from construction camps; site disturbance activities (barrage, intake, and outlet construction; river sand extraction); sediment from material stockpiles, crushing activities, and spoil disposal; and pollution from fuel storage, workshops, camps, etc. Mitigation measures that are being implemented or will be implemented include: the provision of community latrines, septic tanks, and soak pits for construction labor camp sanitation; the provision of suspended sediment settling tanks for the treatment of crusher and tunneling effluent; sludge disposal as solid waste; spoil stabilization and erosion and sediment control; quarry restoration; and the operation of a sewage treatment plant to serve the permanent project workforce.

56. **Material Extraction.** The extraction of construction materials complies strictly with the planning requirements, as approved by the authorities. The contractor prepares and submits the plans and documents required for statutory approval and proceeds with extraction only after approval is granted. NTPC ensures that mining and quarrying practices comply with the guidelines and directives of the relevant authorities. The contractor has the excavation plans approved by engineers. No construction material is to be extracted from the riverbed.

57. **Spoil Disposal.** Around 2.2 million m^3 of tunnel and other excavation spoil will be generated in excess of the volume of material that will be used in construction. This material is being disposed of in the vicinity of excavation sites, on riversides and on lower-slope government and acquired land (26.67 ha), with protection works (mainly retaining walls) installed to stabilize the new landforms. Retaining walls, generally built from rock gabions, are being constructed on the contour at surveyed spoil disposal sites to provide stable disposal areas. Spoil is being placed and compacted behind the retaining walls to form stable landforms. No spoil is being placed in watercourses or on grades that have the potential to fail. Completed spoil disposal areas are being revegetated with a cover of topsoil and seeded or planted with tubestock.

58. **Road Construction Impacts.** The construction of project roads could destabilize slopes and create erosion. Such impacts are being kept to a minimum through minimal vegetation clearance, balancing of cut and fill where possible to generate less spoil,

controlled disposal of excess spoil, stabilization of excavated slopes, and controlled rock blasting. All road construction is being done mainly by the State Public Works Department and the Border Roads Organization.

59. **Additional Mitigation Measures.** Additional impact mitigation measures that are being implemented or will be implemented by NTPC or its contactors include: provision of electricity supply in camps; provision of solid waste collection and disposal facilities; greenbelt planting using native trees; provision of first-aid posts at each major construction site and a dispensary; provision of personal noise protection equipment to workers exposed for extended periods; and regular machinery maintenance to keep noise at the design level. No historic or religious sites will be affected by project construction.

8. Cumulative Impact

60. Two hydropower projects totaling 850 MW are now being built on the Alaknanda River downstream of the project site, and five other hydropower projects totaling 1,999 MW are planned on the Dhauliganga and Alaknanda rivers. These projects will increase installed capacity on this river basin by 2,860 MW (Table 3).

Table 3: Hydropower Projects Proposed, Under Construction, or Operating on the Dhauliganga and Alaknanda Rivers

Project	**Installed Capacity** (MW)	**Status**
Lata–Tapovan	171	Proposed
Badrinath	140	Proposed
Vishnuprayag	400	Operating
Vishnugad–Pipalkoti	444	Under construction
Bovala Nand Prayag	132	Proposed
Kam Prayag	252	Proposed
Utyasu Dam	1,000	Proposed
Srinagar	330	Under construction

MW = megawatt.
Source: Public information.

61. The Alaknanda River is becoming a highly regulated water resource that is likely to have several HEPs installed over the next 10 years. The two HEPs that are most likely to increase or mitigate the impacts created by the Tapovan–Vishnugad HEP are the operating Vishnuprayag HEP and the proposed Vishnugad–Pipalkoti HEP, both on the Alaknanda River. The 400 MW Vishnuprayag HEP has a 14 m high barrage about 16 km upstream of the Dhauliganga confluence, with a tailrace outlet 1–2 km below the confluence. This project is dewatering the intermediate 18 km section of the Alaknanda River in the dry season. The Tapovan–Vishnugad HEP will also dewater the 1–2 km section of the Alaknanda River below the Dhauliganga confluence in the dry season, reducing the Alaknanda to a minor flow. The proposed Vishnugad–Pipalkoti HEP dam, 2.5 km downstream of the Project's tailrace outlet, will inundate the Alaknanda to within 1 km of the project tailrace outlet. This will reregulate the variable dry season generation releases from the Tapovan–Vishnugad HEP. Thus, the impact of the Project will be confined to less than 1 km.

62. The migration patterns of mid- to long-range fish species in the Alaknanda and Dhauliganga rivers are likely to be blocked by the downstream Vishnugad–Pipalkoti HEP (if built) and the Srinagar HEP. Accordingly, the migration of these species is unlikely to be substantially adversely affected by the Tapovan–Vishnugad HEP, and only short-range species are likely to be affected. The future operation of the proposed Lata–Tapovan HEP upstream of the Tapovan–Vishnugad HEP may also affect local fish movement.

E. Economic Assessment

63. The capital cost of the Project is estimated at Rs29,785 million ($677 million). Operation and maintenance costs, including labor and administration, are estimated to be Rs44.26 million a year. The total estimated cost of the main environmental management measures included in the project cost is Rs222.79 million ($5 million), as detailed in Appendix 2.

64. The main quantifiable economic benefit of the Project will be the value of the 2,418 GWh of incremental electricity generation added to the Northern region grid. The levelized cost of generation from the plant will be about Rs2 ($0.0455) per kWh. The financial indicators of the Project are satisfactory and the Project appears to be economically viable under normal operating conditions. Stable power supply is crucial for the sustainable development of India: the increased availability of energy will stimulate balanced growth and provide employment opportunities. The economic cost of plants like Tapovan–Vishnugad HEP is less than the cost of private generation of electricity because of economies of scale and the less-efficient technology and fuel sources used in private off-grid generation.

F. Environmental Management Plan

65. Project environmental management is being undertaken and will continue to be undertaken by NTPC according to the management measures proposed in the comprehensive EIA. The main measures included in the project design, being implemented during construction and to be implemented during operation, are summarized in Table 4. NTPC will monitor the Project as summarized in Table 5.

Table 4: Main Environmental Mitigation Measures

Stage	Impact	Mitigation Measure	Implementation Responsibility
Land			
Construction	Increased river turbidity downstream of barrage and power station sites	Proper collection and disposal of spoil	NTPC
	Generation of solid waste from labor camps/colonies	Disposal at designated landfill sites	NTPC
Water Resources			
Operation	Reduced flow along river stretch from barrage to tailrace outlet	Minimum flow of 1.1 m^3/s released to maintain riverine ecology and dilute domestic effluent	NTPC
	Negligible sedimentation	Treatment of directly draining catchment to reduce erosion and sedimentation	Forest Department/ NTPC
Water Quality			
Construction	Water pollution due to disposal of sewage from labor colonies	Provision of community toilets, septic tanks, and soak pits	NTPC
	Disposal of high-turbidity effluents from crushers and tunnel adits	Provision of settling tanks	Project contractor
Operation	Deterioration of water quality between the barrage and tailrace outlet during the dry season	Minimum flow of 1.1 m^3/s released to maintain a flowing body of water	NTPC
	Disposal of sewage from project colony	Commissioning of a sewage treatment plant	NTPC
Terrestrial Flora			
Construction	Cutting of trees for fuelwood for the labor force	Provision of subsidized kerosene and LPG to labor force and technical staff	Project contractor/ NTPC
	Acquisition of forest land	Compensatory afforestation	Forest and Revenue Departments/ NTPC
Terrestrial Fauna			
Operation	Disturbance to wildlife due to greater accessibility of the area	Surveillance at check posts	NTPC
Aquatic Ecology			
Construction	Marginal decrease in aquatic productivity due to increased turbidity and reduced light penetration	Treatment in settling tanks	Project contractor
Operation	Impact on migration of snow trout	Stocking of Dhauliganga upstream and downstream of barrage	Fisheries Department
	Drying of river stretch between barrage and tailrace outfall	Release of minimum flow of 1.1 m^3/s	NTPC
Noise			
Construction	Marginal increase in noise levels due to operation of equipment	Maintenance of construction equipment	Project contractor
		Provision of ear plugs/earmuffs to workers in high-noise areas	Project contractor
Air Quality			
Construction	Fugitive emissions due to crusher operation	Commissioning of cyclone in crusher	Project contractor
Socioeconomic Conditions			
Construction	Acquisition of private land and other properties	Compensation according to resettlement and rehabilitation	NTPC
Health			
Construction	Increased incidence of water related diseases and other health problems	Development of public health centers, first aid centre and anti-mosquito spray	NTPC and District Public Health Dept.
		Medical checkup of laborers and development of medical facilities	NTPC and District Public Health Dept.

LPG = liquefied petroleum gas, m^3/s = cubic meter per second.
Source: WAPCOS. 2004. *EIA Study for Tapovan–Vishnugad Hydroelectric Project*. Gurgaon.

Table 5: Environmental Monitoring Program

Aspect	Parameter	Location	Frequency	Responsibility
Construction				
Effluent from septic tanks	pH, BOD, TSS, TDS	Before and after treatment	Monthly	NTPC or external agency
Noise	L_{eq}	Main construction sites	Quarterly	NTPC or external agency
Ambient air quality	RPM, SPM, SO_2, NOx	Joshimath, Tapovan, Hellang, Shelong	Every winter, summer and post monsoon	External agency approved by SPCB
Meteorology	Temperature, rainfall, relative humidity, wind speed and direction	One site	Once each season	NTPC or external agency
Water-related diseases	Identification of diseases, adequacy of vector control and curative measures	Labor camps and colonies	Every 4 months	Public Health Dept.
Operation				
Surface water quality	pH, temperature, conductivity, turbidity, TDS, calcium, magnesium, hardness, chlorides, sulphates, nitrates, DO, COD, BOD, iron, zinc, manganese	1 km upstream of barrage, reservoir water, 1 km and 3 km downstream of tailrace outlet	Every 4 months	NTPC or external agency
Effluent from sewage treatment plant	pH, BOD, COD, TSS, TDS	Before and after treatment	Weekly	NTPC or external agency
Soil erosion and slope stability	Erosion rates, embankment stability, revegetation	Construction sites, spoil disposal areas	Twice a year	NTPC
Soil quality	pH, EC, organic matter, texture	Sites in the catchment	Yearly	NTPC or external agency
Aquatic ecology	Phytoplankton, zooplanktons, benthic organisms, fish composition	1 km upstream of barrage, reservoir water, 1 km and 3 km downstream of tailrace outlet	Yearly	External agency
Terrestrial ecology	Status of afforestation program	Afforestation sites	Every 2 years	External agency
Land use	Land-use pattern	Sites in the catchment	Yearly	NTPC or external agency
Water-related diseases	Identification of diseases, adequacy of vector control and curative measures	Villages adjacent to project sites	Every 4 months	Public Health Dept.

BOD = biochemical oxygen demand, COD = chemical oxygen demand, DO = dissolved oxygen, EC = electrical conductivity, L_{eq} = equivalent noise level, NOx = nitrogen oxides, RPM = respirable particulate matter, SO_2 = sulfur dioxide, SPCB = state pollution control board, SPM = suspended particulate matter, TDS = total dissolved solids, TSS = total suspended solids.
Source: WAPCOS. 2004. *EIA Study for Tapovan–Vishnugad Hydroelectric Project*. Gurgaon.

G. Additional Planning

66. The design of the project barrage and hydro-mechanical works takes into account the earthquake design parameters developed by the Department of Earthquake Engineering of the Indian Institute of Technology in Roorkee, and verified by the National Council of Seismic Design Parameters. The abutments and hill slopes at project sites will be stabilized through appropriate engineering measures to avoid the possibility of slope failure, which could potentially jeopardize project operation. Even if the barrage were damaged, catastrophic damage downstream would be unlikely, as the gross storage capacity of the pondage is only 0.57 MCM.

H. Public Consultation and Disclosure

67. Public consultation and disclosure of information about the Project occurred during land acquisition, at village development advisory committee (VDAC) meetings, and through news bulletins about the approval of the project proposal. A public hearing was held on 13 August 2004 in Joshimath in compliance with the Government's EIA notification No. 1994, No. S.O. 60(E) under the Environment (Protection) Act, 1986. This was preceded by the publication of a notice on 10 July 2004 in the local Hindi daily newspapers *Dainik Jagran* and *Amar Ujala* inviting suggestions, views, comments, and observations on the proposed Project from all concerned, to be provided to the member secretary, Uttaranchal Environment Conservation and Pollution Control Board, Dehradun. The replies received were read at the public hearing and the main HEP mitigation measures were described. The main issues raised by the public related to the stability of the geology; the impact of the Project on water quality and religious places, infrastructure development, schooling, and local employment; the treatment of sewage from labor camps and townships; the development of alternative medicinal practices; and compensatory forest planting. A list of attendees at the 2004 public hearing is provided in Appendix 5. Additional public consultations have been regularly held through VDAC meetings, which include representatives from the affected villages, NTPC, and district officials. These VDAC meetings have been held periodically since 2006.

I. Due Diligence Review of Associated Facilities

68. The 400 kV transmission line being developed separately by PTCUL to evacuate power from the Tapovan–Vishnugad HEP is essential to the Project. This 20 km long line to Pipalkoti is being developed as part of the integrated power transmission system of the Uttaranchal Power Sector Investment Program, financed under an ADB multitranche financing facility (No. 003 and Loan No. 2309-IND, approved by the ADB Board in March 2006).

69. The transmission line subprojects under this program are classified as environmental Category B[5] and an initial environmental examination (IEE) was prepared for these developments. The transmission line route was selected to avoid communities (particularly tribal communities), monuments of cultural or historical importance, conservation areas (e.g., sanctuaries, national parks, wildlife reserves, forest reserves) and other natural resource areas (e.g., agricultural land). In addition, the route has been set back 10–15 km from major towns where possible to accommodate future urban expansion, and avoids wetlands and unstable areas.

70. Three alternative transmission line routes, 10.5–12 km in length, were initially considered. The selection of the proposed route was based on minimum right-of-way area and tree clearance. The IEE found no endangered, rare, or threatened species of flora or fauna at any subproject site. There are adequate provisions in the Project for environmental mitigation and monitoring and their associated costs.

[5] ADB. 2006. *Report and Recommendation of the President to the Board of Directors on the Proposed Multitranche Financing Facility for the Uttaranchal Power Sector Investment Program in India (Project 37139)*. Manila.

III. LOHARINAG–PALA HYDROELECTRIC PROJECT

71. The description of the Loharinag–Pala HEP in this SEIA is based primarily on the information contained in the comprehensive EIA (2004) and on more recent documentation obtained by NTPC.

A. Description of the Project

72. The Loharinag-Pala HEP, as shown in Maps 1 and 3, will consist of four 150 MW turbines, for an installed capacity of 600 MW. It will feature a 115 m long and 15 m high barrage across the Bhagirathi River in Uttarkashi District, Uttarakhand. The barrage will consist of four gates 13 m wide and 8.5 m high. The barrage pond will extend 350 m upstream at full supply level, with a maximum depth of 8.5 m and a maximum operating range of 2.5 m (between MDDL 2,145.0 m and FSL 2,147.5 m). The pond will have a small submergence area (3 ha) and a short-term storage of 20 minutes at maximum design discharge.

73. The Project has been designed to use a design discharge of 159.0 m^3/s, available from July to mid-September in 90% of years. River flows will be diverted into a 13.5 km long head-race tunnel via a desilting basin and intake 60 m upstream of the barrage on the right bank. The intake sill level will be 2.5 m above the riverbed level at an elevation of 2,142 m to prevent the entry of bed load. The head-race tunnel will divert most of the river flow around a 16 km section of the Bhagirathi River, creating a gross head of 475.67 m. The maximum head-race tunnel discharge will be 158.6 m^3/s.

74. The Project will be operated as a run-of-river scheme, generating base-load power throughout the year (monsoon and dry season). The river inflow up to a maximum of 158.6 m^3/s will be used for generation, the design discharge for the 600 MW installed capacity of the Project. Throughout the year the minimum release from the barrage will be 0.85 m^3/s, according to the environmental clearance from MOEF.

75. The underground powerhouse will be on the right bank of the Bhagirathi River near Pala village. The tailrace outlet will consist of a tunnel 510 m long and 6.0 m in diameter and a rectangular discharge channel 25 m long and 17 m wide.

76. Project tunneling and other project works will generate an estimated 785,000 m^3 of spoil. An estimated 350,000 m^3 of this material (from underground excavation) will be used in construction. Additional construction material will be obtained from Government approved quarries. Ancillary works will include the construction of 14.06 km of road and the widening and upgrading of some existing roads.

77. Transport to the site is via NH 108, the only access road to religious sites at Gangotri farther up the valley. Ancillary works will include the construction of 11.5 km of road and the widening and upgrading of some existing roads. The total project workforce is estimated to peak at 2,600, with up to 8,200 additional people (project workforce, service people, and families) residing in the valley during construction.

78. Power from the plant will be evacuated via a new 400 kV high voltage transmission line to be constructed by PTCUL. This 88 km line will run to a pooling point at Koteshwar, to connect to the existing 400 kV system.

79. The total cost of the Project is estimated to be Rs28,951 million ($658 million). Construction began in July 2006 and is expected to be completed in October 2011. The main site works begun as of January 2007 are:

(i) barrage site preparation works, including the main access road, site facilities, and managed spoil disposal;
(ii) intake and adit tunneling; and
(iii) tailrace outlet site preparation works and tunneling.

B. Description of the Environment

1. Physical Resources

80. The project site is on the Bhagirathi River below the confluence of the Songad, in the Garhwal Himalaya. The barrage site is in Loharinag, next to NH 108. The Project has a 3,316 km^2 mountainous catchment area, with 1,849 km^2 (56%) covered in snow. The Bhagirathi extends about 82 km above the barrage.

81. The mean annual river flow at the barrage site is 106.9 m^3/s (Appendix 1, Table A1.2). The average annual river discharge at the barrage site is 3,847 MCM. The maximum river discharge is 4,492 MCM, according to the available data series for 18 years. Annual river flows indicate that the year 1997–1998 was a 90% dependable year, with maximum discharge of 333 m^3/s and and minimum discharge of 19.9 m^3/s.

82. The average annual rainfall at Dharasu (78 km from the barrage site) is 1,095 mm. Rainfall occurs mainly during the monsoon season, with around 75% received between June and September. Temperatures peak in May and early June before the monsoon, then decrease once the monsoon starts. The drop in temperatures extends until January, when the lowest temperature occurs. Humidity is generally low during the dry season, reaching a low of around 40% in the pre-monsoon months. The ambient air quality in the area is good because of the absence of pollution sources and low population density.

83. Site topography consists of a steep-sided valley with the occasional riverside alluvial fan. The barrage pond area will flood alluvial deposits along the edge of the river. The tailrace outlet and power station access sites consist of a narrower valley cross-section.

84. The project site is in the Uttarakhand Himalayas, in the central part of the Himalayan folded belt. Geology in the Uttarkashi region is made up of Higher Himalayan Central crystallines and Lesser Himalayan formations. Surface soils in the project area, as in other regions of the Himalayas, are young. Soils on slopes above 30^o are generally shallow because of erosion and mass wasting, with medium to coarse texture. Valley soils are developed from colluvium and alluvium derived from the upper slopes. In general, north-facing slopes support deep, moist, and fertile soils while south-facing slopes are too steep and vulnerable to denudation. Soil pH decreases with increasing elevation.

85. Land cover in the surrounding area is dominated by grassland, with cultivation occurring on lower-slope land with better soils. Secondary land cover types include forest (5.6%) and water bodies (1.5%). Site land use before construction consisted of barren land, rocky areas, riverine features, and private agricultural land (cropping and grazing).

86. Uttarakhand is a seismically active state under seismic zones IV and V on the Seismic Zoning Map of India, corresponding to zone factors of 0.24 and 0.36 for effective peak ground acceleration in terms of gravitational acceleration, g. This area is very susceptible to earthquakes, with a large part of Uttarakhand in the high earthquake hazard category. The project area is also prone to landslides.

87. Local rivers and springs allow limited water use (by volume) by the small population in the area for their domestic and irrigation needs. Water quality in the Bhagirathi River near the tailrace outlet site is good and fit for drinking, apart from raised coliform levels

(Appendix 2 and 3), because of the low population density and the lack of industry in the catchment.

2. Ecological Resources

88. The dominant forest types in the Project area are Himalayan moist temperate forest and Himalayan dry temperate forest. A floristic survey of the area recorded 221 plant species pre- monsoon and 165 plant species post-monsoon, dominated by herb species. Although the Project is in an ecologically sensitive region, however, vegetation diversity and density at the barrage site and in the reservoir area is low. Site vegetation cover consists mainly of shrubs and grassland, and some cultivated areas. The main local forest reserves are Harsil, Suki, Tihar, Gangeni, Raithal, Maneri, Jaleri, Huri, and Pilang.

89. Wildlife in the area is reported to include leopard, jungle cat, civet, wild dog, and Indian fox, and, at higher elevations, bharal, thar, musk deer, snow leopard, and brown bear. Local bird species include partridge, pheasants, pigeons, woodpeckers, and cuckoos. Seven to 10 fish species are reported to occur in the Bhagirathi River, although the "large stream zone" of the river where the Project is located is likely to have fewer species. A survey of the river by the National Research Centre found that snow trout (*Schizothorax richardsonii*) dominates the local catch, composing 80–85%. Other important species contributing to the catch are mahseer (*Tor putitora*), kalabans (*Labeo dero*), carp (*Labeo dyocheilus),* sucker head (*Garra gotyla*), catfish (*Glyptothorax brevipinnis*), and point-snouted snow trout (*Schizothorax progastus*). The planktonic population in the Bhagirathi River is low. Benthic microfauna and microflora have an important role in the propagation of benthic fauna and fish life.

3. Economic Development

90. Livestock grazing and cultivation are the dominant land-use activities in the area. Because of the high altitude most crops are grown in summer (March to October). Crops include paddy, amaranth, mustard, buckwheat, barley, kidney beans, potato, and rice beans. Dryland cultivation is the dominant form of cropping, with irrigation practiced on terraced fields where water is available. Fruit is also grown in orchards in the area, as well as house garden crops.

91. Forest products harvested in the area include wood for construction, furniture, and implements; fodder; fuel wood; fruits and berries; medicines; and essential oils. Fishing is a only part-time activity, and some of the catch is sold locally.

4. Social and Cultural Resources

92. The study area has 12 villages with a combined population of about 5,500. The population consists of general caste (91%), scheduled castes (8.5%), and scheduled tribes (0.5%). The local literacy rate is 48%. The main occupation in the area is crop cultivation (69%); other agricultural activities (labor, livestock rearing) make up 4%, and a range of occupations, the remaining 27%. However, land is being acquired from only four villages. Acquisition of land from four additional villages is being considered for the township and spoil disposal sites.

93. The local settlement pattern is characterized by the 12 small rural villages with the odd isolated house. Seven of the local villages are accessible via *kutchha* road, four via *pucca* road, and one via foot track only. Medical facilities in the study area villages are poor, and are limited to primary health subcenters and maternity and child welfare centers in Sungar and Bhatwari, and a dispensary in Bhatwari. But the villages have well-developed

educational facilities, with a primary school in each village (Bhatwari has three), middle schools in four villages, and a high school and pre-university college in Bhatwari.

94. There are no historic or religious sites in the Project sites. Apart from village temples, the nearest significant site of historic and religious importance is Gangotri Temple, on the Bhagirathi River, 3,140 m above mean sea level. This site is 40 km from the barrage site, and is accessible via NH 108. Gangotri Temple is around 250 years old and is visited by about 250,000 pilgrims yearly between May and October.

C. Alternatives

95. **No Project**. Without the Project, the 2,353 GWh reduction in the significant energy deficit in the Northern region (10.9% deficit in 2006–2007) would not come from this renewable energy source. The expansion of industry would be stifled and residential consumption of electricity curbed. Alternatively, an equal amount of power would have to be generated by other means, most likely from a fossil fuel–powered plant.

96. **Fuel Type**. India has a hydropower-to-thermal-power generation ratio of 25:75. Given the country's limited coal reserves and untapped hydroelectricity potential (primarily in the Himalayas), as well as the global shift to renewable energy, the Government is supporting hydropower development to meet the current power deficit and achieve a generation ratio of 40:60. NTPC has a corporate aim of diversifying the forms of generation, to reduce dependence on fossil fuels. In addition, the state of Uttarakhand does not have fossil fuel reserves, but has an estimated hydropower potential of 18,175 MW, of which only 6% has been developed. The installed capacity of the state is about 1,109 MW, consisting almost entirely of hydropower.

97. **Location**. Nine alternative barrage sites along the Bhagirathi River were considered for the Project. Site geology and topography were taken into account during site selection. Avalanches occur along this stretch of the river, but this problem is greatest downstream of the Loh Gad confluence. Two sites were preferred by the Geological Survey of India on the basis of geological stability, but these were rejected because there was not enough space for the sediment tank. The selected barrage site has the favorable features of a relatively straight section of river, a small submergence area, minimal land acquisition, reasonable space for the intake structure, space for construction activities, no areas of dense forest affected, and no ecologically sensitive sites within 7 km.

98. **Project Type**. The proposed Project configuration, consisting of a run-of-river scheme to operate as a base-load station, was selected over a storage HEP because the valley cross-section at lower elevations upstream of the barrage site is not large enough to economically store water. In addition, the impact of this run-of-river project is considerably less than that of a storage project because the submergence area is limited and there will be no alteration of the seasonal river flow pattern.

D. Anticipated Environmental Impacts and Mitigation Measures

99. The likely primary adverse environmental impacts of the Project, based on type, duration, extent, and severity, will be changes in river hydrology, loss of agricultural and forest land, and a decline in the quality of aquatic ecosystems (Table 6). Most of the likely primary project impacts will occur during project operation, the most significant being altered river hydrology between the barrage and the tailrace outlet.

Table 6: Likely Primary Adverse Environmental and Social Impacts of the Loharinag-Pala HEP

Issue/Feature	Impact	Extent	Duration
Hydrology	• Reduced river flows between barrage and tailrace outlet • Decline in river water quality	Along a 16 km stretch of river	Permanent Permanent
Aquatic ecosystems	• Altered river ecosystem • Prevention of upstream fish movement	14 km Bhagirathi and the pondage inundation area Up to 82 km of the Bhagirathi plus its tributaries	Permanent Permanent
Land resources	• Loss of agricultural and forest land	188.7 ha total land conversion	Permanent
Social	• Resettlement of households	Approximately 36 households predominantly self-relocating	Permanent

Source: Adapted from WAPCOS. 2004. *EIA Study for Loharinag–Pala Hydroelectric Project*. Gurgaon.

1. Altered River Flow Volumes

100. A substantial reduction in river flows will occur along a 16 km stretch of river below the barrage, particularly during the dry season, when the flows will be reduced to a minimum release of 0.85 m^3/s from the barrage. The monsoon season flow will also be reduced along this section of river, restricted to a 32 m^3/s sediment flushing flow when river flows do not exceed 191 m^3/s (the turbine capacity plus the flushing flow), and reduced by 159 m^3/s (the turbine capacity) when river flows exceed 191 m^3/s. The reduced flow from the barrage will increase in volume farther downstream as intermediate catchment inflows from Bhagirathi tributaries enter the river. In addition, the daily distribution of flows, particularly in the dry season, will change from a high diurnal variation produced by higher daytime snow melt to a more constant flow released from the barrage (particularly when the flow is reduced to the minimum dry season release).

2. Decline in Water Quality

101. A decline in water quality will occur along the 16 km reach of the Bhagirathi below the barrage during project operation because of a higher concentration of sediment during the monsoon and when intermittent sediment flushing is undertaken in the transition period between the monsoon and dry seasons. However, the impact of the increased sediment load is unlikely to be significant because the river has a naturally high sediment load during these periods. Water quality is also likely to deteriorate in this stretch of the river below the barrage as dilution of runoff from the intermediate sub-catchment between the barrage and the tailrace outlet is reduced.

102. River flows discharged from the barrage will be reduced to a minimum release of 0.85m^3/s in the dry season. This flow is equivalent to 7.5% of the lowest flow observed at the barrage site (11.32 m^3/s in January); therefore, the dry season flow will be equal to or less than 7.5% of flows in October–May. Intermediate catchment flows between the barrage and the tailrace outlet will lessen this impact to some extent.

3. Disruption of Fish Migration

103. The migration of fish species in the Bhagirathi River is unlikely to be affected by the construction of the barrage as the Maneri–Bhali HEP barrage about 17 km downstream of the Loharinag–Pala tailrace outlet site has prevented the upstream migration of fish since its installation in 1984. This concrete barrage spillway has created a 9–10 m high obstacle that does not allow migratory fish to pass. The Maneri–Bhali HEP stocks the river with fish but the effect of this is unknown.

104. The Project proposes supplementary stocking of the Bhagirathi River annually with snow trout 10 km upstream and downstream of the barrage, although this may have little value. Each year the State Fisheries Department will stock the river with about a hundred 30 mm for every kilometer. The department will therefore develop and operate a fish hatchery and rearing nursery consisting of a hatchery building, hatching troughs, nursery ponds, and rearing tanks, estimated to cost Rs6.5 million. The supply of seeds from this facility may be supplemented by collection from natural sources.

4. Land Acquisition and Land Use Conversion

105. The Project will entail the conversion of 197.3 ha of land to permanent and temporary project features (barrage, pond, switchyard, etc.) and ancillary sites (camps, storage areas, workshops, etc.). Of this total, 156.06 ha will be government land (classed as forest and revenue land) and 41.07 ha private land from eight villages (Bhangeli, Tihar, Kujjan, Jhala, Kyark, Matli, Bandrani and Raithal) (Table 7). Most of the forest land is degraded forest. The agriculture on private land is terraced cultivation. 154.18 ha of land has been acquired (Table 7) and the balance 25.90 ha of private land and 17.04 ha of Government land is being acquired for township and spoil disposal areas. Land acquisition was undertaken by the Uttarakhand state government as provided in the Land Acquisition Act, 1894.

Table 7: Land Acquisition and Affected Structures, by Village

Village	Land Acquisition (ha)		Structures Affected	No. of Affected Farmers
	Private	Government		
Bhangeli	2.804	139.03 (forest and gov't)	54 authorized cattle sheds/ hutments, 33 illegal/encroached hutments/kiosks	243 people/128 groups of landowners
Jhala	0.006			
Kunjan	2.385			
Tihar (Bhukki–Kunjan road)	3.495			
Tihar + helgu adit	6.473			

ha = hectares.
Source: NTPC estimates.

106. Tree planting will be undertaken in accordance with the Forest (Conservation) Act, 1980, to compensate for the loss of vegetation from the project sites. Forests will be planted by the State Forest Department on 312.12 ha of land identified by it—double the area of forest land that is being acquired for the Project. The cost of this compensatory forest program is covered by the land price paid by NTPC.

5. Resettlement

107. While the major impact of the Project will be on land, the Project will also affect structures and entail their dislocation. A majority of the households affected are in the hamlets of main villages and some have alternative accommodation in these villages. All affected households will relocate locally on their own but using the compensation provided by NTPC. The resettlement of households will follow NTPC's policies and practice for self-resettlement. A census/social survey and land acquisition has been completed in four of the eight affected villages, and will be undertaken in Raithal, Bandrani, Kyark and Matli villages.

108. A resettlement plan (RP), detailing the impacts and measures that will be taken to mitigate various project losses, is being prepared. The RP is based on the general findings of the census/social survey, field visits, and meetings with various project-affected persons.

109. Community development plans are under preparation in consultation with stakeholders. The initiatives in these plans include the construction or renovation of school buildings and community halls, the extension of water supply lines, track construction, and

other community works. Land for the works will be made available by the gram panchayat, which will operate and maintain these facilities once established. Village youth will also be trained, while regular medical camps will be organized by the Project.

6. Reduction of Greenhouse Gas Emissions

110. The 2,353 GWh of electricity to be generated each year by the Project will offset the electricity now generated from other sources. According to the Central Electricity Authority's database on CO_2 emissions in the Indian power sector, the combined margin for the Northern grid is 0.75 ton of CO_2 emissions per MWh (based on a 75:25 mix of thermal power to hydropower generation). The CO_2 emission reduction from the above Project is estimated to be 1.756 million MT per year. In addition, the Project is expected to offset the emission of 73.87 MT/day of SO_2 and 37.47 MT/day of NOx, given the emissions from an equivalent amount of electricity generated from the NTPC Sipat Thermal Power Plant, a modern coal-fired plant.

7. Secondary Impacts

111. Standard construction impacts, relating mainly to specific construction activities, site disturbance, spoil disposal, river flow disruption, and the influx of workers into the area, will occur. These types of construction impacts, common to most hydropower projects, are described below, together with the associated mitigation measures.

112. **Decline in Water Quality.** River water quality could substantially decline during construction from sewage discharge from construction camps; site disturbance activities (barrage, intake, and outlet construction; river sand extraction); sediment from material stockpiles, crushing activities, and spoil disposal; and pollution from fuel storage, workshops, the camps, etc. Mitigation measures that are being implemented or will be implemented include: the provision of community latrines, septic tanks, and soak pits for construction labor camp sanitation; the provision of suspended sediment settling tanks for treating crusher and tunneling effluent; sludge disposal as solid waste; spoil stabilization and erosion and sediment controls; quarry restoration; and the operation of a sewage treatment plant to serve the permanent project workforce. Turbid water will not be discharged from the settling ponds but will be used to water roads to suppress dust. Alternatively, coagulants will be used at appropriate rates to settle out fine material before discharge.

113. **Material Extraction.** The extraction of construction materials complies strictly with the planning requirements. The contractor prepares and submits the plans and documents required for statutory approval, and proceeds with extraction only after approval is granted. NTPC ensures that mining and quarrying practices comply with the guidelines and directives of the relevant authorities. The contractor has the excavation plans approved by engineers. No construction material is proposed to be extracted from the riverbed.

114. **Spoil Disposal.** Around 435,000 m^3 of tunnel and other excavation spoil will be generated in excess of the volume of material that will be used in construction. This material is being disposed of in the vicinity of excavation sites on riversides and on lower-slope government and acquired land (11 ha), with protection works (mainly retaining walls) installed to stabilize the new landforms. Retaining walls, generally built from rock gabions, are being constructed on the contour at surveyed spoil disposal sites to provide stable disposal areas. Spoil is being placed and compacted behind the retaining walls to form stable landforms. No spoil is being placed in watercourses or on grades that have the potential to fail. Completed spoil disposal areas are being revegetated with a cover of topsoil and seeded or planted with tubestock.

115. **Road Construction Impacts.** The construction of Project roads could potentially destabilize slopes and create erosion. Measures being taken to minimize impacts include minimized vegetation clearance, balancing of cut and fill where possible to minimize spoil generation, controlled disposal of excess spoil, stabilization of excavated slopes for protection, and controlled rock blasting. All road construction is to be carried out mainly by the State Public Works Department and the Border Roads Organization.

116. **Religious Significance of the River and Access to Gangotri Temple.** The Bhagirathi River is recognized as the headwater of the Ganges River. An estimated 250,000 pilgrims visit Gangotri Temple each year, traveling through the valley via NH 108 past the project site primarily in the months of May to October. Peak traffic occurs in May and June. Traffic management by the Project will be important at this time of the year to avoid accidents or conflicts.

117. **Additional Mitigation Measures.** Additional impact mitigation measures that are being implemented or will be implemented by NTPC or its contactors are: provision of electricity supply in camps; provision of solid waste collection and disposal facilities; greenbelt planting using native trees; provision of first-aid posts and a dispensary at each major construction site; provision of personal noise protection equipment to workers exposed for extended periods; and regular machinery maintenance to keep noise at the design level. No historic or religious sites will be affected by project construction.

8. Cumulative Impact

118. Two hydropower projects—Maneri Bhali Stage 1 and Tehri, totaling 1,090 MW—are now operating in the Bhagirathi basin downstream of the project site. Other hydropower projects that are planned or under construction in the Bhagirathi basin, as summarized in Table 8.

Table 8: Hydropower Projects Proposed, Under Construction, or Operating on the Bhagirathi River

Project	Installed Capacity (MW)	Status
Harsil	210	Proposed
Gangotri	55	Proposed
Bhairon Ghat Stage 1 and 2	65	Proposed
Pala–Maneri	480	Proposed
Maneri Bhali - Stage 1	90	Operating
Maneri Bhali - Stage 2	304	Under construction
Tehri Dam	1,000	Operating
Tehri Pumped Storage	1,000	Under construction
Koteshwar Dam	400	Under construction

MW = megawatt.
Source: Public information.

119. The Bhagirathi River is a regulated water resource on which a number of HEPs are proposed for construction over the next 10 years. Two HEPs are now operating on this river—the 90 MW Maneri Bhali run-of-river project and the 1,000 MW Tehri hydroelectric project. These projects reduce water flow in certain sections of the river (Map 1).

120. The construction of the Loharinag–Pala HEP on this river will have a further impact on aquatic ecosystems, but this will primarily be restricted to the dewatered section between the barrage and the tailrace outlet. The mid- and long-range migration of fish in the Bhagarithi River has been blocked by the two downstream HEPs; therefore, the Project is unlikely to affect the migration of these fish species.

E. Economic Assessment

121. The capital cost of the Project is estimated at Rs28,951 million ($657.98 million). Operation and maintenance costs, including labor and administration, are estimated to be Rs43.13 million a year. The total estimated cost of the main environmental management measures included in the project cost is Rs201 million, as detailed in Appendix 2.

122. The main quantifiable economic benefit of the Project will be the addition of 2,353.37 GWh of electricity generation to the Northern region grid. The levelized cost of generation from the plant will be about Rs2.00 ($0.0455) per kWh. The financial indicators of the Project are satisfactory and the Project appears to be economically viable under normal operating conditions. Stable power supply is crucial for balanced growth and increased employment opportunities. The economic cost of plants like the Loharinag–Pala HEP is less than the cost of private generation of electricity because of economies of scale and the less-efficient technology and fuel sources used in private off-grid generation.

F. Environmental Management Plan

123. Project environmental management is being undertaken and will continue to be undertaken by NTPC according to the management measures proposed in the EIA report. The main measures included in the project design, being implemented during construction and to be implemented during operation, are summarized in Table 9. Project monitoring will be as summarized in Table 10.

Table 9: Main Environmental Mitigation Measures

Stage	Impact	Mitigation Measure	Implementation Responsibility
Land			
Construction	Increased river turbidity downstream of barrage and power station sites	Proper collection and disposal of spoil	NTPC
	Generation of solid waste from labor camps/colonies	Disposal at designated landfill sites	NTPC
Water Resources			
Operation	Reduced flow along river stretch from barrage to tailrace outlet	Minimum flow of 0.85 m^3/s released to maintain riverine ecology and dilute domestic effluent	NTPC
	Negligible sedimentation	Treatment of directly draining catchment to reduce erosion and sedimentation	Forest Department/ NTPC
Water Quality			
Construction	Water pollution due to disposal of sewage from labor colonies	Provision of community toilets, septic tanks, and soak pits	NTPC
	Disposal of high-turbidity effluents from crushers and tunnel adits	Provision of settling tanks	Project contractor
Operation	Deterioration of water quality between the barrage and the tailrace outlet during the dry season	Minimum flow of 0.85 m^3/s released to maintain a flowing body of water	NTPC
	Disposal of sewage from project colony	Commissioning of a sewage treatment plant	NTPC
Terrestrial Flora			
Construction	Cutting of trees for fuelwood for the labor force	Provision of subsidized kerosene and LPG to labor force and technical staff	Project contractor / NTPC
	Acquisition of forest land	Compensatory afforestation	Forest and Revenue Departments/NTPC
Terrestrial Fauna			
Operation	Disturbance to wildlife due to greater accessibility of the area	Surveillance at check posts	NTPC
Aquatic Ecology			
Construction	Marginal decrease in aquatic productivity due to increased turbidity and reduced light penetration	Treatment in settling tanks	Project contractor
Operation	Impact on migration of snow trout	Stocking of Bhagirathi upstream and downstream of barrage with snow trout	Fisheries Department/NTPC
	Drying of river stretch between barrage and tailrace outfall	Release of minimum flow of 0.85 m^3/s	NTPC
Noise			
Construction	Marginal increase in noise levels due to operation of equipment	Maintenance of construction equipment	Project contractor
		Provision of earplugs/earmuffs to workers in high-noise areas	Project contractor
Air Quality			
Construction	Fugitive emissions due to crusher operation	Commissioning of cyclone in crusher	Project contractor
Socioeconomic Conditions			
Construction	Acquisition of private land and other properties	Compensation according to resettlement and rehabilitation	NTPC
Health			
Construction	Increased incidence of water-related diseases and other health problems	Development of public health centers, first-aid center, and anti-mosquito spray	NTPC and District Public Health Dept.
		Medical checkup of laborers and development of medical facilities	NTPC and District Public Health Dept.

LPG = liquefied petroleum gas, m^3/s = cubic meter per second.
Source: WAPCOS. *2004. EIA Study for Loharinag–Pala Hydroelectric Project*. Gurgaon.

Table 10: Environmental Monitoring Program

Aspect	Parameter	Location	Frequency	Responsibility
Construction				
Effluent from septic tanks	pH, BOD, TSS, TDS	Before and after treatment	Monthly	NTPC or external agency
Noise	L_{eq}	Main construction sites	Quarterly	NTPC/External Agency
Ambient air quality	RPM, SPM, SO_2, NOx	Loharinag, Pala, Bhangeli, Tihar	Every winter and summer, and after the monsoon	External agency approved by SPCB
Meteorology	Temperature, rainfall, relative humidity, wind speed and direction	One site	Once each season	NTPC/External agency
Water-related diseases	Identification of diseases, adequacy of vector control and curative measures	Labor camps and colonies	Every 4 months	Public Health Dept.
Operation				
Surface water quality	pH, temperature, conductivity, turbidity, TDS, calcium, magnesium, hardness, chlorides, sulphates, nitrates, DO, COD, BOD, iron, zinc, manganese	1 km upstream of barrage, reservoir water, 1 km and 3 km downstream of tailrace outlet	Every four months	NTPC or external agency
Effluent from sewage treatment plant	pH, BOD, COD, TSS, TDS	Before and after treatment	Weekly	NTPC or external agency
Soil erosion and slope stability	Erosion rates, embankment stability, revegetation	Construction sites, spoil disposal areas	Twice a year	-do-
Soil quality	pH, organic matter, texture	Sites in the catchment	Yearly	-do-
Aquatic ecology	Phytoplankton, zooplanktons, benthic organisms, fish composition	1 km upstream of barrage, reservoir water, 1 km and 3 km downstream of tailrace outlet	Yearly	External agency
Terrestrial ecology	Status of afforestation program	Afforestation sites	Every 2 years	External agency
Land use	Land-use pattern	Sites in the catchment	Yearly	-do-
Water-related diseases	Identification of diseases, adequacy of vector control and curative measures	Villages adjacent to project sites	Every 4 months	Public Health Dept.

BOD = biochemical oxygen demand, COD = chemical oxygen demand, DO = dissolved oxygen, L_{eq} = equivalent noise level, NOx = nitrogen oxides, RPM = respirable particulate matter, SO_2 = sulfur dioxide, SPCB = state pollution control board, SPM = suspended particulate matter, TDS = total dissolved solids, TSS = total suspended solids.

Source: WAPCOS. 2004. *EIA Study for Loharinag-Pala Hydroelectric Project*. Gurgaon.

G. Additional Planning

124. The design of the project barrage and hydromechanical works takes into account the earthquake design parameters developed by the Department of Earthquake Engineering of the Indian Institute of Technology in Roorkee, and verified by the National Council of Seismic Design Parameters. The abutments and hill slopes at the project sites will be stabilized to avoid slope failure, which could jeopardize project operation. If the barrage were to be damaged, catastrophic damage downstream would be unlikely, as the gross storage capacity of the pondage is negligible.

H. Public Consultation and Disclosure

125. Public consultation and disclosure of information about the Project occurred during land acquisition, at VDAC meetings, and through news bulletins about the approval of the proposed Project. A public hearing was held on 31 July 2004 in compliance with the Government's EIA notification No. 1994, No. S.O. 60(E) under the Environment (Protection) Act, 1986. This was preceded by a notice published in two newspapers on 30 June 2004 and 1 July 2004 inviting suggestions, views, comments, and observations on the proposed Project from all concerned. During the public hearing the Project, its likely impacts, and main mitigation measures, were described. The main issues raised by the public related to local employment from the Project, health-care services, religious sites and the crematorium on the banks of the Bhagirathi River, resettlement and compensation, treatment of sewage from labor camps, and the impact on ecology and water resources. A list of attendees at the public hearing is provided in Appendix 6. Additional public consultations have been regularly held through VDAC meetings, which include representatives from the affected villages, NTPC, and district officials. These VDAC meetings have been held periodically since 2006.

I. Due Diligence Review of Associated Facilities

126. The 400 kV transmission line being developed separately by PTCUL to evacuate power from the Loharinag–Pala HEP is essential to the Project. This 88 km long line up to Koteshwar is being developed as part of the integrated power transmission system of the Uttaranchal Power Sector Investment Program, financed under an ADB multitranche financing facility (No. 003 and Loan No. 2309-IND, approved by the ADB Board in March 2006).

127. The transmission subprojects under this program are classified as environmental category B. An IEE was prepared for these developments. The transmission line route was selected to avoid communities (particularly tribal communities), monuments of cultural or historical importance, conservation areas (e.g., sanctuaries, national parks, wildlife reserves, forest reserves), and other natural resource areas (e.g., agricultural land). In addition, the route is set back 10–15 km from major towns where possible to accommodate future urban expansion, and wetlands and unstable areas are avoided.

128. Three alternative transmission line routes, 82–90 km in length, were considered. The proposed route was selected on the basis of minimum tree clearance, which was estimated to be 28,000 trees, compared with 39,500–50,500 trees for the other options. The IEE found no endangered, rare, or threatened species of flora or fauna at any subproject site. The Project has adequate provisions for environmental mitigation and monitoring, including the costs involved.

IV. CONCLUSIONS

129. Demand for electricity in India continues to outstrip supply, with the total shortfall in electricity supply across the country estimated to be 8.3% per annum (footnote 1). Industrial, commercial, and domestic electricity consumption is restricted by supply; thus, additional generation is required for economic growth and poverty alleviation. The Tapovan–Vishnugad and Loharinag–Pala HEPs will provide India with a combined total of around 4,771 GWh of electricity per year. This should partly meet the current shortfall in supply. Increased electricity supply from these run-of-river hydroelectric projects will avoid the generation of a similar amount of energy from fossil fuel–powered generation plants, thus reducing net greenhouse gas production. The projects will also create short-term construction employment and long-term operational jobs.

130. Both projects have received all necessary MOEF and state pollution control board clearances and approvals following the preparation of EIAs and the conduct of public hearings in accordance with government requirements.

131. The main adverse environmental impacts of the HEPs will be changes in river hydrology, a decline in the quality of aquatic ecosystems, loss of agricultural and forest land, and resettlement. Impacts on the rivers will be mitigated by the release of a 0.85–1.1 m^3/s minimum environmental flow from the barrage in the dry season from the Tapovan–Vishnugad and Loharinag–Pala dams, the release of monsoon season flushing flows, and the yearly restocking of rivers above and below the barrage sites with snow trout. The loss of private agricultural and forest land has been or will be mitigated by the acquisition of private land at an above-market rate. The social impact of the projects will be mitigated by NTPC's resettlement and rehabilitation procedures, with fair compensation being paid by NTPC.

132. The environmental features that relate to the main project impacts will be regularly monitored for compliance with project approval conditions and pollution standards. The principal parameters to be monitored will be river flow volumes, water quality and aquatic ecology downstream of the barrages, and local meteorology.

MEAN MONTHLY RIVER FLOWS

Table A1.1: Mean Monthly Flows of the Dhauliganga River Tapovan–Vishnugad Barrage Site (m^3/s)

January	21.19
February	19.57
March	22.70
April	41.31
May	108.74
June	213.26
July	310.61
August	280.95
September	173.54
October	83.81
November	50.10
December	32.72
Mean	**113.71**

m^3/s = cubic meter per second.
Source: Central Water Commission, India.

Table A1.2: Mean Monthly Flows of the Bhagirathi River Loharinag–Pala Barrage Site (m^3/s)

January	22.8
February	20.4
March	24.3
April	41.9
May	92.6
June	180.2
July	304.6
August	307.7
September	163.0
October	60.9
November	36.8
December	27.4
Mean	**106.9**

m^3/s = cubic meter per second.
Source: Central Water Commission, India.

RIVER WATER QUALITY ANALYSIS

Table A2.1: Post-Monsoon Water Quality of the Dhauliganga and Alaknanda Rivers

Parameter	Unit	Sampling Site				
		W1	W2	W3	W4	W5
pH	-	7.6	7.4	7.4	7.5	7.5
Temperature	^{o}C	7.5	8.1	8.1	7.8	7.9
Dissolved oxygen	mg/L	8.0	8.2	8.4	8.4	8.2
Electrical conductivity	us/cm	64	65	64	65	66
Total dissolved solids	mg/l	46	47	45	46	46
Turbidity	JTU/NTU	10	11	12	12	12
Alkalinity	mg/l	7.2	8.1	7.4	7.4	7.2
Hardness	mg/l	34	35	35	41	36
Fluorides	mg/l	0.3	0.2	0.5	0.2	0.2
Carbonates	mg/l	4	4	4	4	7
BOD	mg/l	1.0	1.0	1.0	1.1	1.0
COD	mg/l	3.2	3.1	3.2	3.0	3.0
Nitrates	mg/l	3.4	3.5	3.4	3.4	3.4
Phenolic compounds	mg/l	nil	nil	nil	nil	Nil
Fecal coliform	MPN/100 ml	absent	absent	absent	absent	absent
Total coliform	MPN/100 ml	58	32	65	78	97

BOD = biochemical oxygen demand, C = Celsius, COD = chemical oxygen demand, JTU = Jackson turbidity units, mg/L = milligram per liter, ml = milliliter, MPN = most probable number, NTU = nephelometric turbidity units, us/cm = microSiemens per centimeter.
Source: WAPCOS. 2004. *EIA Study for Tapovan–Vishnugad Hydroelectric Project*. Gurgaon.

Table A2.2: Pre-Monsoon Water Quality of the Dhauliganga and Alaknanda Rivers

Parameter	Unit	Sampling Site				
		W1	W2	W3	W4	W5
pH	-	7.5	7.2	7.4	7.4	7.5
Dissolved oxygen	mg/L	8.0	8.2	8.4	8.4	8.2
Electrical conductivity	us/cm	62	62	61	59	62
Total dissolved solids	mg/l	45	44	45	43	45
Turbidity	JTU/NTU	8	7	8	8	8
Alkalinity	mg/l	6.9	7.4	7.4	7.2	7.1
Hardness	mg/l	32	32	33	38	38
Fluorides	mg/l	0.1	0.1	0.3	0.3	0.3
Carbonates	mg/l	3	4	4	4	8
BOD	mg/l	1.1	1.2	1.3	1.1	1.0
COD	mg/l	2.1	2.1	2.4	2.3	2.1
Nitrates	mg/l	3.1	3.2	3.2	3.1	3.0
Phenolic compounds	mg/l	nil	nil	nil	nil	Nil
Fecal coliform	MPN/100 ml	absent	absent	absent	absent	absent
Total coliform	MPN/100 ml	42	40	52	54	67

BOD = biochemical oxygen demand, C = Celsius, COD = chemical oxygen demand, JTU = Jackson turbidity units, mg/L = milligram per liter, ml = milliliter, MPN = most probable number, NTU = nephelometric turbidity units, us/cm = microSiemens per centimeter.
Source: WAPCOS. 2004. *EIA Study for Tapovan–Vishnugad Hydroelectric Project*. Gurgaon.

Sampling Sites:
W1 – Dhauliganga River upstream of barrage site.
W2 – Dhauliganga River downstream of barrage site.
W3 – near Bargaon – near habitation.
W4 – tributary in confluence with Dhauliganga River.
W5 – Alaknanda River downstream of tailrace outfall.

Table A2.3: Post-Monsoon Water Quality of the Bhagirathi River

Parameter	Unit	Sampling Site					
		W1	W2	W3	W4	W5	W6
pH	-	7.7	7.6	7.7	7.7	7.7	7.7
Temperature	^oC	7.4	7.6	7.6	7.6	7.5	7.6
Dissolved oxygen	mg/L	8.4	8.5	8.6	8.7	8.4	8.7
Electrical conductivity	us/cm	77	76	74	81	77	78
Total dissolved solids	mg/l	56	53	53	57	53	54
Turbidity	JTU/NTU	12	15	12	13	15	12
Alkalinity	mg/l	8	8	9	8	8	9
Hardness	mg/l	32	34	32	30	30	31
Fluorides	mg/l	1.0	1.0	1.0	1.0	1.0	1.0
Carbonates	mg/l	5.7	5.6	5.7	5.6	5.6	5.6
BOD	mg/l	1.0	1.0	1.0	1.0	1.0	1.0
COD	mg/l	2.7	2.8	2.9	2.8	2.7	2.5
Nitrates	mg/l	4.2	4.2	4.1	4.0	4.1	4.1
Phenolic compounds	mg/l	nil	nil	nil	nil	nil	nil
Fecal coliform	MPN/100 ml	absent	absent	absent	absent	absent	absent
Total coliform	MPN/100 ml	65	53	46	44	32	25

BOD = biochemical oxygen demand, C = Celsius, COD = chemical oxygen demand, JTU = Jackson turbidity units, mg/L = milligram per liter, ml = milliliter, MPN = most probable number, NTU = nephelometric turbidity units, us/cm = microSiemens per centimeter.
Source: WAPCOS. *2004. EIA Study for Loharinag–Pala Hydroelectric Project*. Gurgaon.

Table A2.4: Pre-Monsoon Water Quality of the Bhagirathi River

Parameter	Unit	Sampling Site					
		W1	W2	W3	W4	W5	W6
pH	-	7.6	7.7	7.6	7.7	7.7	7.6
Dissolved oxygen	mg/L	7.9	8.1	8.2	8.3	8.1	8.2
Electrical conductivity	us/cm	76	72	71	82	78	75
Total dissolved solids	mg/l	54	51	50	57	53	54
Turbidity	JTU/NTU	12	15	12	13	15	12
Alkalinity	mg/l	8	10	8	9	8	8
Hardness	mg/l	32	35	36	34	31	35
Fluorides	mg/l	1.0	1.0	1.0	1.0	1.0	1.0
Carbonates	mg/l	5.7	5.6	5.7	5.6	5.6	5.6
BOD	mg/l	1.4	1.4	1.2	1.3	1.1	1.4
COD	mg/l	2.9	2.8	2.5	2.7	2.6	2.7
Nitrates	mg/l	4.2	4.2	4.1	4.0	4.1	4.1
Phenolic compounds	mg/l	Nil	nil	nil	nil	nil	nil
Fecal coliform	MPN/100 ml	Absent	absent	absent	absent	absent	absent
Total coliform	MPN/100 ml	41	42	40	40	30	24

BOD = biochemical oxygen demand, C = Celsius, COD = chemical oxygen demand, JTU = Jackson turbidity units, mg/L = milligram per liter, ml = milliliter, MPN = most probable number, NTU = nephelometric turbidity units, us/cm = microSiemens per centimeter.
Source: WAPCOS. *2004. EIA Study for Loharinag–Pala Hydroelectric Project*. Gurgaon.

Sampling Sites:
W1 – tributary in confluence with the Bhagirathi River, upstream of the barrage site.
W2 – tributary in confluence with the Bhagirathi River, just downstream of the barrage site.
W3 – Bhagirathi River downstream of barrage site.
W4 – Bhagirathi River upstream of barrage site.
W5 – Bhagirathi River upstream of powerhouse site.
W6 – Bhagirathi River downstream of tailrace outfall.

NATIONAL WATER QUALITY STANDARDS

Designated Best-Use	Class of Water	Criteria
Drinking water source without conventional treatment but after disinfection	A	1. Total coliform organisms MPN/100 ml 50 or less 2. pH between 6.5 and 8.5 3. Dissolved oxygen 6 mg/l or more 4. 5-day biochemical oxygen demand at 20^{o}C 2 mg/l or less
Outdoor bathing (organized)	B	1. Total coliform organisms MPN/100 ml 500 or less 2. pH between 6.5 and 8.5 3. Dissolved oxygen 5 mg/l or more 4. 5-day biochemical oxygen demand at 20^{o}C 3 mg/l or less
Drinking water source after conventional treatment and disinfection	C	1. Total coliform organisms MPN/100 ml 5,000 or less 2. pH between 6 and 9 3. Dissolved oxygen 4 mg/l or more 4. 5-day biochemical oxygen demand at 20^{o}C 3 mg/l or less
Propagation of wildlife and fisheries	D	1. pH between 6.5 and 8.5 2. Dissolved oxygen 4 mg/l or more 3. Free ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	E	1. pH between 6.0 and 8.5 2. Electrical conductivity at 25^{o}C micro mhos/cm Max. 2,250 3. Sodium absorption ratio maximum 26 4. Boron maximum 2 mg/l
	Below E	Not meeting A, B, C, D, and E criteria

^{o}C = degrees celsius, mg = milligram, ml = milliliters, MPN = most probable number.
Source: Central Pollution Control Board, Ministry of Environment and Forests.

COST OF MAIN ENVIRONMENTAL IMPACT MITIGATION MEASURES

Table A4.1: Cost of Main Tapovan–Vishnugad HEP Mitigation Measures

Item	Total Cost ($ million)	Total Cost (Rs million)
Sanitary facilities in labor camps	0.963	42.36
Solid waste management	0.214	9.40
Provision for free fuelwood distribution	0.455	20.00
Management of muck disposal sites	0.386	17.00
Environmental management in road construction	0.182	8.00
Stabilization of quarry sites	0.113	5.00
Landscaping and restoration of construction sites	0.113	5.00
Greenbelt development	0.182	8.00
Public health delivery system	0.568	25.00
Construction of settling tanks	0.045	2.00
Fish management	0.148	6.50
Wildlife conservation	0.115	5.06
Treatment of directly draining catchment area	0.575	25.30
Environmental laboratory	0.091	4.00
Environmental monitoring program	0.273	12.00
Environmental scientific studies	0.159	7.00
Contingencies	0.341	15.00
Escalation	0.140	6.17
Total	**5.063**	**222.79**

HEP = hydroelectric project.
Source: WAPCOS. 2004. *EIA Study for Tapovan–Vishnugad Hydroelectric Project*. Gurgaon.

Table A4.2: Cost of Main Loharinag–Pala HEP Mitigation Measures

Item	Total Cost ($ million)	Total Cost (Rs million)
Sanitary facilities in labor camps	0.926	40.75
Solid waste management	0.191	8.40
Provision for free fuelwood distribution	0.454	20.00
Management of muck disposal sites	0.386	17.00
Environmental management in road construction	0.182	8.00
Stabilization of quarry sites	0.113	5.00
Landscaping and restoration of construction sites	0.113	5.00
Greenbelt development	0.182	8.00
Public health delivery system	0.568	25.00
Construction of settling tanks	0.045	2.00
Fish management	0.148	6.50
Wildlife conservation	0.115	5.06
Treatment of directly draining catchment area	0.325	14.29
Environmental laboratory	0.091	4.00
Environmental monitoring program	0.273	12.00
Environmental scientific studies	0.113	5.00
Contingencies	0.341	15.00
Escalation	0.227	10.00
Total	**4.793**	**211.00**

HEP = hydroelectric project.
Source: WAPCOS. 2004. *EIA Study for Loharinag–Pala Hydroelectric Project*. Gurgaon.

LIST OF PUBLIC HEARING ATTENDEES

Table A5.1: List of Attendees at Tapovan–Vishnugad Public Hearing, 13 August 2004

SL No.	Name (S/Shri)	Address
1.	Jagdish Prasad	Joshimath
2.	Govind Singh Panwar	Joshimath
3.	Mohan Prasad Thapliyal	Panchayat Member, Joshimath
4.	Keshav Prasad	Chairman, Vyapar Sabha
5.	Bhero Singh Kunwar	
6.	Ram Krishna Singh Rawat	District Chairman, Bjp
7.	Prakash Bhandari, Advocate	Baragaon
8.	Dharam Singh	Paini
9.	Tula Ram Nautial	Gram Panchayat, Paini
10.	Mohan Singh	Gram Pradhan,
11.	Peetamber Dutt Thapliyal	Dhak
12.	Karan Singh	Shalong
13.	R.K. Singh	New Delhi
14.	P.D.	New Delhi
15.	Priyaranian	Joshimath
16.	Rajesh Singh	Paini
17.	Abal Singh	Paini
18.	Prem Singh Bisht	Paini
19.	Govind Singh	Tapovan
20.	Rakesh	Tapovan
21.	Pradum Singh	Ravigram
22.	Puran Singh	Subhoi
23.	Surender Singh Rawat	Bhenguyl
24.	Kanjuman Singh	Shalong
25.	Kps Tyagi	Delhi
26.	S.Selva Kumar	Wapcos, Delhi
27.	Smt. Rana	Gram Pradhan, Raini
28.	Kalam Singh	Shalong
29.	Bharat Singh	Paini
30.	Kishan Singh	Shalong
31.	Rishi Prasad Sati	Joshimath, Panchayat Member
32.	Atul	Joshimath
33.	Inder Singh Visht	Upper Bazaar, Gadi
34.	Vachana Singh Panwar	Shalong
35.	Rama Kant Uniyal	Joshimath
36.	Pushkar Singh	Joshimath
37.	Lal Mani	Chamoli District
38.	Mohan Singh Rawat	Joshimath
39.	Uma Lal Shah	Joshimath, Upper Bazaar
40.	Jagat Singh	Shalong
41.	Chandi Prasad	Upper Bazaar
42.	Navneet	Ravigram
43.	Kamlesh	Joshimath
44.	Ramesh Dimri	Chairman, Vyapar Mandal, Joshimath

SL No.	Name (S/Shri)	Address
45.	Madan Prasad Dimri	Ravigram, Joshimath
46.	Major Bhuvan Chand Dimri	Ravigram, Joshimath
47.	Raj Prasad	Ravigram, Joshimath
48.	Block Mantri,Joshimath	Joshimath
49.	Harindra Singh	Selang
50.	***Blank***	
51.	Neeraj Kapur	NTPC New Delhi
52.	Uday Singh	Pradhan, Gram Panchayat, Shalong
53.	Harish Bhandari	Bhawara Gram
54.	Mohan Lal	Dhak
55.	Arun Kumar Shah	Joshimath
56.	Rameshwar Prasad	Dhak
57.	Digamber Singh	Shalong
58.	Devender Singh Rawat	Ravigram, Joshimath
59.	Tajendrapal Singh	Joshimath
60.	Harinder Singh	Joshimath
61.	Pratap Singh	Joshimath
62.	Narinder Lal	Joshimath
63.	Anand Singh Rana	Shalong
64.	Joshimath Pradhan	Joshimath
65.	Ravigram Pradhan	Helong
66.	Kedar Singh	Joshimath
67.	Vishan Singh	Joshimath
68.	Pradeep Bhandari	Helong
69.	***Illegible***	Ravi Gram
70.	Prakash Pandey	Ravi Gram
71.	Rakesh Pant	Tapoban
72.	Parmanand Pradhan	Tapoban
73.	Bhagat Singh	Shalong
74.	Bhagat Ram	Joshimath
75.	Mathura Singh	Negi Tabi Gaon
76.	Mohan Prasad	Paini
77.	Dimri	Ravigram, Joshimath
78.	Bhupal Singh	Chaii
79.	Visheshwar Prasad	Tapoban
80.	B. Rawat	Shalong
81.	Guddu	Bhema Jaglat
82.	Narinder Singh	Shalong
83.	Vachan Singh	Shalong
84.	Shri Chandi Prasad	Joshimath
85.	S. Devi	Joshimath
86.	V.Singh Bisht	Shalong
87.	Mohan Prasad Dimri	Ravigram
88.	Brij Raj	Ravigram
89.	Virendra Singh	Helong
90.	Charan Singh	Helong
91.	Rajender Prasad Dimri	Ravigram
92.	Pramot Dimri	Ravigram
93.	Mahendra Dimri	Ravigram
94.	Smt. Rukmani Devi	Paini
95.	N.N. Dimri	Ravigram

Source: Minutes of the Public Hearing, Uttaranchal State Pollution Control Board, Dehradun.

Table A5.2: List of Attendees at Loharinag–Pala Public Hearing, 31 July 2004

SL No.	Name (S/Shri)	Address
1.	Kamlesh Kumar Pant	District Magistrate, Uttarakashi
2.	Indu Dhar	Adm, Uttarakashi
3.	D. S. Dhindiyal	Sdm
4.	Bharat Singh Rawat	The. Marwari, Uttarakashi
5.	Smt. Sushma	Member, District Panchayat
6.	Khushhal Singh Negi	Dy. Chairman, District Panchayat, Uttarakashi
7.	Suresh Chauhan	Head, Bhatwari
8.	V.K. Singh	Sdo, Uttarakashi
9.	Raj Kumar	Executive Engineer , Electricity Distribution, Uttarakashi
10.	Gopal Singh Rawat	Vill. Shalong
11.	Amar Das	Vill. Mengori
12.	Pyar Singh	Vill. Pala
13.	Pyare Lal	Bhatwari
14.	Pradhan Singh	Kanasi
15.	Satas	Vill. Pala
16.	Torwa Singh	Vill. Pala
17.	Baundra	Vill. Barsu
18.	Vinod Singh Panwar	Vill. Kyask
19.	Dharam Singh	Vill. Regari
20.	Darmiyan Singh	Vill. Kyani
21.	Kushagra	Vill. Bhatwari
22.	Satya Sharam Sengwal	Vill. Bhatwari
23.	Kameshwar Prasad	Vill. Bhatwari, Chairman, Vyapar Mandal, Uttarakashi
24.	V. Rawat	Pradhan, Vill. Panchyat, Bhageli
25.	Kamal Singh Panwar	Pradhan, Vill. Pala
26.	Ajaypal Singh Rawat	Vill. Bansoo
27.	Dhirendra Singh Rawat	Vill. Pala
28.	Dharmendra Singh Rawat	Vill. Taru
29.	S. Singh Rawat	Bhatwari
30.	Vikram Lal	Bhatwari
31.	Kishori Prasad	Bhatwari
32.	S. Singh Rawat	Kajark (Bhatwari)
33.	M. Rawat	Vill. Bhatwari
34.	Avtar Singh	Vill. Bansoo
35.	Surakoli	Vill. Bhatwari
36.	Satya Singh Rawat	Maneri
37.	M. Rawat	Bhalla
38.	Dharamsingh Rana	Vi.. Sukhi
39.	Uday Singh	Raithal
40.	Narkumar	Gorshali
41.	H.Singh	Kyosk
42.	Ravindra Singh	Raithal
43.	Abdul	Badrani
44.	Rajendra Singh	Bhatwari
45.	Bharat Singh Negi	Kyani
46.	Balbir Singh Rana	Kyani
47.	Chandra Mohan Singh Panwar	Kyani
48.	Jabar Singh	Kyani

SL No.	Name (S/Shri)	Address
49.	Dharam Singh Negi	Kyani
50.	Inder Singh	Badrani
51.	Surender Singh	Vasam
52.	Sunder Singh	Badrani
53.	Amar Singh	Badrani
54.	Kamal Singh	Raithal
55.	Mangal Singh	Kihar
56.	Ramesh Singh	Kihar
57.	Jagtaap Singh	Juwanwar
58.	Pratap Singh	Pala
59.	N.S. Singh	Kyani
60.	Rajan Lal	Bhatwari
61.	Virender Singh Rawat	Bhatwari
62.	S. Seemar	Bhatwari
63.	V. Dimri	Natni
64.	Dharam Singh Rana	Vill. Sukhi
65.	Subhodh Kumar	Vill. Bhatwari
66.	Bharat Lal	Vi8ll. Bhatwari
67.	G.Singh Rawat	Kyani
68.	Chatur Singh	Kyani
69.	Satyeshwar Prasad	Vill. Kyaki
70.	Madan Singh	Vi.. Raikhal
71.	Sudarshan Singh	Saalang
72.	Ranuvendra Singh	Vill. Pala
73.	Mahavir Singh	Kyani
74.	Rajvir Singh	Raithal
75.	Vijay Singh Rana	Raithal
76.	Ravinder Singh Rana	Raithal
77.	Mathura Prasad	Bhatwari
78.	Jeet Singh	Brahni
79.	Karan Singh	Brahani
80.	Jaman Singh	Kihar
81.	Gajender Singh	Kyaki
82.	Dhanpal Singh	Raithal
83.	Bhagwat Singh	Bansoo
84.	Ratan Singh	Vandrarani
85.	S.Singh	Vandrarani
86.	Sumal Singh	Tihar
87.	Jameer	Lata
88.	Raghukaran	Lata

Source: Minutes of the Public Hearing, Uttaranchal State Pollution Control Board, Dehradun.