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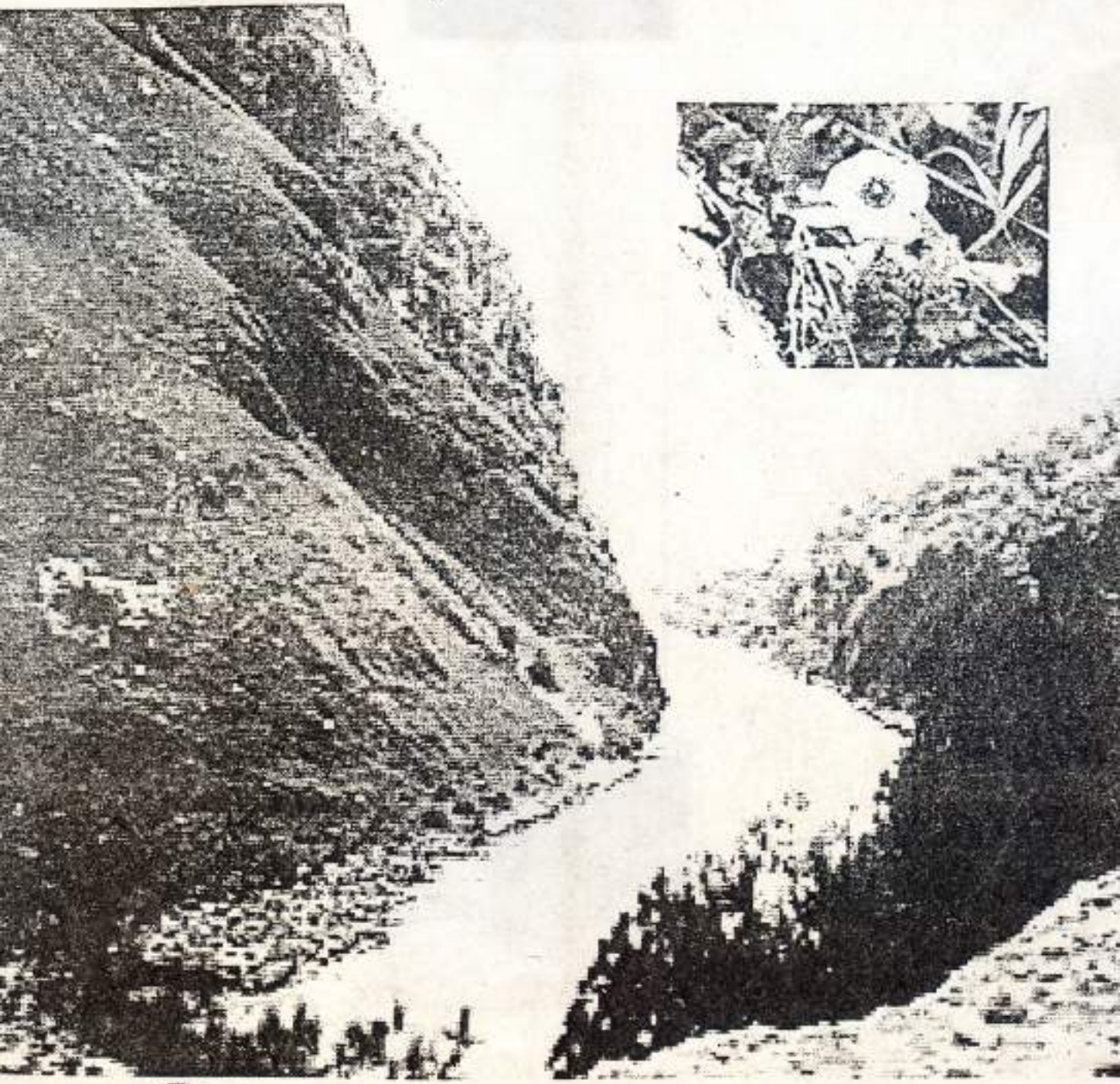
Environment Management Plan of Parvati Stage-II Hydro-electric Project Himachal Pradesh



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National Hydro-electric Power Corporation Ltd.

CENTRE FOR INTER-DISCIPLINARY STUDIES OF
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envisage summergence of any village or family. In addition the plan proposes to create amenities for education, health and communication for the communities lining in the project area. The chapter on public health delivery system reviews the existing mechanisms of health delivery as well as the prevalent diseases in the affected areas and in light of this proposes to create medical facilities for the rehabilitated families. In addition facilities like veterenary dispensaries, maintenance of Water Quality and Sewage Management have also been included. The proposed plans envisage to create a better quality of life for the residents of the affected area.

The cooperation and assistance of NHPC and the concerned officers at the Corporate Office as well as site office is gratefully acknowledged. We sincerely thank and owe a lot of gratitude to Shri Yogendra Prasad, CMD, Shri Bal Mukand, Executive Director, Shri H.M. Narang, GM, Shri Ashok Chhabra and Shri R.N. Mishra ,Chief Engineers, Dr. Usha Bhatt and Shri Rajiv Sachdeva, Sr. Managers and Shri P.K.Gupta, Shri Vipin Kumar, Shri V.B. Bhatt and Shri Shahid Ali.

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PREFACE

The Environment Management Plan including action plans for catchment area treatment, environment conservation and management, rehabilitation and resettlement and public health delivery system for the proposed Parvati Stage-II H.E. project on Parvati river has been prepared with the main objective of fulfilling the mandatory requirements of environmental concerns and also the goal of achieving sustainable development.

The first chapter contains action plan for environment management to circumvent various perceived threats to environment and biological species due to construction and related activities of the proposed hydroelectric project. As a result of our studies, areas requiring conservation/ preservation have been identified and suitable action plans for their management have been clearly enunciated. For the development of fisheries a separate plan has been prepared.

The second chapter deals with Catchment Area Treatment with the objective of arresting soil erosion and also rejuvenating various degraded ecosystems of the catchment. The catchment area treatment becomes extremely crucial particularly in the context of hydro power development because the life of reservoir depends on the type of catchment from which it collects the drainage. The degraded areas in the catchment have been identified and measures for the treatment have been suggested at subwatershed levels. The remediation methodologies include engineering as well as biological measures. In the end scheme for the implementation of catchment area treatment plan including the cost estimates over a period of 8 years has been indicated.

The chapters on Economic Rehabilitation and Public Health Delivery System for the proposed project include the action plans for ensuring proper compensation to and rehabilitation of affected families. The project does not

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ENVIRONMENT CONSERVATION MANAGEMENT PLAN

1.1 INTRODUCTION

The environment conservation management plan for the Parvati valley and the adjacent valleys of Hurla Nal and Jiwa Nal are being prepared in view of the foreseen disturbance and degradation of natural ecosystems that are likely to arise due to the various project activities like dam building, tunneling, trench weirs, adits, quarrying and dumping, road construction and other related works (Fig. 1.1). The plan aims to focus and highlight mainly the following aspects:

(i) Conservation and preservation of natural ecosystems which hold potentially important species from the conservation and or economic point of view,

(ii) Restoration and rejuvenation of degraded ecosystems/ habitats in the catchment,

(iii) Rehabilitation of keystone species, if any,

(iv) Mitigation of biotic and/or abiotic pressures/influences on the habitats.

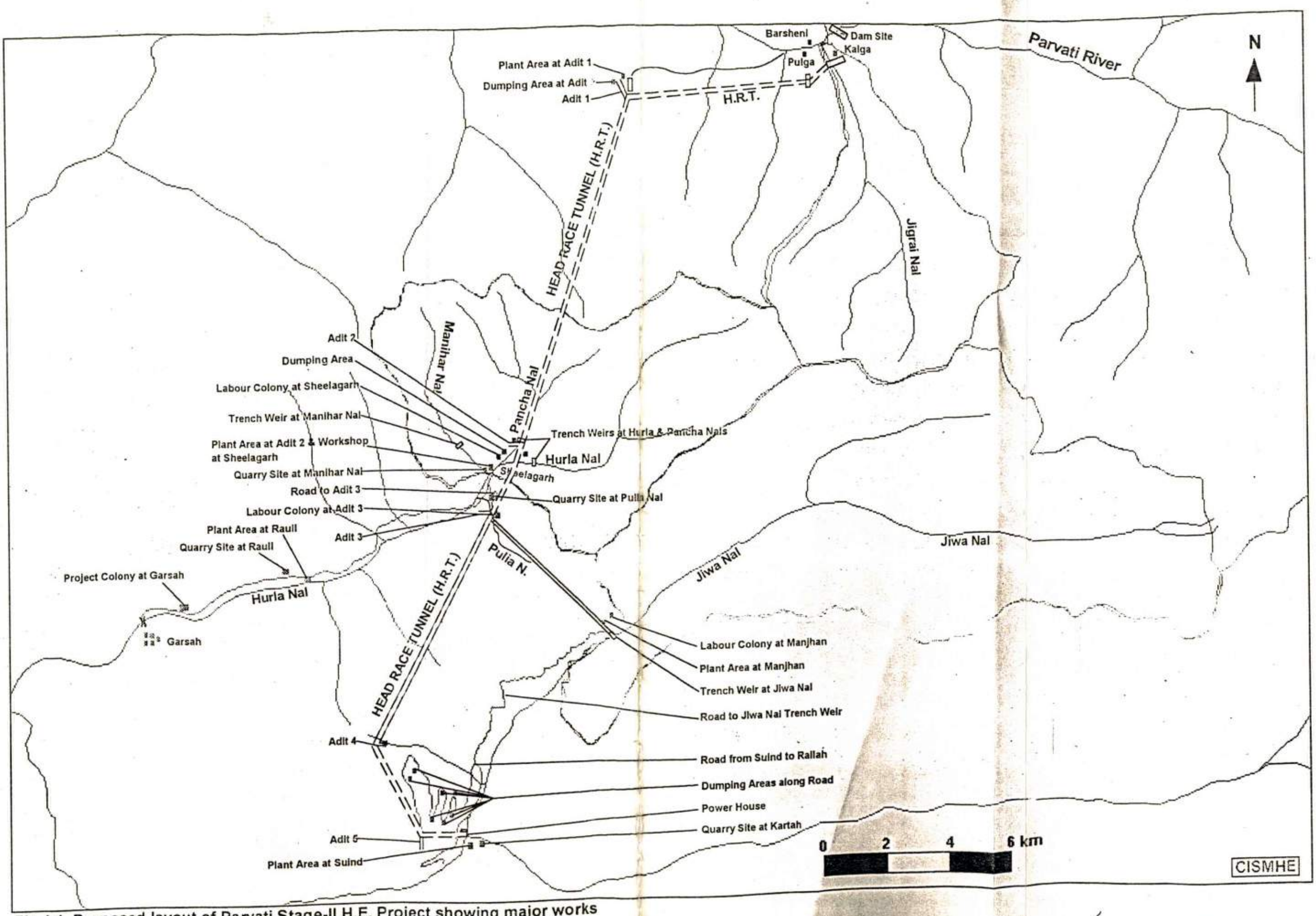

Fig.1.1 Proposed layout of Parvati Stage-II H.E. Project showing major works

1.2 BIOLOGICALLY RICH AREAS

1.2.1 Protected Areas

The catchments of Parvati river, Hurla Nal, Jigrai Nal and Jiwa Nal harbour a rich diversity of flora and fauna. Kanawar Wildlife Sanctuary and Great Himalayan National Park (GHNP) are the major protected areas situated in the vicinity of project area (Fig. 1.2). The Kanawar WLS is situated downstream of Manikaran on the left bank of river Parvati. It covers an area of 62.49 sq km and is densely forested with sub-tropical to alpine forests. The entire area of the sanctuary is highly undulating with rocky and precipitous steep slopes and is an ideal habitat for Himalayan Tahr. Great Himalayan National Park is comprised of catchments of Jiwa Nal, Sainj river and Tirthan river with an area of 754.4 sq km as per the Notification of 28th May, 1999 of Forest Department, Government of Himachal Pradesh. The altitude range of park area varies from 1,700 m to 5,800 m and the highest peak within the Park is 5,800 m. GHNP area is comprised of Wildlife Range Jiwa (Deun and Maror Blocks), Wildlife Range Sainj (Dhilai Block), Wildlife Range Tirthan (Rolla and Tirthan Blocks) and Tirthan Wildlife Sanctuary. The boundaries of GHNP are contiguous with the Pin valley National Park in Trans-Himalayan and Rupi-Bhaba WLS in the Sutlej catchment. An area extending up to 5 km from the western boundary of GHNP has been designated as Eco-development Project Area (EPA). A special Environmental Conservation Cell would be constituted by the project authorities to safeguard the protected areas and also to monitor the impact of project related activities.

1.2.2 Conservation/Preservation Areas

In addition to the protected areas, Parvati valley and Hurla Nal catchments also have pockets of biologically rich areas that require specific conservation measures to ensure their protection. These areas would also be covered under the proposed conservation cell.

As has been indicated in the EIA report, there are extensive primary forests in Parvati, Hurla and Jiwa catchments. The submergence area does not have any such floral or faunal elements, which need rehabilitation as most of the taxa are common and only a limited number of these species will be submerged. The natural forests, represented by dense canopy, are found scattered in all the three catchments. These forests are mostly coniferous, mixed broad-leaf coniferous or broad-leaf type.

These dense forests need protection because their existence may be threatened due to road building, construction of colonies and other works. Figure 1.3 shows that amidst these biodiversity rich areas there are some minor proposed activities as mentioned above. If these forests are not brought under protective framework, these may be permanently lost, which will be a blow to the biodiversity of the area, animal habitats and their migration corridors and avifaunal populations. The protection of these forests is important from the point of view of biological conservation, river hydrology and also the sustenance of the aquatic fauna in the river which draws its food from the vegetation in these forests.

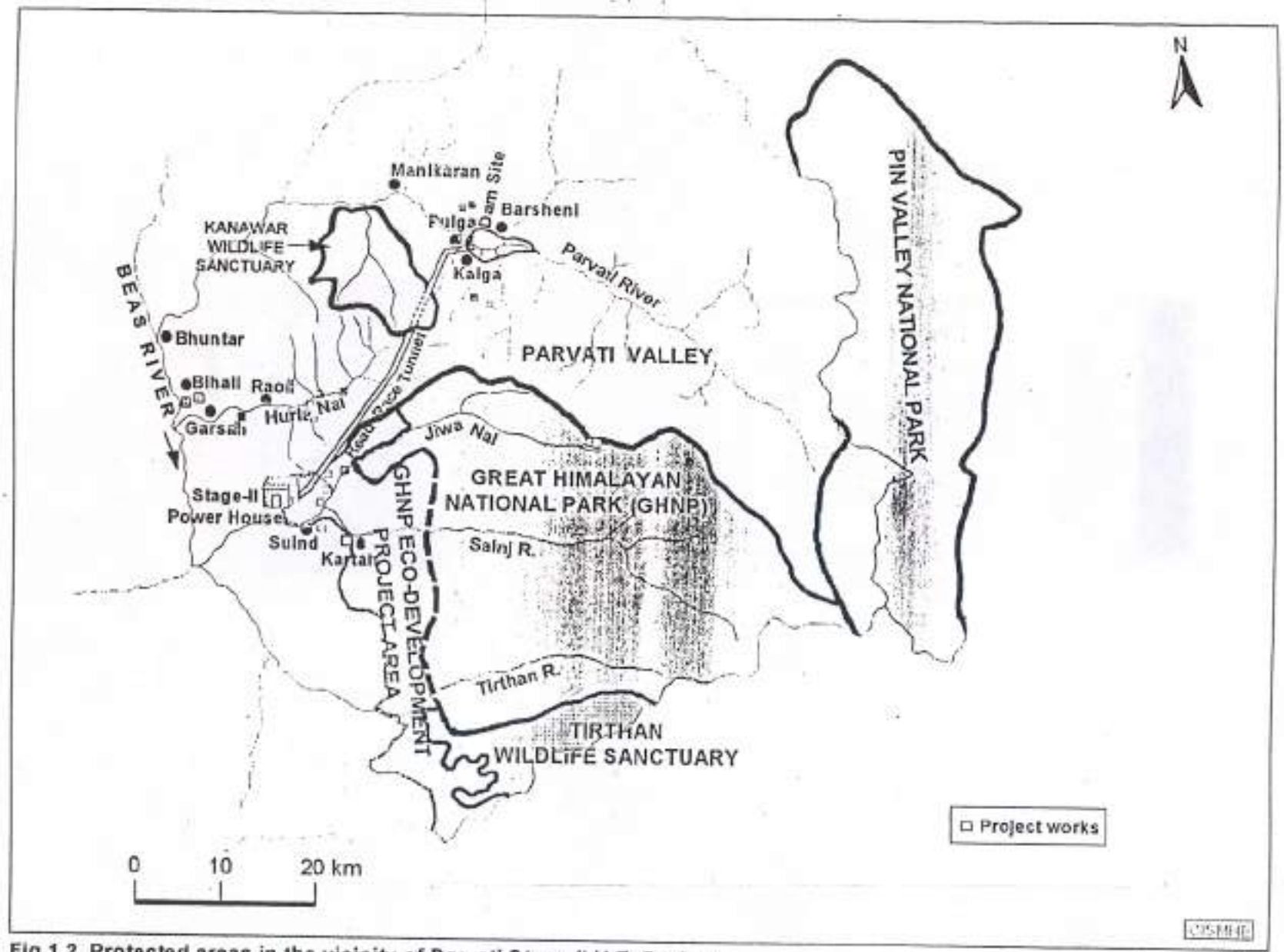

Fig.1.2 Protected areas in the vicinity of Parvati Stage-II H.E. Project

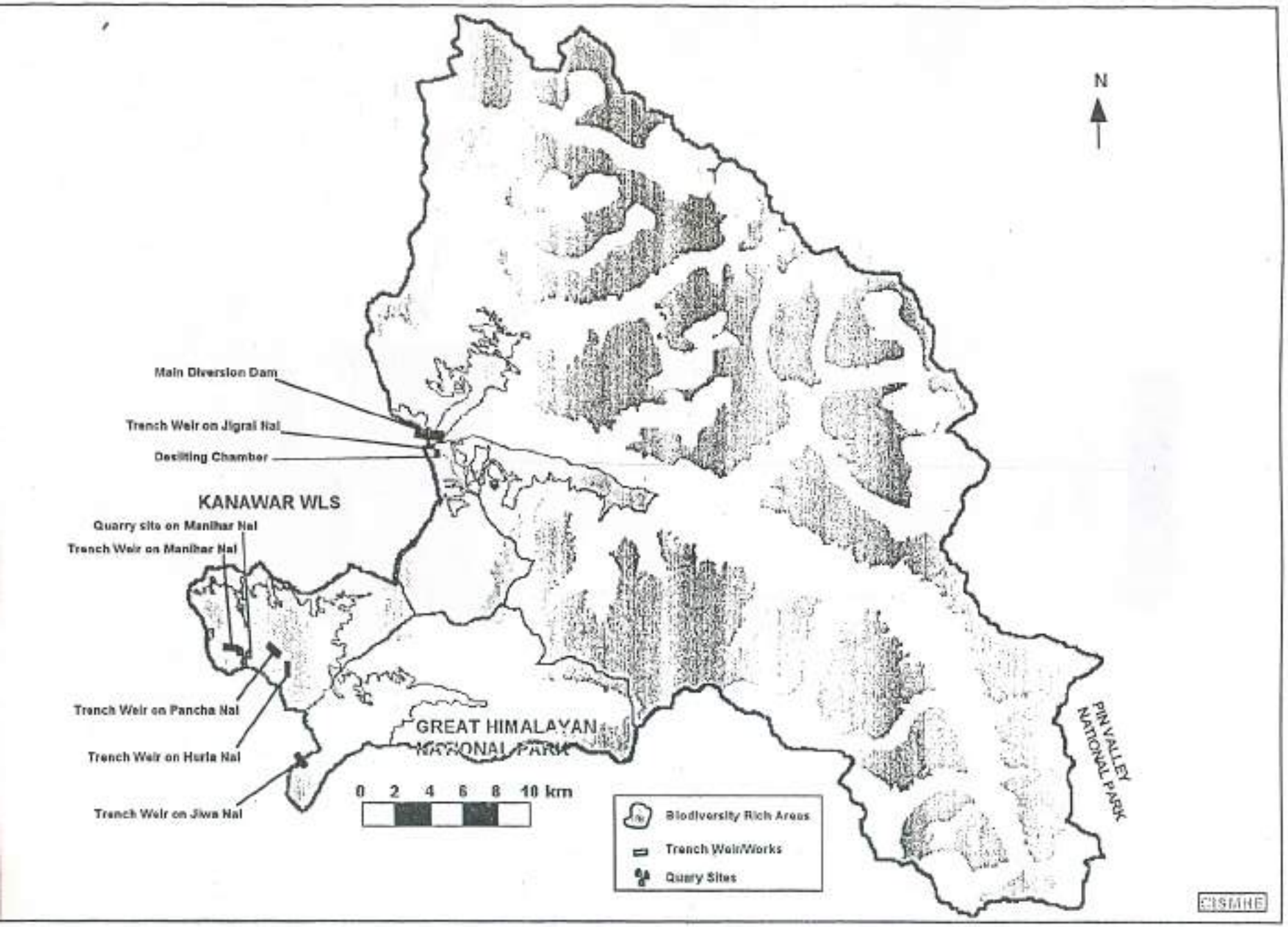

Fig.1.3 Areas of Rich Biodiversity to be monitored by PVCC. Note the location of project works in the vicinity of these conservation areas. These areas need special conservation management and care during execution of project work.

The total area for the preservation/conservation has been demarcated in Fig. 1.3. These areas constitute sub-watersheds of Parvati, Jigrai, Hurla and Jiwa and are spread over an area of 11,553 ha. In these sub-watersheds 70-75% of the snow free area is under dense forest cover. The main floral constituents in these forests include representatives of Asteraceae, Poaceae, Lamiaceae, Fabaceae, Brassicaceae, Rosaceae, Apiaceae, Liliaceae, Ranunculaceae, Boraginaceae, Caryophyllaceae, Orchidaceae and Scrophulariaceae. Some of the dominant species that represent these and other plant families are: *Alnus nitida*, *Lyonia ovalifolia*, *Ulmus wallichiana*, *Juglans regia*, *Cornus capitata*, *Aesculus indica*, *Acer caesium*, *A. acuminatum* and *Quercus semecarpifolia*. The conifers in this zone are *Cedrus deodara*, *Picea smithiana and Abies pindrow* .

1.3 CONSERVATION PRIORITIES FOR FLORA

1.3.1 Endemics and Monotypics

Some of the endemic Himalayan plant taxa which are present in the valley and need special conservation attention are: *Aconitum chasmanthum*, *Meconopsis aculeata*, *Ougeinia oogeinensis*, *Nardostachys jatamansi*, *Hemiphragma heterophyllum*, *Picrorhiza kurrooa*, *Veronica laxa* and *Phlogacanthus thyrsiflorus*. Among the notable species with restricted distribution where conservation efforts have to be focused include *Delphinium cashmerianum*, *Bupleurum dalhousianum and Viburnum foetens*. Since these species are showing highly restricted distribution, special *in situ* and *ex situ* programmes will be launched for their conservation and preservation.

Parvati valley and its adjoining valleys harbour a number of monotypic genera distributed along the altitudinal cline and these taxa also require special conservation measures. Some of these taxa that need to be monitored for conservation are as follows: *Asperugo procumbens* (Boraginaceae), *Boenninghausenia albiflora* (Rutaceae), *Hemiphragma heterophyllum* (Scrophulariaceae), *Parochetus communis*, *Ougeinia oogeinensis* (Fabaceae) and *Oxyria digyna* (Chenopodiaceae).

1.3.2 Orchid Flora

There are about 15 species of orchids found in the project areas surveyed. Majority of these orchid species are terrestrial. These orchid species need to be conserved both *in situ* as well as *ex situ* (if required). A number of protocols are readily available for their *in vitro* mass propagation. Some of the orchid species that need to be covered under conservation measures include *Aerides multiflorum, Calanthe tricarinata, Cephalanthera ensifolia, C. longifolia, Cypripedium cordigerum, Dactylorhiza hatagirea, Epipactis gigantea, Gastrodia orobanchoides, Goodyera repens, Habenaria acuminata, H. edgeworthii, H. latilabris, Herminium lanceum, H. monorchis, H. pugioniforme, Malaxis muscifera and Spiranthes sinensis*. Out of these, critical species like *Cypripedium cordigerum, Dactylorhiza hatagirea, H. edgeworthii and H. latilabris* would be taken up for *ex situ* conservation measures like tissue culture propagation. The protocois for their rapid multiplication and *ex situ* conservation are detailed out in (Brasch and Kocsis, 1980), (Chaturvedi and Sharma,

1986), (Goh 1973), (Homma and Asahira, 1985), (Kokubu et. al., 1980), (Kotomori and Murashige, 1965), (Mathews and Rao, 1980), (Mitra, 1986), (Mitra *et al.*, 1976), (Morel, 1974), (Murashige and Skoog, 1962), (Partanen, 1965), (Raghavan, 1977), (Vij and Malhotra, 1988), (Vij and Shekhar, 1986), (Vij and Pathak, 1988a), (Vij and Pathak, 1988b), (Vij *et al.*, 1986), (Withner, 1974) and (Zimmer and Pieper, 1978).

1.4 ENDANGERED FLORA AND ITS CONSERVATION

Deforestation at lower limits and over-grazing and indiscriminate over-exploitation of medicinal herbs in higher reaches have led to an irretrievable loss in the genetic diversity of these species. A number of populations have been wiped out as a result putting these species at risk. It is envisaged that the project activities and presence of large numbers of human population around the natural habitats may exert a lot of pressure on these resources. In order to reverse this process of species loss and dwindling population numbers and sizes, the project authorities in addition to the monitoring of illicit activities of plant extraction, will initiate positive steps of conservation of these species at risk. Maximum attention will be given to the habitat protection and strict watch would be maintained against species targeted extraction from wild habitats. Some of the critically endangered species that need such monitoring and watch besides conservation programmes are: *Aconitum chasmanthum, Atropa acuminata*, *Codonopsis ovata*, *Dioscorea deltoidea, Gentiana kurroo*, *Meconopsis aculeata*, *Nardostachys jatamansi*, *Picrorhiza kurrooa*, *Potentilla nepalensis*, *Podophyllum hexandrum*, *Polygonatum verticillatum*, *Trillidium govanianum*, *Saussurea gossypiphora*, *S. lappa and Taxus*

baccata.Many of these species are away from the sites of project activity, but a few of them are present in the habitats where activities like road building, plant construction, etc. are proposed. Conservation measures will be focused on the species with high risks.

1.5 CONSERVATION OF FAUNA

Some of the Schedule-I animals reported from the catchment areas include Snow leopard, Common leopard, Wolf, Leopard cat, Himalayan black bear, Himalayan brown bear, Bharal, Himalayan ibex, Himalayan tahr, Serow and Musk deer. Maximum efforts would be made to avoid degradation and damage to the habitat and migration routes of these animals. Though majority of the habitats of these animal species are away from the project sites, but some animals do stray into the areas where project works will be carried out. The project authorities would take the following steps in order to ensure habitat protection and protection to animal and bird species like Monal and Western Tragopan, around the project sites.

1.6 GUIDELINES FOR CONSERVATION OF BIOTA

(i) There will be strict monitoring of labourer and associated workers for any activity related to endangering the life or habitat of wild animals and birds.

(ii) Strict restrictions will be imposed on the workers at project sites to ensure that they do not harvest any produce from the natural forests and cause any danger or harm to the animals and birds in wild.

(iii) Minimum levels of noise during construction activities will be maintained and no activity will be carried out at night where the project site is in the close vicinity of natural animal/bird habitats. These habitats are essentially in the vicinity of Sheelagarh, Pancha Nal, Hurla and Manihar Nals where dense forest cover exists. These areas have been demarcated on the map (Fig. 1.3).

(v) The fuelwood to the labourers will be provided from plantations meant for the purpose and/or the provision has been made for the supply of the free subsidized kerosene/LPG from the depots being set up for this purpose to avoid forest degradation and animal habitats.

(vi) The interference of human population would be kept to the minimum and it would be ensured that the contractors do not set up labourer colonies in the vicinity of forests and wilderness areas. No permanent human colonies, for example, will be allowed to come up beyond Kaĩga village in Parvati valley, as the Himalayan black bear frequents the area. Similarly, no human activities will be allowed beyond Sheelagarh, Manihar village and in Pancha Nal area. These areas form important habitats of the wild animals.

(vii) A mix of incentives for protection of wildlife and their habitats and strict regulatory framework will be put in place to implement the conservation effort.

(viii) The project authorities will be bound by the rules and regulations of the Wildlife Protection Acts or any such agency of the State, which may exist or will be promulgated from time to time for the preservation of habitats and protection of wild animals.

1.7 NOISE MITIGATION AND MANAGEMENT

The maximum noise levels allowed in human silence zones are 10 dB in addition to the baseline noise (Therivel, 1995) . Humans can tolerate noise levels up to 60-65 dB without any health damages. Higher noise levels in the range of 100 dB and above are reported to cause high blood pressures, risk of heart attacks, disturbance in sleep, annoyance and anxiety in humans. However, studies indicating harmful effects of high noise levels on wild animals and birds in wilderness areas are very few. Given the fact that during civil engineering works in the proposed project noise levels at a distance of 7m will vary from 150-300 dB at a given time, it is presumed that such high noise levels would be serious health hazard for wildlife. However, these areas being pristine, baseline noise levels would be minimum and the vegetation being extensive, it will act as noise absorber. Therefore, it would be ensured that the noise levels in no case go above 100-150 dB in the areas marked in Fig. 1.3. One of the measures that is proposed to be adopted is that the blasting will be restricted during nights, early mornings and late afternoons, which are the feeding times of most of the fauna. Blasting will be resorted to only if extremely necessary.

Some of the suggested methodologies for reduction and mitigation of noise so as to cause as little disturbance to the animals as possible are given below:

(i) Only well maintained/new equipment that produce lesser noise than old and worn out one would be installed at the work sites.

(ii) The best way to control the noise is at source. Certain equipment that need to be placed permanently at one place like generators, etc. would be housed in some enclosed structures to cut off the noise.

(iii) The heavy equipment like rotating or impacting machines will be based on anti-vibration mountings.

(iv) Wherever combustion engines are required they will be fitted with silencers.

(v) The traffic (trucks, etc.) used by the project works will be managed to produce a smooth flow instead of a noise producing stop and start flow. Necessary training/orientation will be provided to the traffic operators/drivers. Sounding of loud horns, etc. in the forested areas will be banned.

(vi) While clearing the land of vegetation for any project work, the project authorities will ensure that the work area has sufficient layers of tree cover around it. It will be an effective noise absorber. It will be better not to have bigger trees lopped or cut around the periphery of the site. The tree layer will act as buffer zone and these are known to cut off noise by about 3-12 dB at a site depending upon the density of

vegetation. These measures will be planned in advance and well before starting operation at any site.

(vi) The project authorities will monitor the noise at critical sites (Fig. 1.3) from time to time.

(vii) For details on the methods and techniques for noise control the project authorities may refer to Mulholland & Attenborough (1981); SRL (1991) and Lipscomb & Taylor (1978).

1.8 ACTION PLAN FOR CONSERVATION AND PRESERVATION

It is evident from the above description that owing to the importance of various areas in the catchments an institutional and management framework has to be set up to safeguard the biological richness and diversity of the areas that are not affected by the project, but are in its vicinity. The project authorities are committed to providing sufficient funds for the activities of prevention of damage to habitats/ wildlife, protection of animal/plant life in association with other State agencies like Wildlife/Forest Department, Great Himalayan National Park or any other institution concerned with conservation efforts in this region.

One of the first steps to ensure undisturbed continuity of these habitats is to declare these forest areas protected forests or hand-off areas for any human intervention. No activities should be permitted either by the private or public agencies in these protected areas. The nature of the regulatory framework and its implementation will be left to the State Government, however, an action plan for the

preservation and management of these protected areas is indicated here.

1.8.1 Parvati Valley Conservation Cell

It is recommended that a Parvati Valley Conservation Cell be created under the aegis of Director, Great Himalayan National Park (GHNP). The funding support for this would be provided by the project authorities for a period of 8 years The action plan for this Cell is as follows :

(i) A Parvati Valley Conservation Cell (PVCC) will be set up by the State Government upon the recommendation of Ministry of Environment & Forests, Government of India under the direct and over all administrative control of the Chief Wildlife Warden, Himachal Pradesh.

(ii) The PVCC would be governed by a Board under the Chairmanship of the Chief Wildlife Warden/Director (GHNP) and shall include two members each from State Forest Department, two renowned Ecologists/Conservationists, two representatives of local NGOs and one Central Government representative of Ministry of Environment & Forests.

(iii) The PVCC shall be housed in the office of the Chief Wildlife Warden and would have a minimum staff of 31 personnel namely Assistant Conservator of Forests (2), Wildlife Rangers (5), Forest Guards (12), Head Clerks (2), Drivers (3), Peons (7).

1.8.1.1 Activities to be undertaken by PVCC

(i) The main job of this Cell would be to look after the conservation areas in the vicinity of existing Protected Areas, monitor and enforce regulatory provisions and ensure that the natural ecosystem structure and functions are not changed or subjected to any threat.

(ii) The proposed Cell will endeavour to conduct works related to documentation of the existing biological diversity in the proposed protected area and publish check lists of flora and fauna. However, this effort would be supplemented by detailed surveys on flora and fauna that are proposed to be conducted by the competent institutions/agencies.

(iii) *Surveillance*

The Cell through its staff will ensure that the landuse frozen at the beginning is not changed and no anthropogenic activities from private or public agencies are carried out within the boundaries of the protected area.

(iv) *Fire Protection*

The forests of the Parvati and adjoining catchments are at times subjected to forest fires. Special attention, therefore needs to be paid to the prevention of forests fires as well as the protection of forests during forest fires.

(v) *Local Participation*

The inhabitants of the area would be encouraged to adopt conservation oriented practices and economic activities. This would ensure habitat protection and continuity as well as rule out loss of wildlife species. These practices will also help in preventing disruption, disturbance and fragmentation of the wildlife habitats.

(vi) *Enforcement of Anti-poaching Laws*

Necessary provisions of law will need to be put in place to empower these field personnel within the existing framework of the Himachal Pradesh State Forest Department.

(vii) The penalty to the violator/s carrying out any illegal operations in this area shall be dealt under existing laws of the Forest Conservation Act, CITES and other laws which may exist or may come in force from time to time to prevent damage/disturbance to these natural ecosystems.

(viii) *Monitoring*

A monitoring committee will be set up which will monitor and ensure the implementation of conservation measures. The monitoring committee would include all the members of governing board of PVCC and will also have a representative of NHPC. The Cell would monitor the

conservation measurs like the control of poaching, regulation of biotic activities, prevention of domestic cattle straying into Protected Areas, conservation awareness, research and monitoring and alternate income generating activities like cultivation of medicinal plants and `Guchhi' collection from pristine forest areas..

1.9 Financial Resources

Sufficient provision has been made in the project cost for the establishment of PVCC. The estimated cost of setting up of Cell is given in Table 1.1.

Table 1.1. Financial requirement for setting up of PVCC.

S.No.	Items	Qty	Amount (Rs. in lakhs)
A.	**Capital Expenditure**		
i)	Office/Building Space	1	15.00
ii)	Equipment (Forest equipment, guns, wireless sets for communication, laboratory equipment, computers, etc.		40.00
iii)	Furniture and furnishings		5.00
iv)	Vehicles (3)		15.00
	Total (A)		**75.00**
B.	**Recurring Expenditure (for 8 years)**		
1.	Salaries & Wages		
i)	Assistant Conservator (2) @ Rs. 15,000/- per month = 8 x 2 x 12 x 15,000		28.80
i).	Wildlife Rangers (5) @ Rs. 10,000/- per month = 8 x 5 x 12 x 10,000		48.00

	ii).	Guards (12) @ Rs. 6,000/- per month = 8 x 12 x 12 x 6,000	69.12
	iii).	Head Clerks (2) @ Rs. 8,000/- per month = 8 x 2 x 12 x 8,000	15.36
	iv).	Drivers (3) Rs. 5,000/- per month = 8 x 3 x 12 x 5,000	14.40
	v).	Peons (7) Rs. 5,000/- per month = 8 x 7 x 12 x 5,000	33.60
	2.	Contingent expenditure L.S. @ Rs. 8.00 lakhs per year	64.00
	3.	Running and Maintenance of vehicles L.S. @ Rs. 5.00 lakhs per year	40.00
	4.	Miscellaneous expenses L.S. @ Rs. 5.00 lakhs per year	40.00
	Total (B)		**353.28**
C.	**Surveys and studies**		**100.00**
Grand Total (A+B+C)			**453.28**

1.10. RESTORATION OF DEGRADED ECOSYSTEMS

To ascertain the unhindered and unimpaired ecosystem processes in the Parvati basin it is essential to restore the already degraded forest ecosystems, though very small in area. These are spread over an area of 8,355 ha in the basin. The scheme of events follows a pattern whereby dense forests are degraded to make them open forests and subsequently open forests are subjected to agriculture practices/cultivation.

To restore the degraded forests and bring them back to the condition of dense forests, these areas be taken up on priority basis for afforestation purposes. Since afforestation programmes will be undertaken to augment the needs of fuelwood for the human population, fodder for the domestic cattle and also the timber

requirement from time to time, the degraded forest ecosystem areas will be earmarked for this activity. Figure 2.13 shows the areas that need immediate attention through afforestation and other measures resulting in restoration of these degraded areas.

The major benefits accruing from the restoration of these degraded areas include:

(i) Rejuvenation of ecosystems and enlarging the habitats and migration corridors of wildlife and faunal species,

(ii) Ensuring minimal soil loss and preventing siltation of river channels and proposed reservoir,

(iii) Better stream hydrology regulation and extending the period of perennial flow in the river, and

(iv) Maintenance of the aquatic ecosystem processes by ensuring less siltation, more water availability, optimal water temperatures, and food availability to invertebrate and vertebrate fauna throughout the stream channels.

The major tree species that should be considered for afforestation in these degraded forests would depend on the varying altitudes in the catchment. The indigenous, ecologically and economically important species will be given priority in the afforestation programme. These species will include: *Pinus wallichiana, Cedrus deodara, Alnus nitida, Aesculus indica, Juglans regia, Quercus dilatata, Acer caeasium, Betula utilis,* etc.

The mechanisms and management for this afforestation programme and restoration of the degraded ecosystems will be

undertaken by the State Forest Department. An action plan is indicated here to assist these agencies to carry out the task in the earmarked catchment area.

The help and assistance of local NGOs, Co-operatives, or Village Communities in each specified area would be sought in carrying out the task of afforestation. The following actions are envisaged for this purpose:

(i) Constitute village level committees/co-operatives/Van Panchayats for each area under the aegis of the State Forest Department as the funds would be disbursed to the participating individuals/institutions through the implementing agency,

(ii) Participation of local institutions and individuals would be a key to the success of implementation of the programme because it would ensure protection and preservation of these areas on a long term basis,

(iii) The implementing agency would raise and develop plant nurseries and provide employment to the local individuals participating in the afforestation programme through joint participatory management schemes,

(iv) Incentives to the participants would be given in the form of cash and/or food for work.

(v) The participation of the local bodies/individuals shall be ensured keeping in view their short- and long-term interests in managing these forested areas.

1.11 CONSERVATION MEASURES FOR CRITICAL AREAS

In the proposed hydro-power development project only a smaller area will be submerged and it does not contain any endangered plant species and also does not constitute the exclusive habitat of an animal species. However, other activities like road building and works like trench weir construction would pass through or are located in some critical habitats, which need special care for their preservation.

The natural ecosystems between Sheelagarh and Pancha Nal and Sheelagarh and Manihar Nal are critical areas of concern in this project. There are proposed road activities and trench weirs at both these sites and these activities are bound to degrade and disturb these natural ecosystems. In order to minimize damage on these ecosystems, it is proposed to undertake the responsibility of preservation, conservation and if need arises propagation of some of the very important plant species which may be threatened due to the project activity. The following measures are proposed to be undertaken to safeguard the critical areas from degradation.

i) Labourer population will be kept to a minimum to avoid crowding of the area, particularly in the regions and vicinity of high biodiversity and animal and bird habitats.

ii) The labourers will be given a one-day orientation training, which will highlight the importance of critical species of animals and plants and the consequences of bringing any harm to them. Strict penal actions will be mentioned to them clearly in this workshop.

iii) There will be strict monitoring of the labourers so that they do not engage in harvesting, poaching or any kind of trade of these critical/ endangered species.

iv) The labourers will be strictly forbidden to enter the forest areas and under no circumstances create any disturbance and necessary provisions for fines and termination of labourer services will be enforced to ensure compliance.

v) The temporary labourer colonies will be constructed at Sheelagarh and no such colonies will be allowed to come up between Sheelagarh and Pancha Nal.

vi) In order to prevent labourers venturing into the forest in search of fuelwood and fodder, necessary arrangements are being made for providing them subsidized kerosene oil or fuelwood from the depots established for this purpose.

vii) Efforts would be made with the help of the local administration to ban opening up of any roadside kiosk, shop or any such joint, which will attract concentrated human population. The project authorities would ensure that these pristine habitats remain hands off areas for general public as far as any activity inside these habitats is concerned. Necessary regulatory mechanisms will be put in place to ensure the undisturbed nature of these ecosystems.

viii) In case of geo-technical feasibility it is proposed that wherever possible roads will be avoided and instead small distance tunnels would be constructed. In this manner a lot of disturbance and degradation will be avoided. In fact one of

the key features of this project is its environmental sustainability because of least damage to the environment. As most of the water augmentation is being done through underground tunnels, very little disturbance or degradation will be caused to the precious forest ecosystems and wildlife habitats.

1.12. CONSERVATION PLAN FOR CRITICAL SPECIES

1.12.1 Flora

Some of the plant species which are critical in nature in terms of their small population sizes, will be specially selected for conservation/ preservation. Some of the species like *Trillidium govanianum, Polygonatum verticillatum, Podophyllum hexandrum*, etc. will be taken up for *in situ* and *ex situ* conservation. The *in situ* measures will include rehabilitation of these species in the similar habitats around the area. In case it is known that the population sizes are extremely small in some cases efforts would be made to augment the natural population through artificial multiplication and regeneration.

There are well worked out protocols available for mass multiplication of some of these critical and important plant species. These techniques will be utilized for the mass propagation of these species. Though *in situ* conservation efforts would be given priority and more emphasis, biotechnological tools will also be employed in the conservation effort as and when necessary. Sufficient provisions are being made for the establishment of tissue/organ culture laboratory for the mass multiplication and conservation of some of the species.

1.12.1.1 *In situ* Conservation Measures

The *in situ* conservation measures for the critical species, particularly in Hurla Nal and Jiwa Nal catchments, will be given highest priority. The taxa with small population sizes will be identified and relocated in the similar habitats. Their niche requirements would be analysed so that their relocation takes place smoothly and they are able to propagate naturally. The areas for *in situ* relocation will be in the vicinity of their natural habitats. The relocation sites will be selected in a manner so that these taxa are not exposed to any biotic or abiotic threat or pressure. The different taxa would be segregated based on their reproductive propagules. As majority of these critical species are herbaceous perennials with rhizome/rootstock/corm/bulb as the reproductive propagules, sufficient care will be taken to relocate them initially in nurseries for proper establishment and finally these will be transferred to the selected sites for natural propagation.

The nurseries of about 1 acre area will be located in the broad-leaf forests of Hurla Nal and the relocation habitats will be randomly selected among the forests in the area. This exercise will be accomplished by the State Forest Department. NHPC will provide the necessary funding support and sufficient provision has been made in the project cost for this purpose and hence avoid acquiring any land for nurseries and/or rehabilitation sites. Since the naturalness of habitats has to be maintained in all respects, no artificial means will be employed to assist these taxa in their relocation.

1.12.1.2 *Ex-situ* Conservation Measures

Ex-situ conservation measures will be pursued in the case of critical species which have low reproductive potential and efficiency. The taxa with low individual numbers will be selected and *ex-situ* conservation measures like seed collection, *in vitro* seed germination and nursery establishment will be carried out. Plant tissue culture will be tried for mass multiplication of such critical taxa for which protocols are already developed. Some of the critical species that need such conservation programmes are: *Acorus calamus*, *Allium humile*, *Atropa acuminata*, *Dactylorhiza hatagirea*, *Delphinium denudatum*, *Gentiana kurroo*, *Hedychium spicatum*, *Phlomis bracteosa*, *Phytolacca acinosa*, *Podophyllum hexandrum*, *Polygonatum verticillatum*, *Potentilla nepalensis*, *Picrorhiza kurrooa*, *Rheum webbiana*, *Taxus baccata* and *Trillidium govinanum*. Of these 16 threatened plant species, 6 are critically endangered, 1 is endangered while rest of them are vulnerable. All these species are present in the habitats where activities like road building, plant construction, etc. are proposed.

In vitro pant regeneration of medicinally important plant species have been achieved by using different explants or through organogenesis from callus and cell suspension cultures. Protocols for the *in vitro* micropropagation of some of the critically endangered species i.e, *Atropa acuimata* (Akram *et al.* 1994), *Gentiana kurroo* (Sharma *et al.* 1993), *Polygonatum verticillatum* (Jayanti Sengupta *et al.*, 1987) and *Podophylum hexandrum* (Arumugam and Bhojwani, 1990) and vulnerable species i.e., *Acorous calamus* (Harikrisnan *et*

al., 1997 ; Kulkarni and Rao, 1999) and *Taxus baccata* (Wickremsinhe and Arteca, 1993 ; Chee, 1994) have been developed successfully. The protocols for many of these threatened plant species have been developed indigenously at Department of Botany, University of Delhi (*Podophyllum hexandrum*), Department of Botany, University of Calcutta (*Polygonatum verticillatum*), Department of Botany, University of Calicut and Nuclear Agriculture and Biotechnology Division, BARC, Mumbai (*Acorus calamus*) and National Plant Tissue Culture Repository, NBPGR, New Delhi (*Gentiana kurroo*). Work is also being carried out on the propagation and conservation of *P. hexandrum* at G.B. Pant Institute of Himalayan Environment and Development, Almora. The use of *in vitro* techniques not only helps in the conservation of this threatened species but also potentially increases the production of medicinally important compound for which the particular plant species is being exploited. For example, Woerdenbag *et al.* (1990) reported the increase production of podophyllotoxin in *P. hexandrum* cell suspension cultures. Protocols are not available for the *in vitro* micropropagation of many of the threatened plant species i.e., *Dactylorhiza hatagirea, Trillidium govinanum, Allium humile, Delphinum denudatum, Hedychium spicatum, Phlomis bracteosa, Phytolacca acinosa, Potentilla nepalensis* and *Rheum webbiana*. These threatened plant species are found in the project areas and will be affected by various project activities.

It is proposed that Institutions such as Y.S.Parmar University, Himachal Pradesh, Department of Botany, Punjab University, Chandiga\rh, Departmnet of Botany, University of Delhi, NBPGR and

G.B. Pant Institute of Himalayan Environment and Development, Regional Centre, Mohal (Kullu) shall be involved for the development of protocols for the *in vitro* micropropagation and the subsequent reintroduction of these species in their natural habitats. The necessary funding support for setting up the laboratory and offices, chemicals and equipment, hardening facility and green houses/chick houses, etc. and maintenance for 8 years would be provided by NHPC. The estimated cost of the above facilities and their maintenance for eight years is given in Table 1.2. The Tissue Culture Centre will be taken over by the host institute after the eight-year period upon the approval of Ministry of Environment & Forests, Government of India.

1.12.2 Fauna

1.12.2.1 Mammals

During the construction period of the proposed Parvati Stage - II H.E. Project, there would be sudden spurt in human activities not only in the Parvati river valley but also in the Hurla Nal and Jiwa Nal catchments which are in immediate vicinity of GHNP. The resource extraction and human activities would have negative impact on the wildlife of these areas and their habitats. Therefore, it is necessary to have a well planned management strategy, which can guarantee and safeguard the survival of wildlife population in these areas.

The mammals like Goral, Kakar, Bharal and Ibex found in upper reaches of Parvati valley as well as Hurla valley, frequently descend down to 1,200m on grassy slopes or rockylands between the forests.

The visits are made either in mornings or evenings for feeding. These animals, therefore, expose themselves to risks of being shot down or caught and poached. More importantly, most of these animals breed in the winter months starting October. They also descend down during this period particularly after snowfall. The young ones are born in the months of April to June. The mammals like Himalayan tahr and Himalayan musk deer also found on grassy and precipitous slopes, on the other hand are quite shy and are very fast runners. Even then they are laid down by the poachers. Among large mammals, Brown bear which inhabits upper reaches of Parvati valley descends down in autumn for mating and its young ones are born in February-March. Snow leopard seldom comes down from 3,500m.

1.12.2.2 Avi-fauna

Among the birds Chakor, Hill partridge and pheasants - Kalij, Cheer, Koklas, Monal and Western Tragopan all are known to descend down to lower altitudes during winter months. Their nesting season starts from April extending up to June. Cheer and Monal are found mainly in Hurla and Jiwa valleys while Western Tragopan is found mostly in GHNP. The highly expensive edible mushroom, *Morchella* spp., locally known as '**Gucchhi**' grows in the same habitats as that of pheasants. **Gucchhi** extraction coincides with the breeding season of. Pheasants who are forced to leave nests because of frequent visits of people in their nesting areas. It has reported to lead to decline in breeding success of pheasants (Kumar *et al.*, 1999). Removal of litter and trampling while mushroom collection have also been found

to have negative impact on invertebrate population thriving on ground which are primary source of food for growing pheasant chicks.

1.12.2.3 Management Strategies

Keeping in view the sudden influx of labour population in the wildlife rich areas, the following actions are suggested for the conservation of fauna in the region.

(i) The project authorities would ensure that strict vigil is kept especially during the breeding season of animals i.e., from October- December and when young ones are born/ nesting season, i.e., from March-June. Activities like blasting or heavy machine operations producing noise levels more than 80-100 dB will be restricted during this period. Heavy penalties would be imposed for violation of this conduct by contractors/labourers, etc. during this period.

(ii) Information dissemination emphasizing the need of conservation and legal consequences on violation of Forest and Wildlife (Protection) Acts will be prioritised and publicised. Awareness would also be imparted to the labourers engaged in construction activities in Parvati H.E Stage - II project for exerting great restraint especially during critical months of breeding and nesting of animals and birds.

(iii) The signboards/Notice boards highlighting penalties for violation of rules, will be put nearby habitation areas of

labourers. The importance of conservation of wildlife would also be emphasised.

(iv) Patrolling would be increased during critical months, like winter, when animals and birds come down to warmer altitudes.

(v) Human activities and secondary impacts caused by resource collection i.e., `Gucchhi' and medicinal herb collection would be controlled. Heavy penalties will be imposed for habitat destruction and disturbance and stealing of eggs of pheasants by humans.

(vi) Education and awareness campaigns including screening of audio-visual films would be conducted stressing on the harmful and negative consequences of collection and removal of herbs and 'Gucchhi' in early stages of their growth.

(vii) The extraction of Bamboo for household uses would be discouraged and checked as the Bamboo patches are ideal habitat for Western Tragopan.

(viii) No firearms would be allowed in the valley and the visitors will be made to deposit any firearms with the forest check posts before entering these areas.

(ix) The informers in the villages will be engaged confidentially without making their identity public to check poaching and patrolling. The informers will be paid handsomely for providing reliable and important information about the poachers.

1.13 FINANCIAL RESOURCES

The project authorities will provide sufficient funding support for the rehabilitation of some critical species-populations, which are likely to be disturbed by various project activities. A total of **Rs. 100.00 lakhs** has been earmarked for this purpose. The funding will be provided for:

i) Identification of most critical species-populations that need relocation,

ii) Developing nurseries for these populations in order to monitor their mortality and regenerative behaviour,

iii) Final reintroduction in the natural habitats for natural regeneration and establishment.

The financial requirements for setting up of facilities for *in situ* and *ex situ* conservation measures are given in Table 1.2. In addition to the *in situ* and *ex situ* conservation measures, extensive studies would be required for the collection of baseline data on pheasants and Western Tragopan. The baseline data on habitat use and remote sensing and GIS would provide vital information for the management of these species. For conducting these surveys, finding would be provided to the GHNP and the same has been given in Table 1.2.

Table 1.2 Financial outlay for undertaking *in situ* and *ex situ* conservation measures

S.No.	Items	Qty	Amount (Rs. in lakhs)
A.	**Capital Cost**		
	1. Buildings		80.00
	i) Office	1	
	ii) Laboratories	2	
	iii) Tissue Culture Rooms	2	
	iv) Hardening facility/Greenhouse, etc.	1	
	2. Laboratory fittings and Furnishing, etc.		20.00
	3. Equipment & Chemicals		20.00
	4. Vehicle	1	5.00
	Total (A)		**125.00**
B.	**Recurring Expenditure (For 8 Years)**		
	1. Manpower & Salaries		
	i) Tissue Culture - Scientist (2) @ Rs. 15,000/- per month = 8 x 2 x 12 x 15,000		28.80
	ii) Assistant Tissue Culture Scientists (4) @ Rs 10,000/ per month = 8 x 4 x 12 x 10,000		38.40
	iii) Laboratory Attendants (4) @ Rs. 7,500/- per month = 8 x 4 x 12 x 7,500		28.80
	iv) Field Attendants (6) @ Rs. 5,000/- per month = 8 x 6 x 12 x 5,000		28.80
	v) Driver (1) @ Rs. 5,000/- per month = 8 x 1 x 12 x 5,000		4.80
	vi) Gardners (6) Rs. 5,000/- per month = 8 x 6 x 12 x 5,000		28.80
	2. Consumables @ Rs. 5.00 lakhs per year		40.00
	3. Travelling expenses @ Rs. 2.00 lakh per year		16.00
	4. Running and Maintenance of vehicle @ Rs. 1.50 lakh per year		12.00
	5. Contingency and maintenance of equipment @ Rs. 5.00 lakhs per year		40.00
	7. Miscellaneous expenses @ Rs. 2.00 lakhs per year		16.00
	Total (B)		**282.40**
C.	**Studies, surveys and relocation of critical species**		**100.00**
D.	**Surveys & collection of baseline data on critical animals/birds (Pheasants/Western Tragopan) @ Rs.50 lakhs/ yr for 8 years**		**400.00**
Grand Total (A+B+C+D)			**907.40**

1.14. ENVIRONMENT AWARENESS FOR CONSERVATION

The project authorities will provide assistance and funding support to the existing State Government agencies, like Forest Department, Greater Himalayan National Park in popularizing environmental conservation among the local inhabitants as well as outsiders. The packages will be in the form of incentives to the locals as well as educational awareness. Since Parvati valley attracts lot of tourist traffic during summers, necessary information campaign will be organized with the help of Forest and Wildlife Agencies. Some of the steps that will be initiated includes publication of an Ecotourist's Guide, pamphlets and other dissemination packages for local school children, adults and tourists. These materials will contain Dos and Don'ts as well as penalties in case of violations. These kits in the form of Audio-Visual kits, books, posters and other environmental awareness material will be distributed free of cost to the schools and NGOs for conducting various campaigns under the environment awareness programmes. Furthermore the local NGOs and educational institutions located in the town of Kullu and Manali would also conduct environment awareness workshops, seminars, field trips from time to time highlighting the importance of conserving the natural resources in their area. Similarly orientation programmes would also be conducted for not only the officers working on the project but also for the workers and labourers engaged in various construction activities. The project authorities will also bring out a monthly publication in local language which would list out the progress on various conservation programmes being undertaken in the project area and also announce in advance the schedule of various activities

and seminars to be conducted for different strata of groups. The funding for all the above mentioned activities would be provided by the project authorities. An amount of Rs. 50.00 lakhs has been earmarked for this purpose in addition to the funds of Rs. 50.00 lakhs required for the preparation and publication of relevant material for various conservation programmes. Hence a total of **Rs.100.00 lakhs** have been set aside for conducting various environment awareness programmes.

1.15. ECO-TOURISM DEVELOPMENT

1.15.1 Introduction

In Kullu district, Parvati valley is one of the major attractions for trekkers and tourists due to its natural aesthetic beauty and scenery. It also serves as a route for trekkers going to the Pin valley via Pin-Parvati pass. During construction phase of the proposed project, it is envisaged that tourism and related activities would increase multifold, which are likely to exert immense pressure on this ecologically fragile area. In order to regulate and monitor the unorganised and indiscriminate tourist traffic in the ecologically sensitive areas on one hand and to encourage eco-friendly tourism on the other, project authorities in association with Himachal Pradesh Tourism and Forest Departments propose to formulate a plan which would facilitate the implementation of above objectives.

A provision of **Rs. 80.00 lakhs** has been made in the project cost for this purpose. Tourist spots with tourist huts would be developed at Khirganga Thach, Thakar Kuan Thach and Mantalai in Parvati valley.

The project authorities would seek the help and expertise of HP Tourism Department to plan this activity and oversee and regulate the tourist traffic in the valley. The action plan will include the following aspects.

i) Registration of the travel agencies with the Himachal Pradesh Tourism Department that have their area of operation in the Parvati valley as well as Great Himalayan National Park (GHNP).

ii) Only the registered travel agencies will be allowed to operate in the Parvati valley and GHNP areas.

iii) There are no controlling check points to regulate the entry of visitors to Parvati valley. Therefore, check points would be installed at Manikaran and Barsheni village for entering into Parvati valley in addition to the ones suggested for GHNP at Majharna village in Jiwa Nal subwatershed in the FREE Project report, WII (1999). These check points will help in exercising strict control on the tourist activity in the valley and adjacent areas of GHNP.

iv) A mechanism of passes would be introduced for the registration of foreign tourists and only after due checks they would be allowed to trek in the valley and GHNP.

v) The porters would be registered with the H.P. State Tourist Department. The credentials of these porters would be verified by the Tourism Department and only after this they would be allowed to accompany tourists. A punitive

action would be taken against the unregistered porters as well as the tourists entering into the valley without proper passes.

vi) The information on Dos and Don'ts in the valley would be made available to the tourists wishing to visit the valley at check points and at the time of registration.

vii) The printed material in the form of brochures, pamphlets, eco-trekkers guide, etc. highlighting the importance of biodiversity in the region and its conservation would be made available to the tourists.

viii) The detailed information on flora and fauna of the valley and its conservation significance in the form of posters, handouts and brochures would be sold at the proposed check points at affordable and nominal prices. These could be differentially priced for indigenous and foreign tourists . The material for these would be prepared in association with the Director, GHNP, DFO Parvati Forest Division and the Tourism Department. The cost of printing of this material would be borne by NHPC and provision for the same has been made in the Conservation Management Plan for the region.

1.16 SUMMARY OF COST ESTIMATES

A number of activities will be undertaken in this action plan for the conservation of biological resources of the area and these

measures would require funding of **Rs.1540.68 lakhs**. The summary of cost estimates is given in Table 1.3.

Table 1.3. Summary of cost estimates

S.No.	Item	Amount (Rs. in lakhs)
1.	Setting up of PVCC	453.28
2.	For *ex situ* and *in situ* conservation	907.40
3.	Environment awareness programmes	100.00
4.	Ecotourism development	80.00
	Total	**1540.68**

2

ACTION PLAN FOR CATCHMENT AREA TREATMENT

2.1 INTRODUCTION

In the rapidly developing world and increasing human population the resultant competition for land to meet its various requirements has often led to the degradation of natural resources. This is more so in the case of exploitation of water resource to cater to increased demands of energy, irrigation and water supply. These developmental projects are followed by a number of related activities like deforestation, urbanisation and faulty management practices, etc. which cause degradation of catchments. All these processes damage soil environment which ultimately lead to rapid sedimentation of dam reservoirs. Accelerated soil erosion in the catchment areas of dam reservoirs and transport of detached material through the drainage network gives rise to a series of problems, notably depletion of flow capacity, steady loss of storage capacity, consistent drop in hydro-electric power generation and frequent floods. The loss of dead and live storage leads to heavy economic losses due to reduced life span of reservoirs. Therefore, extensive soil conservation and watershed management programmes are needed

to minimise the damage to catchments and mitigation of soil erosion problems.

For any soil conservation programme or catchment area treatment plan watershed is chosen as the basic unit for implementation of such schemes. This is necessary because watershed is a natural hydrological and geographic unit and at the same time an ecological unit, too. It covers a specific aerial expanse of land surface from which the rainfall-run off flows to a defined drain, channel, stream or river at any particular point. It is delineated by a line joining the highest points on the boundary of drainage basin with reference to specific point drainage. However, watershed below the ground surface does not always coincide with the surface watershed.

As watershed characterises optimum interaction and synergistic effect of land and water resources, its management primarily involves collection of information on a wide range of parameters of static and dynamic nature related to geology, hydrology, soil, geomorphology, topography, drainage conditions, land use, land cover, climate, etc.

2.2 PARVATI RIVER H.E STAGE - II PROJECT

The proposed Parvati H.E. project Stage-II envisages construction of a 90m high dam across the river Parvati near Pulga village in Kullu of Himachal Pradesh. The project comprises the

construction of a 31.25 km long Head Race Tunnel and a surface powerhouse near village Railah in the Sainj river catchment with an envisaged power generation of 800 MW. In addition trench weirs on Manihar Nal, Pancha Nal and Hurla Nal in the Hurla Nal catchment and on Jiwa Nal near Manjhan village in Jiwa Nal catchment are also proposed to augment the water discharge for this scheme (Fig.2.1).

2.3 CATCHMENT AREA TREATMENT PLAN

Parvati river catchment receives major proportion of precipitation in the form of snowfall while rainfall is mainly received in lower parts. The terrain comprises steep to very steep slopes. These two factors are responsible for soil erosion by way of sheet erosion, hill erosion, gully erosion, bank erosion by streams, glacier erosion and erosion by landslides. In addition to these natural processes of erosion, that are active in the region, various project related construction activities would accentuate this process. The landslides in the area are caused mainly by geological, hydrological and seismic factors. One or combination of all these factors cause the landslides in the rainy season. Recurrent blasting for tunnelling, etc. during the construction period would also trigger off landslides due to the reduction of shear strength of rock material.

A catchment area treatment plan has been formulated with the main objective of arresting soil erosion in the upstream catchment of Parvati as well as other catchments in the project area. The catchment area treatment is extremely crucial in the context of hydropower

development as the life of the reservoir depends on the type of the catchment from which it collects the drainage. This will also help in rejuvination of various degraded ecosystems in the catchment. Based on the topographic factors, soil type, climate, landuse/vegetation cover in a catchment area, various measures, both engineering/mechanical and biological, have been proposed for each one. These measures will be undertaken with the aim to check the soil erosion, prevent/check siltation of reservoir and to maintain its storage capacity in the long run. The engineering measures will comprise construction of a number of check dams/walls, retaining walls, wire crates, etc. for gully control, stabilisation of flood prone nallahs, landslides/slopes, river banks, roads, etc.

2.3.1 Objectives

The Parvati catchment area treatment plan has been prepared with the following objectives:

i) Checking soil erosion and land degradation by taking up adequate and effective soil conservation measures in erosion prone areas (very severe and severe).

ii) Rehabilitation of degraded forest areas through afforestation and facilitating natural regeneration.

iii) Landslides control.

2.3.2 The Problem of Erosion in the project area

The river Parvati is known to bring lot of silt during the monsoon months. This is primarily due to the soil erosion taking place in the

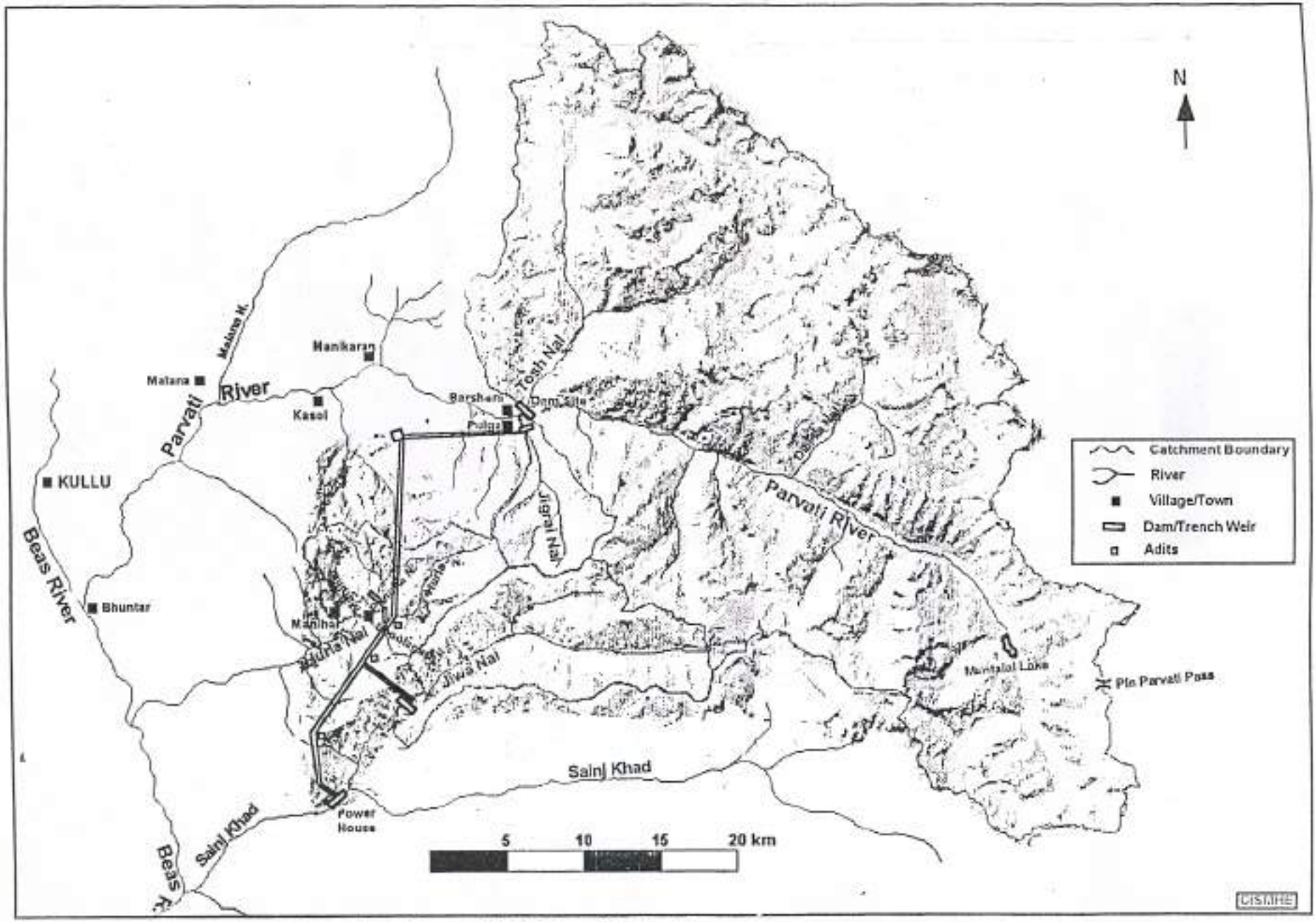

Fig.2.1 Drainage map and major works of Parvati H.E. Stage-II Project Area

catchment upstream. The following types of erosion occurs in the catchments of Parvati river, Hurla Nal and Jiwa Nal. Since more than 84% of Parvati river catchment, 50% of Jigrai Nal catchment, 14% of Hurla Nal catchment and 45% of Jiwa Nal catchment are permanently under snow and both southern and northern slopes are sources of snow avalanches. The glacial action of erosion, transport and deposition of all products of erosion which tend to accumulate at the terminus of glaciers are called moraines. At many places these moraine deposits also form lakes by impounding water. There are a number of such lakes in the upper reaches of Parvati valley.

2.3.2.1 *Causes of erosion*

Water is the single most important agent of erosion. Whenever water moves it erodes the boundaries alongside. Rainfall, streams and rivers all scour soil with their action. The erosion, therefore is essentially a process of smoothening or levelling in which soil and rock particles are carried, rolled or washed down the slope under the influence of both gravity and water. The rainfall is one of the important factors which most influences erosion. The different areas in the Parvati project receive 800 - 900 mm of average annual rainfall. As the area has the history of frequent cloud bursts, therefore an intensive downpour likely to occur at some point of time, has the capacity of causing wide spread damage due to erosion. The steep slopes and vulnerable rocks and soils may be seriously damaged that could become easy sources of erosional content. Several such places have been identified in various catchments of the project.

Besides geological, hydrological and seismic factors the landslides may also be caused by single or a combination of activities like deforestation, overgrazing, unscientific removal of land cover, practising agriculture on steep slopes, blasting for road construction, undercutting of the base of existing slope for road cutting and faulty alignment of roads on weaker and unstable rock formation.

2.3.3 Estimation of Soil Erosion

In order to formulate appropriate soil conservation measures it is essential to estimate the extent of soil erosion that is taking place in the catchment areas. Various factors that are responsible for soil erosion are discussed below.

2.3.3.1 *Drainage*

Parvati river originates from Mantalai lake at an elevation of 6,300 m. Dibi ka Nal is the major right bank tributary of Parvati river originating from Dibi ka Glacier in the upper reaches. Tosh Nal is the other major tributary of Parvati which originates from Sara Umga and Tichu glaciers. It joins Parvati on its right bank upstream of the proposed dam site. No major tributary joins Parvati river on its left bank though a few small nallahs originating from different glaciers join it throughout its course. Most of the area of Parvati catchment has predominantly dendritic drainage pattern with only a few streams exhibiting trellis pattern.

2.3.3.2 *Slope*

Slope of the land determines the speed and extent of run off. Greater the slope, greater will be the velocity of flow of the run off water. According to the law of falling bodies velocity varies as square root of vertical drop, i.e. if land slope is increased four times the velocity of water flowing in the slope is doubled. If velocity is doubled the erosive capacity of run off varies in direct proportion to the slope of land on which the run off occurs. Also, if velocity is doubled the quantity of material that can be carried increases by about 32 times and size of particles that can be transported by pushing or rolling increases by about 64 times.

The slope has a great influence on the soil and water loss from the area and thereby influences the landuse capability. The percentage slope determines the erosion susceptibility of the soil depending on its nature. This helps in classifying various lands in suitable capability classes which enables us to formulate suitable conservation measures for the prevention of soil erosion. The following slope classes and ranges are recommended by All India Soil & Land Use Survey.

Slope Class	Slope Range	Description
A	0 - 1%	Nearly level (Flood plains)
B	1 - 3%	Very gently sloping
C	3 - 5%	Gently sloping
D	5 - 10%	Moderately sloping
E	10 - 15%	Strongly sloping
F	15 - 25%	Moderately steep to steep
G	25 - 33%	Steep
H	33 - 50%	Very steep
I	Over 50%	Very very steep

However, for the present studies the slope classes A-C were merged into one single class, i.e. area under 0-5% slope range has been described as gently sloping as the project area is hilly.

More than 50% area of the constituent catchments of the Parvati project area falls under steep to very very steep slope categories (Figures 2.2–2.6 and Table 2.1). In Parvati river catchment more than 47% of the area is under very steep to very very steep slope categories. Hurla Nal catchment has maximum area under steep to very very steep slope categories (76.47%) followed by that in Jigrai Nal (61.36%) and Jiwa Nal (60.56%) catchments.

Table 2.1 Area in sq km under different slope categories in Parvati H.E. Stage - II Project

Slope Category	Jigrai Nal	Hurla Nal	Jiwa Nal	Parvati River	Total (Parvati Stage- II Project)
Gently Sloping (up to 5%)	1.70	2.88	36.51	353.50	394.62
Moderately Sloping (5-10%)	0.94	1.19	2.71	57.04	61.88
Strongly Sloping (10-15%)	2.90	1.88	7.68	106.66	119.11
Moderately Steep to Steep (15-25%)	11.71	9.81	0.20	52.68	74.40
Steep (25-33%)	13.00	13.69	1.61	37.02	65.31
Very Steep (33-50%)	13.43	31.71	39.04	310.70	394.88
Very Very Steep (>50%)	0.40	5.84	32.26	237.30	275.79

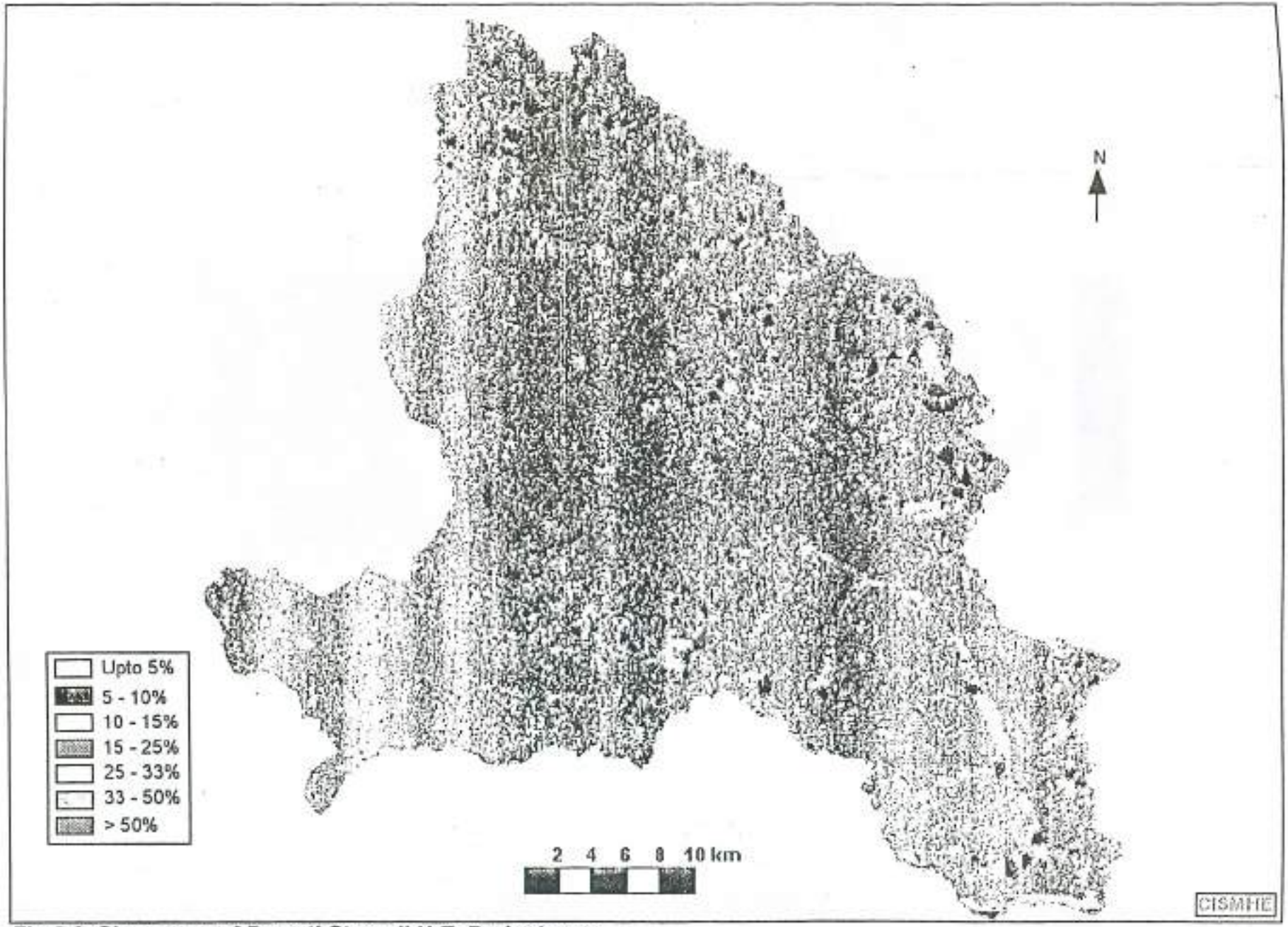

Fig.2.2 Slope map of Parvati Stage-II H.E. Project area

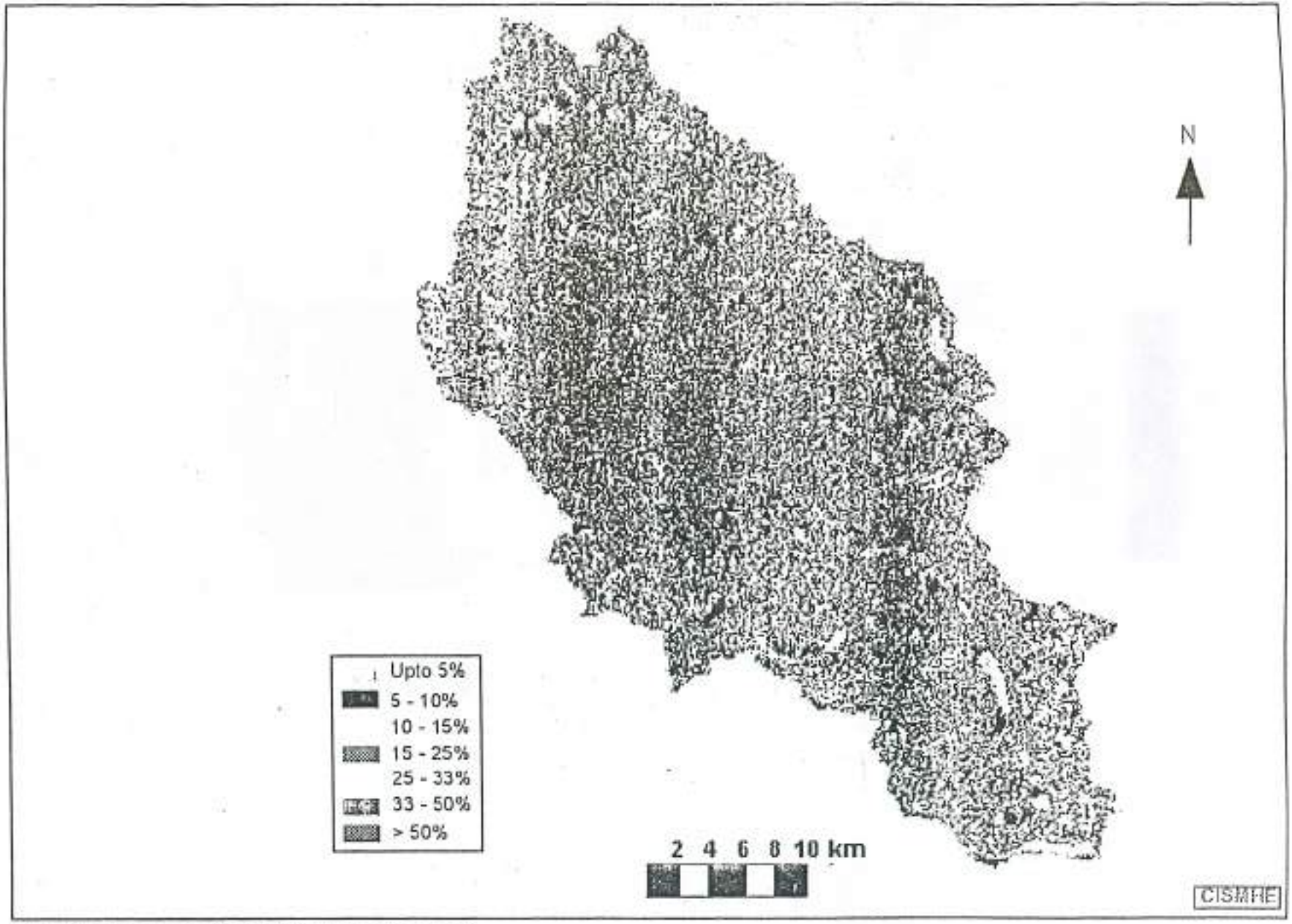

Fig.2.3 Slope map of Parvati river catchment

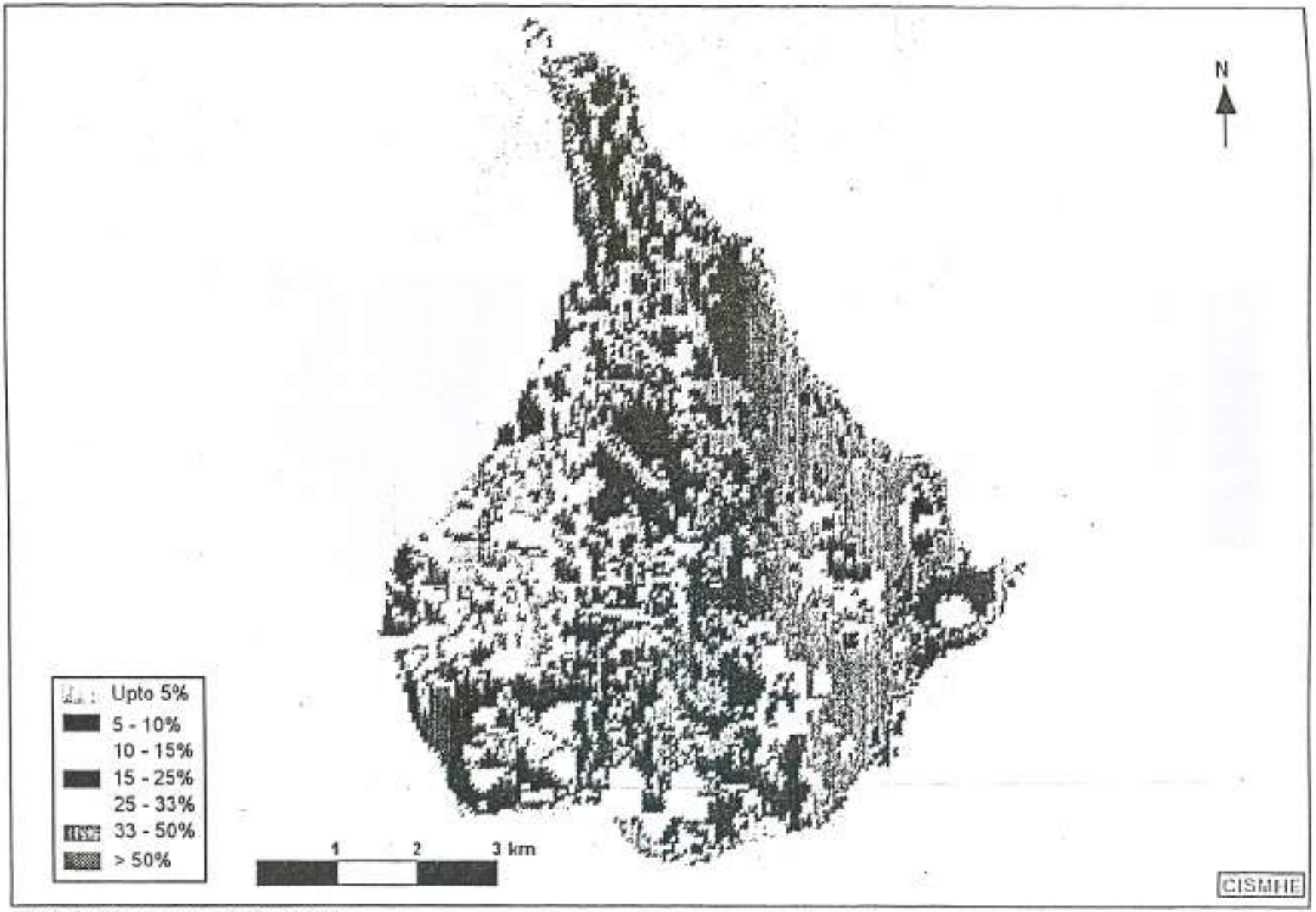

Fig.2.4 Slope map of Jigrai Nal

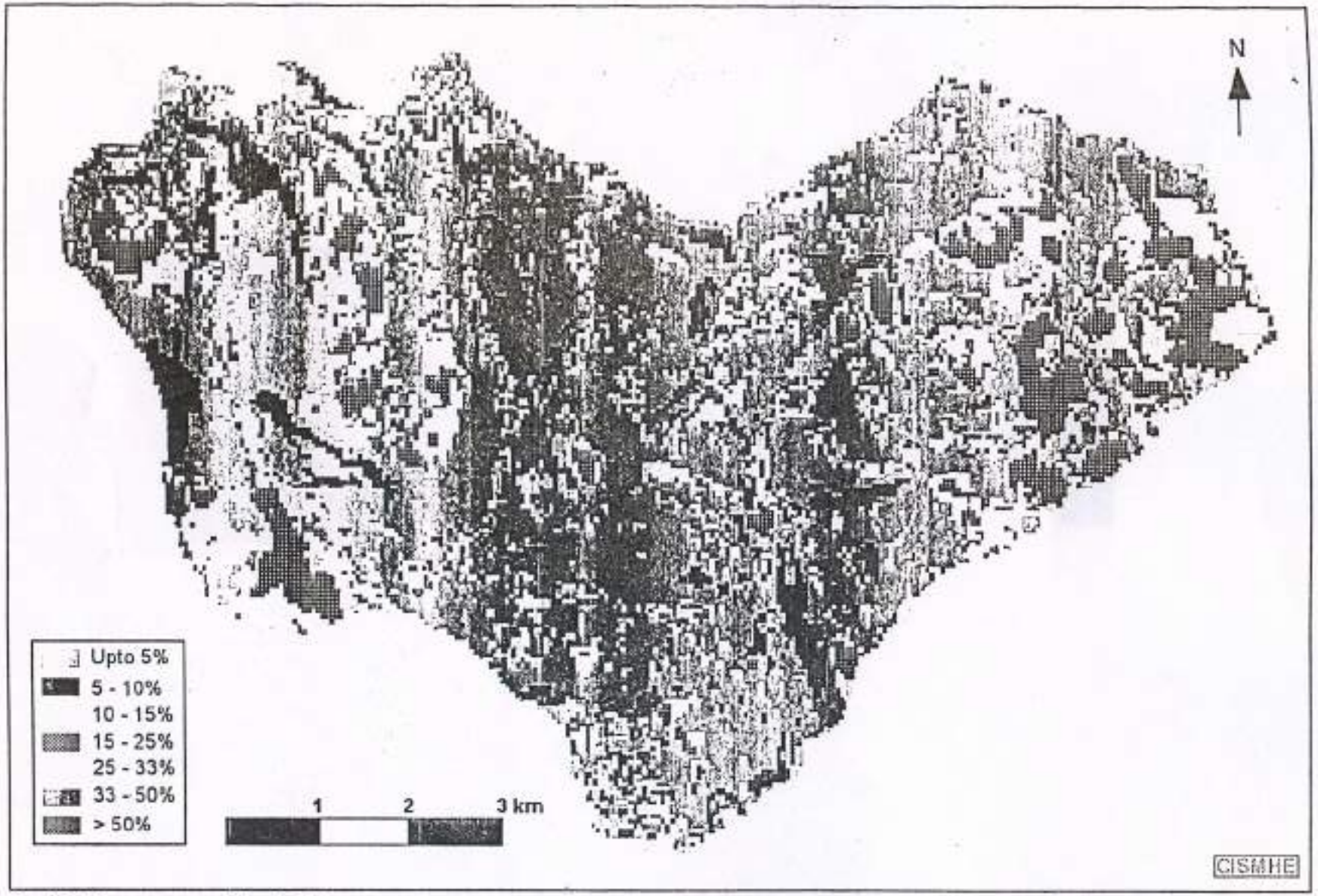

Fig.2.5 Slope map of Hurla Nal

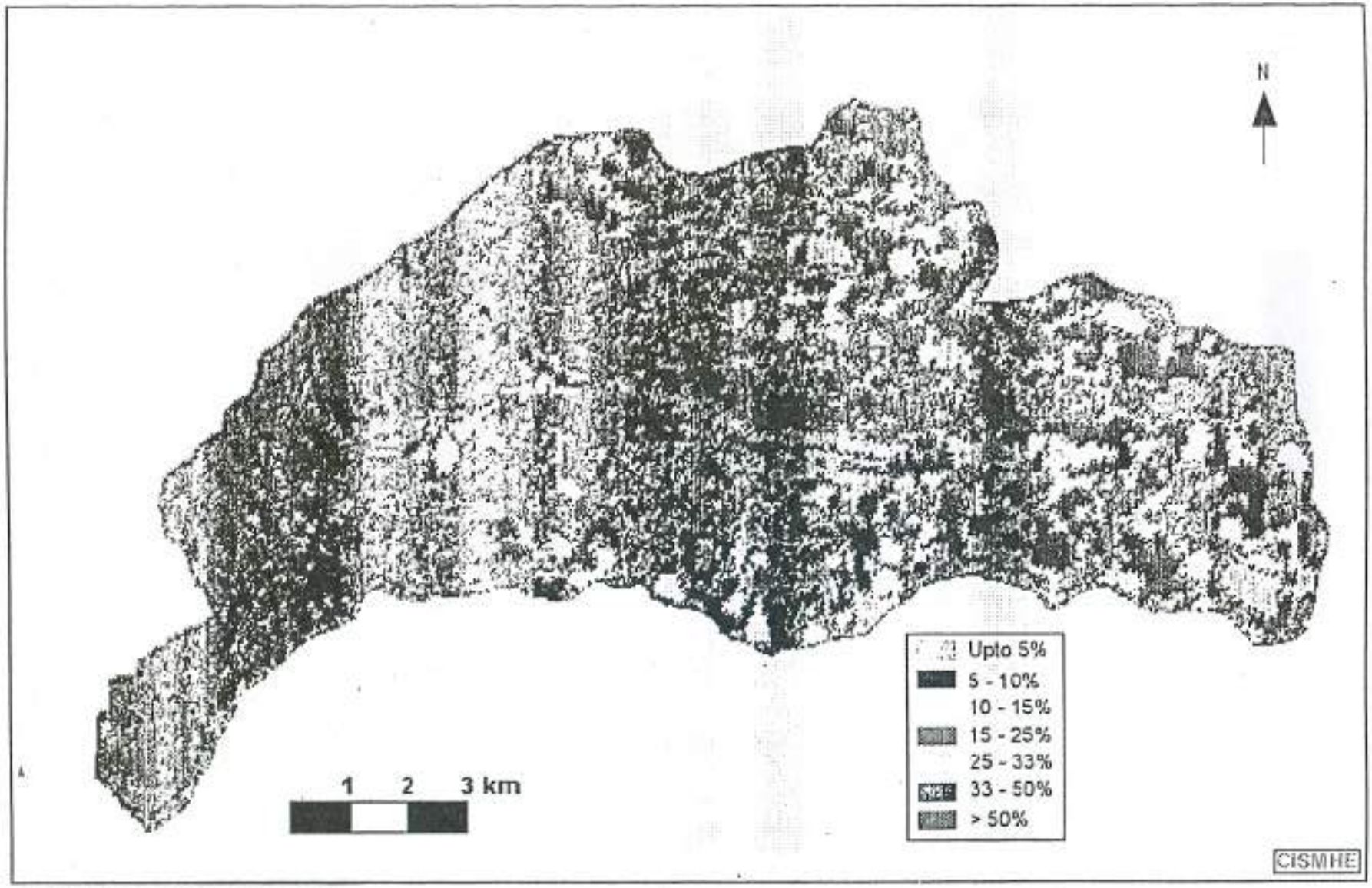

Fig.2.6 Slope map of Jiwa Nal

For the secondary data, Survey of India toposheet numbered 53 E/5, 53 E/9, 53 E/13, 52 H/8,52 H/12 and 52 H/16 on 1:50,000 and 53E and 52H on 1:2,50,000 scale were referred to for the preparation of base map and drainage map.

2.3.3.3.2 *Classification Scheme*

With the objectives of watershed management and catchment area treatment, the following classification scheme was adopted for mapping on 1:50,000 scale.

Density Class	Crown Cover
Dense forest	Crown density > 40%
Open forest	Crown density < 40%
Degraded forest	Crown density up to 10%

An interpretation key was prepared based on the relationships between ground features and image elements. Image elements like texture, tone, shape, location, pattern, etc. were used in the key formulation (Table 2.2). Image interpretation was done for the entire Parvati H.E. Stage-II Project area. Interpreted details (polygons) were then transferred to base map. Since satellite data is geo-coded there was not much error in the geometry of the data and wherever necessary local matching was done while transferring the details.

2.3.3.3 *Landuse/landcover mapping*

Landuse and landcover mapping was carried out by standard methods of analysis of remotely sensed data followed by ground truth collection, and visual interpretation of satellite data. For this purpose geo-coded hard copy prints of satellite data (FCCs) as well as digital data on CDROMs were procured from National Remote Sensing Agency, Hyderabad. Visual interpretation as well as the digital image processing of the satellite data and the analysis of interpreted maps were carried out at the Computer Centre at CISMHE using Image Analyst, I_RAS B, I_RAS C and I_GEOVEC working on Microstation and MGE Terrain Analyst working on MGE NUC GIS Environment of Intergraph.

2.3.3.3.1 *Database*

The details of primary data i.e. FCCs as well as digital data on CDROMs procured from NRSA for visual interpretation and analysis are as follows:

Satellite	Sensor	Path/Row	Date	Datatype & Bands	Scale	SOI Sheet
IRS-1D	L-III	112/054	05.10.1998	FCC & Digital (2,3,4)	1:50,000	53 E/5
IRS-1D	L-III	112/054	05.10.1998	FCC & Digital (2,3,4)	1:50,000	53 E/9
IRS-1D	L-III	112/054	05.10.1998	FCC (2,3,4)	1:50,000	53 E/13
IRS-1D	L-III	112/054	05.10.1998	FCC (2,3,4)	1:50,000	52 H/8
IRS-1D	L-III	112/054	05.10.1998	FCC (2,3,4)	1:50,000	52 H/12

For the secondary data, Survey of India toposheet numbered 53 E/5, 53 E/9, 53 E/13, 52 H/8,52 H/12 and 52 H/16 on 1:50,000 and 53E and 52H on 1:2,50,000 scale were referred to for the preparation of base map and drainage map.

2.3.3.3.2 *Classification Scheme*

With the objectives of watershed management and catchment area treatment, the following classification scheme was adopted for mapping on 1:50,000 scale.

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Degraded forest	Crown density up to 10%

An interpretation key was prepared based on the relationships between ground features and image elements. Image elements like texture, tone, shape, location, pattern, etc. were used in the key formulation (Table 2.2). Image interpretation was done for the entire Parvati H.E. Stage-II Project area. Interpreted details (polygons) were then transferred to base map. Since satellite data is geo-coded there was not much error in the geometry of the data and wherever necessary local matching was done while transferring the details.

Table 2.2 The interpretation key for the preparation of landuse/landcover map

Landuse/Landcover Types				Photocharacteristics			
S.No.	Main Class	Sub Class		Tone/Colour	Texture	Pattern	Location/ Association
1.	Lake			Medium to dark blue	Smooth		Isolated, sub rounded water bodies Hill tops, mostly in the snow covered area
2.	Vegetation	Forest	Open forest	Light red	Smooth	Irregular	Hill slopes to valley
			Dense forest	Dark blackish red	Rough	Irregular	Hill slopes to valley
			Degraded forest	Light to medium red	Coarse	Irregular, patchy	Hill slopes, mostly near cropland
		Scrub	-	Reddish pink	Smooth to medium	Scattered, irregular	Hill slopes
		Crop Land	-	Pinkish brick red	Coarse	Scattered	Along the river
3.	Built up area	Settlement	-	Cyan	Coarse	Clustered	Along the river
4.	Non-forest	Snow cover	-	Bluish white	Smooth	Irregular covering on high altitudes with serrated margin	Hill tops/high altitudes
		Glacier	-	Bluish white	Smooth	Linear	From hill tops to valley
		Rocky land	-	Muddy grey and brown	Smooth to rough	Irregular	Ridge and Hill slopes
		Fan	-	Bluish grey	Smooth	Fan shaped	Hill slopes
		Moraines	-	Bluish grey	Moderately smooth	Linear deposits mostly along the streams	Hill slopes to valley

2.3.3.3.3 *Landuse/landcover*

The base map, drainage map and landuse/landcover map were prepared using the satellite data and the same were digitized on computer for further processing and analysis using the Geo Media Pro. The Survey of India toposheets at 1:50,000 scale were used for the delineation of watersheds of Parvati sub-catchment. These sub-watersheds were then overlaid on the drainage and landuse maps of the catchments in order to extract the drainage and landuse of the respective sub-watersheds. Different theme layers of Parvati watershed i.e. base map, drainage and landuse/land cover maps, were then transferred to Geographic Information System (GIS) using Geo Media Pro for further overlay analysis.

2.3.3.3.4 *Soils*

The underlying rocks in an area play an important role in the formation of soils. For example, quartzites produce sandy soils after disintegration while granites, schists, shales and gneisses produce loamy and sandy soils. On the other hand the mineral and organic contents of the soil are influenced by climatic conditions, type of vegetation cover and a number of other factors. Alluvial soils are formed mainly due to erosion by water and landslips. Such soils are transported and deposited in the river bed and on the banks of the rivers. Podsolic soils develop in temperate regimes and generally hold coniferous vegetation. Due to low temperatures and the acidic pH, Podsolic soils get covered with thick layer of

decomposed humus. The type of soil cover in turn determines the nature of vegetation in a particular ecological zone. The soils of almost all parts of the Parvati valley and adjacent areas are podsolic in nature and are formed *in situ*. As per the soil classification followed in National Atlas Maps, histosols i.e., the snowfields cover maximum area of Parvati project (939.49 sq km), alfisols (sub-montane soils) cover an area of 281.60 sq km and mollisols (mountain meadows) cover an area of 164.92 sq km (Fig.2.7). Brown forest soils are formed in temperate ecozone under broad-leaved forest cover and are characterised by a neutral pH and a little accumulation of humus. In the project area, chil (*Pinus roxburghii*) is found on soils formed by quartzites while deodar (*Cedrus deodara*) is found on soils formed by disintegration of granites. Kail comes on shallower soils with boulders in the sub-soil and fir and spruce are found on all soil types.

Different parts of the project area present different landforms. The higher reaches of Parvati river valley present a picture of glacial landform. The valley has been subjected to heavy glaciation during Pleistocene, which is indicated by the presence of steep sided U-shaped walls of valley, massive deposits of moraines and hanging valleys in the stretch between Dibi ka Nal and the proposed Pulga dam site. The fluvio-glacial landform can also be seen downstream of Pulga dam site on the right bank of Parvati river. This material has been transported by glaciers in the past and finally deposited by the streams. These deposits are very thick with 140 m maximum bed-rock depth in the Parvati valley terrace which is an indication

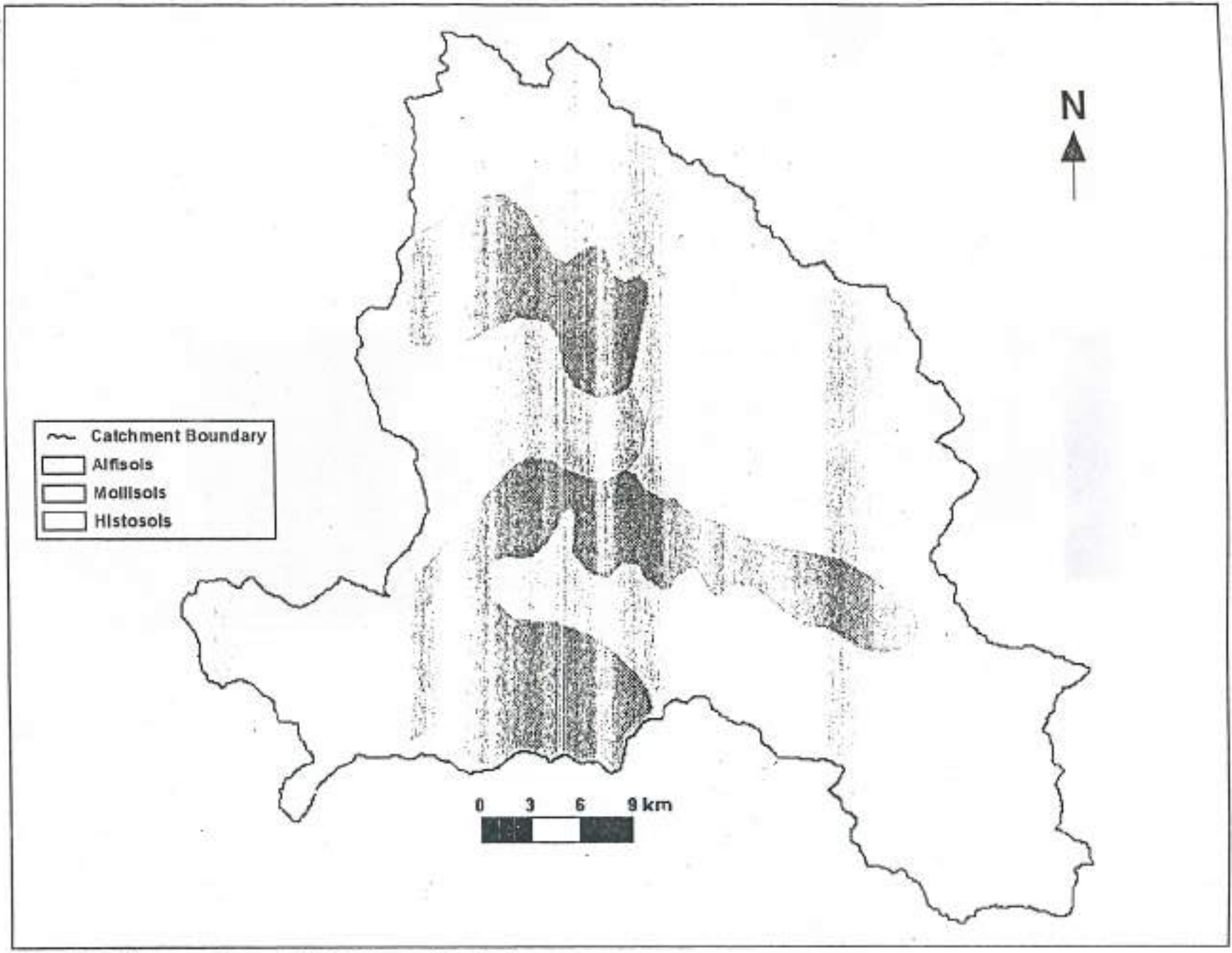


Fig. 2.7 Soil map of Parvati H.E. Stage-II Project area

2.3.3.3.6 *Sediment Yield Index*

To calculate sediment yield index, the methodology developed by All India Soil & Land Use Survey (Department of Agriculture, Govt. of India) was followed, where each erosion intensity unit is assigned a weightage value. When considered collectively, the weightage value represents approximately the relative comparative erosion intensity. A basic factor of K = 10 was used in determining the weightage values. The value of 10 indicates a static condition of an equilibrium between erosion and deposition. Any addition to the factor K (10+X) is suggestive of erosion in ascending order whereas subtraction, i.e. (10-X) is indicative of deposition possibilities.

Delivery ratios were adjusted for each erosion intensity unit. The delivery ratio suggests the percentage of eroded material that finally finds entry into dam/reservoir or river/stream. Area of each composite unit in each watershed was then measured.

Sediment yield index (SYI) was calculated using following empirical formula :

$$SYI = \frac{\sum(A_{ei} \times W_{ei} \times DR)}{AW} \times 100$$

where,

SYI = Sediment yield index

A_{ei} = Area of composite erosion intensity unit

W_{ei} = Weightage of composite erosion intensity unit

DR = Delivery ratio

AW = Total area of the sub-watershed

2.3.3.3.7 *Erosion Intensity and Delivery Ratio*

Determination of erosion intensity unit is primarily based upon the integrated information on soil characters, physiography, slope and landuse/landcover. This is achieved through super-imposition overlays of different thematic maps. Based upon the ground truthing conducted during the field studies, weightage value and delivery ratio were assigned to each erosion intensity unit. A complete legend for composite erosion intensity mapping unit is given in Table 2.3. Delivery ratio, though depending on the type of material, soil erosion, relief length ratio, cover conditions, etc. were assigned to all erosion intensity units depending upon their distance from the nearest stream. The criteria adopted for assigning the delivery ratio were as follows:

Nearest Stream	Delivery ratio
0 - 0.9 km	1.00
1.0 - 2.0 km	0.95
2.1 - 5.0 km	0.90
5.1 - 15.0 km	0.80
15.1 - 30.0 km	0.70

2.4 AREAS TO BE TAKEN UP FOR SOIL CONSERVATION MEASURES

The areas in different sub-watersheds of Parvati Stage - II H.E. project that require treatment have been delineated from the composite erosion intensity unit maps. More than 56% of project area is either

under snow or glaciers and more than 26% is blank comprising moraines, rockyland, etc. in the higher altitudes beyond tree line. Hurla Nal and Jigrai Nal only have blank areas at lower altitudes in their catchments near the human habitation which are susceptible to erosion and require afforestation measures. For various treatment measures only those areas which fall under very severe or severe erosion intensity category would be taken up for soil conservation (Table 2.4 and Fig. 2.8). Based on our studies 4,580 ha of area would be required to be treated in the catchment. This also includes part of areas to be covered under landslide treatment plan. The location of these degraded areas which will be restored in the project area have been given catchmentwise in Figures 2.8–2.12. Silt yield index in Jigrai Nal sub-watershed is maximum followed by that in Parvati river, Hurla Nal and Jiwa Nal in decreasing order (see Annexure–I). Similarly per cent area requiring treatment measures is maximum in Jigrai Nal sub-watershed (11.26%) followed by Parvati sub-watershed (9.49%) and minimum in Jiwa Nal sub-watershed (0.93%).

2.5 LANDSLIDE MAPPING

Parvati river valley and other adjacent valleys of Hurla Nal and Jiwa Nal are prone to landslides. The landslides in these areas were mapped using LISS III-D satellite images as well as the digital data and ground checked. All the landslides were delineated on the 1:50,000 maps. Broadly three types of landslides were mapped, i.e. old landslides, active landslides and potential landslide areas. Most of the '**thaches**' and cultivated areas on hill slopes are the old landslide zones

Table 2.3. Legend for Composite Erosion Intensity Unit

Erosion Intensity Unit	Slope	Landuse/ Landcover	Weightage/DR
Very Severe (a)	Very very steep >50%	Degraded forest, open forest, scrub	20/0.95
Severe (b)	Steep to very steep 25 -50%	Degraded forest, open forest, scrub, cultivation	18/0.90
Slight to moderate (c)	Strongly sloping to moderately steep 10-25%	Dense forest, open forest, cultivation	13-15/0.90
Slight to Negligible (d)	Gently sloping to moderately sloping 5-10%	Dense forest, open forest	11/0.85

Table 2.4 Area in ha under different erosion intensity clsses in sub-watersheds of Parvati H.E. Stage - II Project area

Erosion Intensity Category	Parvati River	Jigrai Nal	Hurla Nal	Jiwa Nal
Very Severe (a)	217	-	25	-
Severe (b)	3682	354	210	92
Slight to moderate (c)	17502	1621	2775	3488
Negligible to slight (d)	19624	1169	3169	6309
Total	**41025**	**3144**	**6179**	**9889**

which were once active landslides and have now stabilised. Active landslide zones are those where the process of mass wasting is still continuing or where mass wasting process has occurred in the very recent past. These areas experience landslides regularly especially during the monsoon. Majority of the active landslides are restricted to the southern aspects in the lower reaches and to northern aspects in upper reaches. The areas where there is probability of mass wasting, like areas with steep scarp slopes with numerous fractures or where seepage is more, have been considered as potential landslide zones. There are more than 60 active landslide zones in the Parvati project area. There are 6-8 active landslide zones in the vicinity of Head race tunnel alignment, roads and powerhouse, (Fig. 2.8 - 2.12). In Parvati valley 5 potential landslide zones were located, while 29 active landslide zones were delineated. There are a number of old stabilised landslides also in the area which are about 17 in number. All the active landslide prone areas would be covered under the landslide control measures.

2.6 ACTIVITIES TO BE UNDERTAKEN

For undertaking soil conservation measures and for stabilisation of landslides in Parvati valley and other project areas, various preventive and remedial measures will be undertaken. These will include biological measures and engineering measures. These activities have been discussed in detail following paragraphs.

2.6.1 Preventive Measures

It is always better to undertake preventive measures than to mitigate the factors that ultimately lead to soil erosion. Such preventive

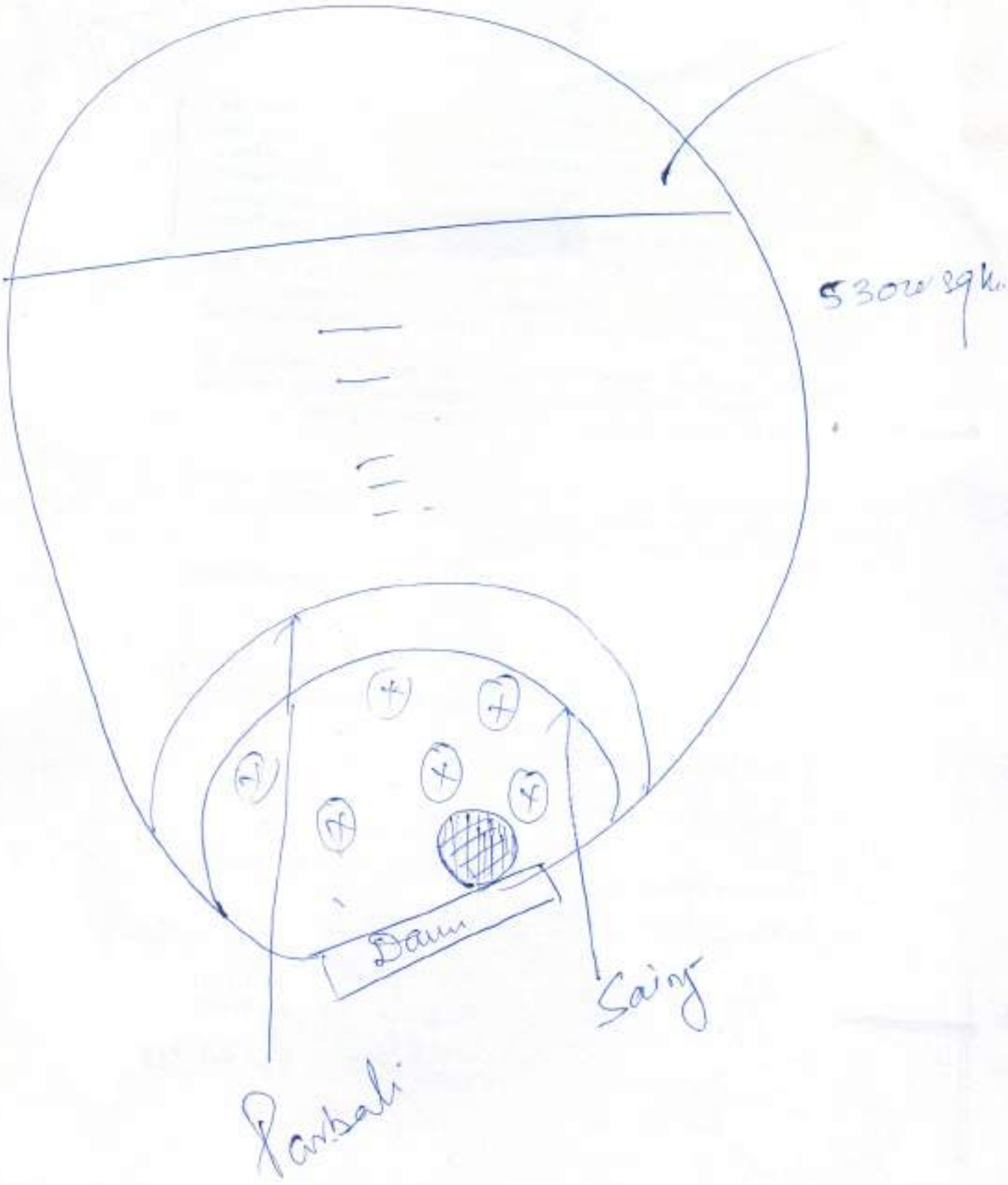
measures will indirectly help to conserve soil in the long run and arrest the degradational processes and events. The approach followed here is two-pronged which will keep in view the importance of integrating eco-restoration strategy with socio-economic needs of the local community. The preventive measures that are suggested for the project area have been discussed below.

2.6.1.1 *Afforestation*

In the hilly region, like the present proposed Project area, the trees and vegetation cover play an important role in the conservation of soil and ecosystems. Afforestation programme would be taken up in such forest areas that contain large chunks of barren grassy slopes and are generally devoid of trees and are honey-combed by private agriculture/horticulture cultivation. In critically degraded areas, plantation of locally useful, diverse and indigenous plant species such as *Alnus nepalensis, Salix, Populus, Quercus* spp., etc. would be undertaken.

2.6.1.2 *Fuelwood and Fodder plantations*

The ever increasing demand for fuelwood, fodder and grazing would exert tremendous pressure on the vegetation in the project area during the construction period. In areas with maximum human and livestock population within and in the vicinity of Parvati project area, it is envisaged to create more resources for fuelwood and fodder to check further degradation of the area. Such a step is bound to go a long way to provide vegetation cover to barren slopes to check erosion and cater to the increase in demand of fuelwood and fodder.


5300 sq k
Dam
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Parbati

Wildlife Warden, Himachal Pradesh, NGOs, etc. For this purpose, the user agency has given a commitment that in case the cost of these two schemes, so prepared by WII including their consultancy charges, is more than the amount earmarked for the purpose in the EMP, they will deposit the additional cost up to 5% with the State Government. The user agency will transfer the cost of implementing these schemes to the State Forest Department in a phased manner.

- Other Environmental protection measures as enumerated in the EMP shall also be taken up at the cost of the user agency in a phased manner.
- The forest land shall not be used for any purpose other than that specified in the proposal.
- Any other condition which the State Government or Conservator of Forests (Central), Regional Office , Chandigarh may stipulate from time to time in the interest of afforestation and protection of forests.

A progress report on compliance of the above conditions shall be furnished by the State Government/user agency regularly (not less than once in a year) to Regional Office of the Ministry at Chandigarh.

Yours faithfully,

(R. K. GUPTA)
Assistant Inspector General of Forests

Copy to,
1) PCCF, Govt. of Himachal Pradesh, Shimla.
2) Nodal Officer, o/o PCCF, Shimla.
3) CF(C), Regional Office, Chandigarh.
4) RO (HQ.)
5) Guard File.
6) M/s National Hydro-electric Power Corporation Ltd., Sector-33, Faridabad.

agency. Besides this Rs. 1 crore shall be paid as condonation cost for afforestation, boundary demarcation, etc.

d. The proposed 22.9252 hectare forest land, which is required for temporary use, shall be returned to the Forest Department as soon as the work is over after restoring it to its original status within a period of 5 years.

e. No tree felling in the area between FRL and 4M below FRL of the reservoir shall be carried out.

f. Minimum number of trees should be felled wherever possible especially in activities like construction of colonies, etc.

g. The roads in forest areas shall be constructed not exceeding the width of 7 meters except upto 10 meters at curves and after completion of the project, these roads would be handed over to the Forest Department. However, user agency may use the road for supervision or maintenance of the project.

h. No blasting for construction of road/tunnels, etc. should be done during the winter months i.e. 15th November to 15th March in the areas adjoining the Great Himalayan National Park, Kullu.

i. No habitation shall be allowed to come up within the areas excluded from the National Park.

j. No labour camps shall be set up in the forest areas. The user agency should make such camps in the adjoining villages and make necessary arrangements for transport of the labour to and fro from the project site.

k. During construction period, such number of forest checkposts shall be maintained in consultation with the Forest Department, to regulate movement of forest produce at the cost of the user agency.

l. Excavated material, if any, will be properly utilised for construction purposes or stabilised and will not be thrown on the slopes or inside the forest land.

m. Catchment area treatment scheme of Rs. 25.69 crores as per the phased catchment area treatment plan approved in the Environmental clearance recorded vide the Ministry's letter No. J-12011/34/2001-IA-I dated 4.6.2001 shall be carried out at the project cost. The user agency will transfer the cost of implementing the catchment area treatment plan to the State Forest Department in a phased manner.

n. As per the EMP submitted for seeking environmental clearance, a sum of Rs. 15.40 crores for conservation of flora & fauna and Rs. 20.00 crores for conservation of endangered species has been earmarked. This fund shall be utilised for afforestation, special habitat improvement projects for the conservation of Western Tragopan and other endangered species in the area as per the recommendations of the State Wildlife Advisory Board. In this regard, the detailed projects for these two schemes shall be prepared by the Wildlife Institute of India in consultation with the Chief

Government of India
Ministry of Environment and Forests
F.C. Division

Paryavaran Bhawan,
CGO Complex, Lodhi Road,
New Delhi - 110 003.
Dated: 04.09.2001

The Secretary (Forests)
Govt. of Himachal Pradesh
Shimla

Sub: Diversion of 87.795 ha. of forest land for Parbati Stage-II Hydro-Electric Project in District Kullu by M/s National Hydro-electric Power Corporation Ltd.

Sir,

I am directed to refer to your letter No. FFE-B-F(3) 22/88 dated 7.6.96, No. FIS. B-F(3)22/88 dated 26.10.1998, No. Ft.48-100/87(M) dated 6.6.2001, even No. dated 20.7.2001 and M/s NHPC Ltd. letter No. NH/PD/Env 75/1243 dated 23.8.2001 on the above mentioned subject seeking prior approval of the Central Government in accordance with Section 2 of the Forest (Conservation) Act, 1980 and to say that the proposal has been examined by the Advisory Committee constituted by the Central Government under Section-3 of the aforesaid Act.

2. After careful consideration of the proposal of the State Government and on the basis of the recommendation of the above mentioned Advisory Committee, the Central Government hereby conveys its approval under Section-2 of the Forest (Conservation) Act, 1980 for diversion of 87.795 ha. of forest land for Parbati Stage-II Hydro-Electric Project in District Kullu by M/s National Hydro-electric Power Corporation Ltd., Himachal Pradesh subject to the fulfillment of following conditions:-

i) Legal status of forest land shall remain unchanged.
ii) Compensatory afforestation will be carried out over double the degraded forest land i.e. 87.795 x 2 = 175.59 ha. at the cost of the user agency.
iii) Penal compensatory afforestation will be carried out over double the degraded forest land i.e. 10.25 x 2 = 20.50 ha. at the cost of the user

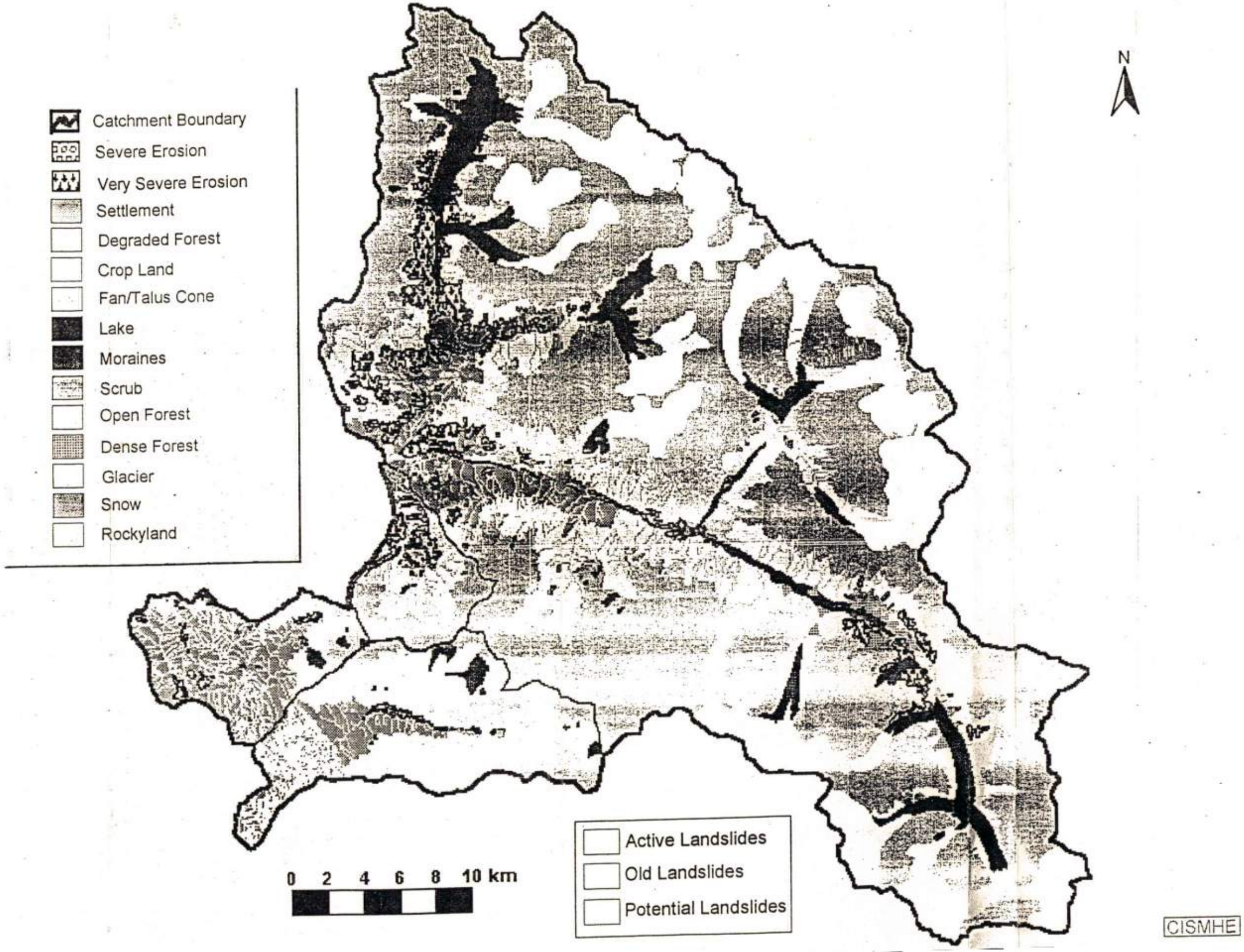

Fig. 2.8 Erosion map of Parvati H.E. Stage-II Project area

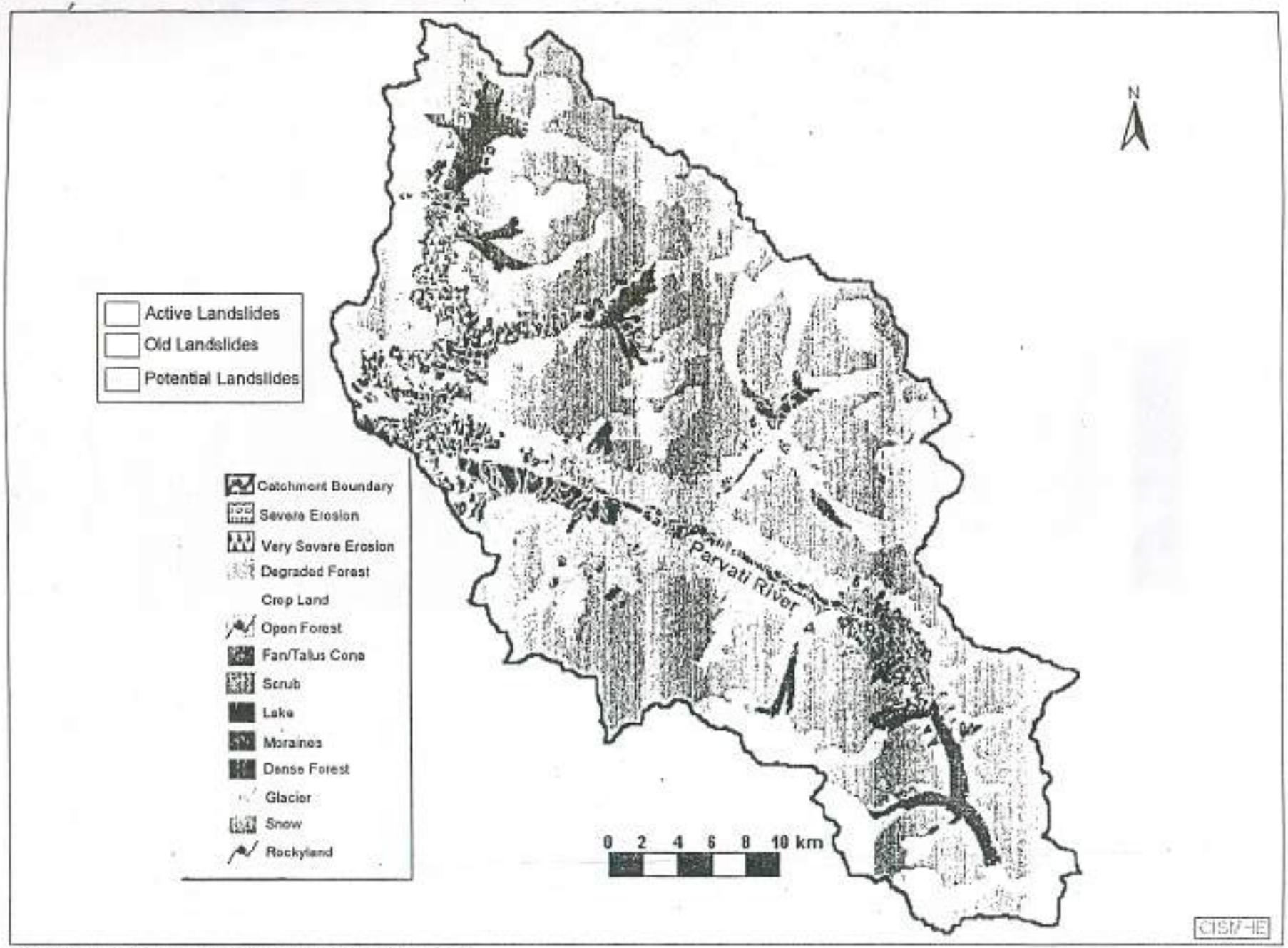

Fig. 2.9 Erosion map of Parvati river catchment

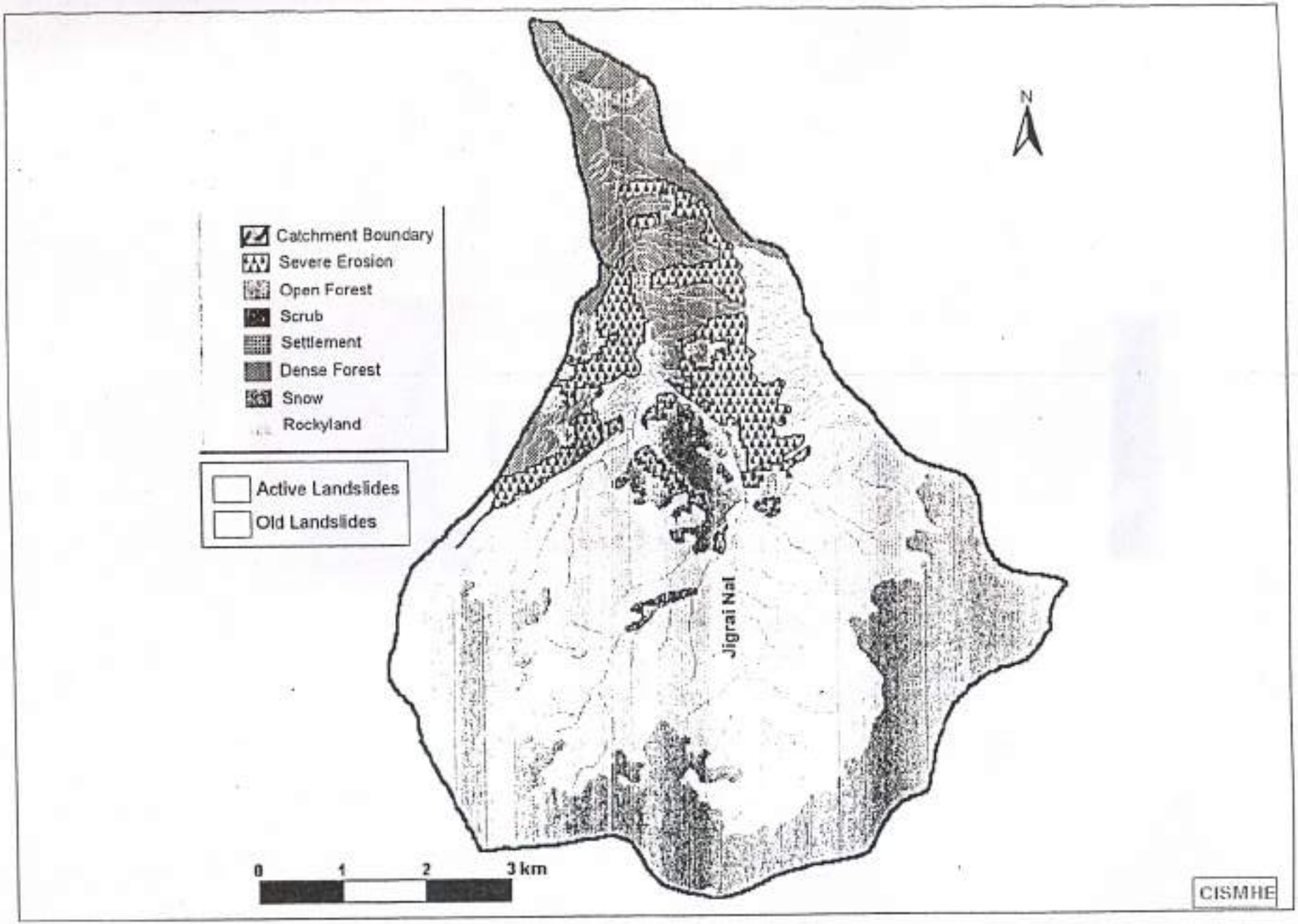

Fig. 2.10 Erosion map of Jigrai Nal

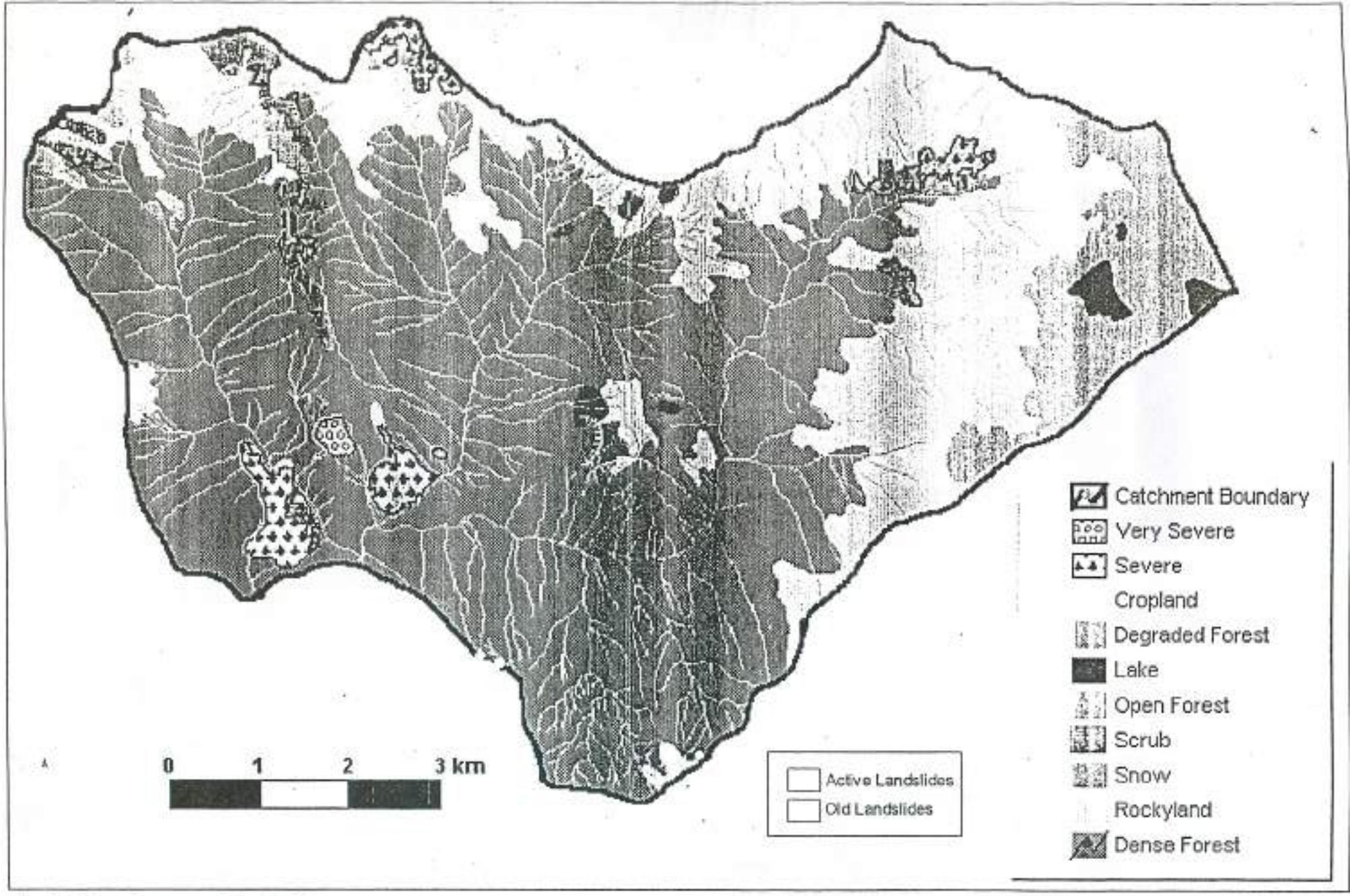

Fig.2.11 Erosion map of Hurla Nal

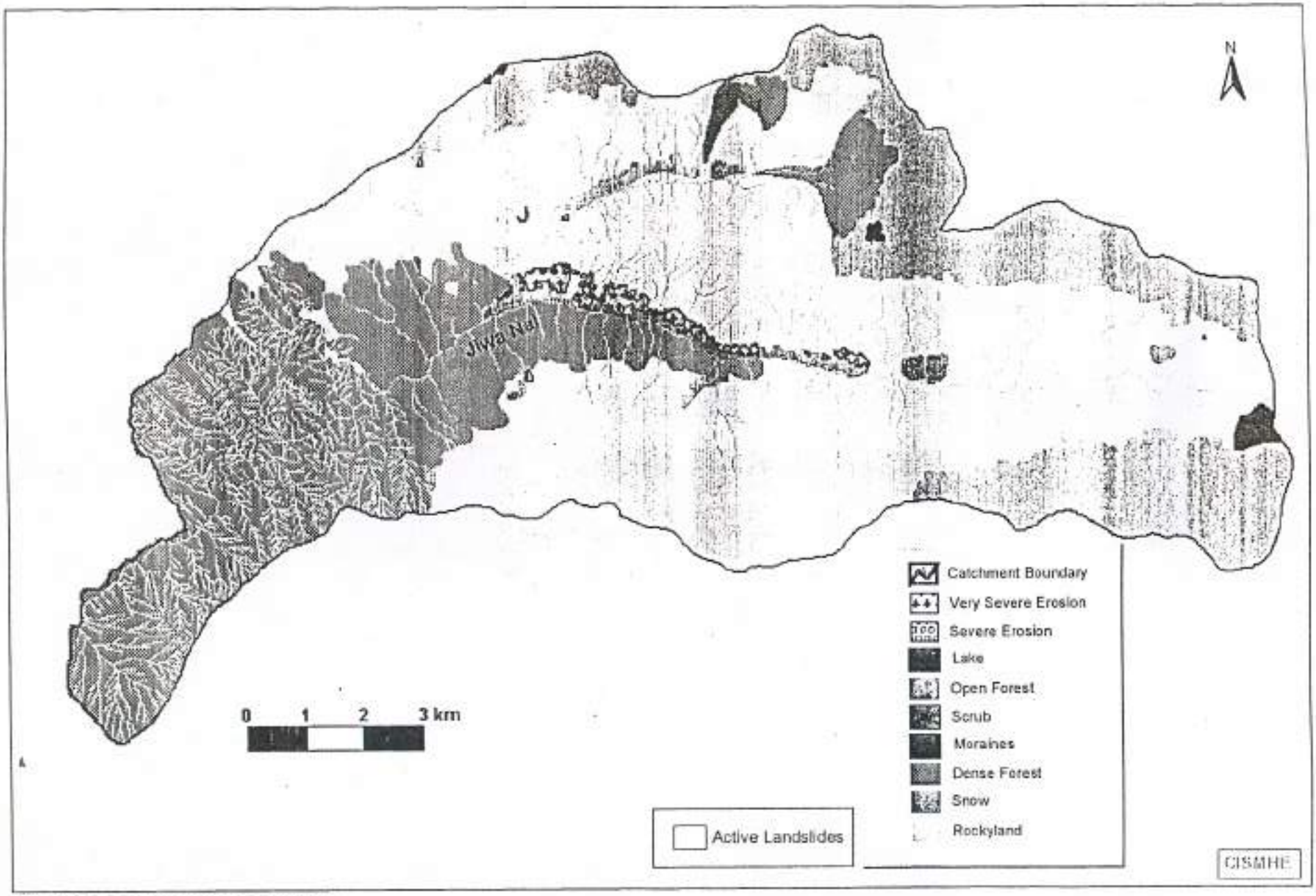

Fig. 2.12 Erosion map of Jiwa Nal

To mitigate the pressures of grazing and for successful establishment of fuelwood and fodder species in the area, it is essential to raise mixed plantations comprising 20-30% of fodder species and 40-50% fuelwood species including a few timber species. Some of the species which will be grown in these mixed plantations are :

2.6.1.3 *Plantation of horticulture crops*

Although very little portion of the Project area is under cultivation, yet wherever agriculture is praticed, it is on the slopes. The cultivation fields are not properly levelled or bench terraced. Such sloping crop fields are prone to heavy rates of soil erosion particularly in the form of sheet, rill and gully erosion. The ploughing and tilling of these sloping fields aggravates the soil erosion. It is suggested either to level the fields properly or change the landuse from agriculture to horticulture plantations in such areas. Under this plan suitable horticultural crop species like apple, plum and prunus shall be planted in selected areas adjacent to the villages. These plantations would become source of good income for the villagers. An area of 120 ha would be brought under horticultural plantations under this scheme.

2.6.1.4 *Silvi-pastoral Development*

In order to meet the demand for green fodder various plant species will be grown in silvi-pastoral plantation areas. To enhance the quality and yield of grasses and fodder, silvi-pastoral development programmes would be taken up in the blank slopes and 'Ghasnies' near the villages in the Project area. Pits of 45cm x 45cm x 45cm

would be dug with a spacing of 5m x 5m (400 pits per ha). In the pits, saplings of leguminous fodder tree species, nutritious grasses and legumes raised in the nursery would be planted at the rate of 400 plants per ha. Legumes and grasses abound in proteins and carbohydrates, respectively. Therefore, an ideal pasture having a mixture of legumes and grasses forms the most nutritious fodder for the cattle.

2.6.1.5 *Afforestation Programme*

Different types of plantations would be undertaken under afforestation programme according to the methodology described below. The plantations that would be undertaken in the forest blanks would have a planting density of 1600 plants per ha and vegetative hedge in contour trenches. Contour planting conserves soil and enhances moisture regime and adverse effect of surface run off of rain water is reduced considerably. Trenches, pits and plants along the contour reduce velocity of water, increase soil moisture and facilitate seepage of water in soil and reduce soil loss resulting in better growth of plants.

In the afforestation areas, the digging of trenches and pits would be done along the contour. About 20 to 30m long contour trenches would be dug with a spacing of 50 cm between the two consecutive trenches. Soil would be dug on the lower side of the trench and after removing pebbles and weeds, the trench to be half refilled with soil and remaining soil would be collected to form berm on lower side of

trench. On the berm, seeds of shrubs/hedges like *Dodonea*, *Duranta*, etc. would be sown to raise vegetative barriers. The size of trench will be 30cm x 20cm and the contour trenches would be at an interval of 5m.

For digging 1600 pits per ha, these would be dug 15 cm uphill side from the contour trenches. The spacing of pits along contour trench will not be closer than 1.25m. In afforestation areas soil working would start in October-November and will be completed by March. Filling of pits and half filling of trenches will be completed before the onset of monsoon to avoid washing away of dug soil by rains and leaving only stones and pebbles near the pit. Extreme care would be taken in transporting the plants from nurseries to the plantation site to avoid any mortality. Planting would be completed within the monsoon period.

With a view to conserve soil and water as well production of fuelwood vegetative barrier of hedge plants would be raised. The seeds of hedges like *Dodonea*, *Duranta*, *Spiraea*, etc. will be sown in contour trenches before the onset of monsoon. The hedges will help check the speed of run-off and also stop silt erosion. The hedge plants would also help percolate water down slowly. Hedges also spread and grow well in the silt left behind and form a natural terrace. The plants in the pits near contour trenches trap more moisture and grow fast.

2.6.1.6 *Choice of Species*

The species for plantations would be selected after considering altitude, aspect, biotic pressures, soil depth, moisture, etc. As there is enormous pressure of cattle grazing at some places, non-fodder/ fuelwood species would also be planted in suitable proportion in between the fodder species. The species for plantations have been divided in 3 groups:

Group 1 - Fodder species:
Kharik (*Celtis australis*)
Bhimal (*Grewia elastica*)
Robinia pseudoacacia
Subabul (*Leucaena leucocephela*)
Shehtut (*Morus serrata*)
Ficus species, Bamboo, Oak, Himalayan Poplar (*Populus ciliata*)
Siras (*Albizzia stipulata*)

Group 2 - Fuelwood species:
Acacia mollissima, Jungle Jalebi (*Pithecolobium dulce*), *Rhus parviflora*, Alder (*Alnus nepalensis*), *Robinia pseudoacacia*, Silver oak, Darli (*Toona serrata*), Anga (*Fraxinus micrantha*), Chillu (*Prunus armeniaca*), Walnut (*Junglans regia*), Khanor (*Aesculus indica*), Willow (*Salix* spp.)

Group 3 - Conifers:

Deodar (*Cedrus deodara*), Kail (*Pinus wallichiana*) Cedar (*Cupressus torulosa*).

be planted 40-50% with species of other 2 groups.

Following are some of the important legumes and grasses which will be selected for fodder growing :

Grasses

1. Cocks foot (*Dactylis glomerata*)
2. Perennial Rye grass (*Lolium perenne*)
3. Tall Fescue (*Festuca arundinacea*)
4. Brome grass (*Bromus inermis*)
5. Georgia selection
6. Timothy grass (*Phleum pratense*)
7. Poa grass

Legumes

1. White clover (*Trifolium repens*)
2. Red clover (*Trifolium pratense*)
3. Lucerene (*Medicago sativa*)
4. Vetch (*Vicia villosa*)
5. Sainfoin (*Onobrychis viciaefolia*)
6. Caucasian clover (*Trifolum ambiguum*)

2.6.1.7 *Fencing*

Stone wall of 120 cm and 45 cm width or 4 strand barbed wire fencing would be erected during first year along with soil working. The

cooperation of local villagers would be sought for the success of the plantation programmes. Plantation watch and ward would be under a local Plantation Protection Committee, which will be constituted to ensure the protection of the plantations over a longer period of time. These plantations grown with the help of local communities would be used by them and this would be a good incentive for their protection.

2.6.1.8 *Weeding and mulching*

Weeding, hoeing, mulching and `thawlabandi' would be carried out during October-November. Weeding and loosening of soil by hoeing breaks the capillary action in soil and thus reduces the moisture loss. Mulching reduces evaporation and conserves soil moisture and adds humus to soil. Cut and uprooted weeds and grasses used as mulching material would be spread in the `thawla' around the plants.

2.6.1.9 *Watch and Ward and Fire Protection*

Protection of plantation is the greatest challenge in hills as villagers and their livestock damage the plantation before it is established. Hence the protection of plantation particularly in the juvenile stage is of paramount importance and watchmen/chaukidars would be engaged from the nearby villages for the job. This would be in addition to the local watch and ward committee. Chowkidars would be required to keep strict vigil in the plantation areas. Huts would be constructed within the plantation area for their accommodation. Since plantations are also susceptible to fire during summer, appropriate measures would

be adopted to ward off these potential threats. Awareness among villagers would be given priority so that fires do not destroy the seedlings.

2.6.2 Engineering Measures

2.6.2.1 *Gully control*

The gullys would be treated with engineering/mechanical as well as vegetative methods. Check dams would be constructed in some of the areas to promote growth of vegetation that will consequently lead to the stabilisation of the slopes/area and prevention of further deepening of gullys and erosion. For controlling the gullys, the erosive velocities are reduced by flattening out the steep gradient of the gully. This is achieved by constructing a series of checks which transform the longitudinal gradient into a series of steps with low risers and long flat treads. Different types of check dams would be required for different conditions comprising different materials depending upon the site conditions and the easy availability of material at local level. The following types are recommended for this area:

i) Brushwood checkdam

ii) DRSM (Dry Rubble Stone Masonary)
-Check dams with stones available at the site

iii) Combination of DRSM and crate works. For moderate to deep gullys with stones available at the sites

In addition to the vegetative measures used for stabilisation of gullys, temporary and/or permanent mechanical measures will be used as supplementary measures to prevent the washing away of young plantations by large volume of run off. The gullys get stabilised over a period of time with the establishment and growth of vegetation cover. With the passage of time mechanical structures weaken and vegetative measures get strengthened. For mechanical measures following types of checkdams are suggested.

i) Brushwood checkdams

The main advantage of brushwood checkdams is that they are quick and easy to construct and are inexpensive. These are constructed by using readily available materials at the site. In brushwood checkdams, small branches preferably of coppiceable species are fixed in two parallel rows across the gully or nala and packed with brushwood between the rows of these vertical stakes. The vertical stakes are tied down with wires or fastened with sticks across the top. The important consideration in erecting brushwood checkdams is to pack the brushwood as tightly as possible and to secure it firmly. This type of checkdam is generally constructed over small gullys or at the starting stretch of gullys. In all, 3,790 brushwood checkdams/vegetative spurs would be constructed to check gully erosion, stream bank protection and slope stabilisation works. The choice of species to be used would depend on altitude, however, *Salix* and *Populus* will be extensively used as they coppice well.

ii) Dry Rubble Stone Masonary (DRSM) checkdams

The site where DRSM checkdams are to be constructed is cleared and the sides are sloped 1:1. The bed of gully is excavated for foundation to a uniform depth of 0.45 m to 0.60 m and dry stones are packed from that level. Over the foundation, DRSM super structure of check dam is constructed. The stones are dressed and properly set in with wedges and chips. The width of checkdam at the base is approximately equal to maximum height and successive courses are narrower so the section is roughly a trapezium. It is common to find upstream face of checkdams vertical with all slopes on the downstream face, but while there is sound engineering reason for this in case of large checkdams but it is not of any consequence in small gully control dams. In the centre of the dam portion sufficient waterway is allowed to discharge the maximum run off. The dry stone work should go up to 0.30m to 0.60m in the stable portion of the gully side to prevent end-cutting. Sufficient apron is provided to prevent scouring of the structure. The thickness of the apron packing would be about 0.45 m and gully sides above the apron have to be protected with packing to a height of at least 0.30 m above the anticipated maximum water level to prevent side scour being formed by the falling water. For gully control measures 250 DRSM checkdams would be constructed in the project area.

iii) Cratewire or wiremesh checkdams

This is a combination of DRSM and crate works and is suitable for moderate to deep gullys with stones available at sites. When a dry

stone checkdam is held down with woven wire netting, the life and strength of the structure is enhanced many fold. The mesh of wire is generally 0.15m x 0.15m and care should be taken that stones used are larger than the mesh size so that stones can not pass through the mesh. The wire netting is spread below the stone foundation and in the sides before starting the stone work and after completion of stone work the wire netting is tied, covering the masonry tightly so that the whole structure becomes one piece. The stability is secured by careful masonry work, setting and wedging. Wiremesh stone checkdams have the flexibility to withstand, absorb and adjust the bending moments due to water pressure. For controlling gullies and nalas in sloping hills, wiremesh stone checkdams have proved very useful and long lasting than ordinary stone checkdams.

2.6.2.2 *Diversion drains/Catchwater Drains*

Diversion drains intercepts the storm water which could otherwise flow down from higher ground on to the arable land. It is the first line of defence and vital for protection systems and structures low down as it effectively controls the run off from outside the arable land and conducts it safely to natural outlet. It is one of the most effective, practical and least expensive measures. All the streams and minor water courses would be diverted around the crown of the slide or the potentially hazardous area through catch water drains with adequate gradient. The catchwater drain avoids the run off to pass over vulnerable areas and water is guided through the drains provided on foot hill or along the Kaccha/Pucca roads. The ground surface of the

threatened area would be levelled to eliminate all depressions where water can accumulate. The soil excavated from the diversion drain shall be deposited on lower side of the drain, leaving a berm of 0.3 m and sectioned in a trapezoidal shape with side slopes not steeper than 1:1. In order to protect the bed and sides of the diversion drain from scour and erosion, suitable type of grasses would be planted. The catchwater drains with estimated length of 22,600 running metres (Rmts) are proposed to be constructed in different areas of the project.

2.6.2.3 *Slope modification by Stepping/Bench Terracing*

Bench terracing is one of the most popular mechanical soil conservation practices adopted by farmers in India and many other countries. It is constructed in the form of step-like fields along contours by half cutting and half filling. It would result in the conversion of the original slope into levelled fields. Thus, hazards of erosion are eliminated and manure and fertilisers applied are retained in the levelled fields. The sloping fields in the valley need to be bench terraced by cutting and filling with the latter supported by retaining stone walls. While making bench terraces, care will be taken not to disturb the top soil by spreading earth from the lower terraces to higher terraces. The vertical intervals between the terraces will not be more than 1.5 m and cutting depth would be kept at 50 cm. The minimum average width of the terrace would be 4 to 5 m to enable the usage of polong hinge. The shoulder bunds of 30 x 15 cm would also be provided. The excess water from the terraces will be drained off by staggered channels. An area of 150 ha will be covered under this plan.

2.6.3 Stabilisation of Landslides

Rainfall pattern of the area, water seepage coupled with geological formations result in landslides. Water plays an important role in triggering of landslides and mass wasting processes alongwith other factors such as slope and nature of soil / land cover/landuse. In addition to these natural factors, human activities in the form of road construction, overgrazing of hill slopes, felling of trees for timber, fuel and fodder and upslope extension of cultivation further contribute to landslides. The landslide prone areas identified in the project area would be taken up for the following treatments.

2.6.3.1 *Stream Bank Protection*

Stream bank erosion is caused by a number of reasons, such as destruction of vegetative cover, mass movement on unstable bank slopes, undermining of top portion of the lower bank by turbulent flow and sliding of slopes when saturated with water. The stream bank protection works would include wire crates and vegetative spurs. Based on our analysis, an area of 800 ha would be treated with these measures. One of the main reasons for the frequent occurrence of landslides in the project area is toe cutting by streams and rivers. In order to confine the flow and deflect water of torrents from toe cutting of banks particularly at the curves, it is desirable to construct spurwalls/ retards. About 1200 wire mesh boulder or stone spurwalls would be constructed for the purpose. In the silt setting between parallel lines of spurwalls, species which grow well near stream beds would be planted,

i.e. *Salix* spp., *Populus ciliata*, *Ipomoea carnea*, *Vitex negundo*, *Alnus nepalensis*, local grasses, etc.

2.6.3.2 *Stabilization of landslipped slopes*

The following measures are suggested for stabilization of land slipped slopes.

(i) **Protective and preventive measures against biotic pressure**

Four strand barbed wire fencing would be erected around the affected area to prevent grazing by cattle, sheep, goats and other animals in the area.

(ii) **Structural measures**

Stone retaining walls along contours would be constructed to withhold and stabilisation of the land slip.

(iii) **Vegetative measures**

The slip area would be planted and well covered with quick establishing species of trees and shrubs, e.g.*Alnus nepalensis* (a colonizer), *Populas ciliata* and the species of *Salix*, *Agave*, *Wendlandia*, *Vitex*, *Ipomoea*, etc.

(iv) **Netting**

Wherever possible, land slipped slopes would be provided with cover of wire netting, rope netting or sack (coarse jute fabric), etc. including wattling and mulching. Several types of netting are used which are woven with wire, jute yarns or

cannabis ropes, etc. To use these nettings, slopes would be smoothened, seeded, fertilized and layer of mulch will be spread followed by unrolling of the mulch and the net would be anchored by wire staples.

(v) Diversion channel

Diversion channels well above the landslide can check rain water coming to fragile sites and divert it to a nearby safer natural course. These channels have already been discussed in the earlier chapter.

2.7 ADMINISTRATIVE SETUP

The catchment treatment project involves intensive and highly technical operations, which require posting of exclusive and expert technical personnel for the job. For this purpose the implementing agency would create a well organised and competent project staff comprising DFO (1), Range Officer (2), Junior Engineer (1), Dy. Ranger (2), Forest Guards (9), Sr. Assistant (1), Jr. Assistant (2), Driver (2) and Peon/Khalasi (4). In addition, the labour huts for the workers involved in the implementation of these measures would also be built.

2.8 MONITORING AND EVALUATION

Monitoring and evaluation will be conducted as in built part of the project management. Thus, a process of self-evaluation at specified intervals of time will ensure the field worthiness and efficacy of the CAT plan. Annual work plan for each range would be prepared well in

advance specifying physical and financial targets, sites, locations and beneficiaries of each component of the project activity. Month-wise work schedule of various items of each component for the financial year would also be prepared in advance and its timely implementation would be ensured. Monthly progress report on all activities would be submitted by the Range Officers to DFO for its subsequent submission to the project authorities and Ministry of Environment & Forests, Government of India. The monitoring committee appointed for this purpose would also monitor on a regular basis the quality and quantity of works carried out in the area.

For the scientific monitoring, bench mark studies are suggested to be undertaken by the project authorities with the initiation of CAT plan vis-a-vis construction of the Parvati H.E. Stage -.II project. These benchmarks would then be compared with the measurement of parameters under study on completion of the CAT plan for the evaluation of its impacts. Therefore, reference points of silt load observation in the river would be installed one each, in Parvati river, Hurla Nal and Jiwa Nal to evaluate the impact of the soil conservation measures. A sum of Rs. 40.00 lakhs has been provided for monitoring and evaluation.

2.9 SUB-WATERSHED-WISE TREATMENT MEASURES

The amount of area and type of treatment to be undertaken is based upon the stream drainage pattern, extent of forest cover, accessibility of the area, landuse, soil profile and slope. The areas

with very severe erosion intensity having very steep slopes and which are inaccessible would be left alone for natural rejuvenation. In some of the sub-watersheds some areas under high erosion intensity category also have been earmarked for treatment owing to local conditions and degradational factors. The details of sub-watershed-wise treatment measures are described below.

2.9.1 Parvati River (1B1D4a)

This is the largest and the main sub-watershed in the project with an area of 1,15,500 ha. Approximately 90% of its landcover is non-forest comprising snow, glaciers, rockyland, morains and debris fans. In the higher reaches alpine scrub forest is predominant, while in lower temperate zone dense broad leaf and Mixed coniferous forests are dominant landuse. However, the sub-watershed is highly prone to landslides (Fig. 2.9). On the right bank of Parvati river, Tosh Nal and its tributaries Jirah ka Nala and Maskar Gaur bring lot of silt and boulders. On the left bank, Chhoti Nal and Piyakachudi Nal also bring lot of silt. All these streams are located and drain in the reservoir catchment. Heavy snowfall in these catchment areas may also trigger snow avalanches which carry alongwith them boulders, trees, etc. On the right bank the area around Rudranag Thach near Shetiruhan Nal is also prone to snow avalanche hazards. An area of 3,676 ha is under severe erosion intensity category while 217 ha is under very severe category that require treatment measures. The following treatment measures are suggested in this sub-watershed:

1. Gully control

Brushwood checkdams	=	382 Nos
DRSM checkdams	=	220 ha
Wire crates		
- Main gullys	=	1280 ha
- Inside gullys	=	335 Nos
- In main nalas	=	179 Nos

2. Bench terracing = 125 ha

3. Stream bank protection

Vegetative spurs	=	1015 Nos
Wire crates	=	410 ha

4. Slope stabilisation

Retaining walls	=	9010 m
Vegetative spurs	=	1600 Nos.
Wire crates	=	680 ha
Diversion drains	=	18,500 Rmts

5. Restorations of degraded areas

Afforestation	=	410 ha
Fodder/fuelwood plantations	=	190 ha
Horticultural plantations	=	75 ha
Silvi-pastoral plantations	=	60 ha

2.9.2 Jigrai Nal (1B1D4b)

This is the smallest sub-watershed having an area of 4,400 ha with 354 ha of area under severe erosion category requiring treatment (Fig. 2.10). The catchment of Jigrai Nal is most degraded where dense

forests comprise only 8% of the forest cover whereas, open forest and scrubs comprise more than 60% of the forest cover. There are two active landslide zones in Jigrai Nal catchment; one of them measuring 500 m x 200 m is located on the left bank of Jigrai Nal at an altitude of 2,700m. The following treatment measures are suggested for this sub-watershed:

1.	Gully control		
	Brushwood checkdams	=	13 Nos
	DRSM checkdams	=	15 ha
	Wire crates		
	- Main gullys	=	40 ha
	- Inside gullys	=	10 Nos
	- In main Nalas	=	10 Nos
2.	Bench terracing	=	10 ha
3.	Stream bank protection		
	Vegetative spurs	=	20 Nos
	Wire crates	=	20 ha
4.	Slope stabilisation		
	Retaining walls	=	120 m
	Vegetative spurs	=	40 Nos
	Wire crates	=	25 ha
	Diversion drains	=	900 Rmts
5.	Restorations of degraded areas		
	Afforestation	=	20 ha
	Fodder/fuelwood plantations	=	25 ha
	Horticultural plantations	=	15 ha
	Silvi-pastoral plantations	=	10 ha

2.9.3 Hurla Nal (1B1D3)

Hurla Nal sub-watershed covering an area of 6,700 ha comprises three micro-catchments viz. Manihar Nal, Pancha Nal and Hamka/ Hurla Nal. The predominant landuse in this sub-watershed is forests (Fig. 2.11). The catchment is covered with dense forests. There are 15 active landslides in its catchment. Therefore, area requiring various treatment measures in very severe and severe erosion intensity category are 25 ha and 210 ha, respectively. The following treatment measures are suggested for this sub-watershed:

1.	Gully control		
	Brushwood checkdams	=	197 Nos
	DRSM checkdams	=	10 ha
	Wire crates		
	- Main gullys	=	150 ha
	- Inside gullys	=	180 Nos
	- In main Nalas	=	8 Nos
2.	Bench terracing	=	10 ha
3.	Stream bank protection		
	Vegetative spurs	=	110 Nos
	Wire crates	=	200 ha
4.	Slope stabilisation		
	Retaining walls	=	520 m
	Vegetative spurs	=	110 Nos
	Wire crates	=	150 ha
	Diversion drains	=	2900 Rmts

5. Restorations of degraded areas

Afforestation	=	45 ha
Fodder/fuelwood plantations	=	45 ha
Horticultural plantations	=	30 ha
Silvi-pastoral plantations	=	40 ha

2.9.4 Jiwa Nal (1B1D2)

Jiwa Nal sub-watershed has an area of 12,000 ha. This sub-watershed is a part of Great Himalayan National Park. More than 25% of Jiwa Nal catchment is covered with dense forests (Fig. 2.12). However, an area of 92 ha in severe erosion intensity category and 6 ha in severe category require different treatment measures. The following treatment measures are suggested for this sub-watershed:

1. Gully control

Brushwood checkdams	=	198 Nos
DRSM checkdams	=	5 ha
Wire crates		
- Main gullys	=	30 ha
- Inside gullys	=	175 Nos
- In main Nalas	=	3 Nos

2. Bench terracing = 5 ha
3. Stream bank protection

Vegetative spurs	=	55 Nos
Wire crates	=	170 ha

4. Slope stabilisation

Retaining walls	=	150 m
Vegetative spurs	=	50 Nos
Wire crates	=	45 ha
Diversion drains	=	300 Rmts

5. Restorations of degraded areas

Afforestation	=	15 ha

2.10 PERIOD AND SCHEDULE OF IMPLEMENTATION

Keeping in view the local topography and climate it is being estimated that the entire treatable area would require at least 8 years to complete. All these works would have to start with the pre-construction activities especially the studies for micro-planning for each sub-watershed would require further detailed investigations which would be started alongwith starting of the project. Based on the silt yield index of the sub-watersheds, the conservation measures would be first taken up in sub-watershed of Jigrai Nal, followed by that in Parvati valley, Hurla Nal and Jiwa Nal (see Annexure-I). The year-wise index map of schedule of implementation of different conservation measures under CAT plan has been given in Figure 2.13.

2.11 COST ESTIMATES

The total estimated cost of catchment area treatment plan to be spent over a period of eight years is **Rs. 2,569.22 lakhs.** The details of cost estimates and physical work schedule as well as phasing of

expenditure are described as follows in Tables 2.5 - 2.8. All the costs towards the administration during the implementation work (Table 2.9) have been included in the cost estimates of CAT. Any other cost towards establishment and micro-planning for various treatment measures for each sub-watershed has also been included in the overall project cost.

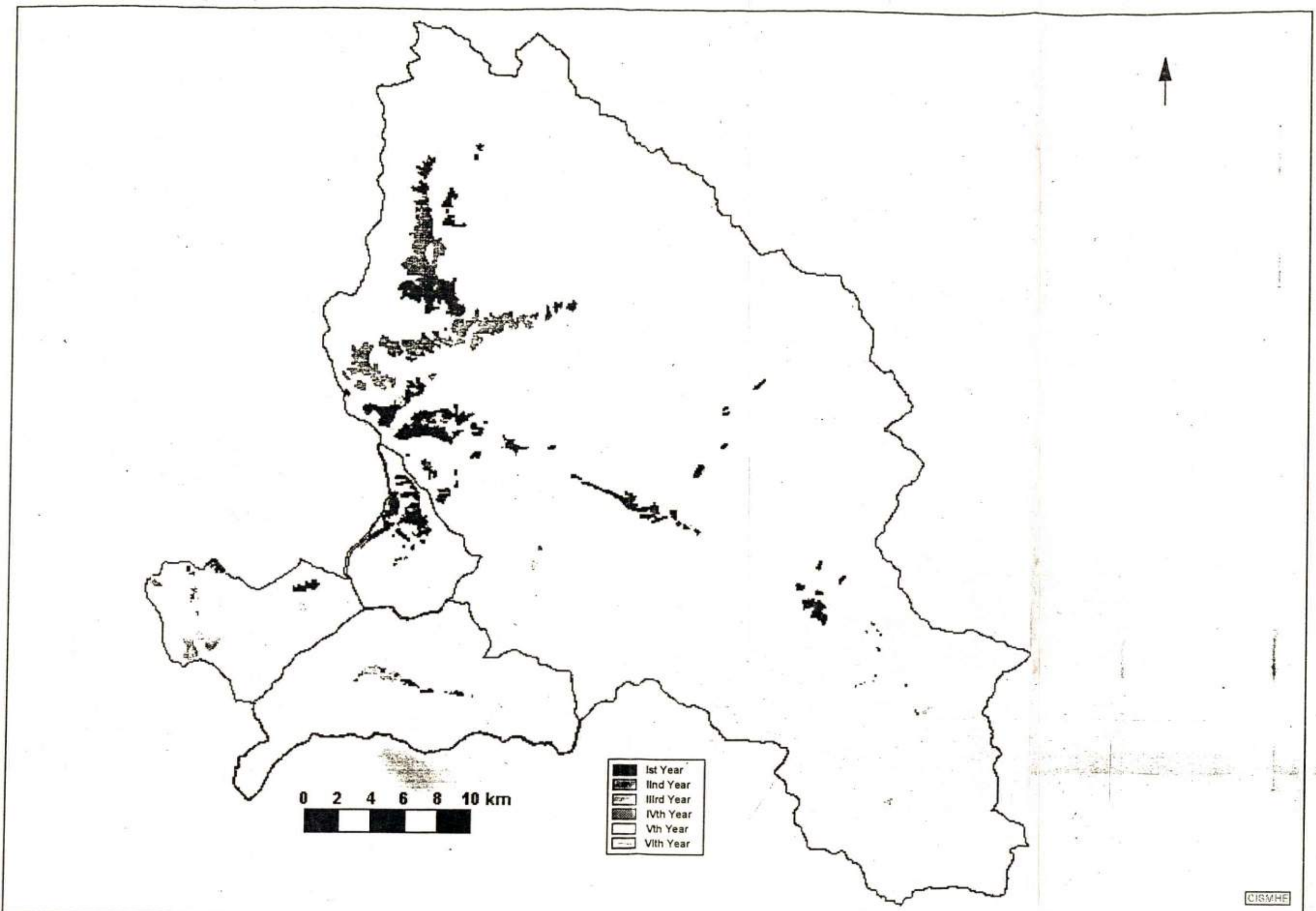

Fig.2.13 Yearwise Index map of Parvati H.E. Stage-II Project Area showing schedule of implementation of conservation measures

Revised CAT Plan

Additional CAT Plan of the Parbati Hydro... Project Stage-II (PHEP-II) ... the National Hydroelectric Power Corporation (NHPC)

Details of the ... events and costs				Quantity					(Rs in lakh)	
S.N.	Components/activities	Unit	Rate	Parvati Div.	Seraj Div.	Kullu Ord.	GHNP	Total	Amount	Remarks
	Improvement in the water supply system of nurseries									
1a	Nursery at Kasol	L/S	1.50	1	-	-	-	1	1.50	
1b	Nursery at Dhalogi	L/S	2.90	1	-	-	-	1	2.90	
	Sub-total (1)	-	-	2	0	0	0	2	4.40	
	Office support systems									
2a	Computerization of Offices Desktop Pentium-4 PCs with accessories & Deskjet printers & 1 Laser Printer	No.	0.85	6	2	2	1	11	9.35	
2b	Provision of Photocopier.	No.	1.00	1	1	1	-	-	-	
	Sub total (2)	-	-	7	3	3	2	15	15.35	
3	**Mobility**									
3a	Provision of one hard top five door Gypsy	No.	4.50	1	1	-	1	3	13.50	
3b	Provision of one Ambassador Euro-II car	No.	5.00	-	-	1	1	2	10.00	
	Sub total (3)	-	-	1	1	1	2	5	23	
4	**Improvements in/Provision of ... stage**									
4a	Pulga (Repair & Furnishing) Kasol Range	L/S	7.50	1	-	-	-	1	7.50	
4b	Gana (Repair & Furnishing) Hurla Range	L/S	4.50	1	-	-	-	1	4.50	
4c	New construction (I/C Furnishing) at Tosh in Kasol Range	L/S	15.00	1	-	-	-	1	15.00	
4d	New construction (I/C Furnishing) at Khir Ganga in Kasol Range	L/S	14.50	1	-	-	-	1	14.50	
4e	New construction (I/C Furnishing) above Hurla-Pancha Road in Hurla village	L/S	15.00	1	-	-	-	1	15.00	
	Sub total (4)	-	-	4	0	0	0	4	56.50	
	Grand total (1 to 4)			14	4	4	4	26	101.75	

To be provided in kind in the first year by ... agency i.e. NHPC

Director
Great Himalayan National Park
Shamshi

Divisional Forest Officer
Parvati Forest Division
Bhuntar (Kullu) H.P.

Divisional Forest Office
Seraj Forest Division
Sainj

Revised proposal for additional forest land, PHEP-II, ... Parvati Forest Division

Table 2.5 Cost Estimate for Catchment Area Treatment Works

Sl. No.	Item of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs. in lakhs)
A.	**Engineering Measures**				
1.	Gully Control (for details see Table 2.6)				
	Check dams				
	a) Brushwood	Nos.	790	1,100/-	8.70
	b) DRSM	ha	250	16,560/-	41.40
	c) Crate wires/wiremesh				
	Crate wires and DRSM in main gullys	ha	1500	27,400/-	411.00
	Inside gullys	Nos.	700	7,600/-	53.20
	In main Nalas	Nos.	200	10,095/-	20.19
	Sub-total (1)				534.49
2.	Bench Terracing/ slope modification	ha	150	9,500/-	14.26
3.	Landslide control				
	a) Stream Bank Protection				
	i) Vegetative spurs	Nos.	1200	1,100/-	13.20
	ii) Wire crates	ha	800	27,400/-	219.20
	b) Slope stabilisation				
	i) Retaining walls	m	9800	1,950/-	191.10
	ii) Vegetative spurs	Nos.	1800	1,100/-	19.80
	iii) Wire crates	ha	900	27,400/-	246.60
	iv) Diversion drains	Running metres	22,600	1,750/-	395.50
	Sub-total (3)				1,085.40
	Total (1+2+3)				1,634.15
	Add 5% for maintenance of structures				81.70
Sub-total (A)					**1,715.85**

B.	**Biological Measures**				
1.	Restoration of Degraded Forest Areas				
	i) Nursery Development	ha	60	5,000/-	3.00
	ii) Maintenance of Nurseries	ha	60	5,000/-	3.00
	iii) Advance works	ha	980	7,500/-	73.50
	iv) Final Plantations				
	a) Afforestation	ha	490	15,000/-	73.50
	b) Fodder Plantations	ha	260	15,000/-	39.00
	c) Horticulture Plantations	ha	120	15,000/-	18.00
	d) Silvi-pastoral	ha	110	15,000/-	16.50
	Sub-total (i-iv)				226.50
	Add 6% of annual cost for Maintenance of Plantations				66.67
	Add 5% for Barbed wired fencing				55.55
	Add 5% for Watch & ward of plantation				55.55
	Sub-total (B)				**404.27**
C.	**Micro-plan preparation @ 3% of A + B**				61.55
D.	**Administrative charges** (Staff salaries & contingencies) (see Table 8)				326.60
E.	**Cost of construction of guard/labour huts** (see Table 9)				20.85
F.	**Monitoring and evaluation** L.S. @ Rs. 5.00 lakhs per year				40.00
Grand Total (A + B + C + D)					**2,569.22**

Table 2.6 **Per unit cost estimates for different types of checkdams for Gully Control Measures**

Brushwood check dams/Vegetative spurs (per unit)

S.No.	Item	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
1.	Supply of brushwood material with 40 bundles in two layers	per bundle	40	15.00	600.00
2.	Cost of wooden poles of 6' length and 6" dia	Nos.	12	25.00	300.00
3.	Labour charges for laying of brushwood in spur and fixing of spur	Mazdoors Nos.	4	50.00	200.00
	Total (Rs.)				1,100.00

Therefore, Cost per structure = Rs. 1,100/-

DRSM check dams

Conditions

- Gullys : shallow to moderate
- Stones available at site locally
- Details for a unit area of 5 ha

No. of check dams to be erected	=	15 Nos.
Average dimension	=	(8m x 1.5m x 2m)
	=	24 cum
Cost @ Rs.200/cum	=	24 x 200
	=	Rs.4,800/-
Average cost for 10 Nos.	=	15 x Rs.4,800/-
	=	Rs. 72,000/-
Add 15% for special hill area and contingency	=	Rs. 10,800/-
Total cost per ha	=	**82,800 / 5 = Rs. 16,560/-**

Unit cost of Cratewire/wiremesh check dams/gully plugging works

Conditions :

- Main gullys - Crate & DRSM
- Inside gullys - DRSM check dams
- Stones available at site (To be extracted and collected locally)
- Details worked for a unit area of 10 ha

i)	No. of crates to be erected	=	18 Nos.
	Average dimension	=	8m x 1.5m x 2m
	Total stones required	=	432 cum
	Average length of crate wall	=	100 m
	a) Cost of crate wire @ Rs. 55/- per m	=	18 x 100 x 55 = Rs. 99.000/-
	b) Carriage, weaving, etc., @ Rs. 60/- per cum	=	432 x 60 = Rs. 25,920/-
	c) Cost of crate with local stones available including tie works @ Rs.200/- per cum	=	432 x 200 = Rs. 86,400/-
	d) Collection & Breaking of boulder stones @Rs. 60/- per cum	=	432 x 60 = Rs. 25,920/-
	Total cost (a+b+c+d)	=	Rs. 2,37,240/-
	Add 12.5% for Special Hill area	=	Rs. 29,655/-
	Add 3% contingency	=	Rs. 7,117/-
	Total cost	=	Rs. 2,74,012/-
	Total cost per ha	=	**2,74,012 / 10 = Rs. 27,401/-**
	Say Rs. 27,400/-		

ii)	**Check dams inside gullys**		
	Average dimension	=	5m x 1.5m x 1.5m
	Total stone required	=	11.25 cum
	Construction cost with local stones available @ Rs.200/cum	=	Rs. 3,375/-
	Carriage, weaving, etc.	=	Rs. 2,500/-
	Collection & Breaking of boulder stones @Rs. 60/- per cum	=	11.25 x 60 = Rs. 675/-

	Total cost	=	Rs. 6,550/-
	Add 12.5% for special hill area	=	Rs. 819/-
	Add 3% for contingency	=	Rs. 197/-
	Total cost per unit	=	Rs. 7,566/-
	Say Rs. 7,600/-		
iii)	Check dams in main Nalas		
	Average dimension	=	8m x 1.5m x 2m
	Total stone required	=	24 cum
	Construction cost with local stones including tie works @ Rs. 200/cum	=	Rs. 4,800/-
	Carriage, weaving, etc.	=	Rs. 2,500/-
	Collection & Breaking of boulder stones @Rs. 60/- per cum	=	24 x 60 = Rs. 1,440/-
	Total cost	=	Rs. 8,740/-
	Add 12.5% for special hill area	=	Rs. 1,093/-
	Add 3% for contingency	=	Rs. 262/-
	Total cost per unit	=	Rs. 10,095/-
	Say Rs. 10,095/-		

Table 2.7 Cost estimate for administrative staff and equipment

Sl.No.	Post	Salary	No. of Posts	Total (Annual) (Rs. in lakhs)
A.	**Adminstrative Staff**			
1.	DFO	20,000	1	2.40
2.	Range Officer	14,000	2	3.36
3.	Junior Engineer	14,000	1	1.68
4.	Dy. Ranger	10,000	2	2.40
5.	Forest Guards	7,000	9	7.56
6.	Sr. Assistant	10,000	1	1.20
7.	Jr. Assistant	8,000	2	1.92
8.	Drivers	7,000	2	1.68
9.	Peons/Khalasi	5,000	4	2.40
Total for Ist year				**24.60**
Total for 2nd year				**27.06**
Total for 3rd year				**29.74**
Total for 4th year				**32.71**
Total for 5th year				**35.98**
Total for 6th year				**39.58**
Total for 7th year				**43.54**
Total for 8th year				**47.89**
Total (A)				281.10

Financial requirements for 8 years = Rs.281.10 lakhs

B. Machinery and Equipment

Item	Qty	Amount (Rs. in lakhs)
Gypsy	2 Nos.	10.00
Trucks	1 No.	8.50
Computer	2 Nos.	2.00
Tools	L.S.	0.50
Misc.	L.S.	0.50
R & M of vehicles and machinery for 8 years	L.S. @ Rs.3.00 per year	24.00
Total (B)		**45.50**
Grand Total (A + B)	=	**326.60**

Table 2.8 Construction cost of Guard/Labour Huts

Plinth area	=	34.75 sq m each
Cost per sq m	=	Rs. 4,000/-
Total cost of 15 huts	=	Rs. 20.85 lakhs
15 x 34 x Rs. 4,000/-		

Computation of Silt Yield Index

Sub-watershed Code	Erosion intensity	Area (ha)	Weightage	Area x weight-age	Delivery ratio yield	Gross silt	Sediment yield index
1B1D4a	a	217	20	4340	0.95	4123	
	b	3,682	18	66276	0.90	59648	
	c	17502	15	262530	0.90	236277	
	d	19624	11	215864	0.85	183484	
Total*		**41025**				**483532**	**1179**
1B1D4b	a	-	-	-	-	-	
	b	354	20	7080	0.95	6726	
	c	1621	18	29178	0.90	26260	
	d	1169	13	15197	0.90	13677	
Total*		**3144**				**46663**	**1484**
1B1D3	a	25	20	500	0.95	475	
	b	210	18	3780	0.90	3402	
	c	2775	13	36075	0.90	32468	
	d	3169	11	34859	0.85	29630	
Total*		**6179**				**65975**	**1068**
1B1D2	a	-	-	-	-	-	
	b	92	18	1656	0.90	1490	
	c	3488	13	45344	0.90	40810	
	d	6309	11	69399	0.85	58989	
Total*		**9889**				**101289**	**1024**

*** Total area here does not include the area permanently under snow/glaciers**

Table 2.9 Physical and Financial details of CAT plan

(Fin. Rs. in lakhs)

Sl. No.	Item of Works	Unit	Unit Cost (Rs.)	Year-wise Breakup														Total	
				Ist Year		IInd Year		IIIrd Year		IVth Year		Vth Year		Vi Year		VIIth Year		VIIIth Year			
				Phy.	Fin.	Phy.	Fin.	Phy.	Fin.	Phy	Fin.	Phy.	Fin.	Phy.	Fin.	Phy.	Fin.	Phy.	Fin.	Phy.	Fin.
A.	**ENGINEERING MEASURES**																				
1.	Gully Control																				
	a) Brushwood	Nos.	1100/-	250	2.75	150	1.65	150	1.65	100	1.10	75	0.83	65	0.72	-	-	-	-	790	8.70
	b) DRSM	ha	16,560/-	80	13.25	60	9.94	55	9.11	40	6.62	15	2.48	-	-	-	-	-	-	250	41.40
	c) Crate wires																				
	- Main gullys	ha	27,400/-	500	137.00	300	82.20	250	68.50	250	68.50	150	41.10	50	13.70	-	-	-	-	1500	411.00
	- Inside gullys	Nos.	7,600/-	250	19.00	150	11.40	125	9.50	125	9.50	50	3.80	-	-	-	-	-	-	700	53.20
	- In main Nalas	Nos.	10,095/-	50	5.05	40	4.04	30	3.03	30	3.03	25	2.52	25	2.52	-	-	-	-	200	20.19
2.	Bench terracing	ha	9,500/-	50	4.75	30	2.85	25	2.38	25	2.38	20	1.90	-	-	-	-	-	-	150	14.26
3.	Lanslide control																				
	Stream Bank Protection																				
a)	Vegetative spurs	Nos.	1,100/-	400	4.40	250	2.75	250	2.75	200	2.20	100	1.10	-	-	-	-	-	-	1200	13.20
b)	Wire crates	ha	27,400/-	250	68.50	200	54.80	150	41.10	100	27.40	100	27.40	-	-	-	-	-	-	800	219.20
	Slope stabilisation																				
a)	Retaining walls	m	1,950/-	2500	48.75	2200	42.90	1800	35.10	1600	31.20	1200	23.40	500	9.75	-	-	-	-	9800	191.10
b)	Vegetative spurs	Nos.	1,100/-	600	6.60	350	3.85	300	3.30	250	2.75	200	2.20	100	1.10	-	-	-	-	1800	19.80
c)	Wire crates	ha	27,400/-	200	54.80	300	82.20	200	54.80	150	41.10	50	13.70		-	-	-	-	-	900	246.60
d)	Diversion drains	Rmts.	1,750/-	8000	140.00	5000	87.50	4500	78.75	3000	52.50	2100	36.75	-	-	-	-	-	-	22,600	395.50
	Sub-total (1-3)	-	-	1080	504.85	890	386.08	680	309.97	565	248.28	335	157.18		27.79	-	-	-	-	3600	1634.15
	Add 5% for maintenance of structures		-	-	25.24	-	19.30	-	15.50	-	12.41	-	7.86	-	1.39	-	-	-	-	-	81.70
	Total (A)	-	-	-	530.09	-	405.38	-	325.47	-	260.69	-	165.04	-	29.18	-	-	-	-	-	1715.85
B.	**BIOLOGICAL MEASURES**																				
i)	Nursery development*	ha	5,000/-	25	1.25	10	0.50	10	0.50	10	0.50	5	0.25	-	-	-	-	-	-	60	3.00
ii)	Maintenance of nurseries	ha	5,000/-	-	-	25	1.25	10	0.50	10	0.50	10	0.50	5	0.25	-	-	-	-	60	3.00
iii)	Advance works	ha	7500/-	300	22.50	200	15.00	200	15.00	150	11.25	130	9.75	-	-	-	-	-	-	980	73.50
iv)	Final plantations																				
	a) Afforestation	ha	15,000/-	-	-	120	18.00	120	18.00	100	15.00	80	12.00	70	10.50	-	-	-	-	490	73.50
	b) Fodder/Fuelwood	ha	15,000/-	-	-	90	13.50	50	7.50	50	7.50	40	6.00	30	4.50	-	-	-	-	260	39.00
	c) Horticultural plantations	ha	15,000/-	-	-	50	7.50	20	3.00	30	4.50	20	3.00	-	-	-	-	-	-	120	18.00
	d) Silvi-pastoral plantations	ha	15,000/-	-	-	40	6.00	10	1.50	20	3.00	10	1.50	30	4.50	-	-	-	-	110	16.50
	Sub-total (i-iv)			-	23.75	300	61.75	200	46.00	200	42.25	150	33.00	130	19.75	-	-	-	-	980	226.50
	Add 6% Maintenance of Plantation			-	-	-	3.71	-	6.47**	-	9.00*	-	10.98*	-	12.17*	-	12.17*	-	12.17*	-	66.67
	Add 5% for Barbed wired fencing			-	-	-	3.09	-	5.39**	-	7.50*	-	9.15*	-	10.14*	-	10.14*	-	10.14*	-	55.55
	Add 5% for Watch & ward for plantations			-	-	-	3.09	-	5.39**	-	7.50*	-	9.15*	-	10.14*	-	10.14*	-	10.14*	-	55.55
	Total (B)	-	-	-	23.75	-	71.64	-	63.25	-	66.25	-	62.28	-	52.20	-	32.45	-	32.45	-	404.27
C.	**Micro-plan preparation @ 3% of total (A+B)**	-	-	-	16.62	-	14.31	-	11.66	-	9.81	-	6.81	-	2.44	-	-	-	-	-	61.55
D.	**Administrative Charges, Staff salaries & contingencies**	-	-	-	49.10	-	30.06	-	32.74	-	35.71	-	38.98	-	42.58	-	46.54	-	50.89	-	326.60
E.	**Construction cost of huts**	-	-	-	20.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.85
F.	**Monitoring and evaluation**	-	-	-	5.00	-	5.00	-	5.00	-	5.00	-	5.00	-	5.00	-	5.00	-	5.00	-	40.00
	Grand Total	-	-	1080	645.41	1190	526.39	880	438.12	765	377.46	485	278.11	180	131.40	-	83.99	-	88.34	-	2569.22

* This area is in addition to the area requiring treatment measures.

** This is calculated from the percentage of the total of previous year/s and the present year.

3

FISHERIES DEVELOPMENT

3.1 INTRODUCTION

Himachal Pradesh has a vast potential of lentic as well as lotic water bodies in the form of ponds, lakes, rivers, rivulets and brooks. However, the available potential of fishery resources has not been fully exploited and it has failed to contribute significantly to the economy of the state. The available fishery resources could be potentially harnessed by developing pisciculture and aquaculture in the region. However, fish seed farming is not considered profitable by the farmers of the region. Therefore, there is a need for conducting awareness programmes regarding the knowledge, methods and benefits of fish culture. Such sustainable development programmes would not only solve the problem of malnutrition of hill people by providing cheep animal protein but will also help in generating additional income.

For more than 50 years, exotic carnivorous fish species i.e., Brown trout and Rainbow trout have been introduced in many rivers of Himachal Pradesh constituting a total of about 600 km stretch of rivers out of a total of 3000 km of river stretch in the state. This has resulted in a decline in the populations of indigenous fish species found in the rivers of Himachal Pradesh.

It is well documented that regulation of rivers and streams changes the riverine environment which consequently affects the aquatic biodiversity and processes like fish migration (Raj 1941; Jhingran 1991). The construction of proposed diversion dam near Pulga village would adversely affect the environment of Parvati river, downstream of proposed dam, which would have a detrimental affect on the populations of indigenous fish species like Snow trouts and other minor Indian trouts, which are already under threat due to the introduction of exotic fish species. Keeping this in view, the project authorities propose to construct two fish farms in the Parvati project area to encourage and develop sound fisheries practices in the region (Fig.3.1). Fisheries development in the region would not only provide an additional source of income for the people in the region but would also help in the reintroduction and maintenance of indigenous fish species diversity in Parvati river which would play a vital role in their conservation.

3.2 SELECTION OF SITES

A survey was conducted in the Parvati valley to select the suitable sites for fish farming. The following factors were considered during the selection of the sites to develop a fish seed farm :

(i) Moderately flat land (at least 0.5 ha),
(ii) Flood unaffected land,
(iii) Lack of seepage,
(iv) Easily accessible site,
(v) Soil with sufficient clay content,
(vi) Assured and continuous supply of water free from pollution and turbidity.

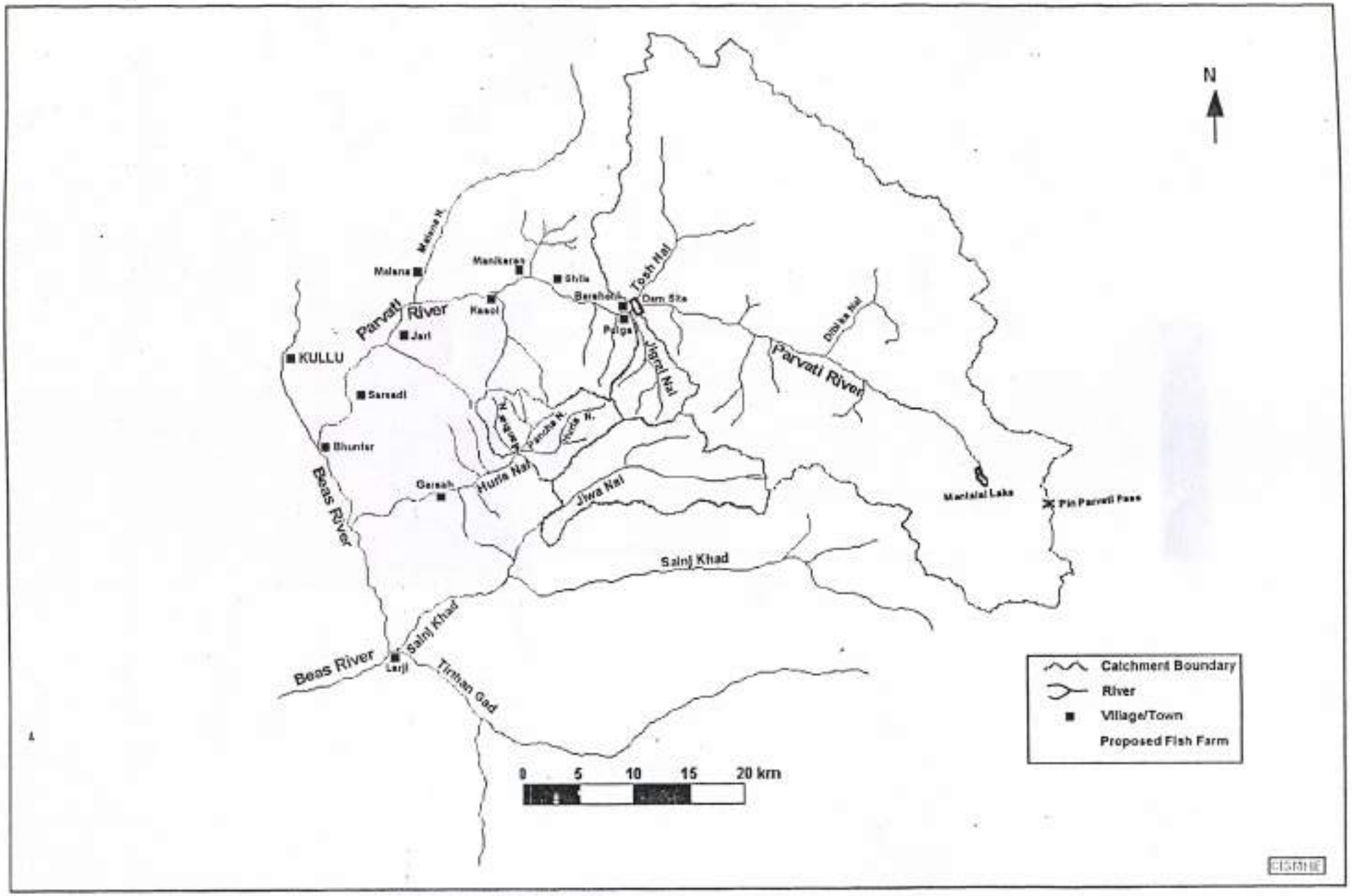

Fig.3.1 Proposed Fish Farms in Parvati H.E. Stage-II Project Area

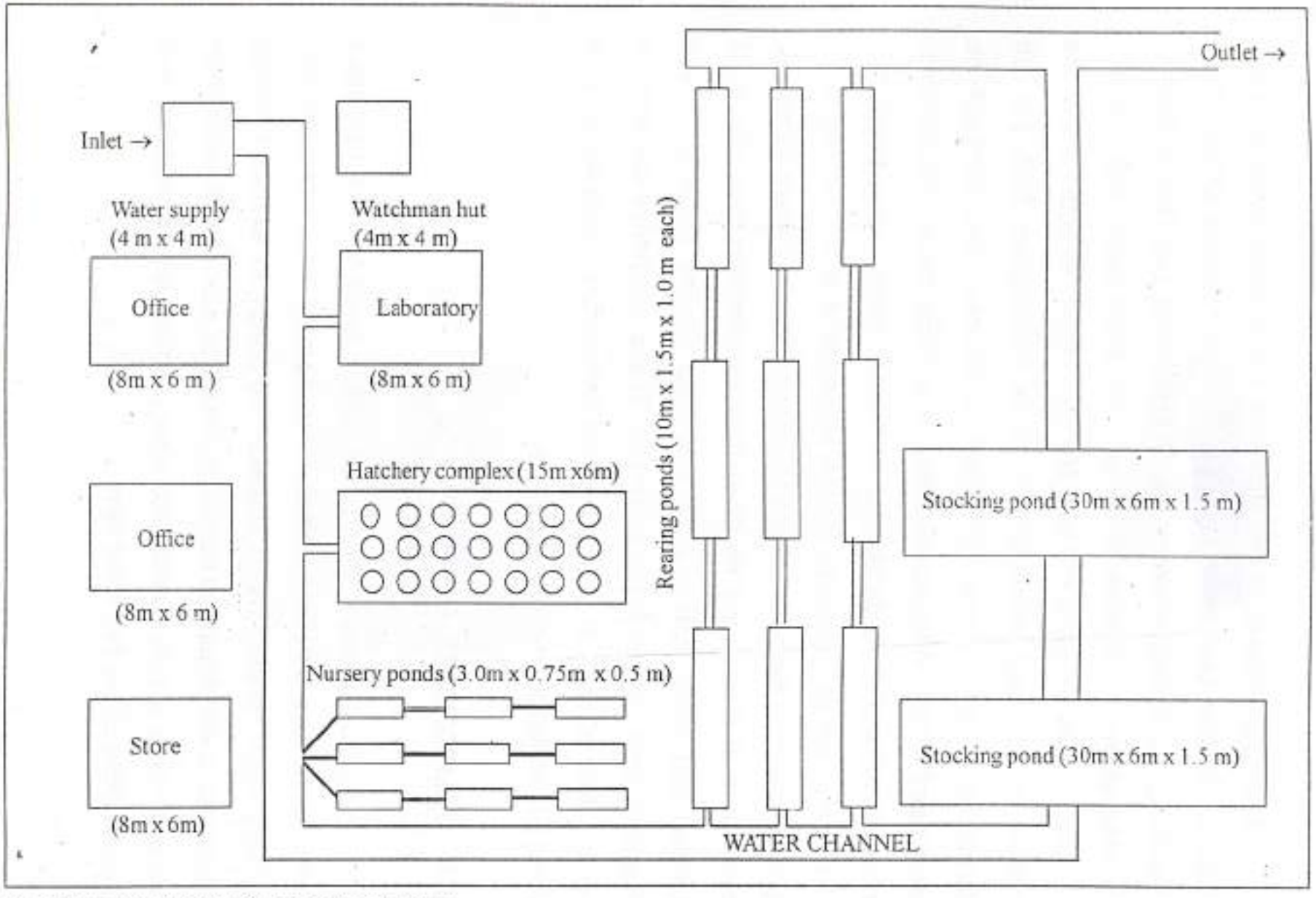

Fig.3.2 Layout Plan of a Fish Seed Farm

During the course of investigations and surveys, three sites one each at Bhuntar, Garsah and Sainj were found suitable which fulfilled the above mentioned requirements. Of these sites, two sites at Bhuntar, located at the confluence of Parvati and Beas rivers and Garsah, situated on the left bank of Hurla Nal were finally selected where the hatcheries for seed production would be constructed. Both the fish farms will be of the same dimensions. At Bhuntar, seed farm will be developed for the indigenous species like Snow trouts (*Schizothorax richardsonii* and *S. plagiostomus*) and other minor Indian trouts and the spawn will be produced for the propagation in the natural water bodies to restore the aquatic biodiversity and capture fishery. Whereas, seed farm at Garsah will be developed for common carp (*Cyprinus carpio*) and exotic trouts i.e., Brown trout (*Salmo trutta fario*) and Rainbow trout (*S. gairdnerii gairdnerii*). These hatcheries will provide spawn, free of cost, to the farmers for fish culture which would give them an additional source of income.

3.3 COMPONENTS OF SEED FARM

Figure 3.2 gives a layout plan of fish seed farm. A fish seed farm comprises different components namely hatchery complex, nursery ponds, rearing ponds and stocking ponds. In addition to these structures, a well equipped laboratory, an office, store-room, watchman hut and water supply system are also required for the support and maintenance of the fish seed farm.

A hatchery is a structure where incubation and hatching would be carried out. This will be set up in a room, provided with rectangular or circular troughs. Each trough will consist of three or four trays. The number of troughs would be determined by the size of hatchery complex and production of seeds to be achieved. Any one of the materials i.e., cement, wood, fiber glass or aluminium are being used for the construction of a trough, while a tray is made of simple wooden or iron frame with a netted mesh. The dimensions of rectangular and circular troughs will be 2.0m x 0.6m x 0.5 m and 2.0m x 0.75 m, respectively. The standard size of a nursery pond would be 3.0m x 0.75m x 0.5 m. The sizes of each rearing and stocking ponds would be 10m x 1.5m x 1.0 m and 30m x 6m x 1.5m, respectively.

3.4 ACTIVITY SCHEDULE

The activity schedule to be followed for the development of fish seed farms is given below :

Activity	Months
(i) Study of the sites	3 months
(ii) Construction of ponds	5 months
(iii) Liming and manuring	1 month
(iv) Introduction of brooders	1 month
(v) Artificial or induced breeding	Seasonal
(vi) Introduction of spawn for rearing	After 10 months

sites would be tested. After the finalization of the sites, the construction of ponds, hatchery complex, office, store, etc. would be started simultaneously. This would be followed by liming, organic and inorganic manuring of ponds. The ponds will then be left for a few days to develop into a natural ecosystem. Finally, the brooders will be introduced in the stocking ponds to obtain the eggs and milt. Hatching will be conducted 2 - 3 times in a breeding season, depending upon the fish species. Production of about 30 - 35 lakh seeds (6,000 - 7,000 eggs / tray ; 25,000 - 30, 000 eggs / trough) would be targeted per breeding season for each hatchery.

3.5 BUDGETARY ESTIMATES

The cost estimates for Fisheries Development is **Rs.73.69 lakhs**, the details of which are given in Table 3.1.

Table 3.1. The cost estimates for fisheries development

S.No.	Particulars	Qty	Rate (Rs.)	Amount (Rs. in lakhs)
A.	**Capital Cost for two farms (Non-recurring expenditure)**			
1.	Hatchery (One room, 20 troughs and 80- 100 trays)	1x2	1,26,000.00	2.52
2.	Nursery ponds (3.0m x 0.75m x 0.5m)	9x2	2,700.00	0.48
3.	Rearing ponds (10m x 1.50m x 0.5m)	9x2	18,000.00	3.24
4.	Stocking ponds (30m x 6.0m x 1.5m)	2x2	32,000.00	1.28
5.	Office, store, hut with infrastructure	4x2	-	3.40

6.	Laboratory	1x2	-	0.70
7.	Water supply (Lumpsum)	-	-	1.50
8.	Other project cost (Drag nets,wide mouth earthen pots, miniature hapa, buckets, bamboo poles,etc.) (Lumpsum)	-		1.00
Total (A)				**14.12**
B.	**Working Capital (Recurring expenditure)**			
1.	Salaries (For 8 years)			
	i) Farm Manager (1) 8 x 1 x 12 x Rs.10,000/-			6.00
	ii) Farm Assistants (2) 8 x 2 x 12 x Rs.7,000/-			13.44
	iii) Farm Attendants (2) 8 x 2 x 12 x Rs.5,000/-			9.60
	iv) Chowkidars (2) 8 x 2 x 12 x Rs.5,000/-			9.60
2.	Fish food (rice bran, oil cake, etc.) Lumpsum @ Rs. 50,000/- per year			4.00
3.	Brooders	300 kg	120	0.36
4.	Ponds manuring			
	i) Cow dung	20 tons	200 /tons	0.04
	ii) Urea	200 kg	5 / kg	0.01
	iii) Potash, Phosphate	200 kg	80 / kg	0.16
5.	Lime	600 kg	6 / kg	0.36
6.	Training and Research Lumpsum @ Rs. 50,000/- per year	-	-	4.00
7.	Chemicals Lumpsum @ Rs. 25,000/- per year	-	-	2.00
8.	Maintenance Lumpsum @ Rs. 50,000/- per year	-	-	4.00
9.	Travel Lumpsum @ Rs. 50,000/- per year	-	-	4.00
10.	Miscellaneous Lumpsum @ Rs. 25,000/- per year	-	-	2.00
Total (B)				**59.57**
GRAND TOTAL (A + B)				**73.69**

4

ECONOMIC REHABILITATION PLAN

4.1 INTRODUCTION

The proposed diversion dam near Pulga village will lead to the submergence of 12.1725 ha of land of which 8.1861 ha and 3.9864 ha are classified as forest land and private land, respectively. The proposed project will not lead to the submergence of any village. However, in addition to the land that would be submerged, 109.0425 ha of land would be required for various project related activities viz. desilting arrangements, approach roads to adits, diversion works, power house complex, quarry sites, plant areas, colonies, etc. Out of this, 79.6089 ha is the forest land belonging to various categories of forests like undemarcated forest (UPF), demarcated forest (DPF) and reserve forest (RF). More than 73% of the forest land acquired will be for permanent and rest would be for temporary use. A total of 121.2150 ha of land, belonging to forest (87.79 ha) and private owners (33.42 ha), would be required for reservoir submergence and other works in Parvati H.E. Stage-II project. The summary of socio-economic survey conducted in the Parvati project area is given in Annexure I.

Majority of the project related activities would be concentrated at and around Pulga dam site and at Sheelagarh project site in Hurla Nal

catchment. The project related activities do not involve major issues such as resettlement and rehabilitation of families in the project area.

The main occupation of the villagers is agriculture and horticulture. Villagers also augment their income by engaging in various other economic activities like animal husbandry, rearing of sheep and goats for wool and meat, cottage and small scale industries, and by extracting medicinal herbs and collecting '**Gucchhi**' from the forest (for details on socio-economic survey see Annexure-I).

In view of the socio-economic backwardness of the project area and as a part of social obligation on the part of project authorities, a socio-economic upliftment plan has been suggested for the people of Parvati and adjacent valleys. This plan would be implemented with the active participation of the local people and NGOs operating in the area. This plan would not only meet the food requirement of the affected households but will also help in the upliftment of their economic conditions. In addition to this, various training programmes are also envisaged for the villagers. This would include the creation of necessary infrastructure, stipends for the needy and salaries for the staff who are likely to run those programmes. Various activities suggested have been described below.

4.2 HORTICULTURE DEVELOPMENT

In the project area agriculture is practised on sloping fields. These unlevelled fields are highly prone to soil erosion particularly to sheet, rill and gully erosion. The ploughing and tilling of these fields further add to the soil erosion. Therefore, these fields are required to be

either levelled or their landuse needs to be changed from agriculture to horticulture. Under the horticulture development programme and with the help of local NGOs, villagers would be motivated to change the existing landuse; they would be encouraged and assisted to establish new orchards. This will not only increase the income of the villagers but will also help in the soil conservation. In addition to the suggested landuse, old and deteriorating orchards will also be improved by providing assistance for pruning, using chaubatia paste, thawla making, spraying of pesticides and using fertilizers which would rejuvenate the existing orchards. For the proper maintenance of these orchards, the cultivators would be provided with the improved horticultural tools such as grafting and pruning knives, secateurs, hand saw, spray machines, etc. Villagers have already realised the vast potential of horticulture and are raising orchards of apple, plum, cherry, walnut, etc. in the region. The cost estimates for undertaking the horticultural development programme will be **Rs.11.60 lakhs** the details of which are given in Table 4.1.

Table 4.1 Cost estimates for horticulture development programme

S. No.	Activities	Area (Ha)	Unit Cost per Ha	Amount (Rs. in lakhs)
1.	Rejuvenation of old orchards	110	Rs. 6,000/-	6.60
2.	Raising of private orchards	80	Rs. 5,000/-	4.00
3.	Distribution of improved horticultural tools	100 sets	Rs. 1,000/-	1.00
	TOTAL			**11.60**

4.3 LIVESTOCK DEVELOPMENT

Animal husbandry is practised for farm yard manure and milk products for the family. The cow dung is the main source of organic matter/fertiliser for the agriculture fields. The cattle are often let free for grazing in the area and stall feeding is seldom practiced. People keep a large number of local cattle which are smaller in size and their milk yield is low. Only a few progressive farmers rear Jersey cows. The villagers also rear sheep and goats for wool and meat which fetch them cash returns. Parvati valley supports a large number of sheep and goats and almost 10,000 sheep graze in the area during summer and villagers camp in the thaches for the extraction of medicinal plants (WII, 1999). The villagers take large flocks of sheep to high altitude meadows during the rainy season for about 5 to 6 months. These huge numbers of livestock put heavy biotic stress on the fragile ecosystem of the alpine regions. The unrestricted grazing in these areas results in denudation of hill slopes. Therefore, to achieve the objective of ecological rehabilitation, a rational programme of livestock management is suggested to be taken up on a large scale with the aim of reduction in unproductive livestock and introduction of better breeds of cows and sheep and encourage stall feeding. The implementation of livestock management programme would reduce the pressure of grazing in the project area and will also help in the increase production of milk and wool.

For livestock development programme and providing animal husbandry services to the villagers of the area, 2 veterinary sub-centres one each in Parvati valley and Hurla valley will be bulit. Sufficient funding support has been provided in the project cost for setting up veterinary sub-centre

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and maintenance for a period of 8 years. Various activities to be initiated under the livestock development programme and setting up of sub-centres would incur an estimated expenditure of **Rs. 55.09 lakhs**. The details of which are given in Tables 4.2 and 4.3.

Table 4.2 The estimated cost of livestock development programme

S.No.	Activities	Unit	Unit cost (Rs.)	Amount (Rs. in lakhs)
1.	Fodder minikits	500 nos.	80.00	0.40
2.	Chaff cutters/feed troughs	250 nos.	1,900.00	4.75
3.	Supply of modern handlooms for weaving	100 nos.	12,000.00	12.00
4.	Construction of silage tanks	Lumpsum grant		0.50
	TOTAL			17.65

Table 4.3 The estimated cost of setting up of veterinary sub-centres

	Particulars	Amount (Rs. in lakhs)
A.	**Non-recurring Cost**	
	i) Building	
	2 Nos. x 46 sq m x Rs.3000/- per sq m	2.76
	ii) Equipment, labcratory facility, furniture, etc.	3.00
	Lumpsum grant	
	Total (A)	**5.76**
B.	**Recurring Cost (For 8 Years)**	
	i) Salaries & Wages	
	Compounder (1) @ Rs.8,000/- per month	
	= 8 x 1 x 8,000 x 12	7.68
	Watchman (1) @ Rs.5,000/- per month	
	= 8 x 1x 5,000 x 12	4.80
	ii) Medicines & other miscellaneous expenditure @ Rs.20,000/- per month	
	= 8 x 20,000 x 12	19.20
	Total (B)	**31.68**
	GRAND TOTAL (A+B)	37.44

Under the livestock development/animal husbandry programme the following activities will be taken up :

i) **Upgrading breed of livestock**

In order to improve the breed of existing livestock, breeding centres at the proposed veterinary sub-centres would be established in the area with one bull of Jersey-Sindhi crossbreed and four Merino rams at each centre.

ii) **Castration of scrub bulls**

This activity is essential to stop the proliferation of scrub and unwanted bulls and rams. Incentive would be given to the owners of such castrated bulls and rams.

iii) **Distribution of fodder minikits**

The seeds of fodder plants like clovers, `Barseem', `Chari', Barley, etc. will be distributed in the form of minikits, free of cost, for raising green fodder in farmers own land and to encourage stall feeding. This distribution of fodder minikits would continue during the project construction period and thereafter the minikits would be made available to the farmers at subsidised rates.

iv) **Supply of feed troughs (tubs) and chaff cutters**

Feed troughs and chaff cutters will be distributed free of cost to the villagers to encourage the proper usage of fodder.

v) **Silage making**

If green fodder is stored without proper drying, it rots and

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iv) Supply of feed troughs (tubs) and chaff cutters

Feed troughs and chaff cutters will be distributed free of cost to the villagers to encourage the proper usage of fodder.

v) Silage making

If green fodder is stored without proper drying, it rots and oxygenation causes formation of biuteric acid which makes the fodder

unpalatable for cattle. However, if green fodder is stored in air and water tight pits or other devices, then the absence of oxygen results in the formation of lactic acid is formed which doesn't allow rotting of fodder and such fodder is relished by cattle. This method would be used to preserve the fodder.

For making silage the green fodder is dried in light shade so that it wilts. Thereafter, it is cut by chaff cutter. One quintal of this fodder is mixed with 2-3 kg of sheera, 5-7 kg of coarse grain pieces and 400 gm of sodium metabisulphate. This mixture is pressed and stored in closed tanks. These tanks are covered with lid and made air tight with mud paste. After 2-3 months of treatment fodder inside the tank becomes `silage' which is not only relished by the cattle but can also be stored safely for 12-18 months.

One cum of silo or tank contains silage which is equivalent to 4 quintals of dry fodder weight whereas same capacity silo will contain only 70 kg of dry hay. Financial help will be provided by the project authorities and the technical advise will be sought from the officials of Great Himalayan National Park and DFO, Parvati Forest Division and Seraj Forest Division for the construction of pucca silage tanks with removable R.C.C lids.

vi) Supply of modern handlooms

Our surveys in the project area revealed that the villagers at present have crude and worn-out handlooms for weaving. The villagers mostly are involved in making woollen cloth locally known as 'Patu'. Given the fact that large quantities of wool are produced in these areas,

modern handlooms will be an asset to the socio-economic upliftment of the villagers engaged in the handloom industry. In order to provide motivation and assistance to these village craftsmen modern handlooms would be distributed among them to help them generate additional income.

4.4 FARM FORESTRY

Farm forestry is an important aspect of forestry programme. It requires low inputs than other plantation models and yields direct and higher benefits to individual farmers. The project authorities will bear the cost of raising the seedlings for farm forestry. Project authorities would create a network of small nurseries with the help of Forest Department which will provide seedlings to the farmers and necessary help and advice for their maintenance. This programme will be extended to the interested farmers as a part of afforestation programme to be taken up under the catchment area treatment (CAT) plan. The marginal farm lands, field bunds and terrace risers would be targeted for farm forestry. The seedlings of fodder and fuelwood species will be supplied free of cost to villagers which would be planted by them in their fields.

4.5 PUBLIC PARTICIPATION

Ensuring people's participation in micro-planning, implementation, benefit sharing and post-project management of assets would be an integral part of the project approach and policy. A sum of **Rs.15.00**

authorities would be specify the activities and their physical goals but the exercise of micro level planning would be undertaken based on Participatory Rural Appraisal (PRA) approach. In this approach villagers should be fully involved in selection of site, locations and beneficiaries (whether for individual, groups or community) of the project activities. Village women play an important role in farming systems, rearing of livestock, fuelwood and fodder collection, agricultural operations etc. besides house keeping, cooking and numerous household chores. Therefore, participation of womenfolk in different programmes would be given high priority. Established democratic institutions like Village Panchayats would also be involved particularly in post-project management of community assets like afforestation sites, pasture development, livestock breeding centres, etc. and in regulating rotational grazing and extraction of medicinal plants, and 'Gucchhi'.

4.6 TRAINING

Majority of the households have marginal or small land holdings and their occupation is mostly agriculture. It is proposed to impart special training to the affected people for augmenting their economic activities as well as management and upkeeping of livestock, such as goats and cows, weaving of handicrafts, apiary, etc. It is also proposed to open two vocational training centres one each in Parvati valley and Hurla valley where the inhabitants of the area would be encouraged to undergo training in horticulture, fisheries, bee-keeping etc. and upgradation of existing skills in carpet weaving, manufacture of handicrafts, etc. This would be in addition to the various ongoing rural

development activities encouraged under schemes like IRDP, NREP, RLEGP, etc. In addition, the people in the area would also be encouraged to get training in typing, development of secretarial assistance and working with computers. A lumpsum grant of **Rs. 50.00 lakhs** has been earmarked for conducting various training programmes. For this the help of local NGOs will be solicited.

4.7 SUMMARY OF VARIOUS COST ESTIMATES

The summary of cost estimates for carrying out various economic rehabilitation activities is given in Table 4.4.

Table 4.4 Summary of cost estimates for economic rehabilitation.

S. No.	Activity	Amount (Rs. in lakhs)
1.	Horticultural Development	11.60
2.	Livestock Development	17.65
3.	Setting up of Veterinary Sub-Centres	37.44
4.	Public Participation	15.00
5.	Training	50.00
	TOTAL	**131.69**

REPORT ON THE SOCIO-ECONOMIC SURVEY OF AFFECTED VILLAGES IN PARVATI H.E. STAGE - II PROJECT AREA

1. PARVATI H.E. PROJECT AREAS AND AFFECTED VILLAGES

The construction of proposed dam near Pulga village in the Parvati Stage - II H.E. project would not lead to submergence of any village or their land. However, the inhabitants of the villages in the vicinity of the project would be indirectly affected due to various project related activities. Therefore, socio-economic surveys were conducted in those villages, which will be directly and/or indirectly connected with the project activities and are expected to be affected by them. The surveys were conducted to collect data on various parameters like human population, livestcock population, land holdings by families, their economic structure and sources of income, the amenities like electric power, water supply, roads and communication network, etc. An account of the same has been presented in the following paragraphs.

There is no village or any agriculture land that would be directly affected by the submergence due to proposed diversion dam across Parvati river near Pulga village. However there are 18 villages that would be indirectly affected by the project related activities like construction of head race tunnel, adits, powerhouse, residential and labour colonies, roads, quarrying, workshop, etc. Of these 7 villages

are located in Parvati valley, 5 villages, in Hurla valley and 6 villages are located in Sainj-Jiwa valleys. Pulga, Kalga, Tulga, Tosh, Nakthan and Kalboti villages are located immediately within the catchment upstream of proposed dam whereas Barsheni is located immediately downstream of dam on the right bank of Parvati river. In the Hurla valley only Manihar village is located near the proposed Manihar Nal trench weir while rest of the 4 villages are located downstream of Sheelagarh. These villages would be affected by proposed road construction, adits, feeder tunnels, colonies, quarrying, etc. Manjhan and Kundar villages in the Jiwa valley would be affected by activities like construction of proposed Jiwa Nal trench weir, colony, roads, etc. and are located in the immediate vicinity of Great Himalayan National Park. The village Railah would be affected by proposed powerhouse construction activities.

2. POPULATION STRUCTURE

Railah is the largest village in terms of human population as well as total area of the village (Table 1). In Parvati valley Barsheni is the largest village with a human population of 528 belonging to 91 families followed by village Tosh in Tosh Nal catchment with a population of 359 belonging to 64 families and Pulga village with a population of 310 belonging to 51 families. In Hurla valley Thela is largest village with a human population of 228 beonging to 60 families and Rauli is the smallest village with human population of only 83 belonging to 15 families. Area-wise Manihar is the largest village (31 Ha) and Rauli village is smallest (4 Ha). In Jiwa valley Railah being the largest, and Manjhan and Kundar being the smallest villages.

The ratio of male to female population varies from village to village (Table 1). Though male to female ratio is more in most of the villages, the population of females is more than the males in Pulga, Tulga, Barsheni and Tosh villages in Parvati valley and Kathiyari, Pashi and Sharan villages in Jiwa valley .

The population of people belonging to scheduled castes is maximum in Pulga village (about 60%) and least in Barsheni village (5.11%) in Parvati valley (Table 1). In Hurla valley, the scheduled caste population is maximum in Garsah village (31.16%) while in Sainj-Jiwa valley, their population is maximum in Sharan village (31.02%). There are no Scheduled Tribes in the project affected villages. Therefore no ehthnography was conducted. The overall literacy is maximum in Kalga village (68.47%) followed by Pulga village (61.29%) in Parvati valley (Table 1). The highest pecentage of literates are found in Garsah village (75.81%) and lowest in Jhuni village (25.30%) in Hurla valley. The percentage of literate population in Jiwa valley is maximum in Sharan village (63.55%) followed closely by Pashi (60.44%). The percentage of population in the age group of 0-6 years i.e. the young ones is lowest (8%) in Pulga village in Parvati valley. The percentage of young ones is highest (27.71%) in Jhuni village in Hurla valley (Table 1).

3. OCCUPATIONAL PATTERN

Majority of the populations of the affected villages are engaged either in agriculture or horticulture. A little more than 40% of the people in Parvati valley are engaged in cultivation practice with a maximum

percentage of cultivators in Kalga and Tulga villages (57-58%) (Table 2). In Hurla valley also more 30% of the people on average are engaged in cultivation. The percentage of people involved in cultivation in Jiwa valley also varies from 36 to 60% (Table 2). Only a small percentage of people have taken to business activities in these villages. Similarly, the percentage of people employed in government service is also very low. However, a number of people get employed on daily wages basis as tourist guides, field workers, labourers for road construction activities, etc.

4. LANDUSE PATTERN

Most of the village land in this area is under unirrigated landuse (Table 3) followed by land under pastures and grazing lands. Only few villages viz., Thela, Jhuni and Garsah in Hurla valley have irrigated landuse. Groves and orchards are the next major landuse in these villages (Table 3) followed by unculturable land. Among all the villages, only Railah has its own village forest.

Among the crops, wheat, maize and barley are the cereal crops grown in the area. Beans and pulses are also grown in most of the villages (Table 4). Among the vegetables, potatoes and garlic are grown in villages of Jiwa valley. The horticulture fruit trees of apple, plum and prunus are grown in all the areas.

5. INFRASTRUCTURE

There are 4 High schools, 3 Middle schools and 10 Primary schools in the area. In Parvati valley, there is only one high school and

one middle school which are located in Barsheni village and 4 primary schools one each in Pulga, Barsheni, Tosh and Nakthan villages (Table 5). The inhabitants of Tulga, Kalga and Kalboti have to travel a distance of 1-4 km to go to the primary schools. For studying in the high schools the students of these villages in Parvati valley are required to travel 3-8 km on an average. Kalboti village has no educational institution. In Hurla valley also, there are only 2 high schools located in Garsah and Najan villages. The middle schools and primary schools in Hurla valley are located at a distance of about 10-13 km from the adjoining villages. There is only one high school in Jiwa valley located at Sainj. The villagers from Sharan, Pashi, etc. have to travel long distances to study in these schools.

There is only one dispensary in Parvati valley which is located in Barsheni (Table 5). In Hurla valley, there are 3 dispensaries located at Najan, Thela and Garsah villages, while in Jiwa valley only one dispensary is located at Sainj. Therefore, the inhabitatnts of most of the villages in the area have to travel long distances i.e. 5 km to 38 km to avail of the medical facilities.

Regarding the Post and Telegraph facilities in the area, there is only one post office each in Parvati valley located at Barsheni, at Thela in Hurla valley and at Railah in Jiwa valley (Table 5). There is no telegraph office in the area. The drinking water is supplied by taps in most of the villages in the area. Only the inhabitants of Kalboti in Parvati valley, Rauli in Hurla valley and Manjhan and Kundar villages in Jiwa valley are dependent upon natural sources for their drinking water needs (Table

5). Most of the villages have electrical supply, however only Barsheni and Garsah have LPG facitity.

6. LIVESTOCK POPULATION

Most of the people in the area keep goats, sheep and cows, whereas only a few keep buffaloes. Livestock population is highest in Tosh village (1507 cattle heads) followed by Pulga (1332) and Barsheni (956) in Parvati valley (Table 6). However, Railah village in Jiwa valley has the largest livestock population (2538) amongst all the villages studied.

Table 1 Population structure of the villages in the vicinity of project area

Villages	No. of house-holds	No. of occupied house-holds	Total popu-lation	Males	Females	Scheduled castes	Literates	Population in the Age Group (0-6 years)
Parvati Valley								
1. Pulga	51	51	310	149	161	187	190	26
2. Kalga	19	19	111	57	54	36	76	14
3. Tulga	22	22	105	48	57	-	61	13
4. Barsheni	91	91	528	261	267	27	288	90
Tosh Valley								
5. Tosh	64	64	359	168	191	61	198	69
6. Nakthan	30	30	187	93	94	86	93	24
7. Kalboti	8	8	40	24	16	-	21	6
Hurla Valley								
8. Manihar	17	17	153	86	67	21	61	32
9. Thela	60	58	228	115	113	54	125	23
10. Jhuni	9	9	83	48	35	-	21	23
11. Garsah	36	36	215	105	110	67	163	22
12. Rauli	15	14	83	46	37	-	35	13
Sainj-Jiwa Valley								
13. Kathiyari	6	6	28	11	17	-	10	3
14. Pashi	64	64	412	198	214	-	249	49
15. Sharan	50	48	332	151	181	103	211	39
16. Railah	112	112	705	381	324	42	396	81
17. Manjhan	6	6	32	17	15	-	17	3
18. Kundar	4	4	26	14	12	-	13	2

Table 2 Occupation pattern of the villages

Villages	Government servants	Businessmen	Cultivators
Parvati Valley			
1. Pulga	6	6	126
2. Kalga	-	2	65
3. Tulga	2	1	60
4. Barsheni	6	5	233
Tosh Valley			
5. Tosh	2	6	102
6. Nakthan	1	2	79
7. Kalboti	-	-	16
Hurla Valley			
8. Manihar	4	-	61
9. Thela	10	7	62
10. Jhuni	2	-	29
11. Garsah	15	12	45
12. Rauli	1	-	38
Sainj-Jiwa Valley			
13. Kathiyari	-	-	13
14. Pashi	4	-	198
15. Sharan	4	2	122
16. Railah	20	10	328
17. Manjhan	-	-	20
18. Kundar	-	-	16

Table 3 Landuse pattern in the villages around the project sites

Villages	Area (ha) Village	Area (ha) Forest	Irrigated	Unirrigated	Groves & Orchards	Uncultivable	Pastures & Grazing land
Parvati Valley							
1. Pulga	38.0	-	-	18.0	10.0	8.0	48.0
2. Kalga	15.0	-	-	7.2	6.0	-	Common
3. Tulga	16.0	-	-	6.0	5.5	3.0	Common
4. Barsheni	46.0	-	-	32.0	4.0	8.0	-
Tosh Valley							
5. Tosh	52.0	-	-	32.2	16.0	-	4.0
6. Nakthan	85.0	-	-	29.2	29.0	20.0	5.0
7. Kalboti	16.0	-	-	16.0	-	-	30.0
Hurla Valley							
8. Manihar	31.0	-	-	25.6	-	2.4	2.0
9. Thela	11.5	-	2.4	5.2	1.2	0.25	-
10. Jhuni	8.0	-	0.06	7.2	-	0.12	0.12
11. Garsah	12.5	-	1.1	7.0	2.0	1.0	-
12. Rauli	4.0	-	-	1.6	1.2	0.8	-
Sainj-Jiwa Valley							
13. Kathiyari	30.0	-	-	20.0	-	10.0	30.0
14. Pashi	72.0	-	-	45.0	10.0	15.0	50.0
15. Sharan	103.0	-	-	80.0	10.0	10.0	35.0
16. Railah	165.0	3.0	-	120.0	35.0	-	100.0
17. Manjhan	6.0	-	-	4.0	-	2.0	-
18. Kundar	6.0	-	-	4.0	-	2.0	-

Table 4 Important crops grown in the area

Villages	Important crops
Parvati Valley	
1. Pulga	Potato, Beans, Pulses, Wheat, Maize, Apple
2. Kalga	Potato, Beans, Pulses, Wheat, Maize, Apple, Prunus
3. Tulga	Potato, Beans, Pulses, Wheat, Maize, Apple, Prunus
4. Barsheni	Wheat, Maize, Pulses, Beans
Tosh Valley	
5. Tosh	Potato, Beans, Wheat, Maize, Apple
6. Nakthan	Apple, Pulses, Beans, Barley, Wheat, Potato, Maize
7. Kalboti	Potato, Medicinal herbs
Hurla Valley	
8. Manihar	Maize, Wheat, Beans, Pulses
9. Thela	Maize, Wheat, Pulses, Apple, Plum
10. Jhuni	Maize, Wheat, Beans, Apple, Plum
11. Garsah	Wheat, Rice, Maize, Vegetables
12. Rauli	Wheat, Maize, Vegetables
Sainj-Jiwa Valley	
13. Kathiyari	Potato, Wheat, Maize, Garlic, Spices, Beans
14. Pashi	Potato, Wheat, Maize, Garlic, Spices, Beans
15. Sharan	Potato, Wheat, Maize, Garlic, Spices, Beans
16. Railah	Potato, Wheat, Maize, Garlic, Spices, Beans
17. Manjhan	Potato, Garlic, Maize
18. Kundar	Potato, Garlic, Maize

Table 6 Livestock population of the villages

Villages	Numbers				
	Goats	Sheeps	Cows	Buffaloes	Others
Parvati Valley					
1. Pulga	412	660	160	12	88
2. Kalga	90	110	20	2	22
3. Tulga	150	200	45	1	30
4. Barsheni	416	306	148	-	86
Tosh Valley					
5. Tosh	225	938	239	-	105
6. Nakthan	229	249	74	-	44
7. Kalboti	30	40	21	-	8
Hurla Valley					
8. Manihar	620	363	13	2	16
9. Thela	-	6	29	2	26
10. Jhuni	79	56	14	-	16
11. Garsah	-	-	67	-	4
12. Rauli	86	45	14	-	12
Sainj-Jiwa Valley					
13. Kathiyari	90	74	16	-	21
14. Pashi	820	800	210	3	152
15. Sharan	710	450	154	3	152
16. Railah	1100	650	370	3	405
17. Manjhan	120	68	28	-	12
18. Kundar	86	60	16	-	8

5

PUBLIC HEALTH DELIVERY SYSTEM

5.1 THE STATUS OF MEDICAL FACILITIES

The delivery of health services is rendered through hospitals, primary health care centres and dispensaries. The District Hospital is a referral centre for complicated cases. The primary health centres, care services and dispensaries provide services to the inhabitants in rural and urban areas. Kullu district has four allopathic hospitals/ community health centres, 14 primary health centres, 5 dispensaries and 97 health sub-centres (Kullu District Statistical Handbook, 1998) (Table 5.1). Kullu town has one hospital, one T.B. centre and one family planning centre equipped with 110, 10 and 10 beds, respectively. In addition to the allopathic hospitals there are 37 ayurvedic dispensaries and one ayurvedic hospital in the district. Medical facilities are available to 80 of the villages of Kullu C.D. Block covering 86.70% of the rural population. However, the medical facilities available to the villages in the project area are very poor. There is only one dispensary in Parvati valley which is located at Barsheni. In Hurla valley, there are 3 dispensaries located at Najan, Thela and Garsah villages, while in Jiwa valley only one dispensary is located at Sainj. Therefore, the inhabitants of most of the villages in the area have to travel long distances ranging from 5 to 38 km to avail the medical facilities. The nearest hospital is

located at Bhuntar with only 6 beds. The nearest medical college is situated at Paprola in Kangra district which is more than 160 km from Bhuntar. The area faces the problem of inaccessibility during the rainy season. The villages are sparsely populated and scattered far and wide; many of these villages are not even covered by the primary health care units. None of the PHCs are provided with ambulances and the drugs stocked in these health centres are grossly inadequate. The number of medical workers in allopathic and ayurvedic hospitals is given below.

Allopathic	
Doctors	64
Health Workers	
Female	76
Male	89
Ayurvedic	
Doctors	40
Other workers	61

During the construction of proposed Parvati H.E. Stage - II project there will be a peak force of immigrant labourers ranging from 5,000 to 10,000. These immigrant workers may be the potential carriers of new diseases hitherto unknown/unreported from the project area. Diseases like AIDS, VDS, Malaria, gastro-enteritis, etc. are some of the potential risks to human inhabitants of this area, who could get exposed to the diseases carried by immigrant workers. The skeletal health services existing in the area would be highly inadequate to cater

to vast influx of outside labourers in this area. Therefore, it would be mandatory for the project authorities and their contractors to have all the labourers including their family members registered, quarantined and vaccinated against diseases like malaria, AIDS, VDS, Typhoid, T.B., etc. The project authorities will organise screening camps for the immigrant labourers where rapid blood tests would be conducted for these diseases. Only after valid certification, a labourer or his family members will be registered with a contractor. The project authorities would ensure that the contractors follow this strict quarantine procedure and this clause would be included in the award of the contract/works. Sufficient medical facilities would be provided by the project authorities for this purpose in addition to upgradation and strengthening of existing medical facilities in the area.

Table 5.1 Medical institutions (Nos.) in Kullu district, Kullu tehsil and Project area

S.No.	Particulars	Kullu District	Kullu Tehsil	Project Area
A.	**Allopathic**			
1.	Hospitals/Rural dispensaries and Health Centres	4	2	–
2.	Primary Health Centres	14	6	–
3.	Dispensaries	5	3	5
4.	Health Sub-Centres	97	48	–
B.	**Ayurvedic**			
1.	Hospitals	1	1	–
2.	Dispensaries	37	17	–

Source: Chief Medical Officer, Kullu & District Ayurvedic Officer, Kullu

5.2 MEDICAL FACILITIES TO BE PROVIDED

It has been observed that the inhabitants of the project area and also of the villages in the vicinity of the project site are prone to diseases like diarrhoea, dysentry, malaria, jaundice, etc. There is very little immunity to these diseases especially in the children. Therefore, it would be the responsibility of the project authorities to make provisions for at least one medical sub-centre and one primary health centre each in Parvati, Hurla and Jiwa valleys. These medical sub-centres and primary health centres will provide medical services to the workers and labourers engaged in the project construction work and also to the population of surrounding villages as there is an acute shortage as well as an urgent need of these facilities in these areas. In addition to these medical services, one ambulance/mobile clinic shall also be stationed at the project site to provide emergency medical facilities. This would be extremely helpful in case an emergency arises for shifting of critically ill patients from the remote areas to the nearby hospital/clinic. Initially all the expenditures for setting up of medical facilities and their maintenance would be borne by the project authorities for a period of at least 8 years. Thereafter, it is assumed that it would be taken over by the Himachal Pradesh State Medical Directorate. These facilities would be established at an estimated cost of **Rs.219.60 lakhs.** In addition to the setting of medical sub-centres, the facilities at the dispensaries already situated at Barsheni, Thela, Najan, Garsah and Sainj villages would be upgraded. For this purpose a lumpsum grant of Rs. 5.00 lakhs per dispensary would be provided. Therefore, the estimated cost of setting up of these medical facilities will be **Rs.244.60 lakhs** (Table 5.2).

Table 5.2 Estimated cost for setting up of medical facilities

	Particulars	Amount (Rs. in lakhs)
A.	**Non-recurring Cost**	
	i) Building	5.40
	3 nos. x 60 sq m x Rs.3000	
	ii) Cost of two ambulances	10.00
	iii) Equipments, laboratory facilities, furnitures, etc. Lumpsum grant	5.00
	Total (A)	**20.40**
B.	**Recurring Cost (for 8 years)**	
	i) Salary	
	a) Doctor (1) @ Rs.18,000/- per month = 8 x 1 x 18,000 x 12	17.28
	b) Nurse (2) @ Rs.8,000/- per month = 8 x 2 x 8,000 x 12	15.36
	c) Compounder (4) @ Rs.6,000/- per month (including 2 nos. for ambulances) = 8 x 4 x 5,000 x 12	19.20
	d) Chowkidar (1) @ Rs.5,000/- per month = 8 x 1 x 5,000 x 12	4.80
	e) Driver (2) @ Rs.5,000/- per month = 8 x 2 x 5,000 x 12	9.60
	f) Helper (1) @ Rs.3,500/- per month = 8 x 1 x 3,500 x 12	3.36
	ii) Medicine and other miscellaneous expenditures @ Rs.20,000/- per month for each Centre and Rs.10,000/- per month for each mobile clinic	
	8 x 3 x 25,000 x 12	72.00
	8 x 2 x 10,000 x 12	19.20
	iii) Maintenance of two ambulances @ Rs.20,000 per month for each ambulance	
	8 x 2 x 20,000 x 12	38.40
	Total (B)	**199.20**
C.	**Lumpsum grant for strengthening of 5 dispensaries @ Rs. 5.00 lakhs per dispensary**	**25.00**
Grand Total (A+B+C)		**244.60**

5.3 WATER QUALITY

The water quality analysed for different parameters at various sampling sites in Parvati river is given in Table 5.3. As is evident from the data, the water quality at all the sampling sites was found to be good.

Table 5.3 Water quality characteristics of Parvati River

Parameter	Sampling Sites			
	Bhuntar	Sarsadi	Kasol	Shila
Altitude (m)	950	1200	1600	1800
Temperature (°C)	14	13	9	8
Velocity (m/sec)	0.65	0.9	0.8	1.15
Turbidity (ntu)	90-100	90-100	80-90	80-90
pH	6.5	6.5	6.5	6.5
TDS (mg/l)	2000	2000	1000	1000
DO (mg/l)	9.5	9.0	9.0	9.0
BOD (mg/l)	1.5	1.0	1.5	1.0
Coliform (No./100 ml)	<50	<50	<50	<50
Plankton (No./l)	240	210	270	90
Macro-zoobenthos (No./m^2)	322	364	396	132

BOD, DO, pH and coliform are most important parameters for assessing the water quality. The river water at all the sampling sites was found to be alkaline (pH 6.5) like any other river of North India. The BOD ranged from 1.0 to 1.5 mg/l in the river indicating presence

of pollution-free water of the river and its tributaries. The dissolved oxygen was sufficient in the river ranging above 9 mg/l. Total coliform, the most critical parameter for water quality, used for the grading of water for potability, was observed to be less than 50/100 ml in the river, which indicates the high purity of Parvati river water. The status of other parameters like temperature, velocity and TDS depend on the season, volume and geography of the river. The temperature of water was recorded to range from 8-14°C from Shila downstream to Bhuntar. Water velocity was high at Shila while lowest at Bhuntar. The river was found to be highly turbid during sampling period. The turbidity was recorded to be 80-100 ntu, which indicated lot of silt coming in the river from the catchment slopes.

Among the biological characteristics, the plankton and macro-zoobenthos were found to range from 90-240 per litre and 132-396 m^2, respectively. This is not a healthy status of river in normal condition, but their diversity and density was greatly influenced by turbidity and volume of water. High turbidity and dilution factor due to higher water volume explains the low number of plankton and zoobenthos during sampling. Overall the water quality of the river at all sampling sites was good, which corresponds to grade 'A' river waters (according CPCB norms).

5.4 SEWAGE MANAGEMENT

The aggregation of large number (10,000 peak labour force) of weakers in the project area would exert great pressure on the ecosystem of the area. Therefore, an action plan has been formulated to minimise the stress during the construction phase that would be exerted by the migrant labour residing in the temporary labour colonies.

Generally the labourers are made to live in slum type conditions without the facilities of potable water supply and waste disposal. The source of drinking water supply in the project area is a number of streams/ rivulets. The quality of this water is good and is fit for drinking (see Table 5.3). However, as a precautionary measure, chlorine tablets would be distributed to each worker's household to prevent outbreak of any water-borne diseases. The project authorities would make it mandatory for the contractor involved in construction activities to provide adequate water supply and sanitation facilities to the workers. The project authorities would provide funding support for the construction of community toilets and septic tanks.

One community toilet will be provided per 5 families (25 persons). The sewage from community toilets would be treated in septic tanks. For each 100 families (500 persons), one septic tank would be provided. Drinking water facilities and waste disposal sites would be located away from each other.

The envisaged construction time for the project is 8 years. At the peak of construction phase, there would be an increase in population in the project area by 25,000 (the peak labour-force would be 10,000 and including their family members, the effective number of persons that would be emigrating to the project roughly comes out to be 25,000). Therefore, 1,000 community toilets and 50 septic tanks would be required to be constructed. The estimated cost for the construction of these facilities has been given in Table 5.4.

Table 5.4 Cost estimate for sanitation facilities for labour colonies

S. No.	Unit	Rate (Rs./Unit)	Number	Total Cost (Rs. in lakhs)
1.	Community toilets	10,000	1,000	150.00
2.	Septic tanks	100,000	50	50.00
	Total			200.00

5.5 COST ESTIMATES

The estimated cost for the implementation of different activities under the public health delivery system would be **Rs.444.60 lakhs** and sufficient provision has been made in the project cost.

PROVISION FOR FUELWOOD/LPG DEPOTS AND ENERGY CONSERVATION MEASURES

6.1 PROVISION FOR FUELWOOD/LPG DEPOTS

In the villages of the proposed project area the main source of energy is fuelwood, which is also the main cause of ecological degradation. The proposed Parvati H.E. project would further lead to increased demand for fuelwood and fodder and would therefore exert tremendous pressure on forest areas in the vicinity of the project. It is estimated that during the construction of Parvati H.E. Stage-II project a peak labour force ranging from 5,000 to 10,000 shall be employed and the project is expected to be completed in about 8 years. Majority of the labour force will be from outside the project area, most probably from other states.

In order to meet the fuelwood requirements of immigrant labourers, it is proposed to provide free/subsidised fuelwood/kerosene/ LPG from the depots to these workers. This would discourage them from illicit tree feeling and removal of fuelwood and timber from the adjoining forests. These fuelwood/kerosene/LPG depots will be opened and managed by the project authorities. The fuelwood will be provided free to the workers by purchasing it from the State Forest

Department. Similarly, kerosene and cooking gas shall also be arranged from the concerned agencies. Furthermore, community canteen facilities are proposed to be provided to the labourers. In addition to the above mentioned measures, efforts would also be made towards energy conservation and installation of non-conventional sources of energy which will help in conserving the environment. Under this programme following components have been provided.

6.2 COMMUNITY KITCHEN

To minimise the extraction of fuelwood by large congregation of labourers from the nearby forest ares during the construction phase community kitchens would be provided at the main construction sites, in addition to the provision of free/subsidized LPG/fuelwood to the workers. The community kitchen would be run either on a cooperative basis or by the contractors.

An amount of **Rs. 200 lakhs** has been set aside for the supply of free/subsidised fuelwood/kerosene/LPG, etc. to the labour force and for a provision of community kitchens at the major construction sites.

7

RELOCATION AND REHABILITATION OF DUMPING MATERIAL

7.1 INTRODUCTION

The proposed Parvati H.E. Stage - II project envisages the construction of a 31,250 m long head race tunnel (HRT) of 6.0 m diameter and five nos. of D-shaped adit tunnels with lengths varying from 100m to 500m. As a result huge quantity of material would be excavated from HRT and adit tunnels during the tunnelling. In addition to this the construction of desilting arrangement, spillway channel, intake structure, pressure shaft, power house complex and the approach roads would also generate a large amount of excavated material. Even though some of this material will be utilised construction for back filling and the for wire crates for providing protection to slopes along the banks, both upstream and downstream of diversion dam and trench weirs, still maximum quantity will need to be relocated and rehabilitated.

7.2 TOTAL QUANTITY OF MATERIAL TO BE EXCAVATED

The total quantity/volume of material to be dug out or excavated various project structures of Parvati H.E. Project Stage-II is ated to be of the order of 27.68 lakh cubic meters (Table 7.1).

7.3 DUMPING SITES

Most of the excavated material is proposed to be dumped at six suitable locations identified specifically for this purpose. These proposed locations are spread over land area of 5.1775 ha comprising forest land as well as private land (Table 7.2, Fig.1.1). The land for this purpose has already been acquired by the project authorities and necessary forest clearance for the same has also been granted to NHPC. Most of the unused excavated material would be stacked along the roads at different dumping sites (Table 7.3) while some material would be piled at an angle of repose at the pre-identified sites. In the latter case slopes would be broken up by creating benches across the slope. This will be done to provide stability to the slopes and also to provide ample space for planting of trees which would further help in holding and consolidating the material stacked at different sites. The efforts will be made to relocate and rehabilitate the material within short distances from the sites of its generation. The description regarding the stabilisation of the stacked material along the proposed roads has been discussed in the following paragraphs.

7.4 STABILISATION OF DUMPED MATERIAL

For retaining the dumped unused material for subsequent stabilisation along the hill slopes along the stretch of the road, sausage walls of 85m to 300m length are proposed at the six pre-identified dumping sites (Fig. 1.1). The sausage walls will run parallel to the road alignment and will be located at a depth of 30m - 120m from the road

level depending upon the quantity of material to be dumped. The height of sausage walls is proposed to be 20m on an average. A typical plan and cross sections representing different locations of proposed dumping sites are shown in Figures 8.1 - 8.3. As per the calculations given in these figures, sausage walls of 1,15,710 Cum would be required to be built. The total cost of construction of 1,15,710 Cum of sausage walls including the cost of wire mesh, preparation of beds, cutting, etc. would be **Rs. 2140.64 lakhs.**

For the consolidation of unused dumped material at different sites it is proposed to stabilise the same with vegetation cover. The traditional method of afforestation of these areas would be supplemented with the use of special class of fungi that form partnership with plant roots, i.e. vesicular- arbuscular mycorrhizae (VAM). These fungi grow on and extend the reach of plant roots for water and nutritional requirements. The seedlings inoculated with VAM survive better after transplanting and grow faster in nutrient poor soils. This technique has been widely tested and used for remediation of degraded areas. The use of this technologies and other phytoremediation has been tested and demonstrated by Centre for Environmental Management of Degraded Ecosystems, University of Delhi. The use of VAM fungi for the process of soil reclamation and the establishment of juvinile seedlings has been described in detail in Chapter 8 (p 133-136).

7.5 GUIDELINES FOR ROAD CONSTRUCTION

All the approach roads to various project structures will be constructed by employing the methodology devised by B.R.T.F., with minimal environmental damage. The methodology consists in developing the formation width in half cutting and half filling, so that the materials obtained from cutting are utilised in filling. The excavation on hill side will be done to get a stable slope for the materials encountered. At places where there is problem of retaining the hill slope breast walls, Gabion walls shall be constructed on natural slopes to retain the fill materials.

In case of steep gorge, retaining wall, gabion structure shall be constructed to retain the fill material. To minimise the environmental damage, construction material like stones, sand, etc. required for the construction of road will be obtained mostly from the excavated material from project works. In the streams, box culverts will be provided to prevent the erosion of nala bed. In addition stone/concrete work on the downstream area will also be provided at vulnerable places to minimise erosion.

The estimated cost of the relocation and rehabilitation of excavated material is given in Table 7.3. The total cost of these measures will be **Rs. 2190.64 lakhs.**

Table 7.1 The quantity of material to be excavated from various project structures

S.No.	Items	Quantity (Cum)
1.	Dam Intake Works	1,155
2.	Diversion Dam	2,24,800
	i) Excavation in river bed	3,425
	ii) Tunnelling	19,125
	iii) Fossil valley overburden	3,2400
3.	Approach tunnel and Desilting Chamber	4,11,000
4.	Jigrai Nal Diversion Works - Excavation of Overburden	2,475
5.	Sheelagarh Diversion Works	
	i) Manihar Nal trench weir - Excavation of river bed	2,450
	ii) Pancha Nal trench weir	2,450
	iii) Hurla Nal trench weir	3,080
	iv) Desilting arrangements (Chamber and tunnels)	12,000
6.	Jiwa Nal Diversion Works	
	i) Jiwa Nal trench weir	4,200
	ii) Approach tunnel	8,085
	iii) Desilting arrangement	32,000
7.	Head Race Tunnel	
	i) Portals and plant areas	50,000
	ii) Tunnelling excavation	12,75,000
8.	Surge Shaft	
	i) Excavation of plant areas	4,032
	ii) Rock excavation	40,310
9.	Penstock - Rock excavation, etc.	1,39,640
10.	Power House	
	i) Excavation of overburden	1,20,000
	ii) Rock excavation	2,80,000
11.	Jigrai Nal - Water Conductor System	
	i) Excavation of overburden	2,400
	ii) Tunnelling	2,650
12.	Sheelagarh Works - Water Conductor System	
	i) Rock excavation	10,840
	ii) Tunnelling	15,590
13.	Jiwa Nal Works	
	i) Feeder tunnel and shaft	69,055
GRAND TOTAL		27,67,662

Table 7.2 Dumping sites and amount of material to be dumped

S. No.	Dumping Sites	Area (ha)	Approx. quantity to be dumped (Cum)
A	At inlet portal of HRT	0.2345	1,25,000
B	At Adit No. 1 of HRT near Shila village	0.4935	2,80,000
C	At Adit No. 2 of HRT near Pancha Nal	0.7166	3,70,000
D	At Adit No.3 of HRT near Pulia Nal	0.9150	4,70,000
E	At Adit No. 4 of HRT near Railah village	2.7733	15,00,000
F	At Surge shaft near Adit No. 5	0.0445	20,000
	Total	**5.1774**	

Table 7.3 Financial requirements for relocation and rehabilitation of dumping material

S.No:	Item	Quantity	Rate (Rs.)	Amount (Rs. in lakhs)
1.	Construction of sausage walls including the cost of wire mesh, preparation of beds, cutting, etc.	1,15,710 Cum	1850/cum	2140.64
2.	Stabilisation and reclamation of dumped material (i) Field works including collection of VAM strains (ii) Isolation & characterisation of efficient strains (iii) Inoculation of seedlings (iv) Transfer of inoculated seedlings			50.00
	TOTAL			**2190.64**

LANDSCAPING AND RESTORATION OF CONSTRUCTION AREAS

8.1 INTRODUCTION

The proposed Parvati H.E. project Stage -II would involve construction of plant areas, residential and labour colonies and quarrying activity and crushing sites (Fig.1.1). These activities will result either in the modification or destruction of the existing landscape. Therefore, after the project work and related activities are over the project areas, require restoration works to bring them back to their similar or near-similar pre-construction conditions and landuse. Different project related activities will result in the disturbance of 21.5438 ha of the forest land near the proposed dam site and diversion works in Parvati valley, works at Sheelagarh in Hurla Nal and surge shaft and power house near Suind in Sainj valley. For these activities 13.7292 ha of the forest land will be used permanently, while 7.8146 ha of the forest land will be put to temporary use. In addition to the habitat disturbance, project related activities will also result in the accumulation of large amounts of dumps at various construction sites which need either to be relocated or could be utilized for some project activities like retention wall building, road building, filling, etc. Restoration success

will, however largely depend on the topography of the area, the type of constructional activities and their detrimental effects on the terrain and the natural habitats.

8.2 RESTORATION AND LANDSCAPING OF QUARRY SITES

Most of the proposed project – related activities would lead to the removal of vegetation cover along with the top soil and leave the sites barren. After the completion of quarrying activity, these areas will be restored to their normal habitat conditions. To achieve this, measures would be adopted both before and after the quarrying activity at various sites in the project area.

8.2.1 Measures for Pre-project Activity

The top 6-12" of soil will be removed before starting the quarrying activity or any other surface disturbances. The removed top soil will be kept separate and stock piled so that it could be reused subsequently for the rehabilitation of quarry sites after the completion of quarrying activity.

8.2.2 Measures for Post-project Activity

8.2.2.1 *Diversion of Run-off*

Effective drainage system will be provided to avoid the infiltration of run-off and surface waters into the ground of quarry sites to avoid its erosion.

8.2.2.2 *Filling of the Depressions*

Removal of rocks from the quarry sites for different construction works will result in the formation of depression and/or craters. These will be filled up by the dumping materials consisted of boulders, rock, gravel and soil from the near-by plant sites. For filling the quarry site at Chutti Bihal the materials will be obtained from plant area present near the quarry site. Similarly, the filling materials for quarries at Manihar Nal and Pulia Nal will be transported from the plant at adit no. 2 / workshop at Sheelagarh and plant at adit no. 3, respectively.

8.2.2.3 *Construction of Retaining Walls*

Retaining walls will be constructed at the filled up depressions of quarry sites to provide necessary support particularly at the quarry sites of Manihar Nal and Pulia Nal where there are moderately steep slopes.

8.2.2.4 *Rocks for Landscaping*

After the project activity is over, these sites would be splattered with the leftovers of rocks and boulders. These leftovers can support the growth of mosses and lichens which will act as ecological pioneers and would initiate the process of succession and colonization. Boulders of moderate sizes would be used to line the boundary of a path.

8.2.2.5 *Laying of the Top Soil*

The top soil removed before the start of the project activity would be used for covering the filled up depressions/craters at the quarry

sites. Fungal spores naturally present in the top soil would aid the plant growth and natural plant succession.

8.2.2.6 *VAM Fungi for Soil Reclamation*

The process of soil reclamation by using VAM fungi and soil microflora for the early establishment of juvenile seedlings is well documented. For the reclamation of the top soil, microflora isolated from rhizophenic soil and root surroundings (nearby areas), Vesicular-arbuscular mycorrhizal (VAM) fungi isolated from the roots of the plant species growing in these areas and organic manure would be used either individually or in different combinations. The two important factors which improve the existing VAM-plant association are selection of an efficient VAM fungal species which can help to enhance phosphorous supply and the choice of the genotype which can get maximum benefit of the VAM association (Menge, 1983). It is highly recommended to use the cost-effective and highly efficient VAM fungi for the revegetation of the areas degraded by the quarrying activity. VAM fungi have been extensively used for greening the degraded and barren lands and have been reported to increase yields by about 30% - 50%.

Top soil obtained from the project sites, before the start of the quarrying activity, would be reclamated by using VAM fungi. Seedlings will then be transferred to the enriched top soil for the colonization of their roots with VAM fungi. The procedure will be standardized for each of the plant species to achieve optimal colonization of roots by VAM fungi as climate, soil and vegetation types of the areas to be treated would determined the success of VAM fungi in the reclamation of the

degraded areas. A brief description of the recommended procedure to be followed for the colonization of seedlings with VAM fungi is given below :

(i) Top soil collected before the start of proposed activities at the reclamation sites would be used for (a) the preparation of the beds in the nursery, (b) for collection of microflora from the rhizophenic soil and root surroundings, and (c) for filling the small polythene bags which will be used subsequently for transplantation purposes.

(ii) Different strains of VAM would be isolated from the roots of the juvenile seedlings, particularly of dominant tree species, present in the reclamation sites.

(iii) Selection of VAM strains, isolates from the rhizophenic soil and root surroundings for desirable characteristics such as species-specificity, resistance, temperature tolerance etc.

(iv) Some of the commonly used VAM strains i.e., *Cenococcum geophyllum, Hebeloma circinan, H. crustuliniforme, H. cylindrospermum* for *Picea* sp., *Phialocephala fortinii* for *Pinus* sp., *Rhizopogon vinocolor* for mixed conifer forest, *Scleroderma citrinum* for mixed hardwood forest and *Suillus tomentosus* for *Alder* and *Spruce* would also be obtained from IARI, New Delhi and/or IMTECH, Chandigarh.

(v) Commercial strains obtained from organisations and desirable strains isolated from the soil and roots would be cultured in economically viable and efficient synthetic media.

(vi) Preparation of mother cultures and their appropriate dilution to the tub-set up (mix up).

(vii) Plant species which will be inoculated by specific and efficient strains would be grown to 1-2 months old seedlings stage in the beds prepared with the top soil.

(viii) Inoculum will be placed as a thin layer (3-4 cm) below the soil surface in each of the polythene bags involving mycorrhizal treatment. The top of the inoculum will be layered with vermiculite and the mixture will then be sprayed with nutrient solutions and/or hormones. The successful use of mycorrhizal inoculation coupled with the application of hormones in reducing the nursery period from 4-5 years to 3-5 years in *Abies pindrow* has been demonstrated in Himachal Pradesh (Mycorrhiza News, 1999).

(ix) Two days after the treatment of the soil with efficient strains, 1-2 months old seedlings raised in nurseries will be transplanted individually into each of the polythene bags.

(x) After 30 days of inoculation, plants will be selected randomly for the confirmation of VAM colonization on the roots of seedlings by using standard techniques.

(xi) Successfully colonised plantlets would be transplanted to the reclamation sites.

(xii) Monitoring of the colonized seedling for a minimum period of 3-4 years.

8.2.2.7 *Revegetation*

In addition to the use of VAM fungi for the enrichment of the top soil, revegetation of the quarry sites and plant areas would require the initial establishment of fast growing grasses like *Agrostis pilosula* and *Bromus japonicus*. These grasses spread by creeping rootstocks or rhizomes and will also help in binding the soil at these sites. This would initiate the process of colonization of the degraded areas by plant species. Perennial species such as *Festuca rubra, Cynodon dactylon, Chrysopogon serrulatus* and *Eulaliopsis binata* will be established subsequently by seeding or planting them directly into the annual crop residue.

Along with the annuals and perennials, nitrogen-fixing herbaceous legumes (*Trifolium repens* and *Lespedeza juncea*) and non-leguminous shrub (*Elaeagnus parvifolia*) will be planted at these sites to increase the nitrogen levels of the soil. *Trifolium repens* and *Lespedeza juncea* are also desirable food plants and are less aggressive and persistent as compared to other herbaceous legumes. However, only limited use will be made of these legumes, because these legumes with their dense persistent cover will retard or prevent the invasion and establishment of native plant species that contribute

to the habitat diversity. Temporary crop cover of annuals and perennials will thus help in the stabilization of the quarry sites, which will take approximately 5–6 years.

Once the initial establishment of perennials is complete and the quarry sites are stabilized, the sites would be ready for plantation of permanent reclamation species. Plants like *Alnus nitida* would be the first among tree species that would be planted. For quarry site at Chutti Bihal perennials such as *Gerbera gossypina*, *Gypsophila cerastioides*, *Bergenia ciliata*, *Geranium lucidum*, *Barleria cristata* and *Polygala abyssinica* would be planted which grow well among rocks and on open slopes of the degraded areas.

8.3 RESTORATION AND LANDSCAPING OF PLANT AREAS & COLONIES

A total area of 2.6567 ha of the forest land will be used temporarily for the construction of colonies, the plant areas at dam site, Manjhan, Rauli, Chuti-Bihal, near adits 1, 2 and 3 and workshop at Sheelagarh. The forest land at these sites will be cleared for the movement of heavy equipments required for different project related activities which would lead to the fragmentation and destruction of the habitats at these sites. The following measures will be used for the rehabilitation of the plant areas :

(i) Herbaceous plants and tree seedlings, grown in nurseries or in greenhouses, will be sown in alternating rows. The

growth of herbaceous and tree species will provide adequate erosion control, add vegetational variety for aesthetic values and provide the habitat for wildlife.

(ii) The rows of herbaceous plants will be later used for the cultivation of medicinally important plant species such as *Trillidium govanianum, Polygonatum verticillatum, Podophyllum hexandrum, Picrorhiza kurrooa*, etc.

(iii) The choice of the tree species for plantation will depend upon the topography of the area required to be regenerated after the constructional activities. In general, hardwood species i.e., *Robinia pseudoacacia, Alnus nepalensis* and *Populus ciliata* would be planted in alternate rows with conifers (Chil, Kail, Deodar and Rai). The plantation of nitrogen fixing tree species like *R. pseudoacacia* (leguminous) and *A. nepalensis* (non-leguminous) in these areas will increase the nitrogen levels of soil sufficient to maintain growth of non-nitrogen fixing revegetation species. Other tree species which will constitute the hardwood mix will comprise Ban Oak, *Juglans regia, Rhododendron arboreum* or any other species specific to the area. However, for the rehabilitation of the plant area at adit no. 3, located on the right bank of Pulia Nal only hardwood species will be planted.

(iv) Trees such as *R. pseudoacacia* and *Ehretia acuminata* will be planted in waste and unculturable lands of the plant

area located at Chutti Bihal. *R. pseudoacacia* is particularly valuable in reclamation of derelict and infertile land at this site.

8.4 AREA FOR RECLAMATION

A total of 19 ha would required to be reclaimed after the constructional activities are over. About 65-70% of this land would be reclaimed by using VAM and other phytoremediation techniques while rest of the area would be rehabilitated by growing hedges, herbaceous and shrubby species. The layout plan of different reclamation sites are given in Figs. 8.1 - 8.4.

8.5 COST ESTIMATES

The cost estimates of restoration works and landscape designing is **Rs.185.00 lakhs** the details of which are given in Table 8.1.

Table 8.1 Cost Estimates for Restoration Works and Landscape Designing

S.No.	Item of Work	Amount (Rs. In lakhs)
A.	**Pre-construction Measures**	
	Removal of top soil; transportation & Stock piling	15.00
B.	**Post-construction Measures**	
	i) Diversion channels	5.00
	ii) Retaining walls	8.00
	iii) Filling of the craters	5.00
	iv) Preparation of mounds	2.00
	v) Revegetation measures	
C.	**Reclamation and Phytoremediation**	150.00
	a) Field Works : - Collection of microflora from the field - Nursery development - Plantation and maintenance of successfully colonized seedlings	
	b) Laboratory Works : - Selection, culturing and maintenance of strains - Preparation of mother cultures - Confirmation of successful colonization	
	c) Manpower Components : - 5 years for laboratory to land transfer and 3 years for monitoring and maintenance	
	Total	**185.00**

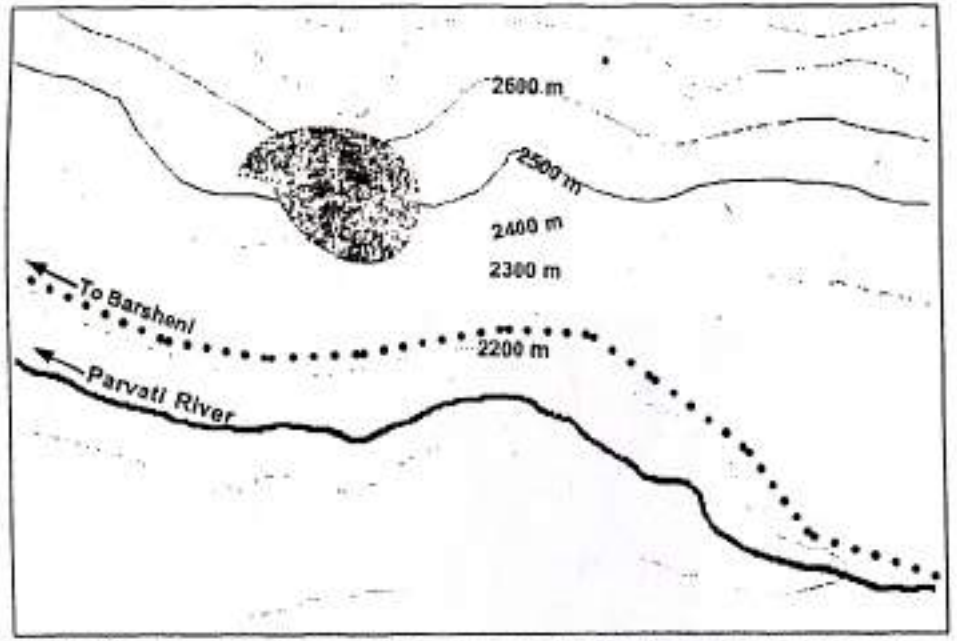
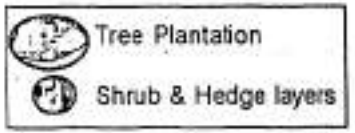


Fig.8.1a Reclamation & Phytoremediation of plant area at Dam Site



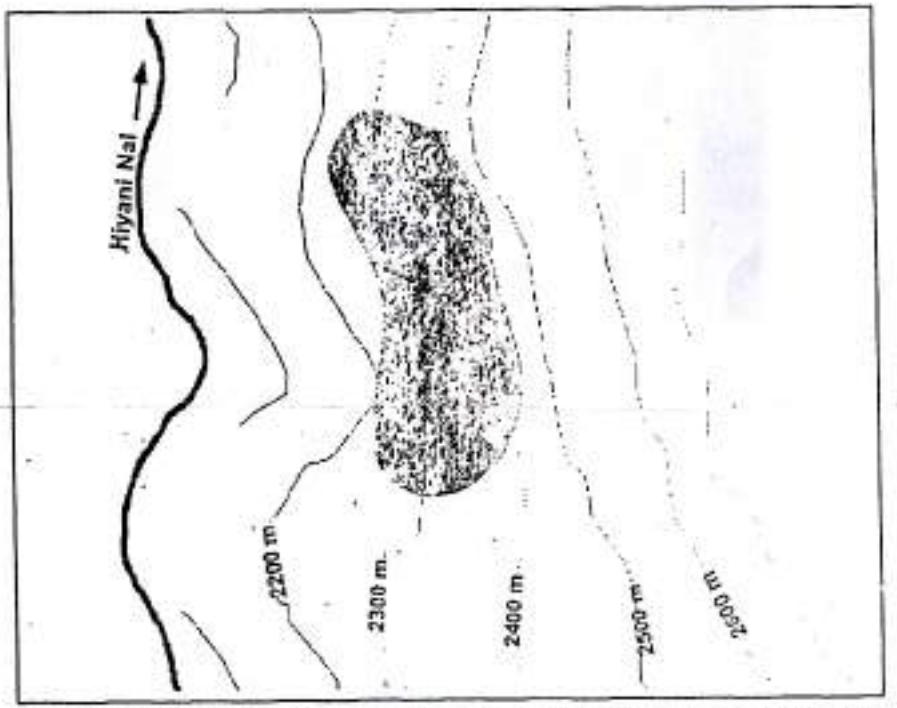


Fig.8.1b Reclamation & Phytoremediation of plant area at Adit No.1

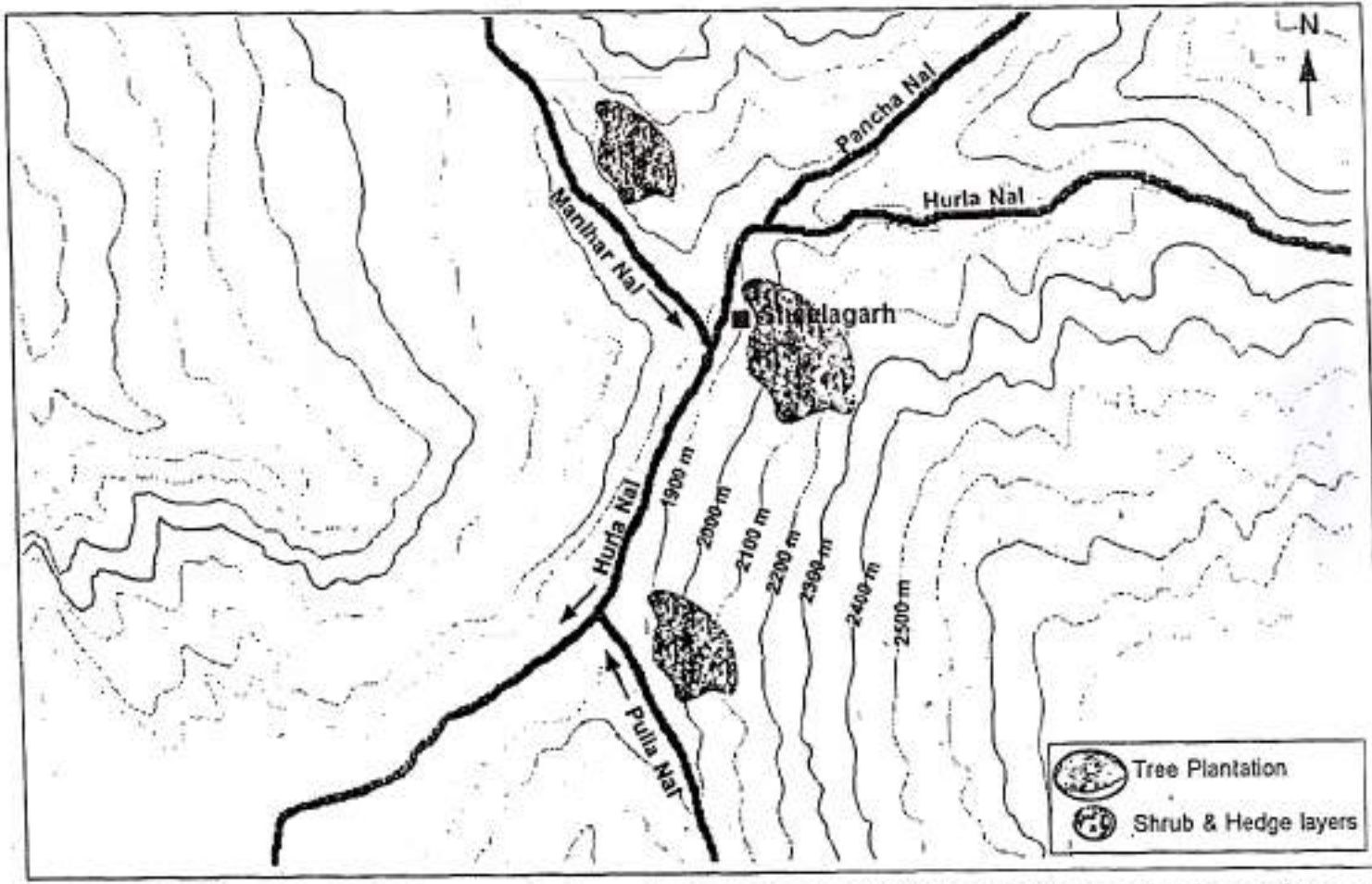


Fig.8.2 Reclamation & Phytoremediation of plant areas at Adit No.2 & 3, Sheelagarh works and quarry sites at Manihar and Pulia Nals

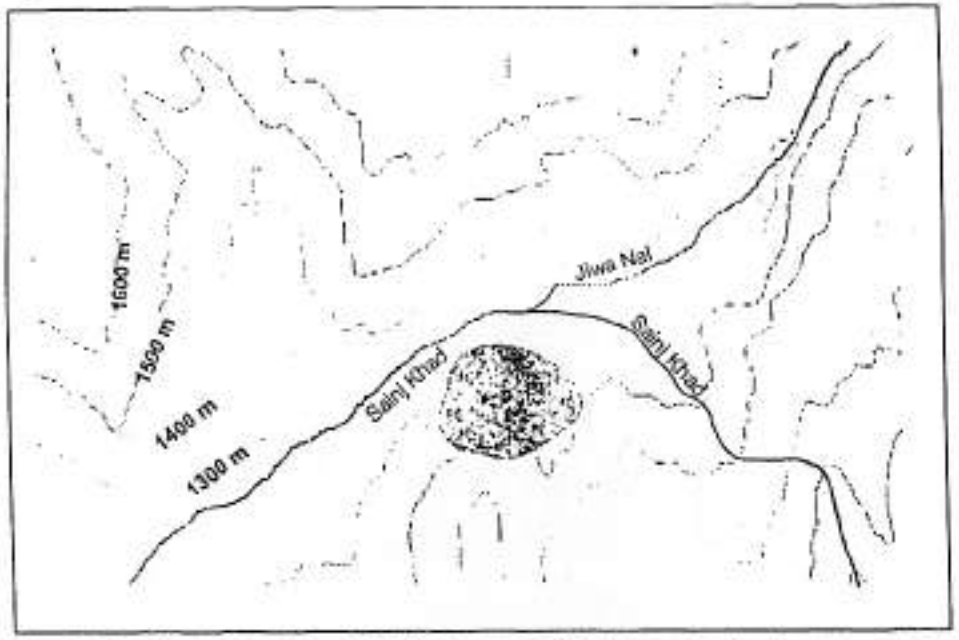
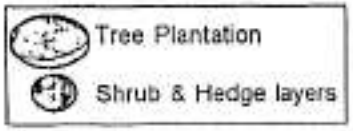


Fig.8.3 Reclamation & Phytoremediation of plant area at Suind



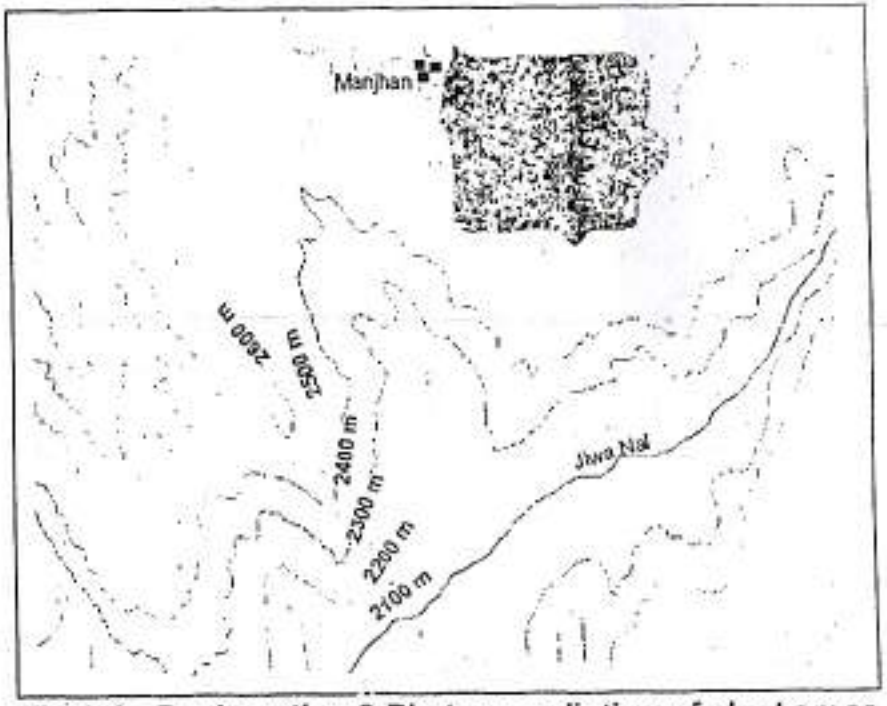


Fig.8.4 Reclamation & Phytoremediation of plant areas and labour colonies at Manjhan

CREATION OF GREEN BELT AROUND RESERVOIR

9.1 GENERAL

A green belt around the reservoir is proposed to be created to protect erosion of soil (sediment) from the portion of catchment draining directly into the reservoir (Fig.9.1). In case of Parvati Reservoir, there is dense vegetation cover on both the banks. The green belt on either side of the reservoir will ensure protection of the reservoir area from any other human activity that could result in the reservoir catchment damage. The forest stands of conifers and mixed broad leaf on the steep slopes of both the banks will be treated as the natural green belt around that part of the reservoir. On moderately steep slopes tree species will be planted for the creation of green belt which are indigenous, economically important, soil binding in nature, and can thrive well under high humidity and flood conditions. A generalised scheme of plantation around the reservoir is given as follows:

(i) The green belt will start from the immediate vicinity of the reservoir rim on both the banks, up to the tail of the reservoir wherever moderately steep slopes are available for plantation.

(ii) The width of the green belt will be around 80 m or as physiographic and land features allow. There would be at least 2-3 layers of plantation. The plantation will start along 2,200 m contour level and would go up to 2,300 m contour level from the dam axis up to the tail of the river.

(iii) The row of tree species nearest the rim will constitute water loving species, preferably *Alnus nitida*, *Salix* spp., *Populus* spp. These species will thrive very well at these altitudes.

(iv) Towards higher altitudes of the reservoir the rows around the reservoir may include *Aesculus indica*, *Populus ciliata*, in addition to *Salix* spp. *Alnus* thrives well on the disturbed/ degraded lands with good water availability. This plant is therefore, most suited for the slope stabilization and phytoremediation of the soil, which will initiate process of colonization of the slopes.

(v) *Alnus nitida* and *Populus* spp. are fast growing and have an elongated plant architecture therefore can act as effective wind breaks as well.

(vi) The middle rows of the green belt will comprise species like *Juglans regia*, *Acer pictum*, *Celtis tetrandra*, and towards higher altitudes *Ulmus wallichiana* and *Betula alnoides* will be planted. These are all purely indigenous and thrive well in these ecosystems.

(vii) The outermost layer of the green belt will constitute of hardy tree species and shrubby mix to withstand any external

influences/ pressures of grazing, browsing by cattle and sheep, etc. The species best suited for this layer at lower altitudes are *Prunus cornuta, Rhododendron aroboreum, Pinus wallichiana, Abies pindrow* and towards higher reaches the outer layers will comprise *Quercus dilatata, Acer caesium, Lyonia ovalifolia, Viburnum cotonifolium, Ulmus wallichiana* and *Aesculus indica*.

(viii) The green belt will be put under a protective regulatory framework to ensure that it is not degraded or disturbed. No ecologically disruptive activity will be allowed in this zone.

9.2 FINANCIAL REQUIREMENTS

NHPC has earmarked sufficient funds for the creation of green belt around the reservoir. The plantations would be carried out on an approximate area of 80 ha. This work would be completed in three years at an estimated cost of **Rs. 20.00 lakhs** at the rate of Rs.25,000/- per ha which includes the cost of nursery creation, advance works, actual plantations and maintenance. The plantation for this purpose will be carried out with the participation of the State Forest / Horticulture Department/s and schedule of implementation is given in Table 9.1.

Table 9.1 The schedule of implementation of creation of green belt

Activity	Duration	Starting Month
Nursery development	16 months	1st
Advance works for plantations	12 months	6th
Plantations	24 months	13th
Maintenance	12 months	6th
Completion of works	—	36th

Estimated Cost - Rs. 20.00 lakhs

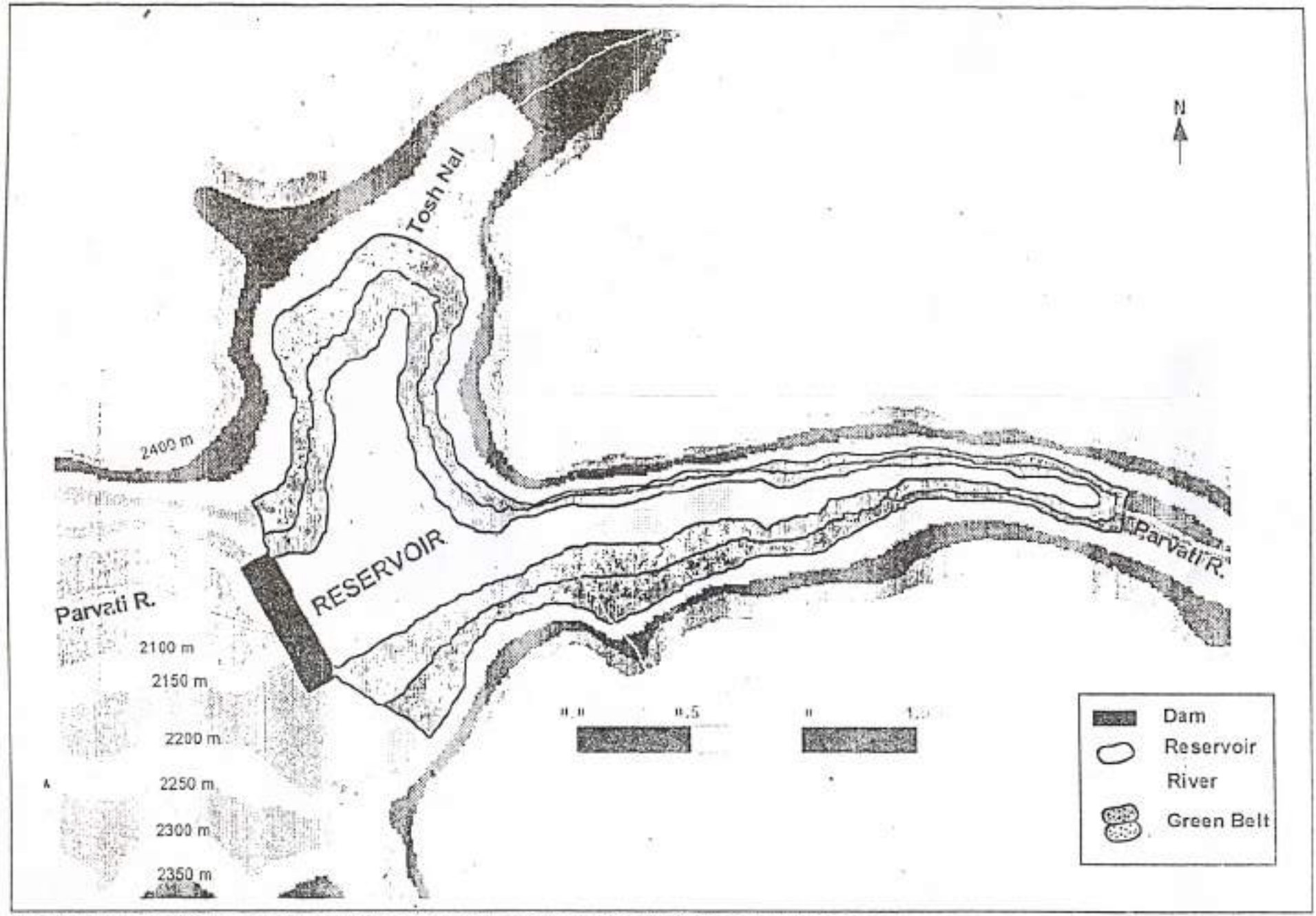


Fig.9.1 Proposed Green Belt around the reservoir periphery of Parvati Stage-II H.E. Project