

**INDIA  
MEGHALAYA  
EAST KHASI HILLS AND JAINTIA HILLS DISTRICTS  
UMNGOT HYDRO-ELECTRIC PROJECT  
(3 X 80 MW)**

**SUMMARY  
OF  
THE ENVIRONMENTAL IMPACT ASSESSMENT  
AND  
ENVIRONMENTAL MANAGEMENT PLAN  
INCLUDING REHABILITATION AND RESETTLEMENT**

**PART - I**  
**ENVIRONMENTAL IMPACT ASSESSMENT (EIA)**

**I. INTRODUCTION**

**1.1** The Government of India has established an exclusive Ministry of Environment and Forests (MOEF) for taking care of environmental protection needs. Safeguarding the interests of environment is done through suitable identification of Environmental Impacts and preparing suitable Environmental Management Plans while sanctioning establishment of industries, reservoirs/dams, railways, thermal power plants, etc to mitigate the impact. In other words, any project interfering with the environment is governed by the Environmental Protection Act enacted by the Government of India. The Ministry of Environment and Forests (MOEF), Government of India, therefore, is the nodal agency for sanctioning the Environmental Clearance for developmental projects. While clearing the projects, the MOEF is taking care of the environmental needs within and around the areas of different developmental projects/schemes in the Country.

**1.2** As part of the process for the mandatory Environmental Clearance as notified, and as per the Terms of References provided, by the MOEF, Govt. of India, the Meghalaya Energy Corporation Limited has conducted various studies for assessing the Environmental Impacts (EIA) and then prepared suitable measures in the Environmental Management Plan (EMP) in order to mitigate and ameliorate the environmental concerns due to the proposed implementation of the Umngot Hydro Electric Project (3X80 MW), in and around the project area.

**1.3 The Project and its Objectives**

**1.3.1** In view of the wide gap between the availability of demand for power in the State, the Meghalaya Energy Corporation Limited (MeECL) is in search of avenues to establish power generation units. As a part of this search exercise, the MeECL identified the Umngot river basin as an ideal choice for establishing one hydro-electric power generation project.

**1.3.2** The state has proposed Umngot Hydro-Electric project with an installed capacity of (3 x 80) 240 MW which would bridge the gap between demand for and the supply of power as well as the ratio of hydro and thermal power generation. Thus, the project is proposed to be implemented with a dual objective of narrowing down the gap between demand and supply of power as well as the adverse ratio of hydro and thermal / fossil fuel power generation.

**1.3.3** The Umngot HEP is the first of the two stage planned development of the Umngot river basin for the generation of hydroelectric power. The concrete gravity dam for this project is proposed to be located near the Siangkhnai village at 92°00'38"E; 25°21'31"N bordering East Khasi Hills District and Moosokhia village in Jaintia Hills District of Meghalaya. The HRT of modified horse shoe shape with 3.5 m diameter will take off from an Intake in just 75 m away from the dam on the right banks which will be driven through a granite-gneiss formation for 5600 m. The Surge Shaft at the end of this tunnel is 70 m high with a diameter of 10 m. The underground High Pressure Shaft of 2100m long and 2.5m dia. will take off from the Surge Shaft and emerge into a surface Powerhouse housing 3 units of 80 MW machines which is situated on the right bank of Umngot at a distance of about 20 Km away from the Dam site.

## **1.4 Environmental Impact Studies**

**1.4.1** The change in the environment may be because of submergence of land, displacement of population including Flora and Fauna and resettlement in the surrounding catchment, denudation of Forest, water logging, salinity and alkalinity of soils, water quality and ground water fluctuations etc. Different types of environmental and ecological impacts may be observed in the areas due to this project. It is, therefore, essential to assess the possible adverse impacts along with positive impacts from the relevant areas of the project, so as to formulate a suitable environmental management plan to eliminate or minimize the negative impacts. Thus, the basic objective of the study is to assess the environmental impacts of the proposed Umngot H.E project on land, water, climate, including air and noise, flora and fauna, public health, submergence of habitations, etc., and suggest a suitable Environmental Management plan with necessary mitigative measures.

## **2. THE PROJECT AREA AND BASELINE FEATURES**

**2.1** The Umngot is one of the major southwardly flowing rivers of Meghalaya originating at an altitude of 1840 m from the junction of Nongkrem road and NH-44 which is at a distance of 11 km from Shillong, situated in Khasi Hills district of Meghalaya. The Gross and Live storage of the Umngot storage reservoir is 38.59 MCM and 32.95 MCM at FRL / MWL El 1042.0 m and MDDL at EL 995.0 m respectively. The installed capacity is proposed as 240 MW to be generated through 3 Nos. of Pelton Turbines of 80 MW each.

**2.2** The Umngot Hydro Electric Power project envisages the following main components.

1. Concrete gravity dam in the gorge portion across Umngot River of 111 m high and 362 m long to impound on effective storage of 32.95 MCM.
2. Intake and Head Race Tunnel (HRT) of 5588 m long and 3.6 m diameter modified horse shoe low pressure tunnel.
3. High pressure shaft 2200 m long and 2.75 m diameter.
4. Surface power house (107.5 m x 31 m x 20 m) and Gas Insulated Switchyard (107.5 m x 34 m x 24 m).
5. Tail Race 146 m long to lead the effluents back to Umngot river.
6. Surge shaft with a chamber of 79.9 m high and 10 m diameter between low pressure tunnel and high pressure shaft.

## **2.3 Project Benefits**

**2.3.1** The direct benefits that are expected to be accrued from the implementation of the Umngot HEP are the generation of about 856.35 Million units in a 90 per cent dependable year. The First Year Tariff and Levellised Tariff have been worked out as Rs.3.11 and Rs.3.03 per KWH respectively at 2010 price level.

**2.3.2** The people around the project area are expected to reap many indirect benefits that would bring about a transformation in the uplift of their socio-economic conditions from the implementation of this project. Road communication, Health facilities, School facilities and various other social programmes will be undertaken by project authorities.

### **3. LAND ENVIRONMENT**

**3.1** Meghalaya state is situated on the North Eastern Region of India between Brahmaputra valley in the North and Bangladesh in the south. The catchment area is situated in the mid-control upland, specifically called the Shillong plateau. The entire plateau is mountainous but the eastern and western extensions are relatively lower. The drainage in the Umngot river basin is of Trellis pattern where long tributaries flow down the dip slopes and small tributaries flow down the scarp slopes. The river flows towards south in a stretch of about 20km between the proposed dam site and the power house site and is encountered by number of falls and rapids to drop from an elevation of 940 m to 210 m.

**3.2** The catchments area up to Umngot HEP is worked out as 304 sq.km (30433 ha). The catchment is of undulating nature. The analysis of catchment area shows, steep to very steep slopes (i.e. above 15%) occupy about 76.18 per cent of the total area. Baseline data relating to land use / land cover in the study area, extending up to 10 km radius of various components has been ascertained with the help of GIS applications, RS imageries and the analysis indicates 57% of the area is occupied with Dense and Open Forests. Land use / Land cover in respect of the catchments area indicates arable land is only 20.52 %, land under shifting cultivation is 5.29 %, forest lands 34.30 % and scrubs or grass lands (fallow) is 33.05 %. The forest is community forest land comprising dense mixed jungle and mixed jungles.

**3.3** Various reconnoiter geological traverses and mapping by the Geological Survey of India from limited sub-surface explorations have helped in the selection of suitable locations for Dam, Intake, HRT alignment, Pressure Shaft alignment and Powerhouse.

#### **3.4 Environmental Impact**

Construction of a dam on a river for water poundage produces both negative and positive impacts on various environmental parameters. However, the impacts of a dam on land environment are mostly negative. Excavation of soils, rocks, sand etc and their transportation pollute land environment. Wastes and refuse generated during construction are likely to pose environmental problems through their disposals. Land topography may register changes due to excavations while executing the projects

**3.4.1 Impact on land use / land cover by Quarrying Operation:** Extraction of material from different quarries produces depressions and will naturally change the micro topography of the area to a limited extent. Part of the stone material required for the construction of the dam will be met with from the muck generated during exploration of foundations, tunnel excavations etc. Quarries will be proposed in lands acquired for submergence. No major impact is anticipated from these excavations. However treatment of slopes is proposed as suggested under EMP to avoid any land slides. Sand is proposed to be transported from sand quarries at Karkhana from Myntdu River in Jaintia hills district which is about 55 km. The sand is already being quarried from that river for other projects. Hence no treatment measures need be suggested.

**3.4.2 Muck Disposal :** A large quantity of muck is expected to be generated as a result of excavation. About 50 percent of rock generated from different components can be utilized for construction works like masonry and concrete. Balance 50 per cent of the rock and soil material requires management measures.

**3.4.3 Submergence of land:** The submergence is limited to an extent of 253.85 ha (including water bodies) and no villages are going to be submerged fully. But some cultivated lands pertaining to some of the

villages (12) are likely to be affected. The total area proposed for acquisition towards the submergence of lands, roads and for other appurtenances are 420 ha.

**3.4.4 Other Impacts on Land:** The proposed dam across Umngot River is situated in heavy seismic zone. The design factors are to be considered accordingly. Reservoir induced Seismicity is generally noticed in high dams. The bed rock in the dam and reservoir area is of good quality and hence this aspect would be negligible. No minerals which may change the water quality of the reservoir are available in the submergence area which may be harmful to the inundated water used for hydropower and down stream domestic purposes

**3.4.5 Impact on Soil Erosion:** Soils in the catchments area are red loamy, red sandy and red gravelly soils (Algisols) that are formed by parental material like Gneisses, sand stone & shale's. The catchments area is undulating with gentle to very steep slopes. The area is already under severe to very severe erosion category. It is noticed that there is severe erosion through the side drains of existing roads. No further impact is predicted. The present erosion status is likely to be reduced in view of the catchment area treatment proposed under EMP. Preventive measures are proposed by avenue plantation and other vegetation treatment besides culverts for existing as well as proposed roads.

## 4. WATER ENVIRONMENT

The base line study of water environment is focused on water quality relating to surface water of Umngot River in various seasons. Most of the precipitation is received from south – west monsoon. Rainy season commences from May and continues till September. The other three seasons are spring, (March/April), autumn (October & November) and winter (December to February). Surface water samples were collected during monsoon period 7/2008 and during winter 12/2008.

**4.1 Hydrology:** The Umngot River is a south flowing river and a tributary of Surma River in Bangladesh. The Umngot reservoir intercepts an area of 304sqkm of Umngot River basin. The discharge gauging site is located at the vicinity of the proposed dam and the powerhouse site is drained by a catchment area of 815 sq.km. The observed discharge ranges from about 2 cumecs in the lean periods to about 1500 cumecs in the monsoon periods. The rainfall averages around 3500 mm annually and the trend conforms with the normal distribution of rainfall in the region which gradually decreases from the southern to the northern reaches of the catchments.

**4.1.1 Design flood:** IMD has given the one day maximum precipitation value as 140cms for the Umngot catchments up to the dam site. The flood discharge is estimated at 8969 cumecs. The designed flood at power house site is calculated on a proportionate catchments area basis from the designed flood arrived at dam site. Additional catchment area involved is 60 sq km, near the proposed power house site and the flood for this is worked out to 1770 cumecs. Therefore, the total designed flood at the power house site is estimated as 10740 cumecs.

**4.1.2 Sedimentation rate:** Sediment studies of the nearby catchments of Umiam river, where there are greater developmental activities, indicates a sediment rate of about 23.95 ha-m/100 sq.km/yr from its catchment area, average rate of 17.65 ha-m/100 sq.km/yr is found adequate and is adopted for sedimentation calculations. The volume of sediment deposits for various periods are worked out with the help of the Brune trap efficiency curves and the sediment distribution worked out by using Empirical Area reduction method. The quantity of sedimentation after 50 years would be 4.65 Mm<sup>3</sup>, and after 100 years it would be 11.18 Mm<sup>3</sup>

**4.2 Surface Water Quality:** Samples were collected from Umngot River at dam site and at power house site during monsoon season and post monsoon seasons. In general the surface water quality is good and fresh as per drinking water standards. Similar in the case of samples collected at dam site also.

No impact on the downstream water utilization except impacts on riverine ecology in the stretch between the dam and the confluence point with tail race tunnel. There will be reduction in water flow in the above stretch. Significant reduction in flow is likely to have a minor impact on the aquatic environment. Minimum releases of water below the dam are to be ensured for the sustenance of the aquatic fauna.

**4.2.1 Impact on water quality:** The Umngot HEP is located in an area where the population density is very low with no major sources of pollution. The habitations are much away from the river. The area under assured irrigation is only 2% and is negligible. The usage of agro-chemicals and manures is also meager. No industries are in the closer vicinity of the river. As such the pollution loading from different sources such as domestic sewage, industrial effluents and agro-chemical residues of agricultural lands in the project area is virtually negligible. Since the proposed project contemplates no irrigation, no impact on the surface or ground water is anticipated

The project construction is likely to last for a period of 6 years. About 1500 workers and 500 technical staff are likely to work during the construction phase. The domestic water requirements have been estimated as 110 lpd. Thus, total water requirement works out to 0.55 mld. It is assumed that about 80% of the water supplied will be generated as sewage. The total quantum of waste water generated is expected to be of the order of 0.44 mld. The BOD load contributed by domestic sources will be about 270 kg/day. Labour colonies are proposed at 6 locations on the left flank, right flank and upstream of the proposed dam location and at other head works. It is assumed that all the waste water generated from various labour colonies would fall into the river at a common point. It is also assumed that the sewage is let out without any treatment. For these conditions the minimum flow required for dilution of sewage is about 1.00 cumec with a dilution ratio of 1:200. Thus minimum releases of 1.0 cumec shall be ensured below the dam during operation period to neutralize the sewage loads as well as for the sustenance of aquatic fauna between the dam and the confluence point of Tail Race Channel.

No impact is anticipated on quality of water after the commissioning of the project.

**4.2.2 Impact Due to Change in Hydraulic regime:** The design peak flood is assessed to be 8969.0 cumec. Even though no moderation of flood is proposed, the storage and diversion will provide some kind of relief to the lower reaches of the river in the flood probabilities, before it confluences with Surma river in Bangladesh. Also, due to the storage in the reservoir there will be development of greenery, rise in water table in the area which will tend to increase the runoff characteristics. Thus no major change in the hydraulic regime of Umngot River due to the dam is anticipated.

## **5. BIOLOGICAL ENVIRONMENT**

Meghalaya is a treasure trove of Nature, with its richly varied and dense endemic, exotic and cultivated flora. It has a total geographical area of 22,429 km<sup>2</sup>. The total estimated forest area of the State is 8,514 km<sup>2</sup> of which only 722.36 km<sup>2</sup> are directly under the control of the State Forest Department. The forests of Meghalaya can be broadly grouped into tropical, subtropical and temperate types. The Indian Institute of

Remote Sensing have classified the vegetation of Meghalaya into tropical evergreen, tropical semi-evergreen, tropical moist deciduous, subtropical broad leaved, subtropical pine and temperate forest types, grasslands and savannas. There are no Sanctuaries or National parks or Biosphere reserves in the catchment area which includes the reservoir.

There are no reserve forests in the area of submergence where the dam is built. The forests that occur in the area of submergence are typical tropical riverside forests dominated by different species. Found with list of trees including the lianas, Bamboos, shrubs, non-woody plants, grasses, orchids, Pteridophytes, Bryophytes and other macrophytes. There are a couple of small sacred groves in the catchment area. One is near Mosakhia in Jaintia Hills and the other at Nonghulew near Siangkhanai in East Khasi Hills.

Frequency, density, dominance (as percent cover) and IVI values of the structural species encountered in the sampling locations in the catchment area and reservoir area are calculated. It may be concluded that the Shannon – Weaver Indices of diversity was over 4 and the evenness was higher than 0.95 but dominance was lower. *Nepenthes khasiana*, a rare and endemic insectivorous plant is not found to occur either in the catchment or reservoir area of the River. Hunting has been a customary cultural practice in the area and the practice is still continued. There are no large game animals like deer and hence there are no chances of occurrence of any hunting animals.

**Predicted impacts :** A logical and systematic approach has been adopted for impact identification based on the guidelines evolved by the International Association for Impact Assessment (IAIA). The impacts may be divided into reversible or irreversible; direct or indirect; severe, moderate or light depending on magnitude; short term or long term depending on duration of impacts. The direct impacts of the proposed Hydro Power plant shall be limited to an area of about 260 ha only (254 Ha for reservoir and 6 ha for power plant). Most of the REET species of mammals have not been spotted either in the reservoir or catchment area. All the trees and the terrestrial plant species present in the area of submergence of 253.85 ha are going to be lost permanently. But there are no REET species and hence there shall be no loss of any REET biological species. Similarly, the flora and fauna of the power plant site of 6 ha and the quarry area are going to be severely effected.

## 6. CLIMATE AND METEOROLOGY

The climate in the catchments, as in the whole of Meghalaya, is determined by the altitude of the land surface and alternating high and low pressure created by the seasonal winds. Warm, moist winds come from the South and Southwest during summer and cold winds from the north-west during winter. The hills of Meghalaya which run East-West receive most of the rainfall from South-West Monsoon. The rainy season begins from the end of May and continues till early October.

**Climatic Factors:** The four major factors that determine the climate of a project area are (a) rainfall; (b) temperature; (c) Relative humidity and (d) wind velocity. The mean Maximum and Minimum temperatures observed in 1999-2000 years are 25.1°C and 6.1 °C. The variations of temperatures are marginal. The normal mean annual rainfall of the project area is 3530.626 mm. The relative humidity values are in the range of 35% to 82% in the post monsoon season, 65% to 85% during hot weather season and 76% to 82% in the monsoon season. The wind speed is observed to be moderate in the project area. Wind speed during post monsoon season varies between 1.0 to 9.0 kmph, in hot weather period it varies between 1.0 and 3.0 kmph and in monsoon season it varies between 1 to 2 kmph. The existing noise levels at Syntung and Siangkhanai of

Umngot H.E project area have been observed during monsoon season post-monsoon season of 2008 and pre-monsoon season of 2009. The levels found to range between 40.2 and 48.7 dB (A). Ambient Noise Levels observed during day and night times were found to be within standard limits for Residential area as prescribed vide EPA Notification.

**6.2 Impacts on Air:** The impact on air environment on the surroundings is mainly during construction phase. Most of the operations are mechanized and are operated on Diesel. This activity contributes to increase in suspended particulate matter (SPM), SO<sub>2</sub> and NO<sub>x</sub>. Indirect air pollution may be there due to CO and HC. The attached activity like the temporary human settlements near the project will also have impact but it is insignificant when compared to the other sources of air pollution. The different parameters of ambient air quality are within permissible limits as per the baseline data. The proposed activity has little or marginal adverse effect on various environmental parameters related to air quality, and noise levels while they have positive impact on socio-economic status of community. The proposed activity creating air pollution such as fugitive emissions from drilling, excavation, construction material handling, etc have marginal adverse effects with respect to air quality and aesthetics during construction phase. Utmost care has to be taken because even in the case of minor lapses, appreciable adverse effects may be possible.

**6.3 Environmental Benefits and Estimation of CDM Revenues:** Emission of Green House Gases into the atmosphere results in Global Warming. The Clean Development Mechanism (CDM) allows developed countries to fund projects in developing countries that reduce CHCs. In return the developed countries receive Certified Emission Reduction Units ( CERs) also called carbon credits from UNFCCC, which can be used to meet their targets. 1 CER stands for one tonne of carbon dioxide reduction. Government or Private organisations in developing countries may implement the projects that can reduce CO<sub>2</sub> emissions and obtain CERs from UNFCCC. These CERs can be sold to any parties in developed countries at mutually agreed rates. The Government of India has set up National CDM Authority under Ministry of Environment & Forests on April 16, 2004 to approve the projects coming under CDM. This authority clears the CDM projects submitted to it after thorough scrutiny of meeting the eligibility criteria. The Umngot HEP qualifies as a CDM project and this will reduce the unit cost by about Rs 0.41 per unit of energy.

## 7. PUBLIC HEALTH

The study revealed that lack of health, hygiene and sanitation in the project area would cause the following impacts. During the construction phase large number of labour force will be employed. The labours are generally housed in temporary colonies with sheds which may be far from satisfactory from the point of view of sanitation. The seasonal congregation of labour at the project site can create new health problems. The project workers may come from non-malarial zone of vice-versa thereby increasing the incidence of Malaria. Similarly, due to intermingling of local population and the migrated labour, chances of increase in HIV can be suspected.

If proper toilet facilities are not provided, the construction labours resort to open defecation. The faecal matter is the biggest source of infection of diseases like Ameobiasis, worms, etc. Similarly, during the rainy season, the poor sanitary system contributes towards increases in Gastro Enteritis, Diarrhea, etc. Pollution due to dust and debris during the construction phase at the project site would lead to lung and respiratory diseases. Poor quality of drinking water may also lead to water borne diseases. Necessary plans were made for mitigative measures to keep the impacts at the minimum both during construction and in post – construction phases.

**PART - II**  
**ENVIRONMENT MANAGEMENT PLAN (EMP)**

**8. CATCHMENT AREA TREATMENT**

A well designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above mentioned adverse impacts of soil erosion. In a hilly catchment area, erosion due to water is a common phenomenon and the same has been studied as a part of the Catchment Area Treatment (CAT) Plan. The total annual rainfall in the Umngot HEP catchment area varied between 2890 to 4904 mm during the years 1991-92 to 2005-2006. Hence soil erosion in this area will be very high.

The catchment Area Treatment (CAT) Plan highlights the management techniques to control erosion in the catchment area of HE project. The catchment area treatment involves understanding of the erosion characteristics of the terrain and suggesting remedial measures to reduce the erosion rate. In the present study 'Silt Yield Index' (SYI) method has been used. In this method, the terrain is sub-divided into various small sub-watersheds and the erodibility is determined on relative basis. SYI's provide comparative erodibility criteria of catchment (low, moderate, high, etc.)

**8.1 Characteristics of Catchment Areas**

**8.1.1 Prioritization of Sub Watersheds:** In total the area is divided into 19 micro-watersheds with areas ranging from 754 ha to as high as 2736 ha. Suitable treatment measures are proposed for five micro-watersheds, which are under very high category covering an area of 8819 ha. This accounted for 28.98 percent of total catchment area. The other category micro-water sheds have not been recommended for any treatment. Thus, the areas proposed for treatment measures are as below.

1. Open forest	-	-	470 ha
2. Scrub lands	-	-	730 ha
3. Shifting cultivation	-	-	788 ha
4. Arable area	-	-	<u>1030 ha</u>
Total area	-	-	<u>3018 ha</u>

**8.2 Conservation and Management Measures**

**8.2.1 Afforestation and Reforestation Programme:** An area of 1200 ha in the micro-watersheds of very high priority category is proposed for forestry and Silvi-pastoral measures in the open forest and scrub lands. The forest areas are entirely community forests and the scrublands may be Government owned or private lands. Considering the data furnished by the forest department and accepting the information regarding possible increase in wage rates in near future and to bring uniformity in the rates for the purpose of compilation of the report, the cost per ha is fixed at Rs.32,100 per ha to be spread over a period of 5 years. Since the forest areas are predominantly of open forest (470 ha) and scrub (730 ha) categories, intensive afforestation reforestation and enrichment of planting are suggested for these gap areas along with reservoir rim treatment by creation of a Green Belt along the periphery of the reservoir. Therefore, the cost of afforestation by Silvi- pastoral measures in the priority zone works out to [Rs. 385.20 lakh](#) phased for 5 years.

**8.2.2 Staggered Trenches:** Staggered trenches will be constructed for silvi-horticultural plantation as well as for treatment of open scrub / degraded areas for detention and conservation of rain water and eroded soil. Run-off water from mixed crop strips will flow through staggered trenches in silvi-horticulture strip, resulting in setting of sediments and arrest of run-off water to recharge soil profile and ground water. Staggered contour trenches will be constructed in rows spaced at 5 m, with a spacing of 3.30 m within the rows. Cost per hectare works out to Rs.11701/-. Area proposed for formation of staggered trenches in respect of Umngot worked out to be 2230 of Scrub and Arable lands. Total cost is worked out as [Rs 260.93 lakh](#).

**8.2.3 Planting and development of pasture and fodder grasses (by subsidy):** It is assessed that staggered trenches @ 5 numbers per ha can recharge soil profile and ground water to meet the water requirement of pasture and fodder grasses of the patchy areas. For raising 'fuel-wood and fodder' plantations a subsidy of Rs.2,500/- per ha to be provided in the estimate. The subsidy cost worked out to Rs.55.75 lakh.

**8.2.4 Bench Terracing:** Bench terracing is proposed for an area where slope is in the range of 10 to 35%, so as to modify the degree of slope by cutting and filling. Out of different types of bench terraces, Table Top / Level Terraces and Sloping Inward terraces are suggested. The cost per ha worked out to Rs.47245. Total area proposed is 3011 ha in prioritized sub-watersheds and in the slope range. Total cost works out to be [Rs 1422.55 lakh](#).

#### **8.2.5 Soil and Water Conservation – Engineering / Mechanical Measures**

The pre – requisites for soil and water conservation measures are physiography, soil properties, vegetative cover and land use practices and resin fall and runoff. Engineering measures for such purposes is aimed at constructing barriers across the direction of flow of run-off water to retard or retain the run-off and thereby to reduce the siltation into reservoir. In order to achieve and create favorable conditions, following engineering measures are suggested:

**8.2.5.1 Gully Control Structures or Gully Plugging:** Two types of structures namely Double Row Post Brush Dam and Loose boulder check Dam.

*Double Row Post Brush Dam: This type of check dam is generally used to control medium and deep gullies (about 2 m to 2.50 m deep and upto 6 m wide). The country wood stakes, about 10 cm to 13 cm in diameter, are driven 0.90 m apart, in two rows, to go at least 0.90 m to 1.20 m into the hard bed of gully. The distance between the rows will be around 0.90 m. Cost per each structure of average dimension works out to be Rs 1783/- and the total cost for constructing 140 Double Row Post Brush Dam works out to [Rs 2.50 lakh](#).*

*Loose Boulder Check Dam: This is used for forming check dams when loose boulders of fairly good size are available in large quantities. The site where the dam is to be erected is cleared and the sides are sloped to 1.5:1. The boulder filling should go upto 0.30 m to 0.60 m into the stable portion of the gully side to prevent end cutting. In the rear, sufficient length (0.90 m) and width of apron has to be provided to prevent scour. Cost per each of such check dam of average dimension works about to be Rs12966/- and the total cost for constructing 310 Loose boulder check Dam works out to [Rs 40.19 lakh](#).*

### 8.2.5.2 Water Conservation Structures

**8.2.5.2.1 Percolation Tanks (PTs):** At places where there is sudden depression and hump on either side or in wide and deep gullies at the location of entering gentle slope areas where maximum water can be stored an earthen bund with stone revetment on the upstream side and a surplus weir on one side are to be constructed. In total 6 numbers of such tanks are proposed at a lump sum cost of Rs.1.00 lakh each. The total cost works out to [Rs 6.00 lakh](#).

**8.2.5.2.2 Control of Shifting Cultivation in the Catchment:** Shifting cultivation or jhumming, an age-old traditional practice is at the crux of the land use problem in the catchment. It is proposed to develop Strip-Cropping (Contour Stripping) and Modified Strip Cropping (Field Stripping) and Agricultural and Horticultural Development, Horticultural Crop Strips and Cover Crop and Mixed Crop Strips, Vegetative barriers with an amount of [Rs 46.66 lakh](#) for implementing measures to control shifting cultivation.

### 8.2.6 Reservoir Rim Treatment / Green Belt Development

Under the reservoir the total identified submergible area of 253.85 ha upto FRL contour will be impounded with water during monsoon period. A total length of the proposed reservoir rim treatment is 60000 m or 60 km and the area of greenbelt works out to 60 ha. Hence it is proposed to provide afforestation in an extent of 60 ha for green belt development along reservoir rim. A provision towards the cost of reservoir rim treatment for 60 ha will be [Rs.19.26 lakh](#)

The estimated cost for the recommended treatment measures is Rs. 2,239.0 lakh excluding compensatory afforestation in lieu of submergence of forest lands.

### 8.2.7 Compensatory Afforestation

It is proposed to raise compensatory afforestation in an area of 93.53 ha in lieu of submergence of dense forest (12.91 ha) and open forest (80.62 ha). The cost of afforestation would be born by the project proponents at the rate of Rs 32,100/- per ha. The total amount for the activity in an area of 93.53 ha is estimated to be at Rs 30.02 lakh. Compensatory afforestation will be under taken in degraded open forest lands. Twin objective of this proposal of compensatory afforestation would fulfill largely the goal of compensating the loss of forest area going under submergence. Besides, these plantation sites would also fulfill the need based causes of treating the catchment area of the reservoir in preventing silting of the reservoir and soil runoff as the plantation sites are proposed in the catchment Zone. The cost estimation for compensatory afforestation will have three main components namely Cost of afforestation (*Rs 32,100/- per ha for an area of 93.53 ha*), Cost of deforestation (*at a rate of Rs 26250/- per ha*) and Cost of land acquisition and NPV cost (at the rate of Rs 8.03 and 6.26 lakh per ha respectively for Dense and Open Forests). The total cost required for compensatory afforestation of forest land and other items works out to [Rs 662.92 lakh](#).

## 9. LAND MANAGEMENT

**9.1 Plan for Muck Disposal site management:** About 1.09 Mm<sup>3</sup> muck is to be disposed at suitable locations in respect of project. The muck is to be disposed in a planned manner so that it occupies least possible space and is not hazardous to the environment. The quantity of muck generated is quite considerable for the construction of dams across rivers, excavation of tunnels and construction of other associated structures. The

total estimated cost for management and stabilization of muck disposal sites works out to be Rs 118.58 lakh including Engineering Measures like construction of Boulder crater walls, Masonry wall, Catch water drain and Leveling including spreading of excavated soil including Transportation. It also includes Biological Measures like Plant saplings procurement, Plantation, Fencing, Biological fertilizer procurement and Watch & ward 2 Nos @ Rs. 4000/- month / person for 5 years with an escalation of 10% every year

**9.2 Restoration Plan for Quarry Sites:** Most of the aggregate required for the construction of dam, power houses and other head works would be obtained from the muck generated during foundation exploration and tunnels since the rock is found suitable as coarse aggregate in CC and other works. Stone quarries are proposed in the nearby vicinity on the flanks of Umngot River on the upstream area which are likely to be submerged. Quarries will be proposed in Govt. lands. The quarries for fine aggregate are proposed from Myntdu river sand quarry in Jaintia hills district which is situated at about 55 km from the dam axis. Sand is already being quarried from that river to other projects and no mitigation measures are suggested.

The quarries need to be stabilized after extraction of required construction materials is completed by way of Construction of guard walls with dry rubble ( Rs 117.30 lakh) and Filling up land with soil and debris (Rs 38.25 lakh).

## 10. BIO-DIVERSITY MANAGEMENT PLAN

**10.1 Plan for Green Belt Development:** The Green belt helps in maintaining ecological balance of the nature. Planting stocks are readily available from the Social Forest Department as well as from the local private nurseries. All plants are locally adapted. Greenbelt development is proposed in about 40% (55 ha) of the area around the earmarked (136.67 ha) for creating the infrastructure covered under the project. About 500 plants per hectare are proposed to be planted for Green belt development in lieu of loss of Vegetation for various activities. The total cost for Green Belt plantation per hectare is estimated as Rs. 41500. To cover an area of 55 ha an amount of **Rs. 22.83 lakh** was earmarked under EMP.

**10.2 Biodiversity Conservation Plan:** Important Biorich sites in Meghalya are the Nokrek and Balpakram National Park. In addition, there are three protected areas known as Wildlife Sanctuaries. The project proponents plan to develop a biodiversity park in consultation with the forest department and the N.E.H. University, Shillong. Before the reservoir is filled up, the project proponents will sponsor a research project for detailed survey, collection and conservation of all REET species. Wherever in - situ conservation is not possible, ex-situ conservation will be undertaken. Thus it is planned to involve research institutions for getting the work done.

**10.3 Wildlife Conservation Plan:** It is proposed to involve the Meghalaya State Wildlife Division, Shillong for any rescue and rehabilitation of REET fauna if found in the reservoir area. It is also proposed to constitute Umngot biodiversity conservation board with representatives from forest, wildlife, BSI and ZSI from time to time review and implementation of plans for conservation of wildlife and protection of REET species. A budgetary provision of **Rs. 50.00 lakh** will be made for establishing bio-diversity park and implementation of Bio-diversity Wildlife Conservation Plan.

**10.4 Fishery Management Plan:** The plan include provisions for Organisation of Fisherman Cooperative Society and training Programme ( 50 members), Stocking and Selection of Species (The productive area for fishing is estimated about 125 ha i.e. 50% of submergence Area at FRL 1040 m and stocking rate of 200

advanced fingerlings per ha can be adopted), Seed Requirement ( 1.74 lakh spawn to develop 0.25 lakh advanced fingerlings), Infrastructure facilities like providing Fishing Nets, Fishing Boats. Total cost of Fisheries Development for 50 families works out to be **Rs 23.13 lakh**. This provision consists of Rs 20.63 lakh towards capital Cost and Rs 2.50 lakh towards recurring costs (10 years at the rate of Rs 25,000 per year). Fish production from the reservoir will be increased steadily on a sustainable basis so as to attain a yield of 25 tonnes per year on full development. The estimated production rate is 200 kg/ha. The Project will generate employment to more than 50 local fishermen on regular basis.

## **11. PUBLIC HEALTH MANAGEMENT**

**11.1 Labour Camps :** The aggregation of labour population (1000) during construction phase is likely to put significant stress on various facts of environment. In due cause of time, the labour population is likely to increase to 2000. Facilities to be provided in the camps are as follows

**11.2 Sanitation:** One common latrine for 20 persons and one septic tank for 500 people should be provided. The effluent from these septic tanks could be disposed off through soak pits. It has been estimated that about 100 community latrines and 4 septic tanks will need to be constructed. The total budget required for these facilities will be **Rs.40.00 lakh**.

**11.3 Solid Waste Management:** The solid waste likely to be generated from labour camps shall be in the order of 0.85 tones/day. For solid waste collection 8 numbers of masonry storage vats, each of 2 m<sup>3</sup> capacity should be constructed at appropriate locations in various labour camps. A suitable land fill site should be identified and designed to cater to wastes from various project colonies, labour colonies, etc. A total provision of **Rs.61.00 lakh** has been earmarked for the purpose.

**11.4 Sewage from Labour Camps:** The sewage generated from the labour camps after treatment in septic tanks will be disposed of discharging into the river. Septic tanks shall be located so as not to pollute drinking water. Settling tanks of appropriate size for treatment of effluents shall be provided. An amount of **Rs.5.00 lakh** shall be earmarked for construction of various settling tanks. In the post project construction operation phase a planned colony with 100 quarters is likely to be set up. It is recommended to commission a suitable Sewage treatment plant to treat the sewage from the colony.

**11.5 Development of Medical Facilities:** There will be no medical facilities available here or in the nearby vicinity of the project site. It is suggested that suitable medical facilities be developed at the project site. It is recommended that a dispensary should be established during project construction phase itself so that it can serve the labour population migrating in the area as well as the local population. Also considered necessary to have a first aid box at each of the major construction sites so that the affected get immediate attention in case of an injury or accident. An amount of Rs 19.67 lakh per year provision was made for Administration and Man Power Expenses, First Aid Posts Expenses and Drugs and Medicines, Contingencies and First Aid Posts. For the next 5 years maintenance i.e. during construction phase a total of Rs 98.35 lakh provision was made in the EMP.

**11.6 Other Infrastructure :** It is estimated that 5000 Sq.ft plot (costs around Rs 1.00 lakh) will be required for dispensary out of which 3000 Sq.ft will be built up land which includes staff quarters. It is estimated about 1.5 times of built up Area that comes 4500 sq ft plint area of RCC building is to be constructed by incurring an amount of **Rs 41.50 lakhs**. Also First Aid Posts by way of temporary construction with asbestos sheets/Tiles,

bamboo etc., the total cost will be **Rs.2.00 lakh**. An amount of **Rs 11.00 lakh** as capital cost for the first year towards vehicles and furniture.

In all total cost of health delivery system is estimated at **Rs. 278.52 lakhs**

## **12. ENVIRONMENTAL MONITORING PROGRAMME**

Environmental monitoring is an essential component for sustainability of any water resource project. It is an integral part of any environmental assessment process. Monitoring of critical parameters is essential in the project operation phase, thus Environmental Monitoring Programme has been designed.

**12.1 Water Quality:** Construction Phase at Dam and Power House: About 240 samples/year are needed to be analyzed. The parameters to be monitored include pH, Bio-chemical Oxygen Demand, total Suspended Solids and total Dissolved Solids. The cost of testing of one sample is expected to be Rs. 2000. Thus, total cost for analysis of 240 samples is expected to be Rs. 4.80 lakh/year. Considering that the construction phase to last for a period of 6 years and an escalation cost of 10% every year, the total cost over the entire construction phase works out to **Rs 37.00 lakhs**. The analysis work can be done by a laboratory recognized by the State Pollution Control Board or by the State Pollution Control Board at Shillong it self.

**12.1.1 Operation Phase :** The surface water quality of the impounded water and river Umngot needs to be monitored thrice in a year for the sampling sites at Reservoir water upstream of the dam and at the end of Tail Race. A provision of Rs 1.00 lakh was earmarked for the purpose over a period of 10 years. About 50 samples @ Rs. 3000 per sample from Sewage Treatment Plant (STP) need be analyzed. A provision of Rs. 15.00 lakh shall be made for analyzing the samples for 10 years.

The total cost of water quality monitoring works out to **Rs 53.00 lakhs**

**12.2 Air Quality And Meteorology:** The ambient air quality monitoring during construction phase can be carried out. The frequency of monitoring could be twice a week for four consecutive weeks at each station for each season. The parameters to be monitored are Respirable Particulate Matter (RPM) and Suspended Particulate Matter (SPM, Sulphur dioxide (SO<sub>2</sub>) and Nitrogen Oxides (NO<sub>x</sub>).

Every year, ambient air quality is to be monitored at Umngot dam site and Power house. The total samples would be 64 per year. Total cost of Rs. 19.75 lakhs (with 10% escalation) at the rate of Rs. 4000 per sample will be required for the project construction phase of 6 years. A provision of Rs 15.00 lakhs was made in the EMP for setting up a meteorological laboratory near the project. The total cost for the monitoring of air quality and other meteorological parameters works out to **Rs. 34.75 lakh**.

**12.3 Soil Erosion and Siltation :** Soil erosion rates in the catchment areas, of the dams, efficacy of soil conservation measures need to be closely monitored twice a year during the operation phase. An amount of Rs. 5.00 lakhs per year may be provided totaling to **Rs. 50 lakhs** for 10 years. After 10 years the parameters will be reviewed and provisions continued if required from normal funds.

**12.4 Ecology :** Monitoring of aquatic ecology will be essential for future programmes of fish development and is to be monitored twice every year at the water sampling sites namely Left flank & Right flank of the river and at Power house site. The monitoring can be conducted by a reputed external agency for which 1.00 lakhs /

year can be earmarked upto 10 years totaling to Rs 10.0 lakhs. The staff at the proposed unit of the Environment Management cell can undertake the work. A provision of Rs. 5 lakhs per year can be kept for this purpose upto 10 years totaling to Rs 50.00 lakhs. The total cost provision made for Ecology monitoring is **Rs 60.00 lakhs**.

**12.5 Noise :** The frequency of monitoring could be once every month. For monitoring of noise generators, five integrating sound level meters will be required for which an amount of **Rs 3.0 lakhs** was earmarked towards noise emissions.

**12.6 Incidence of Water-Related Diseases :** Identification of water related diseases, adequacy of local vector control and curative measures, status of public health are some of the parameters which should be closely monitored three times a year. A total cost provision for monitoring over the entire project construction phase of 6 years shall be **Rs. 38.58 lakh** including escalation. Similarly increased prevalence of various vector borne diseases and adequacy of local vector control and curative measures need to be monitored. The monitoring can be done three times in a year. The total cost required for monitoring for 10 years in the operation phase works out to **Rs. 31.87 lakhs**.

In all, the total cost for the Environment Monitoring programme worked out to **Rs. 272.48 lakhs**.

### **13. DAM BREAK ANALYSIS AND DISASTER MANAGEMENT PLAN**

The sudden release of the reservoir water forms a catastrophic flood and it results in the catastrophic loss of life and property due to sudden dam break. Therefore, dam-safety programs have been developed in most countries of the world as a result of safety against dam breaks. The maximum time taken to reach the 20 km point would be 0.205 hrs or 12 minutes due to the rapid fall in the topography. The area is likely to be upto the maximum flood elevations at the different locations. The inundation map found that very small extent of land is likely to be inundated outside the river flanks and also there are no habitations within the inundation area. However, a suitable disaster management plan in the event of dam break and consequential floods is prepared.

The disaster is an example of failed or unsustainable development which can only be prevented or mitigated by adoption of more sustainable development practices. An approach for handling the Disasters in the Power plant, Fixed Fire Detection and Protection systems, Portable Fire Extinguishers, Communication Facilities, Emergency Power Supply, Emergency Safety Equipment, Emergency Alarms, action plan along with responsibilities, Training in Disaster Preparedness, Role of various other departments etc., were presented in the report.

### **14. RESETTLEMENT AND REHABILITATION PLAN**

The project envisages that land is required for the submergence of land for the reservoir and for the construction of other appurtenant structures, colony and roads. For the above components 56.60 ha of private land is proposed to be acquired besides 93.53 ha of land covered with forest and 146.84 ha of community lands. The total cost of involuntary acquisition of private agricultural land at Rs. 4,90,000/- per ha and Rs. 4,30,000/- per ha for community lands, loss of tress, loss of standing crop, interest, demarcation, legal and establishment charges is estimated to be Rs. 2,331.07 lakh

The Economic Rehabilitation package for 228 PAF households identified under the SES is estimated to cost about Rs. 524.59 lakh. Further, a margin of 5% is allowed in the indicative budget to meet any additional claims that might arise when the actual implementation of R & R Programme is taken up. Thus the total cost of economic rehabilitation programme of PAF households would be about Rs 550.82 lakh including an indicative budget of Rs 26.23 lakh. All the benefits from the package were estimated by considering present wage rate of Rs 100 per man day.

A lumpsum amount of Rs. 5.00 lakh will be earmarked for this activity. In addition, all the PAFs need to be provided with adequate training to take up new livelihood activities identified for their rehabilitation. A training budget at the rate of Rs. 5000 per family is provided towards training of 228 PAF members. Thus, the total amount to be provided for training of PAF members to take up new livelihood activities is Rs. 11.40 lakh. The total amount provided for training of officials and PAFs is Rs. 16.40 lakh. The total financial requirement for the implementation of Resettlement and Economic Rehabilitation Plan including cost of land acquisition would be about **Rs 2,898.29 lakh**

#### 15. TOTAL PROJECT OUTLAY FOR EMP AND R & R

The total implementation cost of Environmental Management Plan and Resettlement & Rehabilitation Plan is estimated at **Rs 3,823.04 and Rs 2,898.29 lakhs** respectively. The total financial provision required for implementation of EMP under the project is assessed to be about **Rs. 67.22 crore** including R & R costs and **Rs 38.23 crore excluding R & R costs**.

<b>Total Project of EMP and R&amp;R</b>		
<b>Sl. No</b>	<b>Particulars</b>	<b>Amount Rs lakhs</b>
<b>A</b>	<b>Environmental Management Plan</b>	
1	Catchment area treatment including reservoir rim treatment and Compensatory Afforestation	2,901.96
2	Land Management	274.13
3	Biological Conservation plan	95.95
4	Public Health Management Plan	278.52
5	Environmental Monitoring Plan	272.48
	<b>Sub-Total of EMP</b>	<b>3,823.04</b>
<b>B</b>	<b>Resettlement and Rehabilitation Plan</b>	
1	Land Acquisition	2,331.07
2	Economic Rehabilitation	550.82
3	Training	16.40
	<b>Sub-Total of R &amp; R</b>	<b>2,898.29</b>
	<b>Total Project cost Including R &amp; R</b>	<b>6,721.33</b>

## **16. CONCLUSION**

The implementation of the proposed Umngot HEP (3 x 80 MW) will have an impact on the environment and the socio- economic aspects in and around the project area, just like any other developmental projects. The negative impacts have been assessed but the measures formulated to be adopted in the Environmental Management Plan and Rehabilitation and Resettlement Plan will not only mitigate the various impacts but also ameliorate the environmental and socio-economic conditions, not only in the project area but also throughout the catchment. Moreover, the benefits that will be accrued by the implementation of this project will not only meet the energy demand of the state and the country but would also uplift the socio-economic conditions of the people in and around the project.