



DECENTRALIZED GREEN ENERGY DEVELOPMENT PROJECT

TECHNICAL MANUAL

Institute of Natural Resources

Meghalaya Basin Development Authority

TECHNICAL MANUAL

DECENTRALIZED GREEN ENERGY DEVELOPMENT PROJECT

1. PICO HYDROPOWER:

Hydro Power generation has a double benefit, electricity generation for livelihood interventions and catchment protection to ensure availability of hydro. Meghalaya has a huge potential in hydro-power generation. The hydro power potential of Meghalaya is 3000 MW which is about 3 per cent of the total hydro potential of the country. This energy potential can be the solution to the power scenario in Meghalaya and can be tapped with the inclusive initiatives of the people of Meghalaya. Meghalaya Institute of Natural Resource (MINR) under the MBDA and in collaboration with Nagaland Empowerment of People through Energy Development (NEPED) had facilitated one such project in Mawlyngbna (a Pico turbine also known as Hydroger generating approximately 1 kW of power) 1 kW is sufficient to light up to 200 LED (5 W) bulbs. If one house hold in a village uses 4 bulbs, then 50 houses in that village can be lit with such a power.

Harnessed energy has become a symbol of growth and instrument for development. Electric power particularly the small hydro power is a renewable, economically attractive, non-polluting and environmentally benign source of energy. Moreover, the Small Hydro Power is submergence free and has short gestation period. These benefits of SHP have now been sufficiently recognized. The need of the project comes from the benefits of SHP and utilization of resources.

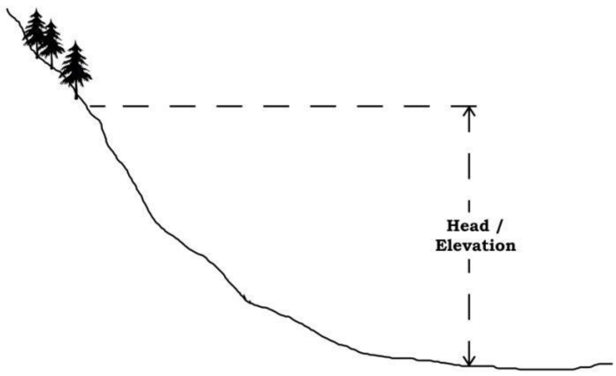
Different categories of small capacity hydro power:

Hydro Category	Power Range
Pico	0 kW – 5 kW
Micro	5 kW – 100 kW

Before embarking on any **hydro power** generation project it is essential to survey and see the feasibility of the proposed site. The two vital factors to consider are the **flow (discharge)** and the **head** of the stream. The **flow** is the volume of water which can be captured and re-directed to turn the **turbine generator**, and the **head** is the distance the water will fall on its way to the generator. The larger the flow - i.e. the more water there is, and the higher the head - i.e. the higher the distance the water falls - the more energy is available for conversion to electricity. It was recommended that for a Pico or Micro Hydro Power the minimumhead required is 10 metres and the minimum discharge required is 20 litres per sec or vice versa. i.e this minimum requirement will at least give an output of 1 kW.

Head

Head could be measured by using a GPS, Altimeter or by any simple technique.



Discharge

The **discharge** of a stream is the product of its velocity **(v** - length of travel per unit of time such as meter/second) times depth of the water (**h** - unit of length) times width (**w** of the water - units of length). (Make sure all three lengths are expressed in the same unit)

For calculating the discharge of a stream we need a few basic equipments:

- Stopwatch/ mobile phone stopwatch app
- Measuring tape
- Floating objects (Thermocol /half full bottle/ ball/ stick/ fruit. etc)

Methods for Calculating the Discharge:

There are two main methods of measuring discharge of a stream, i.e according to the size of the stream.

a. Let us first take the example of a low discharge:

If the stream is of very low discharge, then a bucket or any container of known capacity may be used to calculate the discharge by recording the time taken to fill a known capacity of the container. E.g., if the capacity of the bucket is 20 litres and the time taken to fill this bucket is 5 second, then, the discharge is 4 litres per second (20/5).

b. But in the case of a higher discharge, the following steps may be taken to calculate the discharge:

- Select an area of the stream where the flow is fairly calm, straight and of a fairly uniform width. (it would be easier if the water is flowing through a uniform channel) this is because of the fact that the speed of water in a stream is highly variable—slow in pools, moderate in runs, fast in riffles and rapids, variable around obstacles, slow at undercuts and in dense aquatic vegetation, etc. The goal is to choose a stream section where the speed is reasonably uniform. This run should be free from obstacles (logs, rocks etc.). Access to the water's edge at both ends of the stream section should be easy and offer good visibility. And always keep safety in mind!
- Mark the upstream starting of the section.
- Mark the finish line downstream of the section.
- Note the distance (**L**) between the start and the end of the marked section.
- Note down the width (**w**) of the stream.
- Now measure the depth (**h**) of the stream at equal intervals across the stream. At evenly spaced distances the note down the corresponding stream depths h2, h3, h4, ..., hn-1.
- To determine the average depth, add all the recorded depth and divide by the number of records. Example (six records): 0.5 + 0.4 + 0.3 + 0.4 + 0.5 + 0.7 = 2.8 and 2.8 ÷ 6= 0.46 meters. Now we have the depth (**h**) of the stream.
- Now the cross section area of the stream is given by A=w x h. For example the width is 1 meter and the average depth is 0.46 meter then the cross section area is 1 x 0.46 meter = 0.46 meter^2. Now we have the cross section area (**A**) of the stream.

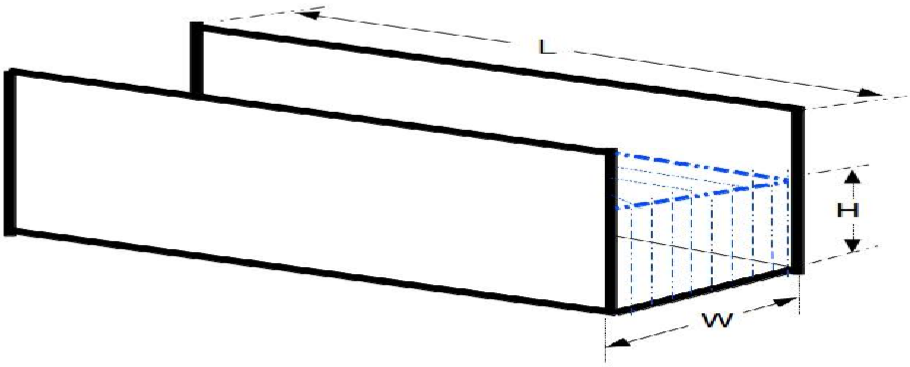


Fig: Volume Calculation.

Note that the height (depth) is uniform throughout its width

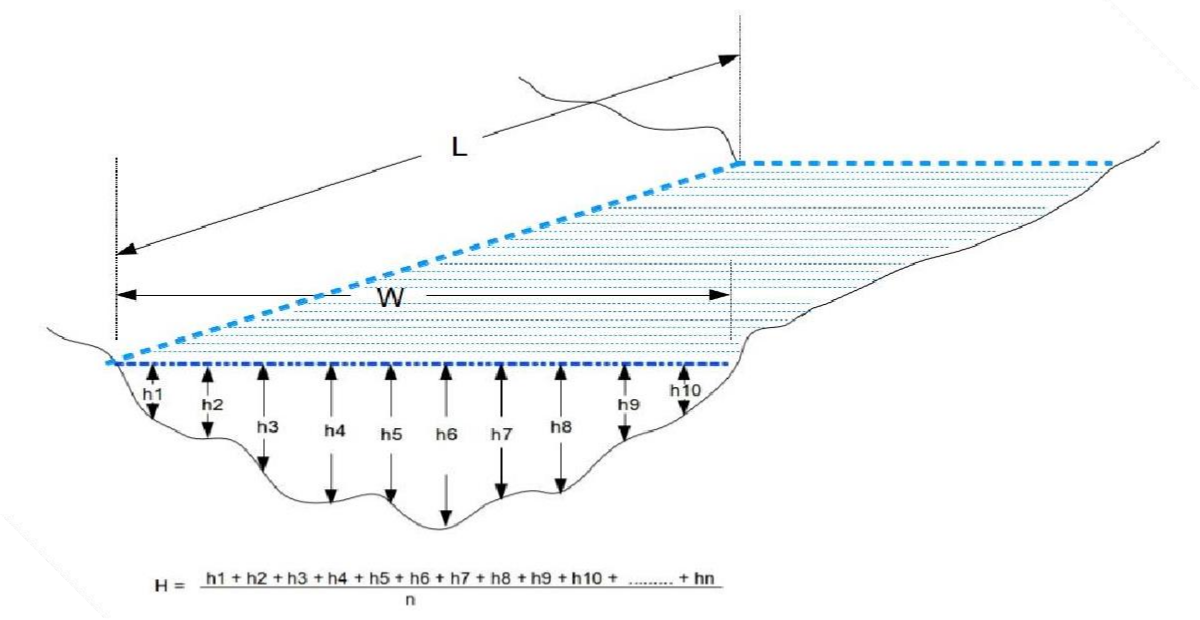


Fig: Volume Calculations

Note the height (depth) varies along its width.

- Now toss a float into the stream a little bit upstream from the imaginary starting line that stretches between the starting marks and start the stopwatch once it reaches the line. It is important to toss the object a little bit upstream from the starting line to give it time to get moving at the speed of the water.
- Someone will call out "stop" when the float crosses the finish line and note down the time (**t**) taken for the object to flow from the starting to the finishing line.
- Repeat the exercise around six trials and note down the time (**t**) for each trial and we will discover that each exercise will give different results.
- For each run, divide **L** (distance) by **t** (time) and record the speed of that run. Example: If the run is 5 metres and 10 seconds is required then 5 meters ÷ 10 seconds = 0.5 meters/second.
- To determine the average speed, add the velocity for each of the trials and divide by the number of trials. Example (six runs): 1.24 + 1.29 + 1.43 + 1.37 + 1.51 + 1.62 = 8.46 and 8.46 ÷ 6 = 1.41 meters per sec. Now we have the velocity of the stream.
- Now after getting all the factors we can calculate the discharge with the following equation:

Discharge = Cross section area(A) x velocity(v)

Or

Discharge = Width of stream(w) x average depth of stream(h) x velocity(v)

For example 0.46 meter^2 is the cross section of the stream, 1.41 meter per sec is the velocity of the stream, and then discharge is given by:

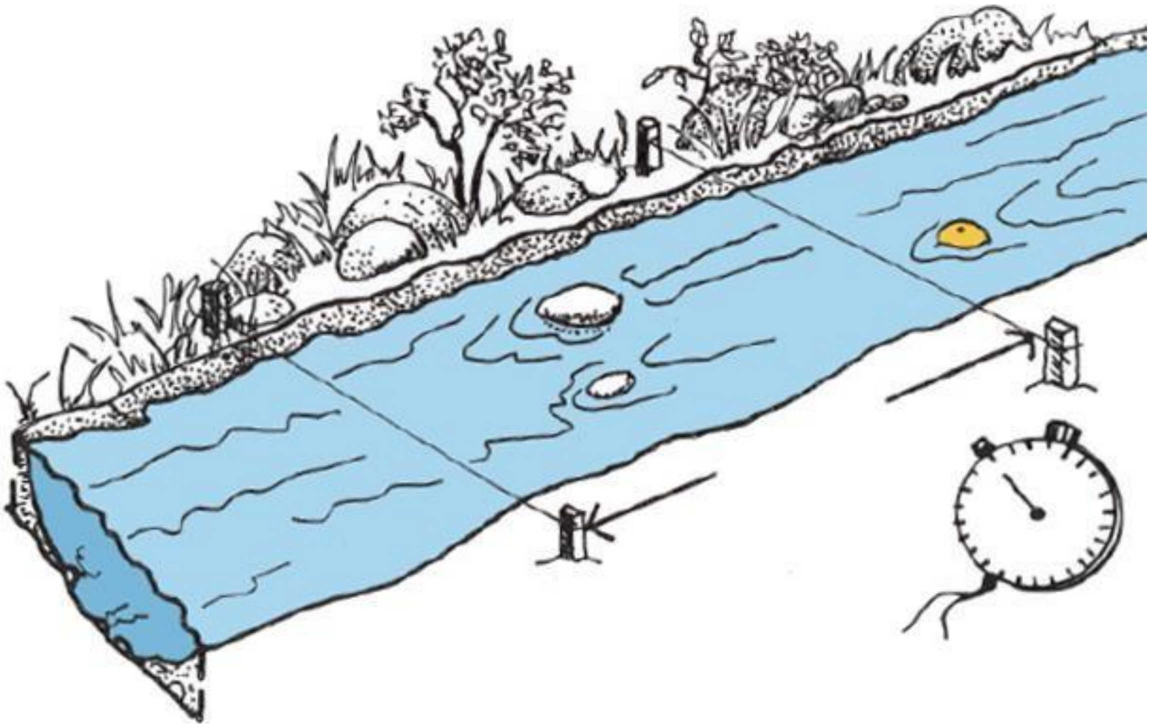
D = 0.46 x 1.41 = 0.65 cubic meters per sec.

- But now the correction factor (0.85) needs to be taken into account the different speeds in the water column. Water flow faster closer to the surface and slower near the channel bottom because of the effects of friction from the stream bed. So now discharge will be given as:

Discharge = Cross section area(A) x velocity(v) x correction factor

D = 0.46 x 1.41 x 0.85 = 0.55 cubic meters per sec

As in the example above the discharge is measured in cubic meters per sec, but this unit can be converted to litres per second. 1 m^3 /sec is equal to 1000 L/sec. So 0.55 m^3 /sec = 550 L/sec.



Discharge or Flow of a stream is not always uniform throughout the year, hence therefore it is required to measure the discharge at least once a month throughout the whole year (the more frequent the better it will be), this will give a very clear understanding on how the stream is behaving in the different seasons and climatic conditions throughout the year.

Power

Now the key equation to remember is the following:

Power = Head x Flow x Gravity

Where **power** is measured in Watts, **head** in metres, **flow/discharge** in litres per second, and**acceleration due to gravity** in metres per second^2.

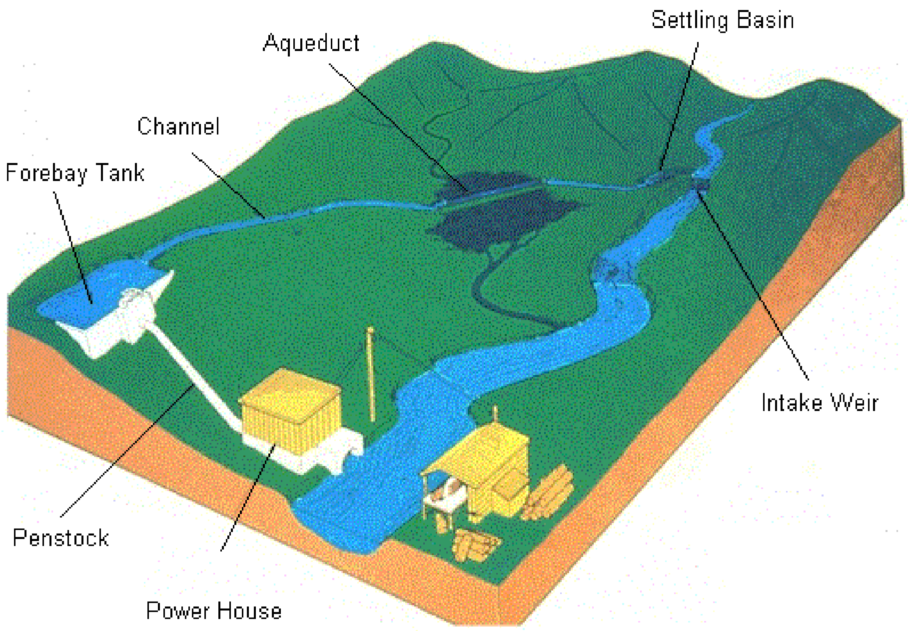
The acceleration due to gravity is approximately 9.81 metres per second^2 - i.e. each second an object is falling, its speed increases by 9.81 metres per second (until it hits its terminal velocity).

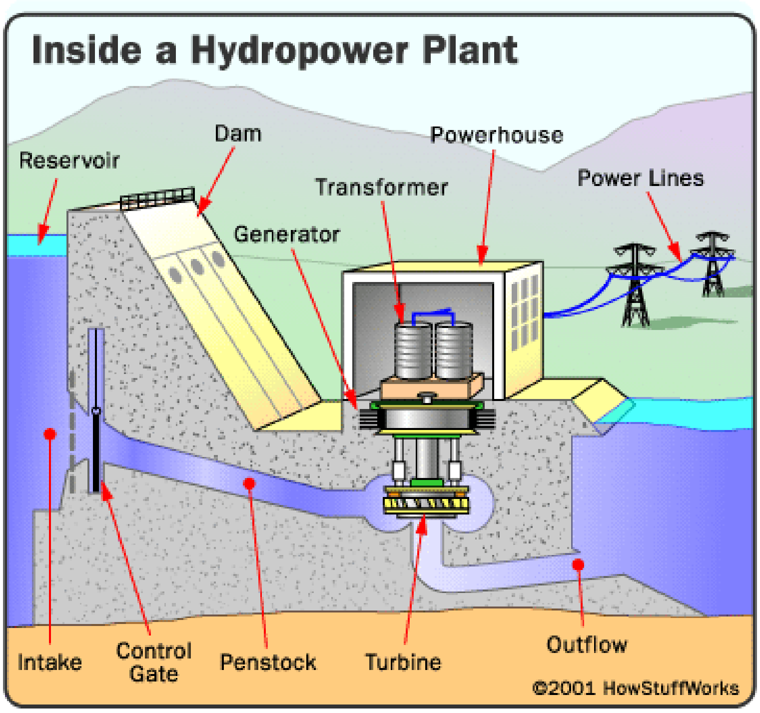
For example: say we have a flow of 10 litres per second with a head of 10 metres. Put those figures in the equation and we will see that:

10 x 10 x 9.81 = 981 Watts

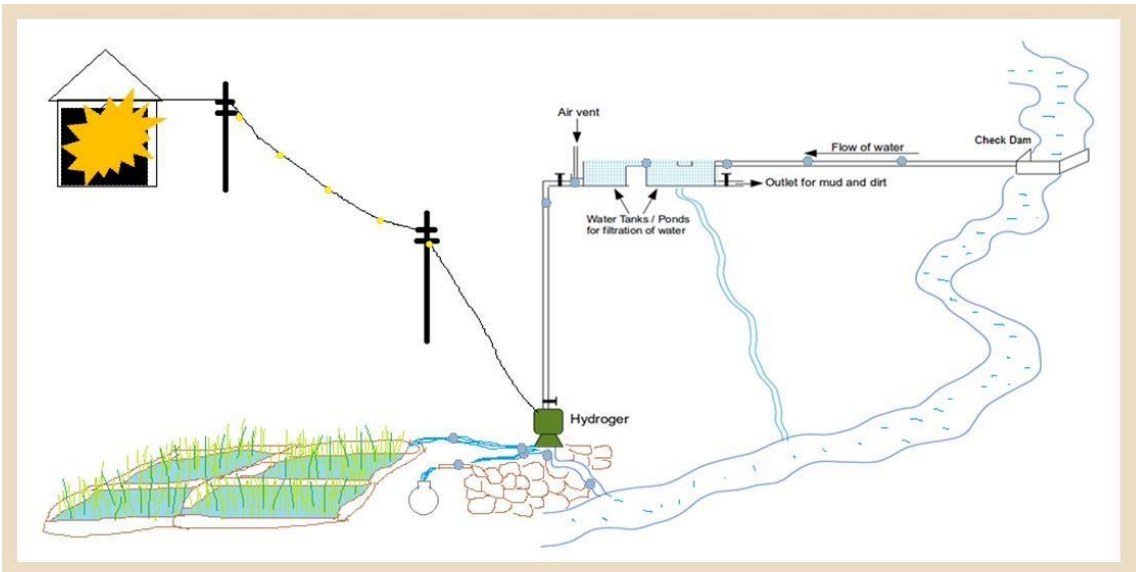
So in the example above, available power is 981 Watts. Sadly it is not possible to tap all of that power - nothing is 100% efficient. However, **hydro power turbine generators** are very efficient when compared to **wind turbine generators** and **solar panels**.

Efficiencies of around 70% can be expected which is to say that 70% of the *hydraulic energy* of the flowing water can be turned into *mechanical energy* spinning the **turbine generator**. The remaining 30% is lost. Approximately 10% energy is again lost in converting the *mechanical energy*into *electrical energy* (electricity) and so one can expect a complete **system efficiency** of around 50% to 60%. In our previous example where 981 W of power was available - we can therefore expect to generate around 589 W of electricity.





Hydroger: Does not require a lot of water and small streams will act as a source to generate electricity. The water from the stream is stored in a reservoir and released 10m down to the hydroger which comprises of cylindrical cast iron casing housing an alternator which is connected to the turbine through the shaft. Hydro (Water) power is used to turn the turbine to generate energy. There are basically two types of turbines, impulse and reaction. A tiny 3kW hydroger unit can meet the lighting requirement of a small village.



Example of an installation of a Hydroger

People's Participation

It is also important to consider People's participation in any pico or micro hydro power project, the success of the project will substantially rest with active participation of the people benefiting. Capacity building for day to day monitoring, adjustments and minor repairing is an essential element of the project. A Village level committee will be needed to be constituted for the ownership and overall maintenance of the Turbine Generator set. The Committee's prime objectives may be laid as:-

i. Revenue collection
ii. Power Distribution Methodology
iii. Maintenance of the Hydro Turbine Generator set.

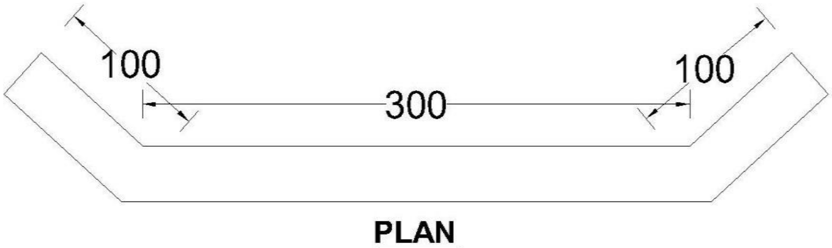
Participation of the people could also be at the level of feasibility study, where the people can study the discharge of the stream, the head and plan the location of the power house.

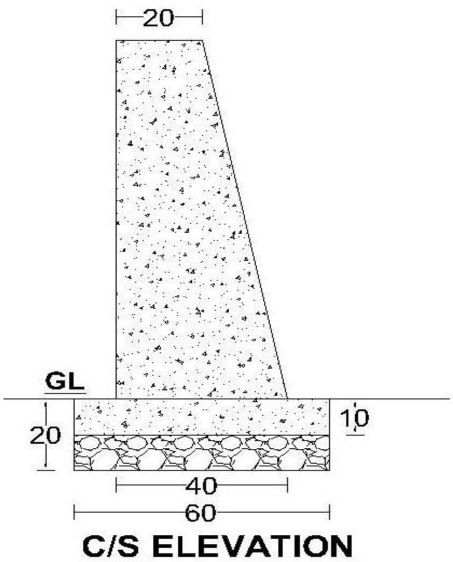
Approach:

Day	Steps
1	Determine the Discharge
	Determine the Head
	Identify the Penstock Area
	Identify the Power House Area
	Determine the Pipe Line Distance
	Identify the points for the Lights to be setup
	Determine the number of Light points
	Identify the wire distance
2	Prepare the Estimate Amount
3	Procure the Equipment
4	Transportation of the Equipment to the village
5	Construction of Penstock / Mini dam
6	Laying the Pipeline
7	Construction of Power House
8	Setting-up of Light / Lamp Poles
9	Wiring
10	Installation of Hydro-Power Setup

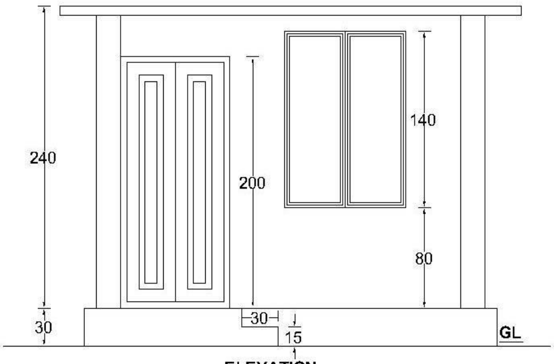
Hydroger

a. Cement Concrete Weir

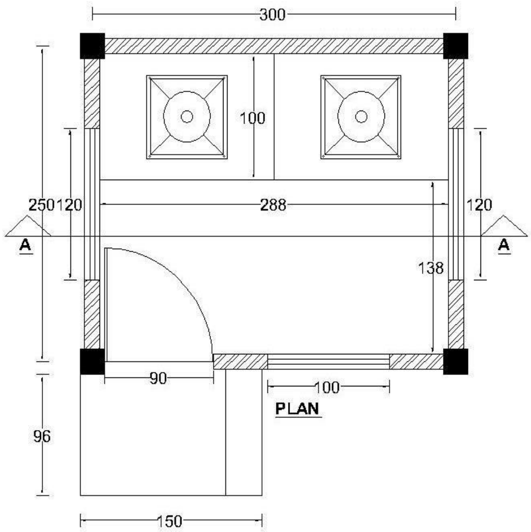


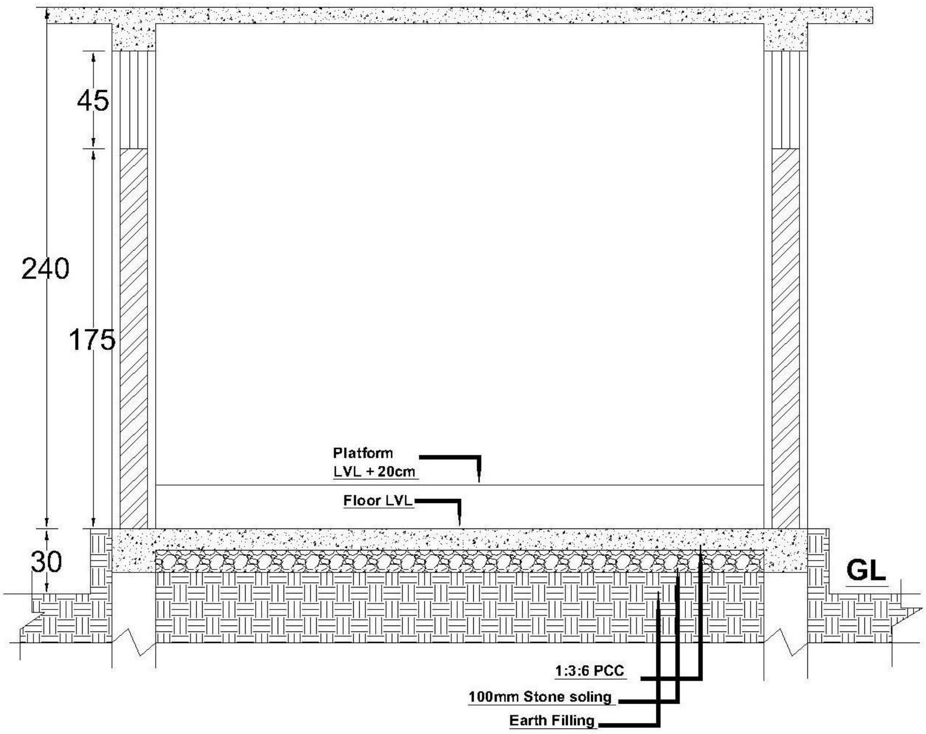


b. Power House



ELEVATION





SECTION AT AA

5. INSTALLATIONS

A. Installation at Sohrarim, Laitkroh Khatarshnong, East Khasi Hills.

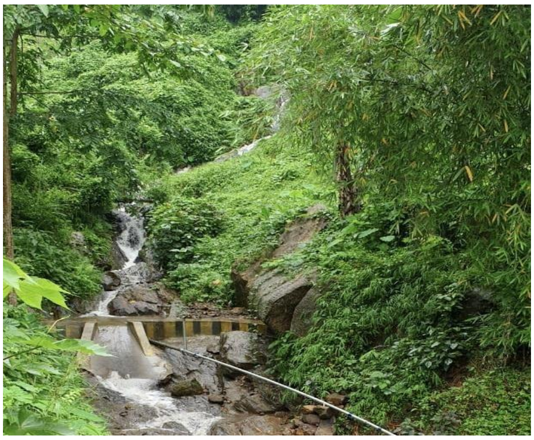
Installation of Pico Turbine was done at Sohrarim Village in Laitkroh Khatarshnong Block in East Khasi Hills District on the 15/06/2020 by the staff from MINR,MBDA with assistance of Green Volunteers and Field Engineers of East Khasi Hills and the members of the VECs. The Pico Turbine installed generates approximately 3kW Power. The Project infrastructure includes laying of pipelines(penstock) from the existing check dam from a perennial source at Sohrarim Village which is fed to the Pico Turbine in the Power House. The purpose is to serve the Village with Street Lighting and Water Lifting.

SITE INSTALLATION PICTURES

B. Installation at Upper Bolsaldam, Kharkutta, North Garo Hills

Installation was done at Upper Bolsaldam village in Kharkutta Block in North Garo Hills District on the 18/06/2020 where the Pico Turbine was installed and approximate 3kW power was generated .The Project infrastructure includes connection of pipeline from the existing check dam from a perennial source Aiar falls in Upper Bolsaldam village which is fed to the Pico Turbine in the Power House. The purpose is to serve the villagers with Village street lighting, Lighting of village school, Lighting of community centre, Lighting of Angawadi centre and Lighting of 10% un electrified households.

Besides, the discharged water from the Pico Turbine is tapped and connected to the village school premises which in turn will improve the quality of water provided at the village school.



C. Installation at Rongtra Village, Baghmara Block, South Garo Hills :

Installation of Pico Turbine was done at Rongtra village in Baghmara Block in South Garo Hills District on the 20/08/2020 by the staff from MINR,MBDA in the presence of Deputy Commissioner South Garo Hills District, Block Development officer Baghmara block, Project Director DRDA and the villagers. where the was installed pico turbine generated approximately

3kW power. The Project infrastructure includes Construction of mini check dam, laying of pipelines(penstock) from the constructed mini check dam from a perennial source Rongtra chi at Rongtra village which is fed to the Pico Turbine in the Power House. The 3KW power generated from this Pico Turbine will be used for the following purposes, Village Household lighting, Village street lighting and Lighting of Village School.

****