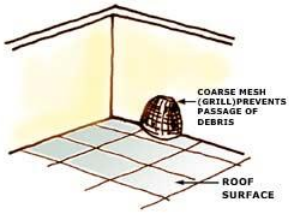
2. Coarse mesh: Present at the corners of the roof to prevent the passage of debris



Source: A water harvesting manual for urban areas

3.**Gutters:**

Channels all around the edge of a sloping roof to collect and transport rainwater to the storage tank. Gutters can be semi-circular or rectangular and could be made using:

- Locally available material such as plain galvanized iron sheet (20 to 22 gauge), folded to required shapes.
- Semi-circular gutters of PVC material can be readily prepared by cutting those pipes into two equal semi-circular channels.
- Bamboo or betel trunks cut vertically in half.

The size of the gutter should be according to the flow during the highest intensity rain. It is advisable to make them 10 to 15 per cent oversize.

Gutters need to be supported so they do not sag or fall off when loaded with water. The way in which gutters are fixed depends on the construction of the house; it is possible to fix iron or timber brackets into the walls, but for houses having wider eaves, some method of attachment to the rafters is necessary.

4 **Conduits or Conveyance:**

Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Conduits can be of any material like polyvinyl chloride (PVC) or galvanized iron (GI), materials that are commonly available.

.

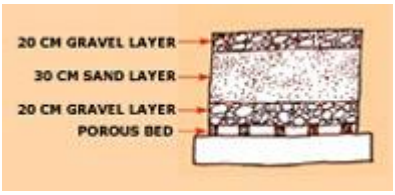
5. **First-flushing**

A first flush device is a valve that ensures that runoff from the first spell of rain is flushed out and does not enter the system. This needs to be done since the first spell of rain carries a relatively larger amount of pollutants from the air and catchment surface.

6. **Filtration or Purification:**

The filter is used to remove suspended pollutants from rainwater collected over roof. A filter unit is a chamber filled with filtering media such as fiber, coarse sand and gravel layers to remove debris and dirt from water before it enters the storage tank or recharges structure. Charcoal can be added for additional filtration.

(i)Charcoal water filter: A simple charcoal filter can be made in a drum or an earthen pot. The filter is made of gravel, sand and charcoal, all of which are easily available.



(ii) **Sand filters**

Sand filters have commonly available sand as filter media. Sand filters are easy and inexpensive to construct. These filters can be employed for treatment of water to effectively remove turbidity (suspended particles like silt and clay), colour and

microorganisms.
In a simple sand filter that can be constructed domestically, the top layer comprises coarse sand followed by a 5-10 mm layer of gravel followed by another 5-25 cm layer of gravel and boulders.

7. **Storage or Sump:** A storage provision to collect filtered water from the tank through the filter channel for storage and collection.
There are various options available for the construction of these tanks with respect to the shape, size and the material of construction.
Shape: Cylindrical, rectangular and square.
Material of construction: Reinforced cement concrete, (RCC), ferrocement, masonry, plastic (polyethylene) or metal (galvanized iron) sheets are commonly used.
Position of tank: Depending on space availability these tanks could be constructed above ground, partly underground or fully underground. Some maintenance measures like cleaning and disinfection are required to ensure the quality of water stored in the container.

B. Charged into the soil for withdrawal later (groundwater recharging)

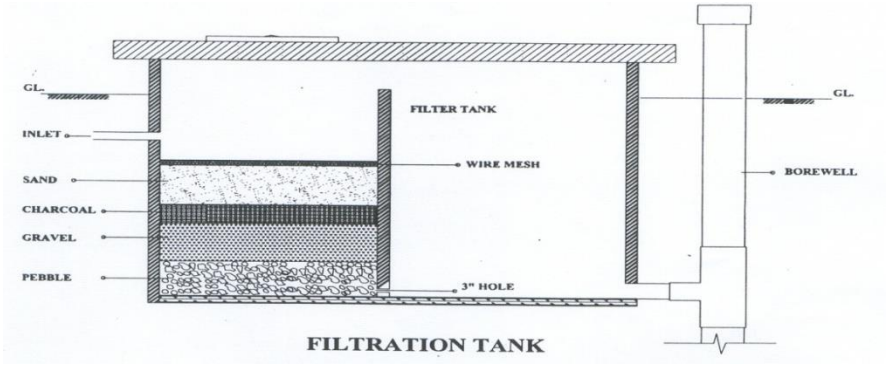
Ground water aquifers can be recharged by various kinds of structures to ensure percolation of rainwater in the ground instead of draining away from the surface. Commonly used recharging methods are:

a) Recharging of bore wells
b) Recharging of dug wells.
c) Recharge pits
d) Recharge Trenches
e) Soak ways or Recharge Shafts
f) Percolation Tanks

a) **Recharging of bore wells**

Rainwater collected from rooftop of the building is diverted through drainpipes to settlement or filtration tank. After settlement filtered water is diverted to bore wells to recharge deep aquifers. Abandoned bore wells can also be used for recharge.

Optimum capacity of settlement tank/filtration tank can be designed on the basis of area of catchments, intensity of rainfall and recharge rate as discussed in design parameters. While recharging, entry of floating matter and silt should be restricted because it may clog the recharge structure. "first one or two shower should be flushed out through rain separator to avoid contamination. This is very important, and all care should be taken to ensure that this has been done."

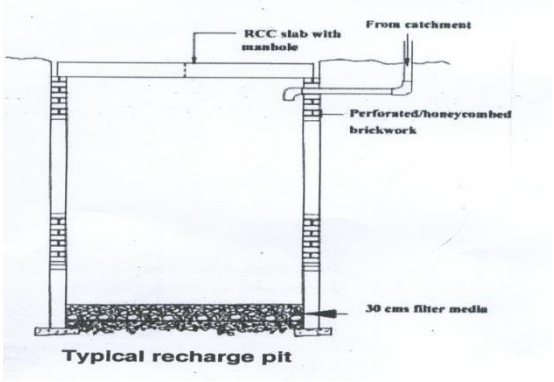


FILTRATION TANK

b) **Recharge pits**

Recharge pits are small pits of any shape rectangular, square or circular, contracted with brick or stone masonry wall with weep hole at regular intervals, top of the pit can be covered with perforated covers. Bottom of pit should be filled with filter media

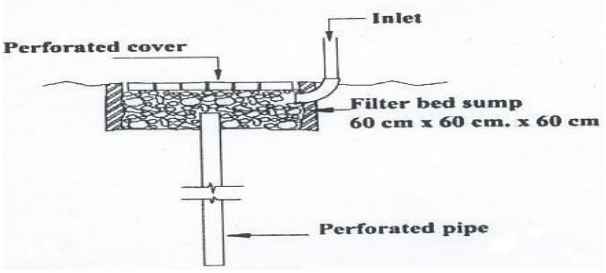
The capacity of the pit can be designed on the basis of catchment area, rainfall intensity and recharge rate of soil. Usually the dimensions of the pit may be of 1 to 2 m width and 2 to 3 m deep depending on the depth of pervious strata. These pits are suitable for recharging of shallow aquifers, and small houses.



Typical recharge pit

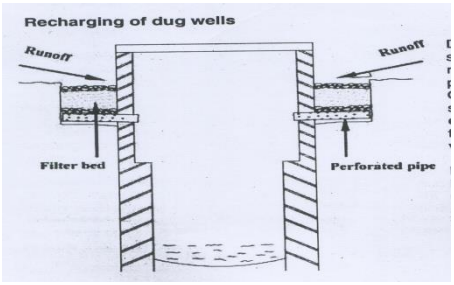
c)soak away or recharge shaft

Soak away or recharge shafts are provided where upper layer of soil is alluvial or less pervious. These are bored hole of 30 cm dia. up to 10 to 15 m deep, depending on depth of pervious layer. Bore should be lined with slotted/perforated PVC/MS pipe to prevent collapse of the vertical sides. At the top of soak away required size sump is constructed to retain runoff before the filters through soak away. Sump should be filled with filter media.



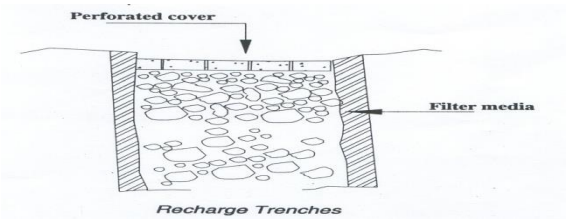
d)Recharging of dug well

Dug well can be used as recharge structure. Rainwater from the rooftop is diverted to dug wells after passing it through filtration bed. Cleaning and desalting of dug well should be done regularly to enhance the recharge rate. The filtration method suggested for bore well recharging could be used



e) Recharge trenches

Recharge trench in provided where upper impervious layer of soil is shallow. It is a trench excavated on the ground and refilled with porous media like pebbles, boulder or brickbats. It is usually made for harvesting the surface runoff. Bore wells can also be provided inside the trench as recharge shafts to enhance percolation. The length of the trench is decided as per the amount of runoff expected. This method is suitable for small houses, playgrounds, parks and roadside drains. The recharge trench can be of size 0.50 to1.0mwideand1.0to1.5mdeep.



f) Percolation tanks

Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation to recharge the ground water. These can be built in big campuses where land is available and topography is suitable. Surface run-off and roof top water can be diverted to this tank. Water

accumulating in the tank percolates in the solid to augment the ground water. The stored water can be used directly for gardening and raw use. Percolation tanks should be built in gardens, open spaces and roadside green belts of urban area.

3.4.2 WATERSHED MANAGEMENT

Introduction:

The land area drained by a river is known as the river basin. The watershed is defined as the land area from which water drains under gravity to a common drainage channel. Thus watershed is a delineated area with a well defined topographic boundary and one water outlet. The watershed can range from a few square kilometers to few thousand square kilometers in size.

In the watershed the hydrological conditions are such that water becomes concentrated within a particular location like a river or a reservoir, by which the watershed is drained. The watershed comprises complex interactions of soil, landform, vegetation, land use activities and water. People and animals are an integral part of a watershed having mutual impacts on each other. We may live anywhere we would be living in some watershed. A watershed affects as it is directly involved in sustained food production, water supply for irrigation, power generation, and transportation as well as for influencing sedimentation and erosion, vegetation growth, floods and droughts. Thus management of watersheds treating them as a basic functional unit is extremely important and the first such Integrated Watershed Management was adopted in 1949 by the Damodar Valley Corporation.

Watershed degradation:

The watersheds are very often found to be degraded due to uncontrolled, unplanned and unscientific land use activities. Organizing, deforestation, mining, construction activities, industrialization, shifting cultivation, natural and artificial fires, soil erosion and ignorance of local people have been responsible for degradation of various watersheds.

Objectives of Watershed Management:

Rational utilization of land and water sources for optimum production causing minimum damage to the natural resources is known as watershed management.

The objectives of watershed management are as follows:

1. To rehabilitate the watershed through proper land use adopting conservation strategies for minimizing soil erosion and moisture retention so as to ensure good productivity of the land for the farmers.
2. To manage the watershed for beneficial developmental activities like domestic water supply, irrigation, hydropower generation etc.
3. To minimize the risks of floods, droughts and landslides.
4. To develop rural areas in the region with clear plans for improving the economy of the regions.

Watershed management practices:

In the fifth year plan, watershed management approach was included with a number of programs for it and a national policy was developed. In watershed management the aspects of development are considered with regard to availability of the resources.

The practices of conservation and development of land and water are taken up with respect to their suitability for people's benefit as well as sustainability.

Various measures taken up for management include the following:

1. **Water harvesting:** Proper storage of water is done with provision for use in dry seasons in low rainfall areas. It also helps in moderation of floods.

2. **Afforestation and agro-forestry:** In watershed development, afforestation and crop plantation play a very important role. They help to prevent soil erosion and retention of moisture. In high rainfall areas, woody trees are grown in between crops to substantially reduce the runoff and loss of fertile soil. In Dehradun trees like Eucalyptus, Leucaena and grasses like chrysopogon are grown along with maize or wheat to achieve the objectives. Woody trees grown successfully in such agro-forestry programs include Sheesham, Teak and Keekar which have been used in watershed areas of river Yamuna.

3. **Mechanical measures for reducing soil erosion and runoff losses**: Several mechanical measures like terracing, bunding, bench terracing, no-till farming, contour cropping, strip cropping etc. are used to minimize runoff and soil erosion particularly on the slopes of watersheds. Bunding has proved to be a very useful method in reducing runoff, peak discharge and soil loss in Dehradun andSiwaliks

4. **Scientific mining and quarrying:** Due to improper mining, the hills lose stability and get disturbed resulting in landslides, rapid erosion etc. Contour trenching a tan interval of one meter on overburdened dump, planting some soil binding plants land draining of water courses in the mined area are recommended for minimizing the destructive effects of mining in watershed areas.

5. **Public participation:** People's involvement including the farmers and tribals is the key to the success of any watershed management program, particularly the soil and water conservation. People's cooperation as well as participation has to be ensured for the same.

3.4.3 RESETTLEMENT AND REHABILITATION OF PEOPLE

Problems and concerns: Economic development raises the quality and standard of living of the people of a country. Developmental projects are planned to bring benefits to the society. However, in the process of development, very often there is over-exploitation of natural resources and degradation of the environment. Besides this, quite often, the native people of the project site are directly affected. These native people are generally the poorest of the poor, underprivileged tribal people. Various types of projects result in the displacement of the native people who undergo tremendous economic and psychological distress, as the socioeconomic and ecological base of the local community is disturbed.

a) Displacement problems due to dams:

The big river valley projects have one of the most serious socio-economic impacts due to large scale displacement of local people from their ancestral home and loss of their traditional

profession or occupation. India is one of the countries in the world leading in big dam construction and in the last 50 years more than 20 million people are estimated o have directly or indirectly affected by these dams e.g. Hirakum Dam, Bhakra Nangal Dam, Tehri Dam are the examples where many people and their villages in the vicinity got affected. It also resulted in movement lead by Sunderlal Bahuguna- movement called Chipko Movement- One more stir is currently on is Sardar Sarovar Project- three states people and many villages get affected.

b) Displacement due to mining:

Mining is another developmental activity, which causes displacement of the native people. Several thousands of hectares of land area is covered in mining operation and the native people are displaced. Sometimes displacement of local people is due to accidents occurring in mined areas like subsidence of land that often leads to shifting people e.g. various mines are predominant in Jharkhand, these mines had displaced many people.

c) Displacement due to creation of National park :

When some forests are covered under a National Park, it is a welcome step for conservation of the natural resources. However, it also has a social aspect associated with it which is often neglected. A major portion of the forest is declared as core-area, where the entry of local dwellers or tribals is prohibited. When these villagers are deprived of their ancestral right or access to forests, they usually retaliate by starting destructive activities. There is a need to look into their problems and provide them some employment

REHABILITATION ISSUES:

The United Nations Universal Declaration on Human Rights has declared that right to housing is a basic human right. In India, most of the displacements have resulted due to land acquisition by the government for various reasons. For this purpose, the government has the Land Acquisition Act, 1894 which empowers it to serve notice to the people to vacate their lands if there is a need as per government planning. Provision of cash compensation in lieu of the land vacated exists in the Act.

The major issues related to displacement and rehabilitation are as follows:

a) Tribals are usually the most affected amongst the displaced who are already poor. Displacement further increases their poverty due to loss of land, home, jobs, food insecurity, loss of access to common property assets, increased morbidity and mortality and social isolation.

b) Break up of families in an important social issue arising due to displacement in which the women are the worst affected and they are not even given cash/land compensation.

c) The tribals are not familiar with the market policies and trends. Even if they get cash compensation, they get alienated in the modern economic set up.

d) The land acquisition laws ignore the communal ownership of property, which is an inbuilt system amongst the tribals. Thus the tribals lose their communitarian basis of economic and cultural existence. They feel like fish out of water.

e) Kinship systems, marriages, social and cultural functions, their folk-songs, dances and activities vanish with their displacement, even when they are resettled; it is individual-based resettlement, which totally ignores communal settlement.

f) Loss of identity and loss of the intimate link between the people and the environment is one of the biggest loss. The age-long indigenous knowledge, which has been inherited and experienced by them about the flora, fauna, their uses etc. gets lost.

Rehabilitation policy:
There is a need for a comprehensive National Rehabilitation Policy. Different states are following different practices in this regard.

CASE STUDY:

In case of **sardar sarovar project** Gujarat Government is formulating its policy through various government resolutions. It has decided that each landed outstee shall be entitled to allotment of irrigable land in the state which he chooses for his resettlement. The area of the land would be equal to that owned by his earlier and the minimum land given to an outstee would be 2 hectares. However, there are problems of landless outstees and those natives who were cultivating forest land. The cut-off date for identifying an adult son in a family has been fixed. It is important since the adult son is to be treated as a separate family. The people of 20 submerged villages in Gujrat hane been resettled at different locations leading to disintegration of joint families.

3.4.4 CLIMATE CHANGE

Climate is the average weather of an area. It is the general weather conditions, seasonal variations and extremes of weather in region. Such conditions which average over a long period at least 30 years is called climate.
The Intergovernmental Panel on Climate Change (IPCC) in 1990 and 1992published best available evidence about past climate change, the green house effect and recent changes in global temperature. It is observed that earth's temperature has changed considerably during the geological times. It has experienced several glacial and interglacial periods.
However, during the past10000 years of the current interglacial period, the mean average temperature has fluctuated by 0.51˚ c over 100 to 200 year period. We have relatively stable climate for thousands of years due to which we have practiced agriculture and increased population.
Even small changes in climatic conditions may disturb agriculture that would lead to migration of animals including humans.
Anthropogenic activities are upsetting the delicate balance that has been established between various components of the environment.
Green house gases are increasing in atmosphere resulting in increase in the average global temperature.
This may upset the hydrological cycle; result in floods and droughts in different regions of the world, cause sea level rise, changes in agricultural productivity, famines and death of humans as well as livestock

3.4.5 GLOBAL WARMING

Introduction:

Before the Industrial Revolution, human activities released very few gases into the atmosphere and all climate changes happened naturally. After the Industrial Revolution, through fossil fuel combustion, changing agricultural practices and deforestation, the natural composition of gases in the atmosphere is getting affected and climate and environment began to alter significantly.
Over the last 100 years, it was found out that the earth is getting warmer and warmer, unlike previous 8000 years when temperatures have been relatively constant. The present temperature is 0.3 - 0.6 ^{o}C warmer than it was 100 years ago.