RAINWATER HARVESTING FOR LARGE SITE DEVELOPMENTS

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Rainwater harvesting, the process of collecting and storing rain for future productive use, has entered the lexicon of our infrastructural designers.

Figure 1: A rainwater harvesting system can be as simple as a rain barrel or a masonry tank collecting rain from the roof

More and more people now want rainwater harvesting in places they occupy. Be it individual homes or large apartment complex. Be it an industry or an institution ,water is at the crux of its operation and therefore rainwater harvesting is seen as a supplement and essential to ensuring the sustainability of water. Cities and states are enforcing legislation making it compulsory. Economic incentives are proposed. The media highlights such actions almost on a daily basis.

Why has this happened? There is a combination of reasons. The city's water supply network, including augmented supply and distribution, has failed to cope with the explosive urbanization we are witnessing. Consequently there has been a large dependence on groundwater to supply the water requirements of industries, institutions and large developments especially those which occur in the periphery of the city.

Unfortunately we are now discovering that groundwater is a limited quantity natural resource. Since most of peninsular India is on hard rock terrain, drilling bore-wells is tricky business. You have broadly a 50% chance of success in striking water. The life of a deep bore well is hard to estimate also. Added to the quantity issue is the quality of the groundwater. Higher and higher salts, fluoride and nitrate now are seen in groundwater.

The solution space: Clearly then managing water in a sustainable way will be a challenge. Some of the options that are likely to come to the fore are **demand management.** Metering water and pricing based on volumetric consumption will be crucial to optimize consumption. Ceilings may perhaps need to be introduced on water supply. Crucial decisions will need to be made on usefulness of water consumption. Can landscapes which are water guzzling be allowed? Will swimming pool designs need to be better to be water efficient? Can better WC's, showers, washing machines and taps be installed which consume less water? The next option will be **recycling** and **reusing** water. Sewage water or waste water as it was previously called will now be a resource. Appropriate treatment of grey water and black water will bring back this stream to and an appropriate use such as toilet flushing or for the landscape. One of the other options will be **rainwater harvesting** depending on the rainfall and distribution in a place.

Let us look at average rainfall in some of our cities and how much rainwater is available on 1 Hectare of land

City	**Rainfall in mm**	**Rainwater endowment on 1 Hectare of land (Lakh litres)**
Bangalore	970	97.00
Chennai	1334	133.40
Kolkata	1641	164.10
Delhi	797	79.70
Mumbai	2147	214.70
Hyderabad	812	81.20

As one observes, these are substantial quantities of water available. The challenge before designers of rainwater harvesting systems would be to harvest as much of the endowment as is possible. 'Zero runoff' could be an objective.

Classification of rainwater on site: Once the rainwater endowment on a site is calculated and matched with demand it will be necessary to understand its quantity and quality characteristics. There is a coefficient of runoff, the amount of water which will run away after it falls as rain. It may be as high as 90% for a roof area and it may be as low as 5% for a landscaped terrain.
The process of change with regard to the hydrological cycle is best captured in the figure below.

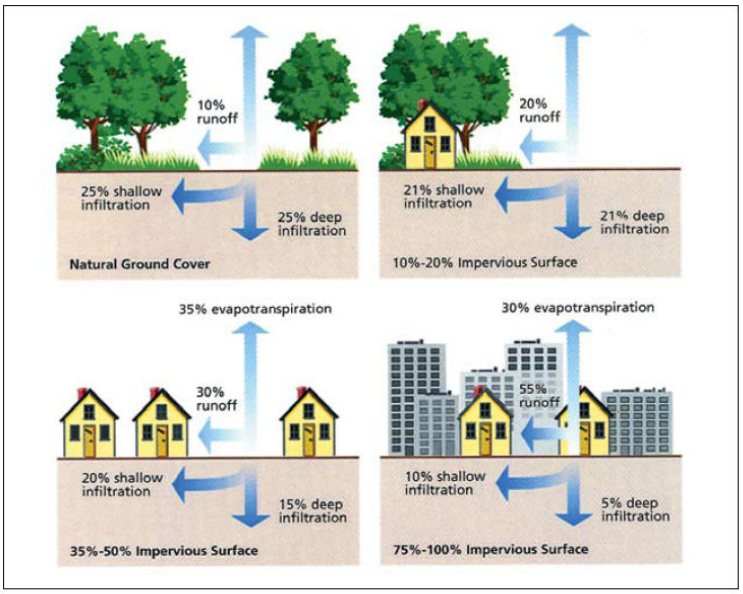

Figure 2. The Impacts of Impervious Cover on the Hydrologic Cycle (Source: FISRWG, 1998, p. 3-21)

Typically once a place is built upon the hard surface area increases and infiltration/percolation space decreases. Surface runoff can increase from 10% to 55% and infiltration can decrease from 50% to 15%.
This causes two problems. The lowering of the groundwater table due to less recharge and the increase in localized flooding. If designed properly good rainwater harvesting system can address both the issues. It will prevent the lowering of the water table by artificial recharge of the aquifer and it will prevent localized flooding by retaining or detaining surface runoff.

Designing a rainwater harvesting system: Parameters that are required would include

- total normal annual rainfall , this will give a good picture of the total rainwater harvesting potential
- highest intensity of rainfall, this will ensure a good design of the conveyance system for transporting rainfall to its storage or recharge point.
- Total rainfall during a continuous wet spell, this will help optimize the storage or recharge system
- Rate of infiltration/percolation at site, this will determine the nature and extant of the recharge systems
- Aquifer storage and transmissivity, this will enable calculation of the total water likely to be recovered
- Evaporation factor, this would determine the design of the surface water storage systems like ponds or lakes.

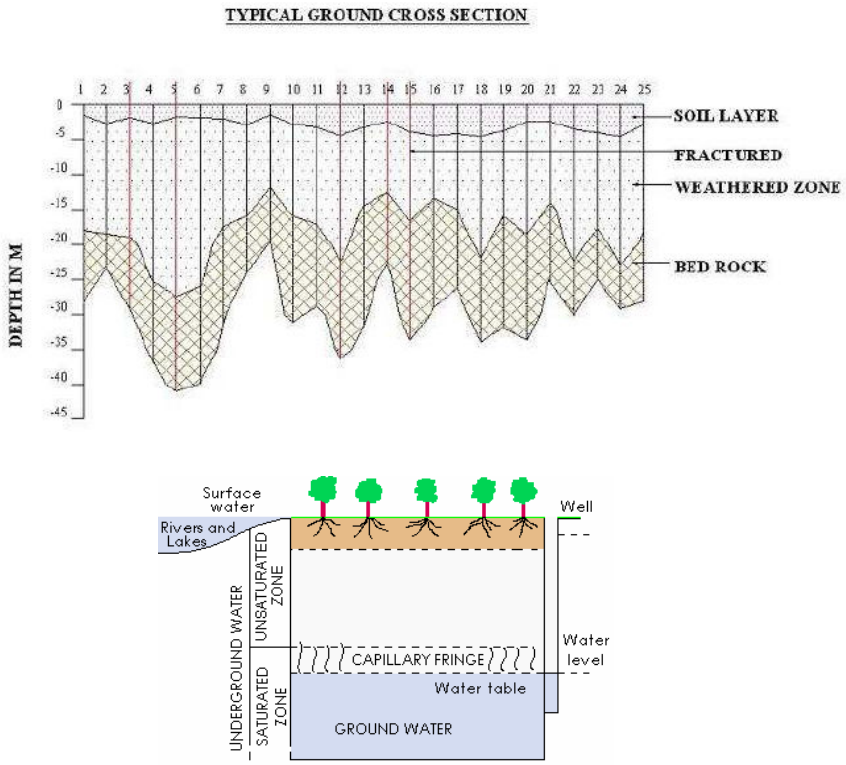

Figure 3: Soil profile will determine how recharge structures are designed

Components of a rainwater harvesting system: Typical components of rainwater harvesting system include

- a catchment
- a conveyance system
- Storage or recharge system.

Catchment: Any surface can act as the catchment for rainwater harvesting. Rooftops are favored because of the large coefficient of run-off generated from them and the relatively less likelihood of their contamination. Paved areas, footpaths and roads are also good rainwater runoff generators and with adequate catchment management strategies can provide good quantity and adequate quality of runoff water for use. Unpaved areas also generate runoff during heavy storms and can be modified to act as rainwater catchment.

Figure 4: Every rooftop needs to be kept clean to act as a good catchment for rainwater

Conveyance: Conveyance systems can be the catchment surface itself acting as a sheet runoff. For rooftops rainwater gutters and rainwater down pipes are conveyance systems, which need to be designed appropriately so as to manage the severest intensity of rain as well as not to lose any water during the conveyance process. Storm water drains, French drains with pebbles are also conveyance systems.

Fig 5: Conveyance systems can be interesting as these chains

Design of down pipes depends on the intensity of the rainfall at a place. The BIS gives charts which makes the design easy.

Sl.No	Dia of Pipe	Average Rainfall	
	mm	mm	
		50mm/hr	75mm/hr
I	50	13.4	8.9
II	65	24.1	16
III	75	40.8	27.0
IV	100	85.4	57.0
V	125	---	---
VI	150	---	---
		Roof Area	Sq.m

Fig 6: Down Pipe diameter for various intensity of rainfall

Storage: From the simplest ground level tank, to underground sumps, surface lined ponds and large lakes storage options are many depending on the context of the rainwater harvesting design.

In many a case the soil profile may also permit artificial recharge of rainwater to open wells and bore-wells where water can be stored to be retrieved later for productive use.

Fig 7 : Storage devices are many from a roof tank to a lake

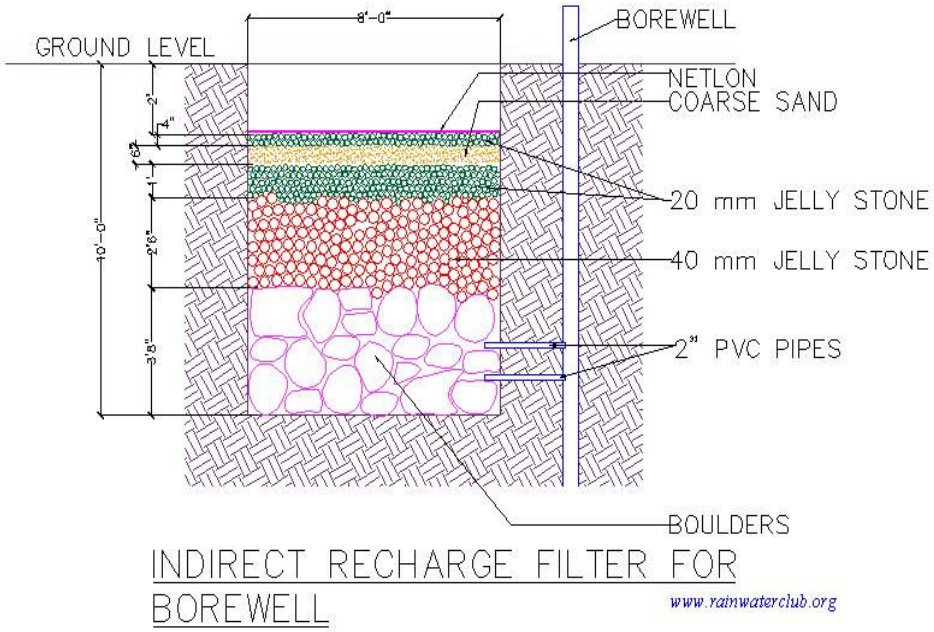

Fig 8: Recharging a bore well is one way of storing rainwater

A silt trap, a filtration system and oil and grease trap become optional depending on runoff quality.

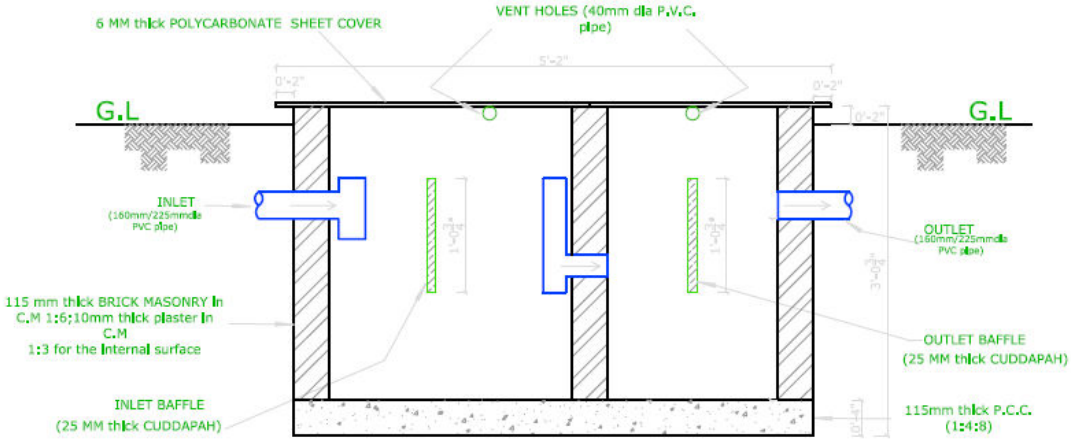

Fig 9: A Grease trap will be essential where rainwater runoff has oil or grease

It is often crucial to segregate rooftop rainwater from surface runoff. This is because it is usually of the best quality and only requires minimum treatment before it can be used. Rooftop rainwater is often stored in rain barrels and used directly for process purpose. Sometimes they are also stored in sump tanks. This water is then pumped up to wherever it is required.

Surface runoff from non-polluted areas comes next. These are stored either in ponds or after a filtration process can be stored in sump tanks too.
Road run off can contain oil and grease and may have to be collected separately. Oil traps become necessary before this water can be harvested.
Run off from unpaved areas can contain heavy loads of silt. If run off is from lawns one has to be careful of pesticides and fertilizers which the rainwater may contain.

Fig 10: Rain barrels at work harvesting rain in a factory

Conclusion: There are many methods of harvesting rainwater and what is appropriate depends on the site condition, rainfall distribution and water requirement. With a combination of demand management, recycling water and harvesting rainwater it is possible to achieve sustainable water supply from small houses to large colonies.
With a structured, scientific approach it is possible to maximize the benefits of harvesting rainwater. A detailed study helps in drawing the maximum benefits. Token gestures should be avoided.