Water Management & Planning

More than 2.2 million people die each year from diseases related to contaminated drinking water and poor sanitation. By the year 2050, water scarcity will affect between two to seven billion people out of the projected total population of 9.3 billion.

By Neeraj Sharma & Subbiah S. Sundaram

Water, being a limited resource, its efficient use is basic for the survival of the ever increasing population of the world. About 20% of the world's population does not have access to safe drinking water. There is insufficient water for adequate sanitation and hygiene, for about 40% of the world's population. Water supplies per capita have fallen dramatically since 1970 and are set to continue declining. More than 2.2 million people die each year from diseases related to contaminated drinking water and poor sanitation. By the year 2050, water scarcity will affect between two to seven billion people out of the projected total population of 9.3 billion.

The world's population is not completely aware of the scale of the problem. The situation can be brought under control through community participation and sometimes through government regulations by effectively promoting public awareness of the grim situation. Rainwater harvesting is also a simple and economical solution available for improving the water scarcity situation.

Urban Demand For Water

Typical urban demand for water is characterized as follows:

Agriculture: for fields and pastures

Domestic: for household use and consumption

Ecological : for preserving and fostering bio-diversity

Industrial : for minor and major industries and factories

Environmental: to moderate micro climate and to absorb storm water runoff as a detention basin

Non Domestic: for commercial and service sector demands as well as for schools, parks and hospitals

Why Harvest Rain Water In Urban Areas

Urban areas confront many issues pertaining to water:

- Urban flooding
- Depletion of ground water aquifers
- Disappearance of lakes and natural hydrological sources
- Lack of full water supply from traditional water sources

Benefits Of Rain Water Harvesting

- Rise in ground water levels
- Prevents decline in water levels
- Increased availability of water from wells
- Reduction in flood hazards and soil erosion
- Reduction in the use of energy for pumping water and

consequently the costs

Methods Of Rain Water Harvesting

- Storing rain water for direct use
- Recharging ground water aquifers from roof top run-off
- Recharging ground water aquifers with run-off from ground areas

Water Management In Housing Complexes

Water Requirement

Water requirement in metro cities like Mumbai, where piped water supply exists, is estimated to be around 145 litres/capita/day (lpcd). Table 1 illustrates the typical break-up of water usage in India.

Rainwater Harvesting, Recycling & Reuse

A rainwater harvesting scheme cannot be viewed in isolation. We need to examine the total water management arrangement in the complex before designing the scheme. In formulating such schemes, our aim should be to reduce the water requirement to a bare minimum level by recycling and reusing water again and again. Figure 1 illustrates a typical water balance diagram with a complete recycling system in a residential complex.

Rainwater is harvested during the monsoons on roof tops, and collected into an underground sump through a filter. Excess water from the tank flows into a recharge pit where the water is used to charge the aquifer. Also water from open areas is collected and diverted into the recharge pit/recharge trench. Rainwater after simple filtration and disinfection is used in bathrooms and also for laundry purposes. Drinking water and cooking water needs are met by using the municipal water supply.

Waste water from the kitchens and bathrooms (called sullage)

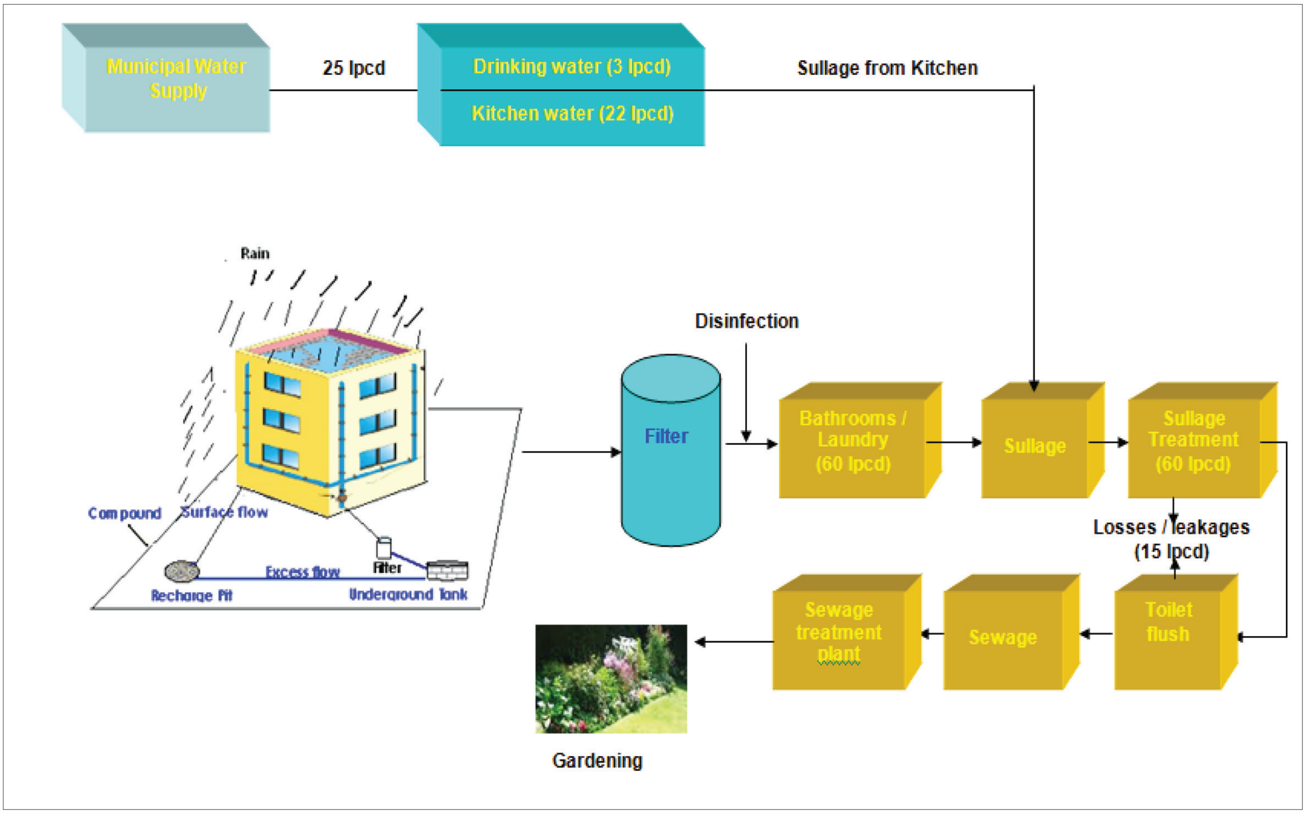

Figure 1: Total Water Management In Residential Complexes Using Rain Water And Sullage

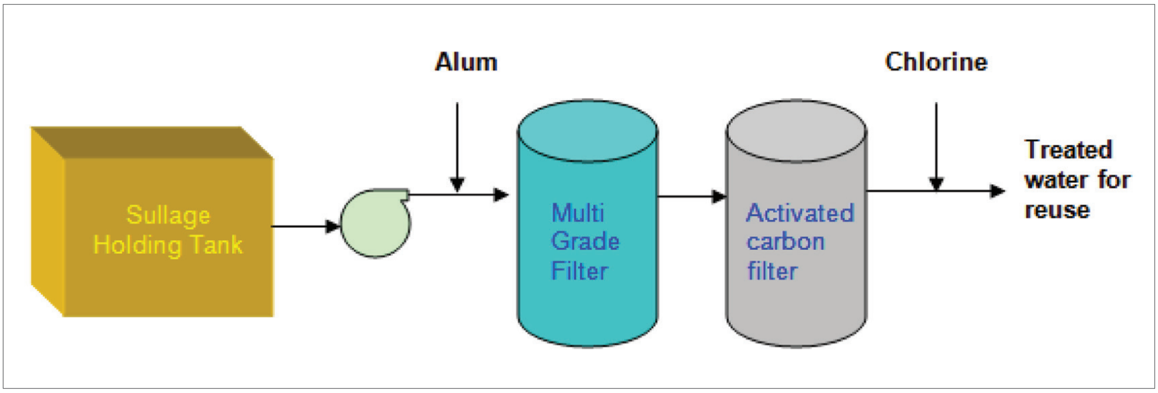

Figure 2: Sullage Recycle System

is collected separately and treated using a sullage treatment plant. Appropriate technology, depending on the quality of the sullage can be adopted to produce treated water suitable for toilet flushing. The treated water can be put into a separate overhead tank with separate plumbing connections for toilet flushing. Furthermore, sewage water generated from toilets can be treated using sewage treatment plants based on different technologies. The treated sewage water can be used for gardening purposes.

By implementing the scheme illustrated in figure1, we can reduce the requirement for the municipal water supply from 145 lpcd to 25 lpcd, which amounts to an 83% reduction. Also, rainwater to be harvested in storage tanks is reduced from 120 lpcd to 60 lpcd, which is a 50% reduction. This will reduce the cost of the rainwater harvesting system. However, the above figures depend on the amount of rainfall in the particular area.

Recycling & Reuse Of Sullage & Sewage Water

Sullage water treatment can comprise of simple filtration through a sand filter and an activated carbon filter, along with disinfection as demonstrated in Figure 2. But in some conditions, this treatment may not be sufficient if the organic content of sullage is excessive and also if sometimes segregation is not foolproof. Many times waste food may find its way into the

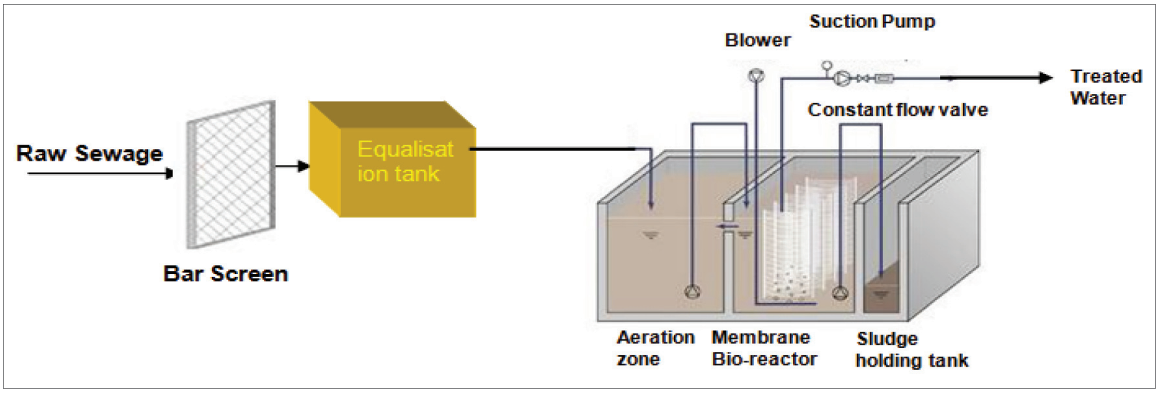

Figure 3: Treatment of Sewage Using Membrane Bio-reactor

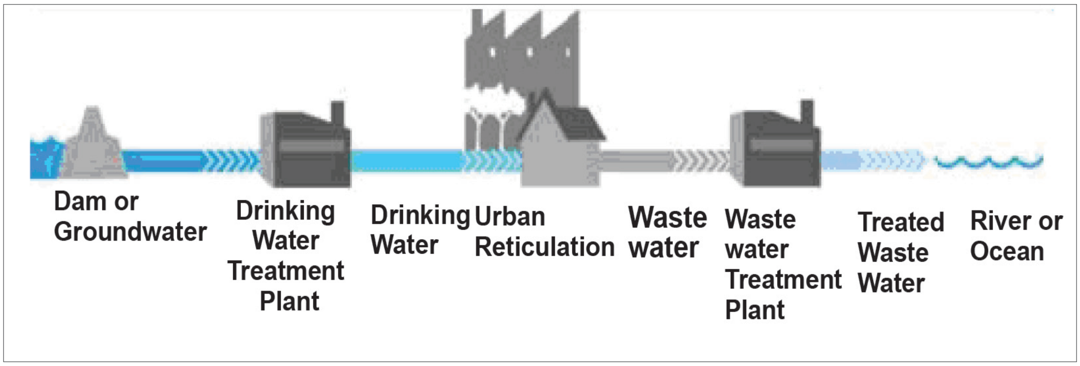

Figure 4: Conventional Drinking Water Supply System

sullage, increasing its organic content. In addition, urinating in bathrooms also adds smell and ammonium content to the sullage.

For treating sewage from toilets, a wide range of commercially available technologies exists. These include the age-old activated sludge process, compact high rate fixed film biological systems and state-of-the-art submerged membrane systems.

Based on the economics and end use of the treated sewage, different schemes can be adopted. Usually treated sewage is used for gardening after tertiary treatment.

The state-of-the-art technology adopted for sewage treatment these days is usually the membrane bio-reactor (Fig. 3). Membrane bio-reactors use bacteria to digest the organic matter in the sewage, and membranes to separate the water from the contaminants.

The treated water from the membrane bio-reactor can be further treated using the reverse osmosis process, to produce high quality water suitable even for drinking. But the human mind rejects treated sewage even though the quality is much better than raw water available from many sources. But these kinds of systems can be used in industries for producing process quality water.

Water Management At Town Planning Level

In town planning water management can be efficiently handled by:

- Harvesting road side runoff water
- Recycling and reusing wastewater

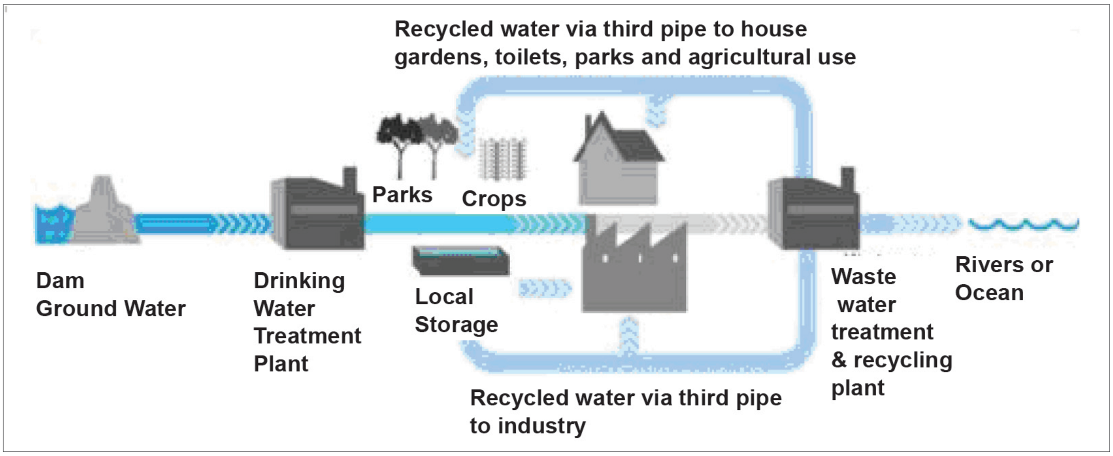

Figure 5: Water Recycling For Non-Drinking Uses

- Harvesting runoff water from parks and open spaces

Harvesting Rainwater From Roads

Rapid growth in urban areas has led to asphalted roads and stone slabs or pavers for footpaths. Consequently, rainwater runoff has increased and ground water recharge has declined.

As the roads are sloped towards the sides, rainwater falling on the road is guided to the side drains. When it rains, water flows from the apex to the sides and collects on the sidewalk area and subsequently flows to the storm water drains.

To increase ground water recharge by percolation and decrease the flooding of storm water drains, an infiltration trench could be built by the side of the drain all along the road, wherever possible. The infiltration trench can be 2 feet wide and 2 feet deep and filled with pebbles or aggregates with a top layer of coarse river sand.

As the rainwater from the road flows into the infiltration trench, water would percolate into the ground. During heavy rainfall, excess water would spill over to the storm water drains. The infiltration trenches could store water temporarily during the rainfall and later for infiltration. These infiltration trenches may be exposed as walk ways or paved with inter-locking pavers, specially designed with gaps in between for water to flow into the infiltration trenches.

Rainwater Harvesting In Parks & Open Spaces

Water harvesting methods in parks and open spaces involve micro-watershed management techniques that allow rainwater infiltration and percolation into the ground. The runoff has to be minimized by providing adequate numbers of percolation pits and dispersion trenches. In large parks, rainwater storage in small ponds is also possible, since the ponds can be integrated with the landscape of the park. Mapping the contours, planning for rainwater outflow in consonance with natural drainage patterns, and identifying appropriate areas for percolation pits/ dispersion trenches would be required.

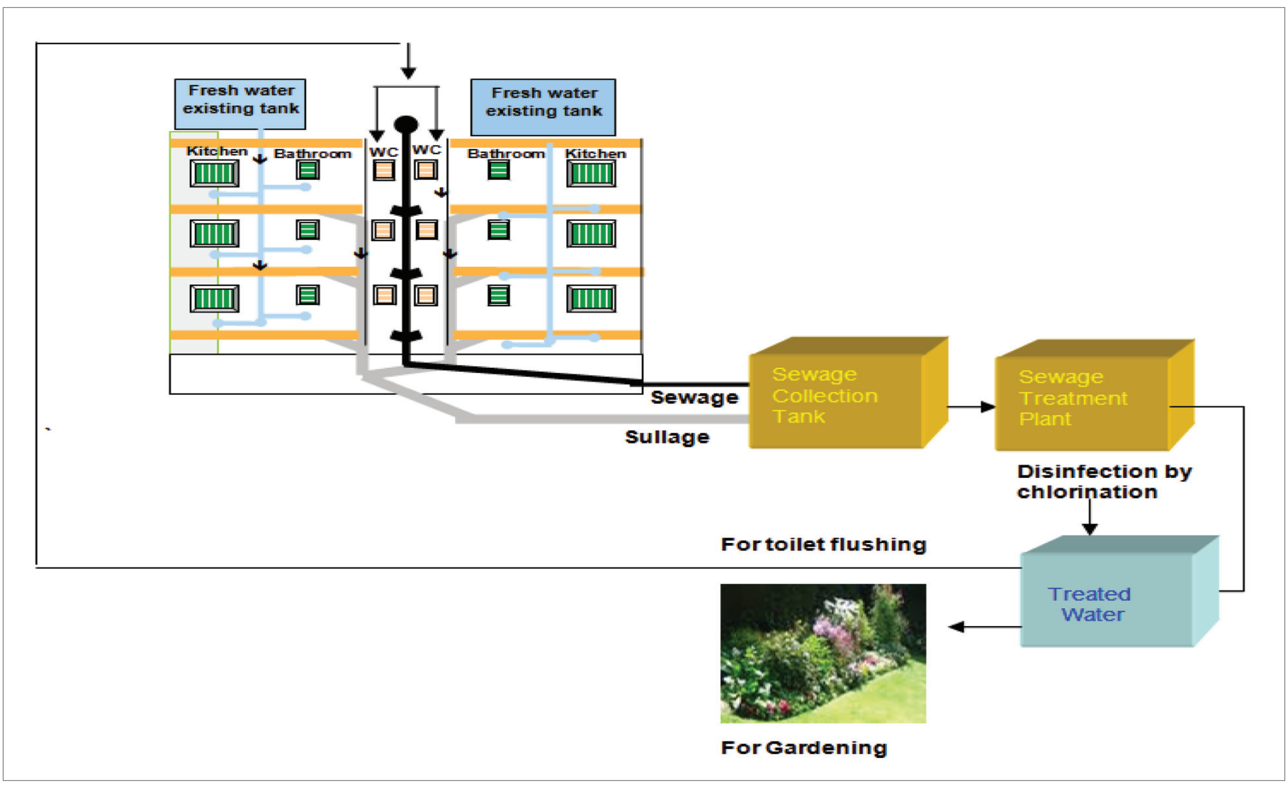

Figure 6: Dual Reticulation Scheme For A Special Economic Zone

Water Usage	Quantity (Litres/capita/day)
Drinking	3
Bathing	30
Toilets/ flushing	45
Laundry	30
Kitchen / Dish washing	22
Total Leakages	15
Total…	145

Table 1: Typical Break-Up Of Water Usage In India

Recycle & Reuse Of Wastewater

Recycled water systems can operate at a number of scales, as outlined below:

Household: On-site treatment, storage and reuse of recycled water.

Neighborhood: Collection of waste water at individual households; treatment and storage at a shared neighborhood facility, with households serviced by dual pipe systems that collect wastewater and return treated water for non-drinking uses. Sewer mining is another source of recycled water for neighborhoods, which involves tapping directly into a proximal sewer main and extracting and treating wastewater for non-drinking uses, with sewer mining by-products returned to the sewerage system.

Centralized: Wastewater is reclaimed from large scale wastewater treatment plants servicing the greater region; reclaimed wastewater is treated to a high, Class A standard and then pumped to the development where it is distributed to individual households by a third pipe reticulation network.

The traditional approach to wastewater services takes a 'once through' approach, where high quality water is used once and then discharged to receiving waters (Figure 4). However there is a potential for taking the water from the wastewater system and treat it to a suitable quality for use in a range of purposes. Recycled water offers the opportunity to 'close the loop' of water use, as it allows for multiple reuses of water supplied to residential developments (Figure 5).

Dual Reticulation System

Dual Reticulation Systems involve the use of water supplies from two different sources supplied through two separate distribution networks. The two systems work independently of each other within the same service area. Dual distribution systems are normally used to supply potable water (in one distribution network) and non-potable water (in the other network). The non-potable water system would be used to augment public water supplies by providing recycled water for toilet flushing, gardening/lawn watering and other external uses such as car washing. It is not suitable for drinking, personal washing, swimming pools or other recreational contact.

This concept is being proposed for many new developments and towns including the Naya Raipur Town Development.

A typical Dual Reticulation scheme for a special economic zone proposed by Ion Exchange is illustrated in figure 6. The sewage and sullage generated from various sources are collected in a sewage collection tank and then pumped to the sewage treatment plant. The final treated water after chlorination is proposed to be used for toilet flushing and gardening.

About The Authors

Mr. Neeraj Sharma works with Ion Exchange (India) Ltd. as a Sr. Executive (Technology), Technology Division. He has a degree in Chemical Engineering and five years of work experience in designing and sizing water treatment, wastewater treatment and effluent treatment plants with various treatment technologies.

Mr. Subbiah S. Sundaram works with Ion Exchange India Ltd. as an Executive (Technology), Technology Division. He is a graduate in Physics and has 5 years of work experience in the field of commissioning and troubleshooting water and waste water treatment plants.