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REMUNERATION OF RAIN WATER HARVESTING IN SHEKAHWATI REGION, RAJASTHAN

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Abstract-
The aim of this paper is to provide the all details about the rain water harvesting. For this purpose we have selected the building of Department of Mechanical Engineering at Shridhar University , Pilani. Study shows that the year 2002 was the worst with rainfall being 62.3% less than mean annual rainfall. Since it is quite easy to collect rainwater falling on roofs, rooftop rainwater harvesting is the process of collecting rainwater falling on rooftops in a tank or sump for future productive use. This depends on the rooftop area, the size of the tank and the rainfall at that place. The existing roof is made use of to collect rainwater. Since rainwater is pure as it falls from the sky it is necessary that the roof be kept clean for it to remain pure when it is collected. It is estimated that annual water harvesting potential from 1402.23 m^2 roof is 5,45,614.003 litres.

1.Introduction- Chirawa is located at 28.25°N 75.63°E .It has an average elevation of 294 metres (965 ft). Chirawa is one of the oldest towns of Shekhawati region.[2]The Rajasthan Legislature approved Way to transform Shridhar University

Sl.No.	Particulars	(figures in sq.km.)
1	Area not suitable for cultivation	355.92
2	Hills & hilly forest	396.14
3	Pasture land	401.74
4	Barren land	65.91
5	Others	79.00
6	Area suitable for cultivation but not cultivated	422.87
7	Area under cultivation	6463.23
i	Area irrigated by wells	2267.38
ii	Area irrigated by canals	0.17
iii	Area irrigated by tanks/ponds	0.36
iv	Area irrigated by other sources	Nil
v	Unirrigated area	4195.32

Table1- Land Use statics

Pilani is just on the Outskirts of Chirawa. Jhunjhunu district is located in the extreme north eastern part (bordering Haryana state) of Rajasthan State and lies between 27°38′ & 28°31′ north latitudes and 75°02′ &76°06′ east longitudes. It covers 5928 sq.km. of geographical area. The population of district is 19,13,689 based on Census,2001 including 1518573(79.35%) rural and 395116 (20.65%) urban. The density of population is 323 persons/ sq.km. Jhunjhunu district is covered under mainly Sekhawati basin and north western part falls under the outside the basin i.e. having inland drainage. The area is drained mainly by Kantli river. The area in the south eastern part is drained by Singhana river and a small area in south western corner of district is drained by Budhi nala. All the rivers/nalas are ephemeral in nature and flows in response to heavy precipitation during monsoon.
and north western part of district has inland drainage. Reappraisal hydrogeological survey was carried out in Jhunjhunu district in parts during 1980-81, 1987-88 and1996-97. Ground water management studies for the entire Jhunjhunu district were carried out during 1999-2000. The term 'rainwater harvesting' is usually taken to mean 'the immediate collection of rainwater running off surfaces upon which it has fallen directly'.

2.RAINFALL AND CLIMATE

The climate of the district can be classified as semi-arid. It is charaterised by very hot summers and very cold winters with poor rainfall during south-west monsoon period. In May and June, the maximum temperature may sometimes goes up to 48^{o}C. The potential evapotranspiration rates are quite high, especially during May and June.**[3]** The total annual potential evapotranspiration is 1502.6mm. The mean annual rainfall of the district, based on 36 years data (1971-2006), works out to be 485.6mm. However normal annual rainfall (1901-71) of the district is 459.5mm. It can be inferred that the rainfall in the district has significantly increased in the recent years.

3.SOIL TYPES - The distribution of soil is given below.

Soil	% covered in district
Sand dunes	2149 sq.km.area forming 36.25%
Lithosols and regisols of hills	329 sq.km.area forming 5.55%
Red desertic soil	468 sq.km.area forming 7.90%
Older alluvium	316 sq.km.area forming 5.33%

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Desert soil	2666 sq.km.area forming 44.97%

Table2-The distribution of soil

The study of water table contour map reveals that general direction of ground water flow is from the hills areas in south and south eastern to northern side except 12 in the south eastern part. In south eastern hilly areas of the district, movement of ground water is The dynamic ground water resources as per ground water estimation as on 31.03.2004 is furnished below.

Block	**Area (m^2)**	**Type**	**Annual GW Available(mcm)**	**Ground water draft for all uses(mcm)**
Chirawa	493.04	NC	04.2657 A	11.3842
		NC	17.8892 A_0	58.3545
Total			**22.1549**	**69.7387**

Table3-The distribution of soil

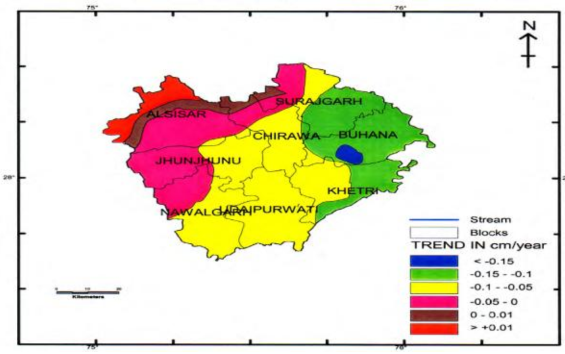


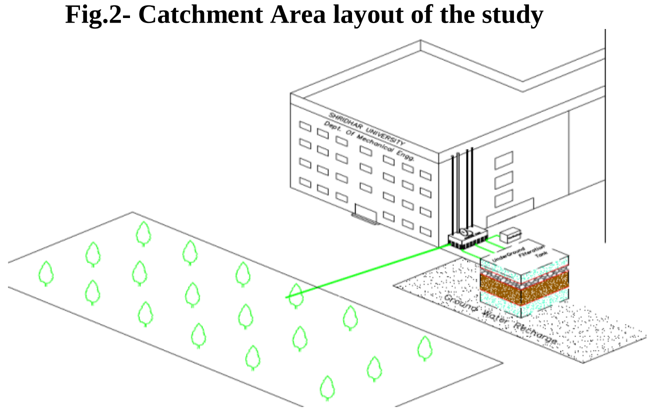
Fig.1-Water Level Trend map of District[4]

Comparatively fast due to steep gradient while it is considerably slow in the remaining parts covered by alluvial formations having gentle gradient. The average hydraulic gradient of ground water table is southern part is 4m/km and is about 2 to 3 m/km in the northern part. Exploratory bore hole data drilled in alluvial formation has indicated that depth of drilling ranges from 27.74 to 135.00 m having depth of wells from 30 to -115m. The discharge of wells varies from 160 to 2733 lpm having moderate drawdown. The transmissivity value of aquifer varies from 100 to 1915 m^2/day and storability from $5.48x10^{-5}$ to $1.05x10^{-2}$.

4.Ground Water Quality The ground water is alkaline type having pH value more than 7 and is potable in major part of the district except in northern part Alsisar block, northern most portion of Chirawa block, south east of Chirawa and in south eastern border (located at midst) of Khetri block. Nitrate concentration ranges from nil to a maximum value of 770 mg/l. Nitrate concentration within permissible limit i.e. 100mg/l is constituted by 69.14% of stations whereas 30.86% of stations represent more than 100 mg/l of nitrate concentration in the district. Nitrate concentration ranges from nil to a maximum value of 770 mg/l. Nitrate concentration within permissible limit i.e. 100mg/l is constituted by 69.14% of stations whereas 30.86% of stations represent more than 100 mg/l of nitrate concentration in the district. The high sodium absorption ratio (SAR) poses problem for irrigation water but sandy, highly porous and permeability nature of soil permit the use of ground water for irrigation. Ground water in Jhunjhunu urban area belongs to C3S3 and C3S4 class indicating the ground water's low suitability for irrigation purposes. The Jhunjhunu urban faces very high fluoride hazards having fluoride concentration reaching maximum to 15.3 mg/ l which is sustaintiated by the fact that 66.67% of stations constitutes fluoride concentration above permissible limit of 1.5 mg/l.**[4]** Apart from this, most part of the Alsisar block and western corner of Chirawa block have fluoride content more than 1.5 mg/l.

5-Need- Long term water level data (pre-monsoon, 1997-2006) have indicated declining water level trend ranging from 0.0222 to 0.2010m/year. This area is under over-exploited category which is needed to be controlled through notifying the blocks and further imposing ban on construction of ground water abstraction structures except under indispensable cases. Three blocks i.e. Chirawa, Buhana, Surajgarh have been notified by Central Ground Water Authority, New Delhi. Due to pollution of both groundwater and surface waters, and the overall increased demand for water resources due to population growth, many communities all over the world are approaching the limits of their traditional water resources. Therefore they have to turn to alternative or 'new' resources like rainwater harvesting (RWH). Rainwater harvesting has regained importance as a valuable alternative
or supplementary water resource

Fig.2- Catchment Area layout of the study



5-Techniques may be adopted- In alluvial area, following ways of recharge techniques may be adopted. There are two main techniques of rain water harvestings.**[8]**

a-Storage of rainwater on surface for future use.

Recharge to ground water.
b-The storage of rain water on surface is a traditional

Table4- Rainfall data of Chirawa Region (2001-2011) in mm(Indian Metrological department)

YEAR	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**TOTAL**
2001	8	0	0	3	43	151	157	100	13	0	0	0	475
2002	0	21	0	19	37	30	0	34	9	0	0	15	165
2003	14	7	6	0	11	27	275	190	16	0	0	7	553
2004	0	0	0	13	33	32	2	263	0	21	0	0	364
2005	9	56	68	0	57	58	0	0	138	0	0	0	386
2006	0	0	56	5	43	86	243	10	77	25	0	2	547
2007	0	74	37	20	43	68	62	26	150	0	0	0	480
2008	0	0	0	31	78	114	87	233	138	0	0	0	681
2009	0	1	15	0	25	41	109	33	50	0	0	0	274
2010	4	10	4	0	0	21	84	203	186	10	20	24	566
2011	0	42	0	0	45	48	45	182	183	0	0	0	545
AVG	3.18	19.18	16.9	8.27	37.72	61.45	96.72	115.81	87.27	5.09	1.82	4.36	457.77

techniques and structures used were underground tanks, ponds, check dams, weirs etc.
i) Roof top/paved area rain water harvesting for recharge to ground water in urban and industrial area.
ii) Village water runoff/roof top water harvesting by dug wells/percolation tanks in rural area.

6-Site and Data Collection-

The effective roof area and the material used in constructing the roof largely influence the efficiency of collection and the water quality. Artificial recharge to ground water is a process by which the ground water reservoir is augmented at a rate exceeding that obtaining under natural conditions or replenishment. Any man-made scheme or facility that adds water to an aquifer may be considered to be an artificial recharge system. Based on the above factors, the water harvesting potential of site could be estimated using the following equation:

Rain Water harvesting potential = Amount of Rainfall x area of catchment x Runoff coefficient

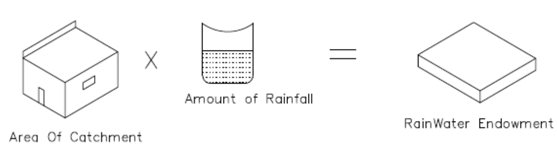


Fig.3- rain water endowment

7-The calculation for runoff is as follows- Because of these factors the quantity of rain water which can effectively be harvested is always less than the rain water endowment. The collection efficiency is mainly dependent on factors like runoff coefficient and first flush wastage etc. The total amount of water which is received in the form of rainfall over an area is called the rainwater endowment of that area. Out of this, the amount that can be effectively wasted is called the rainwater harvesting potential. Based on the calculation of floor, area of the building of department of Mechanical Engineering at Shridhar University, Pilani and rainfall pattern obtained from **Indian Metrological department** with-

Length of flat terrace (L)= 65.22 m
Width of flat terrace (W)= 21.5 m
So, Total area (A) =L*W= 1402.23 m^2

From table no. 1-

The average annual rainfall (R) on the site= 457.77 mm = 0.45777 m

The runoff coefficient (C) for a flat terrace may be considered as 0.85.

So, Annual water harvesting potential from 1402.23 m^2 roof = A x R x C
= 1402.23 x 0.45777 x 0.85
=545.6140 cum
=545.6140x 1000
=5,45,614.003 litres

Diameter of pipe (mm)	**Average rate of rain fall (mm/hr)**		
	50	75	100
100	13.4	8.9	6.6

Table 5- Arrangement of Pipe

8-System Requirement-

The rain water harvesting system consists of following basic components –
(a) Catchment area
(b) Coarse mesh / leaf screen
(c) Gutter
(d) Down spout or conduit
(e) First flushing device

(f) Filter
(g) Storage tank
(h) Recharge structure

Catchment area is the surface on which the rain Water falls. In this study this is the floor of ME Department. This water can also be used for recharging ground aquifers after proper filtration.

Coarse mesh / leaf screen is used to prevent the entry of leaves and other debris in the system.

Gutters are provided to collect and divert the

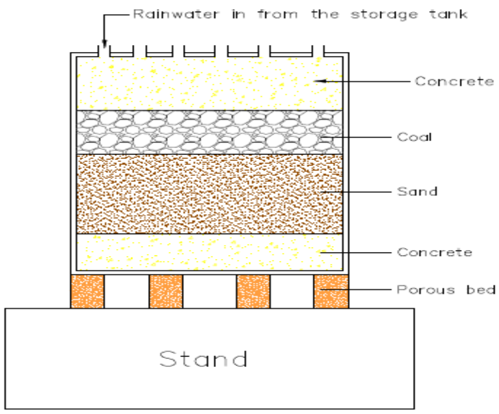


Fig.4- Filteration Tank

rain water to downspout or conduits. Gutters can be of semi-circular, rectangular or trapezoidal shape. Gutters must be properly sized, sloped and installed in order to maximize the quantity of harvested rain.

Conduits can be of any material like PVC, GI or cast iron.

Filteration Tank is used to remove suspended pollutants from rain water collected over roof. The filter unit is basically a chamber filled with filtering media such as fiber, coarse sand and gravel layers to remove debris and dirt from water.

Concrete tanks are either poured in place or prefabricated . They can be constructed above ground or below ground.

Membrane Filtration-

Membrane filtration, such as reverse osmosis and nanofiltration work by forcing water under high pressure through a semipermeable membrane to filter dissolved solids and salts, both of which are in very low concentrations in rainwater.

settlement tank The capacity of recharge tank is designed to retain runoff from at least 15 minutes of rainfall of peak intensity.

capacity of settlement tank = A x r x C
=1402.23x0.028x0.85
=33373 litres

For storing larger quantities of water the system will usually require a tank above or below the ground. Tanks can vary in size from a cubic metre (1,000 litres) up to hundreds of cubic metres for large reservoirs.

The rainwater **storage tank** collects all the filtered rainwater and keeps it for future use. The storage tank is made above the ground and on a platform. It can also be an underground sump in some cases. The capacity of the storage tank is based upon several design criteria: rainfall patterns and volume, the duration of the dry period and, of course, the estimate of demand. Sometimes sophisticated calculations are involved, but these tend not to take into account human behavior and the

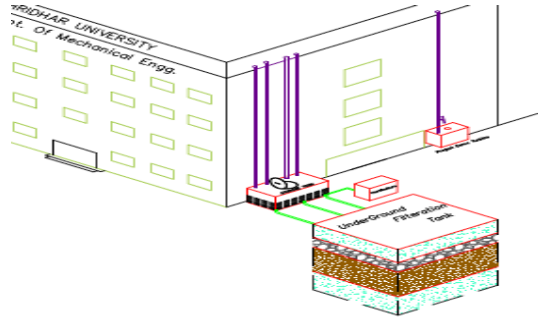


Fig.5-Proposed view of RHW Plan

willingness to use water if it is available and not to conserve it for future use, in the hope that the dry spell will soon be over.

OVERFLOW PIPE: The storage tank will have an overflow pipe from the top of the tank. In case of heavy rain, the overflow pipe will allow the excess rain water to be safely disposed of without causing any flooding.

9-WATER QUALITY CHECK: If the roof, the gutter, the first rain separator and the filter is kept clean, the collected rainwater will be crystal clear. This is an indication that good maintenance is being followed. Most storage tanks are equipped with manholes to allow access for cleaning. Sediment and sludge can be pumped out or siphoned out using hose with an inverted funnel at one end without draining the tank annually. Rainwater harvesting is one of the most promising alternatives for supplying water in the face of increasing water scarcity and escalating demand. The use of slow sand filtration has proved to be a simple and effective treatment technology for the elimination of most of the organic and inorganic pollutants that may be present in rainwater, as well as

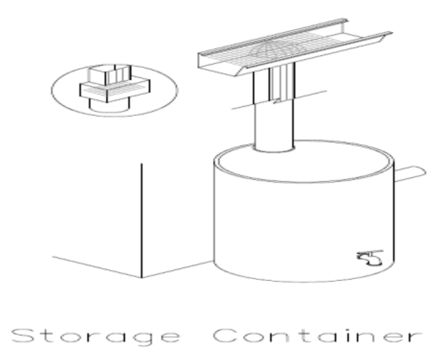


Fig6.- storage Container

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producing a virtually pathogen-free water for drinking.

10-Inspection- As a raindrop falls and comes in contact with the atmosphere, it dissolves naturally occurring carbon dioxide to form a weak acid. The resultant pH is about 5.7, whereas a pH of 7.0 is neutral. So it should be Periodic duty to include: a-monitoring tank levels, cleaning gutters and first-flush devices, repairing leaks, repairing and maintaining the system, and adopting efficient water use practices. The cleanliness of the roof in a rainwater harvesting system most directly affects the quality of the captured water. The cleaner the roof, the less strain is placed on the treatment equipment. Rainwater can be also treated for use as a potable water source.

11-Result & Advantages from the study- We can see that, we can obtain 5,45, 614.003 Liters of water annually. Rain water harvested from catchment surfaces along the ground should be used for lawn watering, flushing, Horticulture and ground water recharge etc. Rainwater is valued for its purity and softness. It has a nearly neutral pH, and is free from disinfection by-products, salts, minerals, and other natural and man-made contaminants. Plants thrive under irrigation with stored rainwater. An advantage

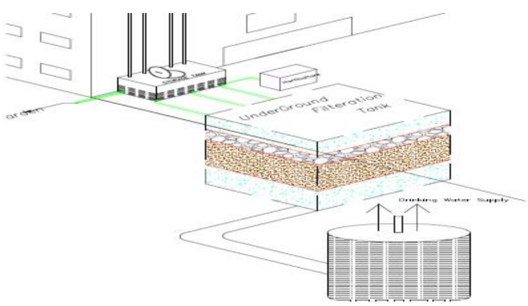

Fig.- Water supply from RHW Supply Tank

for household systems is that users themselves maintain and control their systems without the need to rely on other members of the community. Since almost all roofing material is acceptable for collecting water for household purposes, worldwide many RWH systems have been implemented successfully. Demand for water is growing in most cities as every urban citizen requires almost double the amount of water that a rural citizen requires. Moreover, India is rapidly urbanizing. Urban population in India has grown almost five times in five decades from 1951 (62.44 million) to 2001 (286.08). Not long ago, most of our cities were self sufficient in meeting their water needs from the extensive urban water bodies to supply water to citizens. Today these water bodies have completely disappeared. Rainwater harvesting is practical only when the volume and frequency of rainfall and size of the catchment surface can generate sufficient water for the intended purpose. Rainwater harvesting in urban and rural areas offers several benefits including provision of supplemental water, increasing soil moisture levels for urban greenery, increasing the groundwater table via artificial recharge, mitigating urban flooding and improving the quality of groundwater. In homes and buildings, collected rainwater can be used for irrigation, toilet flushing and laundry.

Rainwater is a relatively clean and free source of water. Rainwater harvesting provides a source of water at the point where it is needed. It is owner-operated and managed. It is socially acceptable and environmentally responsible. It promotes self-sufficiency and conserves water resources .Rainwater is friendly to landscape plants and gardens It reduces storm water runoff and non-point source pollution .It uses simple, flexible technologies that are easy to maintain. Offers potential cost savings especially with rising water costs.

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