APPENDIX - I : REFERENCE TABLES AND DESIGN EXAMPLE OF ROOF TOP HARVESTING

Table A-1.1 : Water Availability for a given Roof Top Area and Rainfall

Roof Top Area (sq.m)	Rainfall (mm)												
	100	200	300	400	500	600	800	1000	1200	1400	1600	1800	2000
	Harvested Water from Roof Top (cum)												
20	1.6	3.2	4.8	6.4	8	9.6	12.8	16	19.2	22.4	25.6	28.8	32
30	2.4	4.8	7.2	9.6	12	14.4	19.2	24	28.8	33.6	38.4	43.2	48
40	3.2	6.4	9.6	12.8	16	19.2	25.6	32	38.4	44.8	51.2	57.6	64
50	4	8	12	16	20	24	32	40	48	56	64	72	80
60	4.8	9.6	14.4	19.2	24	28.8	38.4	48	57.6	67.2	76.8	86.4	96
70	5.6	11.2	16.8	22.4	28	33.6	44.8	56	67.2	78.4	89.6	100.8	112
80	6.4	12.8	19.2	25.6	32	38.4	51.2	64	76.8	89.6	102.4	115.2	128
90	7.2	14.4	21.6	28.8	36	43.2	57.6	72	86.4	100.8	115.2	129.6	144
100	8	16	24	32	40	48	64	80	96	112	128	144	160
150	12	24	36	48	60	72	96	120	144	168	192	216	240
200	16	32	48	64	80	96	128	160	192	224	256	288	320
250	20	40	60	80	100	120	160	200	240	280	320	360	400
300	24	48	72	96	120	144	192	240	288	336	384	432	480
400	32	34	96	128	160	192	256	320	384	448	512	576	640
500	40	80	120	160	200	240	320	400	480	560	640	720	800
1000	80	160	240	320	400	480	640	800	960	1120	1280	1440	1600
2000	160	320	480	640	800	960	1280	1600	1920	2240	2560	2880	3200
3000	240	480	720	960	1200	1440	1920	2400	2880	3360	3840	4320	4800

(i) Figures above ——— For single household

(ii) Figures above ——— For 2 to 5 households depending upon water scarcity
but below ——— (to be stored in one or two tanks)

(iii) Figures above ——— (a) For village community to be stored in two or more tanks
but below ———
(b) Recharge of wells and tubewells

(iv) Figures below ——— (a) Village community tank suitable for recharge of wells and tubewells
(b) Large surface storages in the absence of natural catchment i.e. hill tops/ ridges

Table A-1.2 : Diameter of Gutter and Width of G.I. Sheet

Rainfall Intensity (I) (in mm/hr)		10	15	20	25	30	35	40	45	50	60	70	80	90	100	
Roof Top Area (A) (sq.m)		Diameter (D) of Channel and Width (W) of G.I. Sheet (in mm)														
10	D	20	23	26	28	30	32	33	35	36	39	41	43	45	47	
	W	51	56	60	64	67	70	72	74	77	81	84	88	91	93	
20	D	26	30	33	36	39	41	43	45	47	50	53	56	58	61	
	W	60	67	72	77	81	84	88	91	93	99	103	108	112	115	
30	D	30	35	39	42	45	48	50	52	54	58	62	65	68	71	
	W	67	74	81	86	91	95	99	102	106	112	117	122	127	131	Provide minimum Diameter of channel - 100 mm and Width of sheet - 176 mm
40	D	33	39	43	47	50	53	56	58	61	65	69	72	76	79	
	W	72	81	88	93	99	103	108	112	115	122	128	134	139	144	
50	D	36	42	47	51	54	58	61	63	66	71	75	79	82	86	
	W	77	86	93	100	106	111	115	120	124	131	138	144	149	154	
60	D	39	45	50	54	58	62	65	68	71	76	80	84	88	92	
	W	81	91	99	106	112	117	122	127	131	139	146	152	158	164	
70	D	41	48	53	58	62	65	69	72	75	80	85	89	93	97	
	W	84	95	103	111	117	123	128	133	138	146	153	160	167	172	
80	D	43	50	56	61	65	69	72	76	79	84	89	94	98	102	
	W	88	99	108	115	122	128	134	139	144	152	160	167	174	180	
90	D	45	52	58	63	68	72	76	79	82	88	93	98	102	107	
	W	91	102	112	120	127	133	139	144	149	158	167	174	181	188	
100	D	47	54	61	66	71	75	79	82	86	92	97	102	107	111	
	W	93	106	115	124	131	138	144	149	154	164	172	180	188	194	
150	D	54	63	71	77	82	87	92	96	100	107	113	119	124	129	
	W	106	120	131	141	149	157	164	170	176	188	197	207	215	223	
200	D	61	71	79	86	92	97	102	107	111	119	126	132	138	144	
	W	115	131	144	154	164	172	180	188	194	207	218	228	237	246	
250	D	66	77	86	93	100	105	111	116	121	129	137	144	150	156	
	W	124	141	154	166	176	186	194	202	209	223	235	246	256	266	
300	D	71	82	92	100	107	113	119	124	129	138	146	154	161	167	
	W	131	149	164	176	188	197	207	215	223	237	250	262	273	283	
400	D	79	92	102	111	119	126	132	138	144	154	163	172	179	186	
	W	144	164	180	194	207	218	228	237	246	262	276	290	302	313	
500	D	86	100	111	121	129	137	144	150	156	167	177	186	195	203	
	W	154	176	194	209	223	235	246	256	266	283	299	313	326	339	
1000	D	111	129	144	156	167	177	186	195	203	217	230	242	253	263	
	W	194	223	246	266	283	299	313	326	339	361	381	400	417	433	
2000	D	144	167	186	203	217	230	242	253	263	282	298	314	328	341	Diameter to be limited to - 300 mm and Width of sheet - 510 mm
	W	246	283	313	339	361	381	400	417	433	462	489	513	535	556	
3000	D	167	195	217	236	253	268	282	294	306	328	347	365	382	397	
	W	283	326	361	391	417	441	462	482	501	535	566	594	620	644	

Table A-1.3 : Size of Storage Tank
(Depth of live storage above the outlet pipe = 1.4 m)

Tank Capacity (in cum)	Diameter of Tank (in m)
1.60	1.21
2.40	1.48
3.20	1.71
4.00	1.91
4.80	2.09
5.60	2.26
6.40	2.41
7.20	2.56
8.00	2.70
9.60	2.95
11.20	3.19
12.00	3.30
12.80	3.41
14.40	3.62
16.00	3.81
16.80	3.91
19.20	4.18
20.00	4.26

Note: For rural areas the diameter of tank may be limited to 3 m. The tank would be adequate to meet the drinking water requirements of a family of 5 members for 6 months. For large storage two or more tanks may be provided instead of a single large tank.

DESIGN EXAMPLE

A house has a slopping roof of G.I. sheet with an area of 50 sq.m. The owner of the house has a family of 5 members. Design a roof water harvesting system. The 10 year rainfall for the areas is as follows :

Year 1	320 mm
Year 2	360 mm
Year 3	311 mm
Year 4	290 mm
Year 5	330 mm
Year 6	280 mm
Year 7	335 mm
Year 8	380 mm
Year 9	355 mm
Year 10	340 mm

The maximum rainfall intensity is 10 mm/hour. The lower edge of the roof is 3 m above the ground.
Arranging the rainfall in descending order: 380, 360, 355, 340, 335, 330, 320, 311, 290, 280

The first figure if 380 mm is equalled or exceeded only once in 10 years. Therefore, its expected return period is 1 in 10 years. This is rare. On the other hand the last figure of 280 mm is equalled or exceeded in all the 10 years. Thus is the most reliable figure. So lets us design the system for this figure.

From Table 1, for the roof area of 50 sq.m and rainfall of 280 mm, the available water
= 11.2 cum = 11,200 litres.

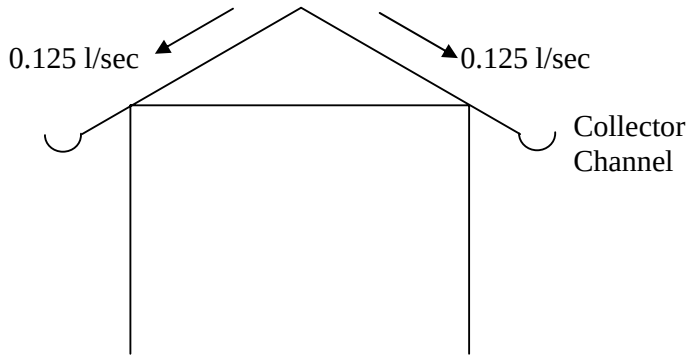
Allowing a consumption of 10 lpcd this water should be sufficient for 224 days or atleast 7 months. In rural areas houses are of low height. So let us limit the height of the tank to 1.6 m with water storage upto 1.4 m height.

A tank of 3.2 m dia and 1.4 m height should be adequate. However provide an extra 0.2 m height to allow for fixing overflow pipe and dead storage below the outlet (tap). Provide a tank size of 3.2 m dia and 1.6 m height.

Size of Collector Channel (Gutter)

During heavy rains i.e. with maximum intensity of 10 mm/hr the runoff coefficient may be taken as 0.9 i.e. assuming a net loss of 10% of rainfall. Maximum rate of runoff from the roof on either side (ignoring the concentration time for runoff i.e. instant generation of runoff is considered)

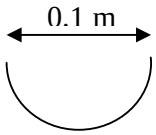
$$= \left[\frac{10.0}{1000} \times \frac{50 \times 0.9}{2 \times 3600}\right] = 0.000125 \text{ cum/sec} = 0.125 \text{ litres/sec}$$



Provide a minimum slope of the collector channel of 5 cm in a length of 10 m i.e. 1 in 200

Trial - I

Providing a collector channel of 0.1 m diameter



Area, $A = \frac{1}{2}\ \pi\ \frac{D^2}{4} = \frac{1}{2} \times \pi \times \frac{0.01}{4} = 0.003925$ sq.m

Perimeter, $P = \frac{\pi D}{2} = 3.14 \times \frac{0.1}{2} = 0.157$ m

Hydraulic Mean Depth, $R = \frac{0.003925}{0.157} = 0.025$ m

Providing a slope of 1 in 200 for the collector channel,

Velocity of flow, $v = \frac{1}{0.025} \times (.025)^{2/3} \times \sqrt{\frac{1}{200}}$

$= \frac{1}{0.025} \times 0.0855 \times \frac{1}{14.14} = 0.24$ m/sec

Discharge, $q = A \times v = 0.003925 \times 0.24$

= 0.000942 cumecs
against the design discharge of 0.000125 cumecs

The channel is too oversized.

Trial - II

Let us try a channel of 0.05 m diameter

Area, $A = \frac{1}{2} \times \pi \times \frac{(0.05)^2}{4} = 0.00098$ sq.m

Perimeter, $P = \pi \times \frac{0.05}{2} = 0.0785$ m

Hydraulic Mean Depth, $R = \frac{0.00098}{0.0785} = 0.0125$ m

Velocity, $v = \frac{1}{0.025} \times (0.0125)^{2/3} \times \frac{1}{14.14} = 0.152$ m/sec

Discharge, $q = A \times v = 0.00098 \times 0.152 = 0.000148$ cumecs

O.K.

The channel may be made of plain G.I. sheet. Width of the G.I. sheet required for channel

= P = 0.0785 m = 78.5 mm

Providing 25 mm extra for fixing with rafters/ purlins

Total width required = 78.5 + 25 = 103.5 mm

say 104 mm

Design of Base for the Tank

Total weight of water = 11.2 × 1 = 11.2 Tonnes

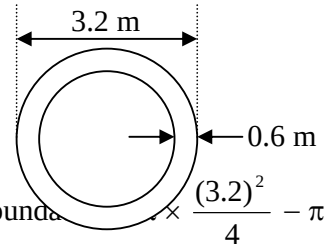
Dead weight of tank & cover (L.S.) = 0.3 Tonnes

Total = 11.5 Tonnes

Assuming bearing capacity of soil = 10 Tonne/sq.m

$\therefore$ Area of foundation = $\frac{11.5}{10} = 1.15$ sq.m

Providing a minimum width of 0.6 m for foundation



Total area of foundation = $\pi \times \frac{(3.2)^2}{4} - \pi \times \frac{(3.2-1.2)^2}{4}$

$= \frac{\pi}{4}[(3.2)^2 - (3.2)^2 - (1.2)^2 + 2 \times 1.2 \times 3.2]$

$= \frac{\pi}{4} \times (6.24) = 4.9$ sq.m

Foundation is safe.

Provide 0.6 m wide circulator foundation in cement concrete 1:4:8, 75 mm thick.

Depth of foundation – 900 mm below ground level.

Brick work in foundation to be provided in width of 450 mm to 228 mm in steps as shown in figure below :