It has always been clear to me that urban rainwater harvesting will require a strategy that has different components. We have to recognise that just passing a law is not enough. It has to be supported with a massive campaign for public awareness and with hard policy actions, which provide incentives and disincentives for its effective implementation. In this case the incentives will have to come in the form of fiscal measures which support households to capture their rain, and the disincentives in the form of pricing of water and supportive urban taxation policies.

— Anil Agarwal

INTRODUCTION

The case of Chennai

Chennai and its suburbs — constituting the Chennai Metropolitan Area (CMA) — are constantly plagued by water shortage. Rapid growth in population, coupled with irregular spells of monsoons, has further intensified the problem in the past couple of years.

The government, various citizens' groups and the media are agog with debates and discussions on how to evolve an effective strategy to avoid such crises and to ensure regular and sufficient supplies.

Informed public discussion on these issues is, however, hampered by lack of adequate information on the nature and magnitude of the problem. Also, there is very little data available on the various initiatives that have been taken, or are being proposed, to tackle these.

The purpose of this publication is to try and plug this gap. It seeks to collate and present a comprehensive overview — based on information culled from official documents and research reports and views of independent, knowledgeable non-official experts.

It explores the water situation of the city and the way it has evolved. It critically reviews the measures taken by the government to meet future requirements. And finally, it seeks to establish the importance of community involvement and initiatives for tackling the water problem.

CHAPTER I

The water supply system: problems and prospects

Origin

Traditionally, the primary source of water in Chennai was a network of eris (tanks), ponds, temple tanks and wells, that were maintained and managed by local communities. The wells, mostly shallow, were attached to a house or were shared by several households.

The first organised public water supply works was executed in 1772. It was designed to supply 0.635 million litres per day (mlpd), eqquivalent to 140,000 gallons per day from a cluster of 10 wells to Fort St George.

A larger scheme, bringing water from two eris — Sholavaram and Red Hills — to a municipal water works and then distributing across Chennai, was completed in 1872. Several projects were taken up during the early decades of this century to extend and improve the supply source.

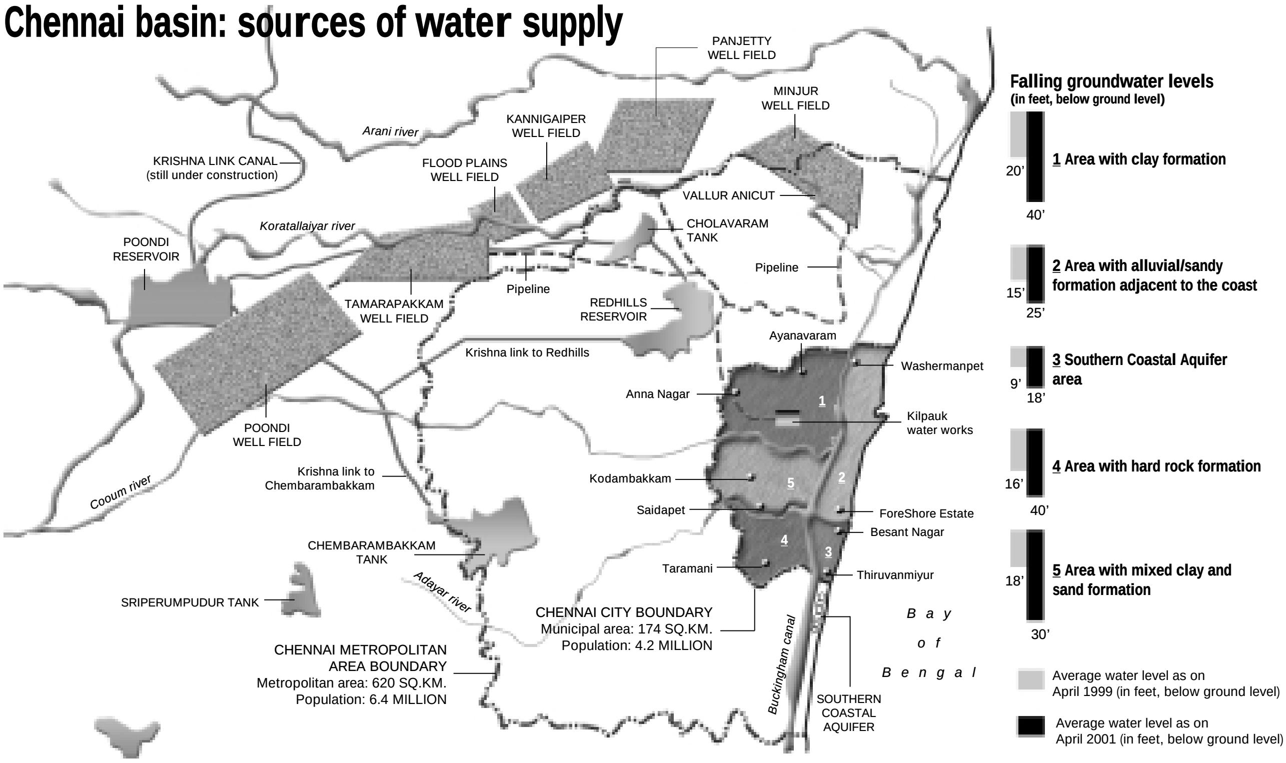
From 1940-1970

By the early 1940s the city's population had reached close to a million, nearly double the size recorded at the turn of the century. To cater to the growing demand, an additional reservoir was constructed at Poondi across the Kortalaiyar. It raised the total surface storage capacity from 100 million cubic meters to 180 million cubic meters. There was no addition to the storage in the subsequent three decades. Till the 1970s, the city's public water supply system depended exclusively on these storages. The progressive reduction in the use of eri waters for irrigation must, however, have been triggered by some increase in the supplies available to the city.

The amount of surface water effectively available to the city's population was, and remains, considerably less than the storage capacity of the reservoirs. Besides the fact that actual storage, depends on the amount of rainfall that varies from year to year, an estimated 40+ per cent of water is lost due to evaporation and seepage.

A further constraint is imposed by the volume which the water works is equipped to handle for distribution. The handling capacity of the system has progressively increased: By 1951 it had reached 190

Chennai basin: sources of water supply



Source: *Chennai Metro Water Supply and Sewage Board*

Table 1a: Daily supply in Chennai (million litres)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVE
1985	244	250	248	248	235	230	230	228	234	235	240	240	239
1986	268	265	260	265	265	260	260	250	245	246	255	245	257
1987	225	190	170	170	165	119	106	104	102	103	120	123	141
1988	128	130	138	151	158	152	149	148	151	158	158	181	150
1989	164	158	153	146	150	150	151	154	140	140	140	141	149
1990	132	136	146	140	135	136	136	137	137	136	217	228	151
1991	229	234	234	230	228	228	228	228	228	228	228	230	229
1992	251	252	252	252	254	254	254	254	254	254	254	251	253
1993	137	107	114	113	106	102	99	86	85	83	81	146	105
1994	160	167	174	253	255	257	266	255	258	258	262	277	237
1995	279	274	282	276	290	288	296	301	335	331	328	328	300
1996	234	243	247	243	251	255	274	276	281	410	410	413	295
1997	434	411	382	380	381	352	327	312	265	250	277	407	348
1998	417	425	394	364	345	335	340	345	384	389	422	436	383
1999	445	423	443	450	454	457	400	452	436	363	339	232	408
2000	214	209	207	209	199	193	186	184	194	218	218	218	204

mlpd and the 'safe yield' for distribution to 200 mlpd. It remained at that level during the next two and half decades. It was only in 1995 the capacity of the water works was increased to 300 mlpd.

As per these charts it is evident that the correlation between storage and volume delivered, though positive, is not strong. The average daily supplies from surface sources ranged from 140 mlpd in 1987 to 400 mlpd in 1999. The ratio of supplies to storage also shows a tendency to be higher when the level of storage is high but the relation is not consistent.

Till 1970s, the city's public supply system depended exclusively on surface water. With capacity remaining constant, and population soaring rapidly, per capita availability from the system fell from 140 lpcd (litres per capita per day)in 1951 to 80 lpcd in 1971. (Table-2) At the same time the public system was under pressure to extend the distribution system to areas with poor access or no access at all to the public water supply. This led to the installation of public taps, bore wells fitted with hand pumps and large tanks to store metro water.

All this resulted in a shortfall in supply, even in areas which previously received abundant water. The government took a series of steps to arrest this trend. The strategy had four salient elements:

- augmenting supplies from surface sources;
- increased use of groundwater; and
- introducing measures to check over-exploitation of groundwater.

Augmentation of surface supplies

As per data recorded on 2001, expected supply from local surface sources in Chennai is around 247 mlpd.

The most significant initiative on this front is the Teluguganga (TG) project. In 1976, three riparian states of Krishna river, Andhra Pradesh, Maharashtra and Karnataka agreed to the divert 12 tmc (Thousand Million Cubic Feet) to Chennai with the Tamil Nadu government bearing the costs of the works involved.

The first phase of the project, commissioned in 1996, was expected to bring 5 tmc(equivalent to 380 mlpd) from the Srisailam reservoir across the Krishna through the Somaseelam reservoir on the Pennar and subsequently through an open channel to Poondi. The capacity of the city water works was also increased to 300 mlpd to handle the additional supplies from Teluguganga. The second phase of the project is expected to give an extra 7 tmc at zero point by 2011.

The water is to be drawn during July-October (8tmc @ 2 tmc per month) and during January–April (4 tmc). Chennai started receiving TG waters from 1996; 2.8 tmc was received in 1997 and 1998; 1.8 tmc in 1999 and 6.5 tmc during September 2000 and

May 2001. However, increase in supply to the city storages has been considerably less than receipts at zero point because of seepage in channels and other losses en route. It is estimated that 5tmc at zero point will add 1.5tmc in the reservoirs.

Exploitation of groundwater

Teluguganga took a long time to materialize. Meanwhile, in a bid to meet growing demands, the public system turned to groundwater during the seventies. The well fields of the Araniyar-Kortaliyar basins as well as other designated groundwater areas were brought under the control of MetroWater authority. The wells taken over by the state-run MetroWater from Tamaraipakkam, Panjatty and Minjur fields were reserved for industries in north Madras. Over the years, the proportion of this amount being diverted for domestic use increased, so much so that several industrial establishments were forced to look for alternative sources of supply — mostly private wells. Much later, Metro water also adopted a policy of insisting on industries using treated sewage for part of their needs.

Aquifers in Poondi, the flood plains of Kortalaiyar and Kannigaiper with an estimated safe yield of 55 mld and the south coastal aquifer (estimated safe yield 10 mld) began to be exploited from the early eighties. In addition, 5 mld is estimated to be available from public bore wells fitted with hand pumps, and perhaps another 50 mlpd from municipal and metro wells.

Total supply from the public system recovered after 1990. It, in fact, even exceeded 200 mlpd in

Table 1b: Combined monthly storage in MCFt. (on 1st of each month)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1978	6252	5685	5106	4427	3894	3227	2862	2639	2156	2167	1935	2871
1979	5965	6056	5525	4865	4093	3651	2939	2538	2195	1965	1759	6144
1980	6268	5555	4954	4278	3605	2904	2355	2034	1884	1500	1284	3145
1981	3731	3356	2949	2490	1978	1612	1211	964	821	1106	310	3607
1982	3621	3196	2783	2370	2087	1545	1212	909	694	524	415	1459
1983	1251	897	594	530	400	294	204	153	390	985	1879	1853
1984	2990	2759	3332	3431	3092	2499	2071	1032	1476	1715	1837	3507
1985	3674	3720	3256	2917	2345	1924	1583	1371	1110	994	917	5297
1986	5369	5487	6200	4409	3783	3066	2581	2060	1623	1393	1350	1763
1987	1493	1001	705	468	335	142	0	0	0	0	103	880
1988	2260	2027	1379	1666	1352	1028	726	582	549	805	721	2083
1989	2255	2318	3050	1741	1336	1042	829	618	455	332	234	1589
1990	2186	1859	1591	1253	1043	1437	1095	894	693	615	2431	3928
1991	3857	3424	3013	2598	2152	1713	1738	1422	1162	1008	1708	6369
1992	6275	2793	5148	4384	3728	3017	2486	2196	1753	1481	1154	1706
1993	1690	1249	1126	875	690	551	441	306	278	239	375	4156
1994	6184	5719	5248	4680	4187	3642	3067	2588	2342	1984	2507	5120
1995	5152	5265	4811	4261	3721	4376	3815	3440	3967	4065	4716	5300
1996	4669	4267	3742	3178	2757	2143	3989	3675	3416	4127	6287	6864
1997	7011	6653	6003	5188	4313	3633	3060	2686	2329	2094	2822	6520
1998	6931	6350	5574	4724	3864	3088	2364	1943	2258	2550	4350	6494
1999	6702	6197	5520	4673	3909	3208	2519	2044	2103	1957	1937	2114
2000	1859	1554	1913	1691	1432	1200	989	768	543	679	1240	0

Source :CMWSSB

Table 2: Chennai city — decadal population growth, water demand, water availability and allocation:

Year	Population	Water demand In mld			Water avail'ity	Water supplied			City supply
		City	Ind.	Tot.		City	Ind.	Tot.	
1901	0.54	—	—	—	110	110	—	110	203
1921	0.56	—	—	—	110	110	—	110	200
1931	0.58	—	—	—	110	110	—	110	189
1941	0.74	—	—	—	110	110	—	110	155
1944	0.86	—	—	—	110	110	—	110	128
1951	1.42	—	—	—	200	200	—	200	141
1961	1.73	—	—	—	200	200	—	200	115
1971	2.47	—	—	—	200	200	—	200	81
1981	3.28	—	—	—	293*	240	53	293	73
1991	4.034	—	—	—	348**	275	73	348	68
2001	4.977	801	170	971	805***	535	140	675	107
2011	6.046	997	330	1327	805	535	140	675	88
2021	7.000	1217	330	1547	1367****	770	300	1070	110

Source: International Symposium on Strides In Civil Eng'93 ("Reuse of Wastewater" S. Nambi Ayyadurai)
*Surface lakes 200mld, groundwater 93mld
**Surface lakes 200mld, groundwater 140mld
***Surface lakes 247mld, groundwater 158mld(incl. 10mld from south coastal aquifer), Telugu Ganga – 400mld
****Surface lakes 247mld, groundwater 158mld, Telugu Ganga – 930 mld; Other sources in distant urbanized area – 32 mld

Table 3: Safe yield from different sources

Source	Safe yield
Poondi, Redhills and Sholavaram (Surface water)	200 MLD
Araniyar – Kortalaiyar Well Fields	148 MLD*
Southern Aquifer	10 MLD
Wells in Urur, Thiruvanmiyur, Porur & Kattupakkam	20 MLD
Municipal Wells within the city	5 MLD
Tube Wells and Hand Pumps	50 MLD
Total	433 MLD

Source: Master Plan for Madras Metropolitan area – 2011, draft report prepared by the Chennai Metropolitan Development Authority, July 1995. (AMM Report)

Table 3.1: *Groundwater extraction from well fields

Well fields	Year of commission	No. of well	Safe yield (mld)
Minjur	1965	12	25
Tamaraipakkam	1979	22	32
Panjetty	1969	12	36
Flood Plains of Kortalaiyar	1987	5	13
Kannigaiper	1987	9	15
Poondi	1987	15	27
Total		75	148

Table 4: Trends in rainfall, storage and public water supply in Chennai 1978-2000

Year	Rainfall in mm	Storage mcft	Water supplied mld total	Ground water	Surface	GW level in m bgl
1978		5242				
1979		5965				
1980		6268				
1981		3731				
1982		3621				
1983		1251				
1984		2990				
1985		3674				
1986		5369				
1987		1493	155	105	50	21.6
1988		2260	155	96	59	21.9
1989		2255	155	87	68	21.8
1990	1572	2186	155	79	76	22.9
1991	1312	3857	230	69	161	23.3
1992	1079	6275	255	66	189	22.7
1993	1590	1690	115	52	63	25
1994	1563	6184	240	52	188	23.2
1995	1607	5152	325	55	270	22.1
1996	2053	4669	320	52	268	20.5
1997	1774	7011	375	54	321	18
1998	1135	6931	410	39	371	17.3
1999	1090	6702	440	40	400	18.6
2000		1859	220	84	136	20.1(JS)

Source: Metro Water

1991, 1992 and 1994 primarily due to higher rainfall and higher levels of storage in the reservoirs. Groundwater exploitation also declined to 50-60 mlpd during this period. But how the system was able to supply more than the rated capacity of the expanded works (300 mlpd) cannot be explained.

Measures to check over exploitation

Successive years of poor rainfall during the latter half of the 1980's (when total system supply was only 155 mlpd) and a severe drought in 1993 (when supplies fell to a low 115 mlpd) forced the government to focus on groundwater recharge in the well fields.

In order to enhance groundwater recharge in the Araniyar-Kortalaiyar basin three new check dams were constructed during the 1990's and two more are planned in the future. The efforts paid dividends. Water level recorded at the end of the decade was considerably higher as compared early 1990s. A run of good rainfall years, also contributed to this.

Cutting demands

In an attempt to reduce the pressure on fresh water resources, Metro Water has sought to limit fresh water supply to industries and is encouraging them to rely more on treated sewage to meet their requirements. It is reported that Metro Water is now supplying 23 mlpd of treated sewage for use by Madras Fertilizers and Madras Refineries

Operation desalination

Desalination of seawater to augment water supplies has been mooted from time to time. But so far only five small plants using the reverse osmosis process have been commissioned and are functioning. They are small sized plants with a total capacity of 0.75 mlpd. Costs are high, ranging from Rs 27 to Rs 40 per kilolitre. Costs would have been lower if the scale of the plants were larger but would still be far too high to be economical and affordable. This option has therefore not been pursued seriously.

CHAPTER III

Public systems in outer urban areas

Areas falling in the CMA but outside the Corporation referred to as outer urban areas or OUAs are not served by Metro Water. They are administered by a number of municipalities and town panchayats which have been given the responsibility to provide civic amenities in their respective domains. They have developed public water supply networks with the help of Tamilnadu Water Supply and Drainage Board (TWAD). These again depend heavily on groundwater. Public systems of 8 urban local bodies (ULB's) in the CMA are currently estimated to supply 8.8 mlpd, drawing both on local groundwater and groundwater piped from wells in the Palar riverbed, 50 km south of the city. The latter is estimated to supply 3 mlpd to Tambaram and Pallavaram areas in the southern part of the city.

The private sector

Before the advent of the public supply systems, the population of Chennai, as indeed in much of Tamil Nadu, depended on local surface storages managed by village communities. The expansion of the public system has reduced dependence on these traditional sources. But this system has not kept pace with rate of growth of population and per capita supplies have been falling steadily.

Result: people are exploring alternative sources of supply. With the disappearance of eris and ponds, the only alternative was ground water. Private exploitation of groundwater, therefore, has increased.

According to the ShriAM Murugappa Chettiar Research Centre (AMMCRC) survey about 28 per cent of the households use water from open wells and 41 per cent from bore wells. Several non-household establishments have their own bore wells; and commercial exploitation by private firms for sale and distribution of water by tankers is also sizeable. A recent survey suggests that while private tankers account for a negligible portion of household consumption, they meet a considerable proportion of the requirements of non-domestic establishments as well as industries.

On the other hand, disruption of recharge systems depending on eris, ponds and temple tanks, erosion of natural drainage networks and the fact that an increasing proportion of the surface area has been covered by asphalt, cement and concrete have cut down sources of groundwater recharge. The combined effect of these factors has been a sharp depletion in groundwater level. No data are available on the trends in the number, depth and volume of water extracted by private wells. But there are ample

Table 5 : Public water supply system in outer urban areas

Urban local body	Present population	Existing supply in mld	Source	Proposed supply in mld
Alandur	150,000	6.20	Palar	8.82
Pammal	70,000	0.90	Palar	1.20
Anakaputhur	35,000	0.50	Palar	1.04
Ullagaram-Puzhudhivakkam	25,000	0.24	Local well	0.84
Porur	35,000	0.35	Local Well	2.55
Valasaravakkam	50,000	0.10	Local Well	2.76
Maduravoyal	50,000	0.40	Local Well	2.30
Meenambakkam	6000	0.10	Palar	0.50
Total	421,000	8.79		20.01

Source : Tamilnadu Urban Infrastructure Finance Corporation

Table 6: Water level in south coastal aquifer

	Water level in metre below ground level							
Rainfall in mm	1776	1422	1170	1243	1553	1560	2444	2035
Year	1990	1991	1992	1993	1994	1995	1996	1997
Kottivakkam	2.65	2.55	0.95	1.65	2.30	2.05	0.90	0.95
Palavakkam	7.55	4.30	1.75	2.70	3.80	4.00	3.80	4.40
Neelankarai	5.20	4.70	1.65	2.40	3.30	2.90	2.90	2.45
Vettuvankeni	3.95	3.70	2.25	2.50	2.80	2.80	2.55	2.75
Injambakkam	4.80	4.70	3.25	3.45	4.20	3.75	2.60	2.95

Source : Policy Implications of the lessons learnt from pioneering efforts being made to introduce rainwater harvesting systems – Chennai city a case study – Paper presented by Shantha Sheela Nair, CMD, C M W S S B in the national conference on the potential for rainwater harvesting.

indications of shallow wells giving place to bore wells, a rapid increase in the number of private bore wells and energized pump sets, a progressive deepening of wells and bore wells and declining yields per well in different parts of the city. Commercial exploitation and sale of groundwater by private firms have also increased.

Laws put in place

In an attempt to check this tendency to overexploit groundwater, MetroWater has sought to regulate private exploitation of groundwater. Under a state enactment of 1988 existing wells in notified areas are required to register with the designated authority; sinking of new wells is subject to licensing; so is the extraction of water for non-domestic use and transportation of water by goods vehicles. While the Act covers all ground water in the city and specified villages in its neighbourhood, existing wells used for agriculture and purely for domestic use are exempted. The focus seems to be mainly on controlling the extraction and transport of water by private firms for sale. New wells require permission and abstraction and transport of water regulated on an annual basis.

Data on water levels in different segments of the south coastal aquifer, a major area of commercial extraction, (Table-6) shows that the water table rose during the first 3 years of the decade despite a fall in average rainfall. During the subsequent 3 years, though rainfall increased, the water table dropped in all but one location. The succeeding 2 years, which received exceptionally good rainfall, (average being 2200 mm against less than 1500 mm in 1990-92), saw a rise in water table in four out of five locations.

However, more extensive data is required to grasp the dynamics of groundwater in the region.

CHAPTER IV

An approximate water balance for Chennai

In order to get an idea of the relative importance of different sources in meeting Chennai's water requirements, an attempt has been made to prepare an overall water balance of sources and uses for the city and for CMA. Though the available database is patchy, it is possible to piece together a broad, approximate picture.

The Master Plan's estimates of 'safe yields' of surface sources in normal years and the sustainable levels of extraction from different sources of groundwater provides one basis for this purpose. According to these estimates, summarized in Table-3, the safe yield of surface storages (from their catchments) is placed at 200 mlpd; the public well fields of AK basin can supply at the rate of 148 mlpd; and all the groundwater sources within the city account for around 85 mlpd adding upto a total of 433 mlpd. The Central Ground Water Board's estimate of total groundwater extraction in the city is considerably higher at 120 mlpd.

On the basis of the latter figure, the resources can sustain around 470 mlpd. Of this, surface sources comprise a little over two fifths; and ground water for the balance (nearly 60 per cent). The safe yield of facilities currently under the public system (which include all surface sources, Metro Water wells in the AK basin and the southern coastal aquifer and municipal wells and public hand pumps) is around 360-370 mlpd or a little over 80 per cent of the total. The public system and ground water play a major role in the city's water system. Similar data for OUAs are not available. But public system clearly plays a far less important role and groundwater is much more important in these areas

The other, and better basis, would be actual consumption and the contribution of various sources to it. The relevant data are available for 1995-6. A sample survey conducted by the AMMCRC estimates per capita household consumption at 97 lpcd . The total population of the city being 4.5 million, this adds upto total domestic consumption of 435 mlpd. The total consumption of large factories was estimated at 105 mlpd and that of other non-domestic establishments at 82 mlpd giving an aggregate consumption of 620 mlpd nearly 150-200 mlpd more than the official figure. (Note that the survey estimate relates to quantities received and consumed at the user end.) The survey further suggests that 45 percent of household consumption and about a fourth of the non-domestic consumption other than large industries is met by Metro Water.

Water balance of Chennai city, 1995			
Sources	mld	Uses	mld
Metrowater of which	325	Households	430
Surface water	270	Non-household, non-industrial	80
Ground water	55	establishments	
Municipal and public wells	15	Industries	100
Private groundwater sources (residual)	320	System losses (15%of Metro supply)	50
Total availability	660	Total use	660

Table 7.1 : Major rivers flowing into Madras District		
River	Length (km)	Sub – basin area (sq km)
Araniyar	66.4	763
Koratalaiyar	110.0	3240
Cooum	66.5	682
Adyar	40.0	857
Source : River Basin Study of Madras Basin Group – An Abstract, Institute of water studies, Tharamani, Misc.Report Nos.3/95, May 1995		

Table 7.2: Ground water balance — Madras basin	
Ground water balance	Million cubic meters
Annual charge	1119.39
Annual discharge	768.86
Annual balance	350.53
Source: River basin study of Madras Basin Group – An Abstract, Institute of water studies, Tharamani, Misc.Report Nos.3/95, May 1995	

Total water released by Metro Water in 1995 was 325 mlpd. Adding an estimated 15 mlpd from municipal wells and hand pumps installed by Metro water, total supply through the public system works out to 340 mlpd. Deducting 55 mlpd of reported supply to industries, releases for household use and non-domestic, non-industrial uses may be placed at around 285 mlpd.

These figures, being based on measurement of releases at the head works, relate to gross supplies. The availability at the user end is likely to be smaller on account of leakages, waste and illegal tapping in the distribution network. These losses have been estimated at 25 per cent. The magnitudes of different sources of loss is not known. In so far as part of it is on account of illegal tapping, some of it is in fact available to users. Assuming this to be 10 per cent of gross supplies, net availability at the users end may be placed at 240 mlpd (285 x 0.85). **This compares with the net consumption (430 x 0.45) + (80 x 0.25) = 214 mlpd estimated from the AMMMCRC survey.**

On this basis, and the AMMMRC survey estimate of consumption, the public system would appear to meet a little over a half of the city's total water requirement. **Groundwater (public and private) is estimated to meet nearly 60 per cent of the city's requirements in that year**. The rate of groundwater extraction by the private sector is reportedly higher than is generally believed.

Data on water use and sources in OUAs are scanty. In 1995 they had a population of 1.8 million. Assuming that per capita domestic use in these areas to be 75 lpcd, which is about one fourth below the city level, total consumption (not counting non-domestic commercial use) would be close to 135 mlpd. Public supply, heavily dependant on ground-water, accounts for less than 10 percent of this. Private supply also draws mostly on groundwater.

Unfortunately, the current state of knowledge and understanding of the status of groundwater is inadequate. The available estimates of recharge and extraction rates are not based on first hand measurements.

CHAPTER V

The future scenario

On the basis of the projected population of the city in 2021, namely 7.4 million, the city's requirements for household use at the rate of 100 lpcd at the user end would be about 740 mlpd. Assuming that consumption of non-domestic, non industrial uses will increase at the same rate as household use, the requirement for all non-industrial uses will rise to 880 mlpd. In the case of the CMA the projected population is 11.4 million. Therefore the requirement for household use will be 1140 mlpd, and for non-industrial use in the CMA will be 1350 mlpd. If one includes the industrial consumption for the entire CMA, estimated, on the basis of the Master Plan projections, at 300 mlpd total requirements in 2021 work out to 1180 mlpd (1650 mlpd).

The resources for the city currently include the three old reservoirs yielding, in a normal year, around 200 mlpd. Teluguganga — I now delivers 5 tmc a year, equivalent to 380 mlpd. However not all this is available for distribution. Allowing for losses between zero point and the reservoirs, the volume available for distribution is estimated at only 130 mlpd. If current levels of groundwater extraction (around 390 mlpd) can be maintained and losses in conveyance and distribution in the public system are reduced to the minimum, total availability for the city will be 985mlpd, about 15 per cent short of projected requirements. The only source from which this can be met is groundwater which is aalready under severe stress.

Ways of averting the crisis

Tapping surface sources

Official plans rely heavily on the expectation of an additional 7 tmc of water from TG-II. However, The experience of TG-I shows that amount of water reaching the city reservoirs is but a fraction of the volume received at zero point. Currently, net addition to supplies is estimated at only 30 per cent of the gross volume received at zero point. The calculation of water balance in 1995 and the projections for 2021 assume that this ratio will remain the same in phase II as well.

The outcome would, however, depend crucially on (a) augmenting capacity to store the extra supplies; (b) magnitude of losses from zero point to the reservoirs and effectiveness of measures to reduce them; and (c) losses in the distribution network. A careful assessment of the sources of loss and measures to plug these are of great significance.

Losses in distribution network depend on its capacity to handle the projected volumes and how well it is designed and maintained. The existing system, being old and poorly maintained, is prone to leakage and waste. A recently completed project to rectify defects in the existing distribution system is reported to have succeeded in reducing losses from 25 percent to 3 per cent.

Table 8: Projected water requirements of Chennai city: 2021

Sources	mld	Uses	mld
Existing sources	720	Households	740
Old surface storages	200	Other domestic	130
Teluguganga (5 tmc at zero point)	130		
Groundwater	390	Industry	300
Prospective sources			
Teluguganga II (7tmc at zero point)	200 ?		
Veeranam	180 ?		
Gap	70		
Total	1170		1170

Notes 1: Household use for 7.4 million people @ 100 lpcd. 2. Ratio of other non-household, non-industrial use to household use as in 1995-6. see table above. 3. Industrial use relates to CMA as per Master plan estimates. 4. TG II: ratio of availability at reservoir to receipts at zero point as in phase I

Changing consumption pattern

Effective supply of fresh water can be increased by not only augmenting total supplies but reducing wasteful and excessive use of water, and by recycling of waste-water. The potential for conserving water by these means is large. But to achieve this it is essential to launch large-scale public education and information campaigns and to introduce policies (operating primarily through appropriate pricing of water) to create strong incentives for users to adopt such practices/devices.

Water used for bathing, washing and toilets as well as that used by industries and power generation plants return to the hydrological system as waste water and effluents. Recycling this would substantially reduce the volume of fresh water needed to meet the growing demand.

More promising is recycling of water in industrial and thermal power units. MetroWater is actively pursuing this as a matter of policy. It has already succeeded in getting two of the largest industrial consumers to use 20-30 mlpd of sewage after primary treatment by MetroWater and urging the industries to take care of tertiary treatment. The potential contribution would be much more if large public and commercial building complexes are persuaded to install recycling plants for their waste water in-situ and to use the output for toilets, gardens and other non potable consumption.

Controlling extraction

Over extraction is undoubtedly the primary reason behind falling water tables and lower yields per well. A comprehensive and systematic study of the behaviour of water table in the well fields and southern aquifers and its relation to rainfall, extraction and regulation is necessary to assess the relative contribution of these elements in explaining the behaviour of the water table. The scope of such inquiries must also be broadened to include the tens of thousands of private wells and bore wells.

Enhancing recharge

Already a major effort has been made by Metro Water to increase recharge in well fields of the Arniyar-Kortaliyar basin. More can a be done by civic agencies such as the city corporation. Protecting irrigation tanks in the metro area; preserving and improving natural depressions to store fresh water; restoring of the numerous temple tanks spread all over the city should figure prominently in any programme to increase recharge.

Asphalting and concreting of roads and concrete lining of storm water drains increase the proportion of rainfall converted into surface flow and reduces the extent of exposed land through which water can percolate. This can be mitigated by leaving the fringes of roads without impermeable covering and by constructing percolation pits at intervals along the sides of roads, in locations which tend to accumulate water in the wake of moderate or heavy rains, and in all storm water drains.

Promoting rooftop rainwater harvesting

By far the greatest potential for increased recharge lies in the installation of rain water harvesting systems in buildings of all kinds: public and private; residential and non residential; single storied and multi storied.

After the severe drought of 1992 and 1993 Metro water began to take active interest in promoting rain water harvesting (RWH). It worked out a ‘statutory understanding’ with CMDA (Chennai Metropolitan Development Authority) and the Chennai Corporation whereby Planning Permission applications for specified categories of buildings were to be admitted only if they included a proposal for RWH as suggested by Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB). The regulation requires that while sanctioning water and sewer connections RWH works must have been constructed in all premises having 4 floors (ground + 3) and special buildings.

It is widely known that this regulation has not been effective. Many buildings which have obtained approvals under the regulation have either not installed any RWH systems or the structures are inadequate. A sample survey — conducted by MIDS at the behest of CSE — of some 75 buildings (out 500) for which approvals had been given in 1997 and 1998 showed the following:

- About three fourths of the approvals were in areas which have inadequate metro water supply.
- About two thirds of the sample buildings had not installed any RWH.
- This proportion was much higher (80 per cent) in zones with adequate water supply
- Buildings which had installed RWH adopted a variety of designs but in about a third of them the devices were not properly designed and therefore ineffective.
- Builders were aware of CMDA regulations and RWH techniques, but about a third of the 23 builders interviewed reported that they are not interested in installing RWH. The rest seemed quite active: 9 reporting installations in up to 10 buildings, and 3 in more than 20 buildings. At least one prominent building firm takes RWH seriously and installs structures appropriate to specific site conditions.
- Of the total 250 buildings where RWH system has been installed, 214 are residential and 95 residential — cum-commercial and 5 primarily commercial.

CHAPTER VI

Activities of the national water harvester's network

Quite independently of government agencies, a number of individuals and NGOs have been actively promoting RWH for several years. Some of the leading activists in this field are now a part of the National Water Harvesters' Network (NWHN) of Tamil Nadu, established under the auspices of the CSE. The members of the Network have made a sustained effort to spread awareness about the potential of RWH through media interactions, public lectures, organizing exhibitions in the city and outside. Several of them have designed RWH in a sizeable number of buildings. They have interceded with the government agencies to construct structures in public buildings and storm water drains in locations where water tends to accumulate during the rains.

The response of the public to the efforts of NWHN has shown a marked spurt in the last couple of years because of successive droughts, palpable water shortages, falling water tables and, in some areas, salination of groundwater.

Reponse of the government

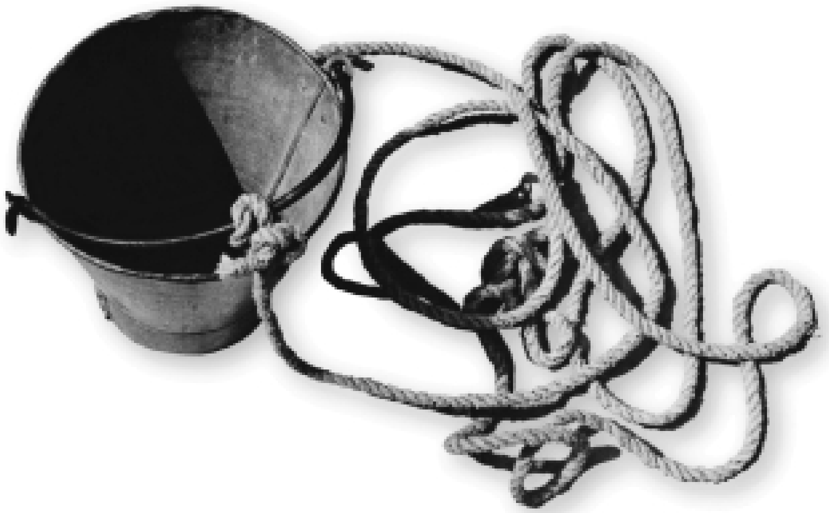
The recent droughts have also galvanized government agencies to take a more proactive role in promoting RWH. A special cell has been created in metro water to create public awareness, information on resource persons for design and installation, offer of technical advice and help to individuals who seek it; and training programmes in RWH techniques.

The Corporation and some government departments have been persuaded to install RWH structures in public buildings, parks and flyovers.

Installation of properly designed RWH systems in public parks and public buildings would not only contribute in significant measure to increasing recharge but would also serve as powerful tools to ssspread awareness about RWH.

There are indications that these potentials are recognized by official agencies, particularly Metro Water. But a more sustained and well defined effort in all these respects is necessary.

Also, as past experience has proved, enacting laws will not make much of a difference unless these are strictly enforced. Proper implementation of regulations and monitoring their observance with the help of civic and community groups is imperative. This must be combined with appropriate pricing of water so that users have a strong economic incentive to conserve water.



CHAPTER VII

Role of citizens' groups

All this underlines the need for systematic and objective documentation of design details, costs and water levels, yields and quality. Active encouragement and support from Metro Water for proper documentation and assessment of RWH works by and through NGOs, neighbourhood associations and universities/research institutions would be of great help to improve the quality and coverage of such information. Wide dissemination of these details combined with visits to sites of installations and interaction with occupants of buildings with RWH are essential to convince skeptics.

Costs of adopting rainwater harvesting

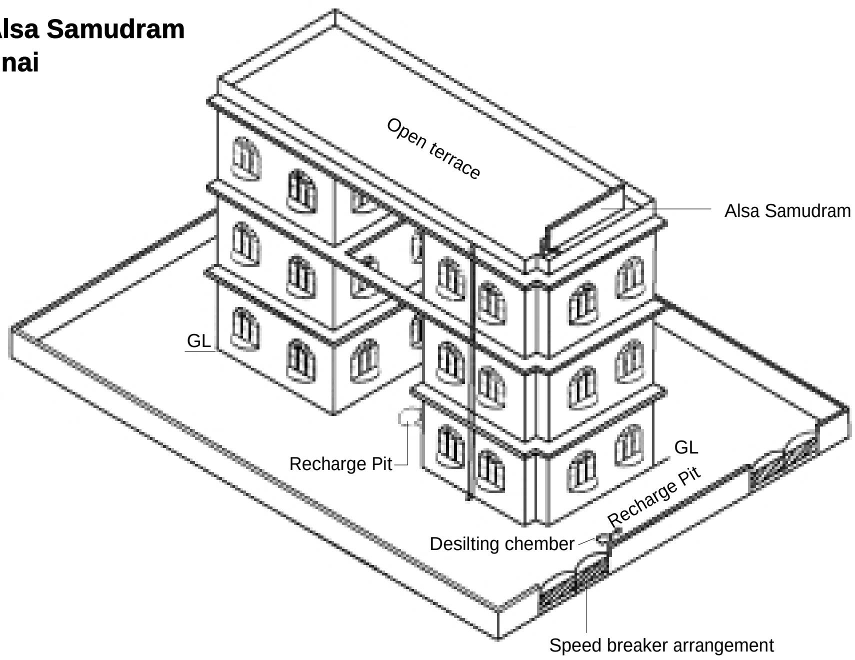
There is much ill informed skepticism among the public about the costs and benefits of RWH. Costs of well designed systems are but a tiny fraction of the total cost of buildings: for instance installation of a system for block of 8 flats on one and a half grounds (= 330 sq.m) in a middle class locality would be around Rs 20,000, while the cost of these flats would exceed Rs 1 crore! The costs would be higher if the system were to be installed in an existing building but still only a fraction of the building value.

Lack of readily accessible information on designs and expert advice on designs appropriate to the conditions of particular localities and sites is a major problem. In many cases the benefits (in terms of increased water levels in wells, better quality and yields) are not striking because of inadequate or defective design. In many cases the benefits may not be immediately apparent because the season or the year following the installation happens to be one of low rainfall and/or drought. There are also difficulties arising from the fact that benefits of isolated installations in individual buildings may not all accrue to the building with the installation: the increased recharge goes to an aquifer which extends beyond the limits of that building and may be reaped by wells in neighbouring buildings. Neighbourhood associations/ groups, and civic organizations should be encouraged and supported to promote implementation of RWH works in groups of contiguous buildings, and preferably on a locality basis.

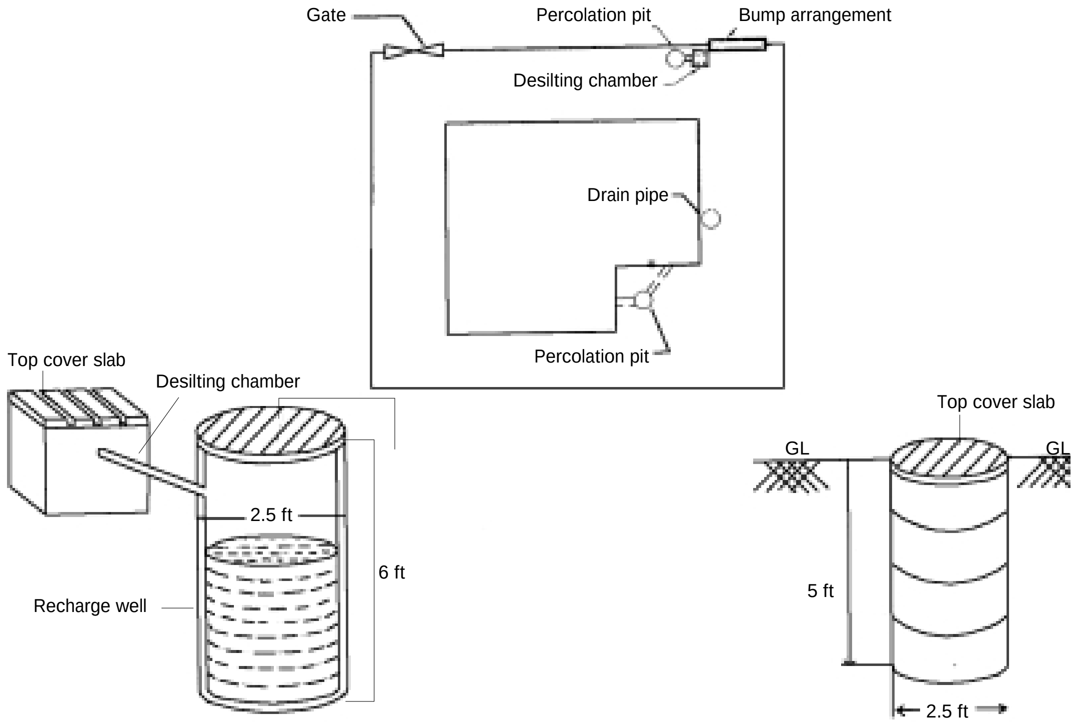
CASE STUDIES

■ **ALSA SAMUDRAM, Chennai**

Rainwater harvesting work at Alsa Samudram Valmiki Nagar, 4th Street, Chennai



Key plan view of Alsa Samudram



Detail of filtering chamber

Detail of percolation pit

Case background

This is a residential flat complex with a total area of 1114.8 square metre (sqm) and built up (roof) area of 557.4 sqm. There are 18 flats housing 60 people. The complex is totally dependant on groundwater.

Total potential of the building is 557.4 sqm x 1.2 m rainfall x 0.9 run off coefficient = 601 cu.m or approximately 6 lakh litres per annum

Measures taken for rainwater harvesting

- The roof water pipes have been interconnected using 4” diameter, 6 kg /sqcm PVC pipes and diverted to a percolation pit of 0.75 metre (m) diameter 1.8 m depth provided with PCC rings and closed with a RCC cover slab.
- The surface run–off (4 lakh litres per annum) which flows out through gate is intercepted by providing a speed breaker like structure (bump arrangement) and the water is diverted to a desilting chamber from which it is diverted to a percolation pit of 0.75 m diameter 1.8 m depth and closed with RCC cover slab. As the area falls in the coastal alluvium track and the formation is mainly sandy, the percolation rate (intake capacity) is high and hence the depth is limited to 1.8m.

Total cost incurred: Rs 6,000.

■ OYESTER OPERA, Chennai

Case background

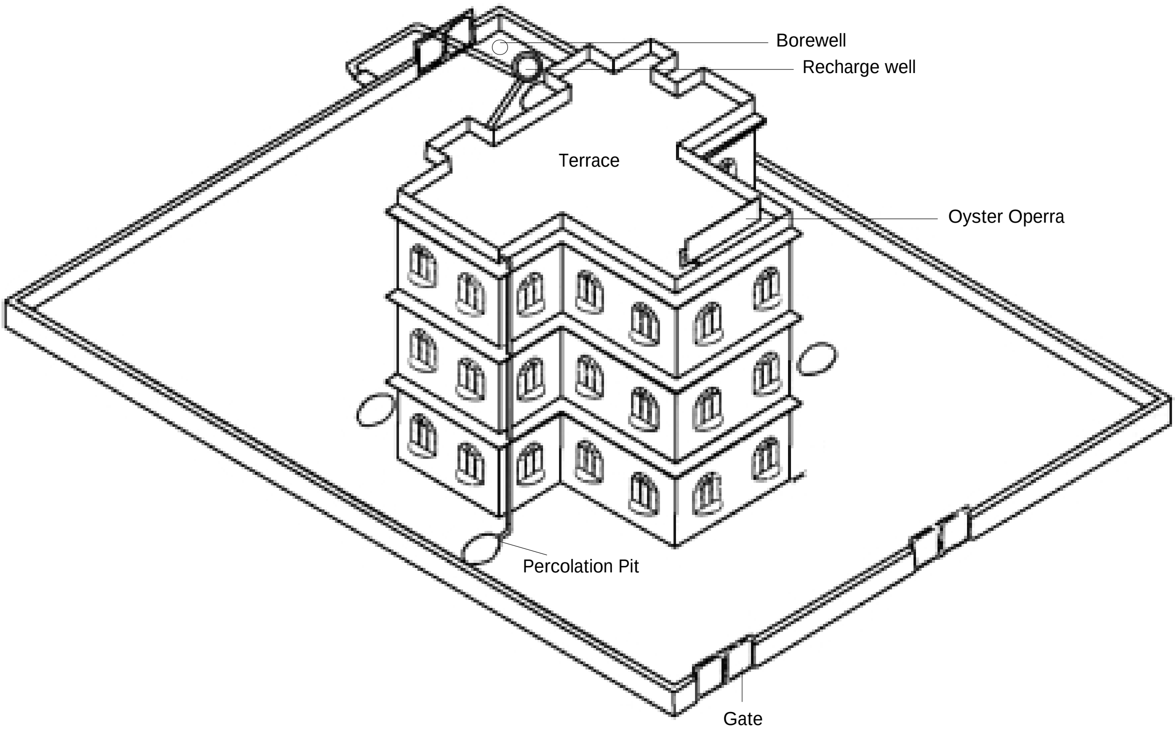
This flat complex has a total area of 873 square metre (sqm). The total water harvesting potential is 891 sqm x 1.2 metre (m) rainfall x 0.9 run off coefficient = 962 cum or approximately 9,62,000 litres per annum.

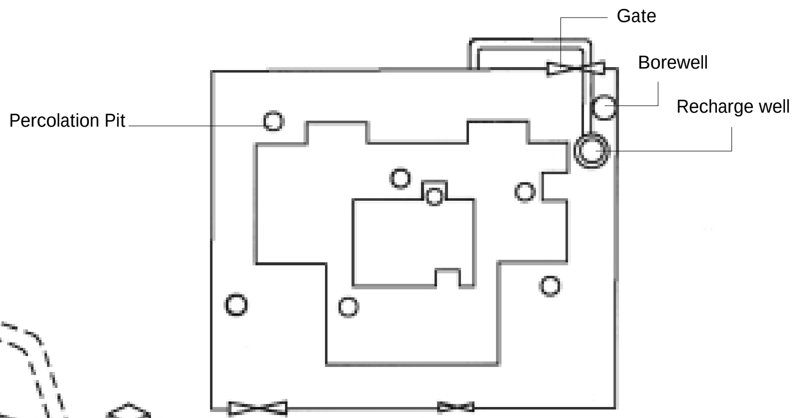
Measures taken for rainwater harvesting

- The roof water pipes are interconnected using 4” diameter, 6 kg/sqcm PVC pipes and diverted to a percolation pit of 0.75 m diameter 1m depth provided with PCC rings. From the bottom of the pit a borehole of 9” diameter with 3 m depth is dug, and filled with quartz pebbles. The pit is closed with a RCC cover slab. A 4” PVC pipe is inserted in the bore that acts as an air vent. Three such pits have been constructed.
- The roof water down-take pipes are diverted to recharge well (0.9 m dia 3 m depth), located near the gate. The well is provided with PCC rings and closed with RCC perforated slab so that it can also take in surface run off.

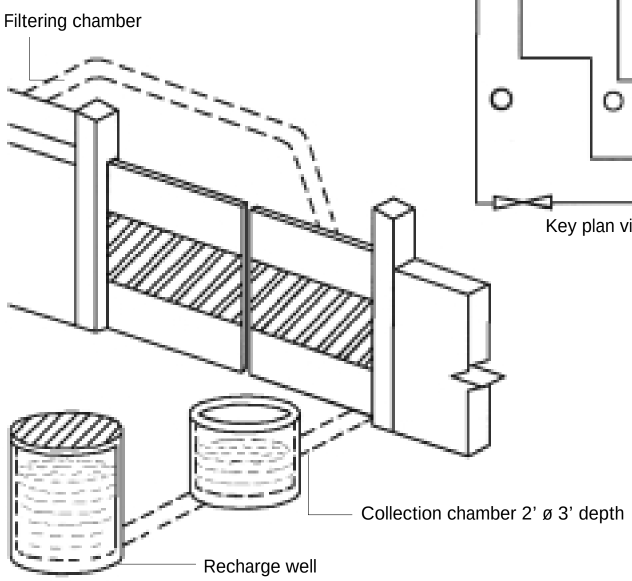
Total cost incurred: Rs 24,000.

Oyster Opera

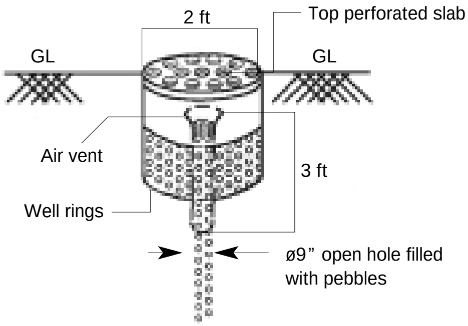




Key plan view of Oyster Operra



Recharge well near gate — 3’ ø 2 10’ depth



Detail of percolation Pit

■ RAMANIYAM APARTMENTS, Chennai

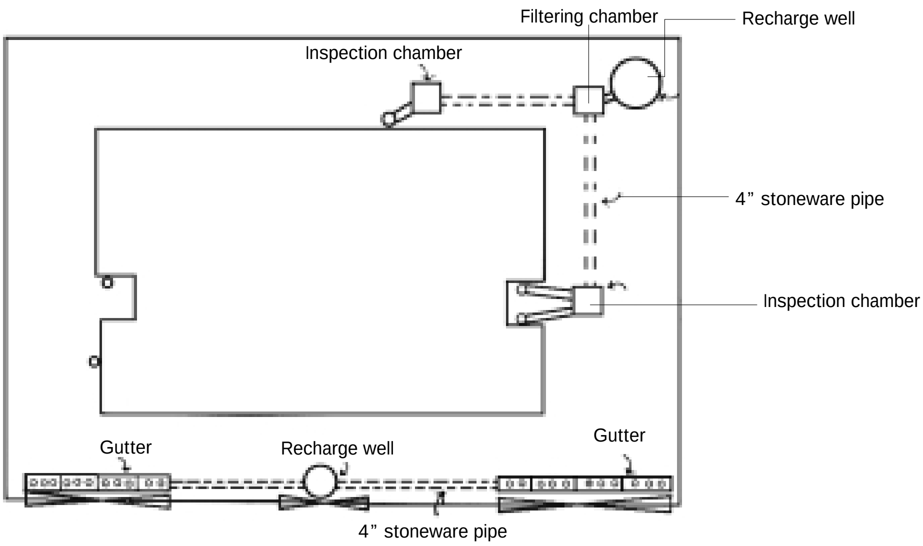
Case background

This residential flat complex has a total area of 669 square metre (sqm). The built up area is 372 sqm. The complex consists of 12 flats with a total population of 40. The total potential is 669 sqm x 1.2 metre (m) rainfall x 0.9 run off coefficient = 722 cum or approximately 7,22,760 litres per annum.

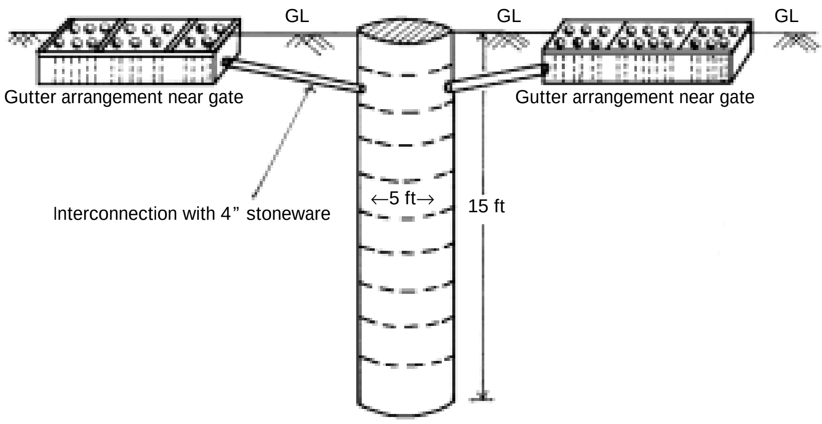
Measures taken for rainwater harvesting

- The roof water pipes have been interconnected using 4" diameter stoneware pipes and passed through a filtering chamber to a recharge well of 1.5 m diameter 4.5 m depth. The chamber is provided with PCC rings and is closed with RCC cover slab.
- The surface run-off is harvested near the gate through a gutter provided with 9" brick work to the total length of the gate. The depth of the finished gutter is 0.3 m and width 0.3 mt. The gutter is closed with a perforated RCC cover slab. A pipe interconnection has been made from the gutter to a recharge well of 1.5 m dia 4.5 m depth, provided with PCC rings and is closed with a RCC cover slab. The surface water collected in the gutter is diverted to the recharge well by interconnecting pipes.

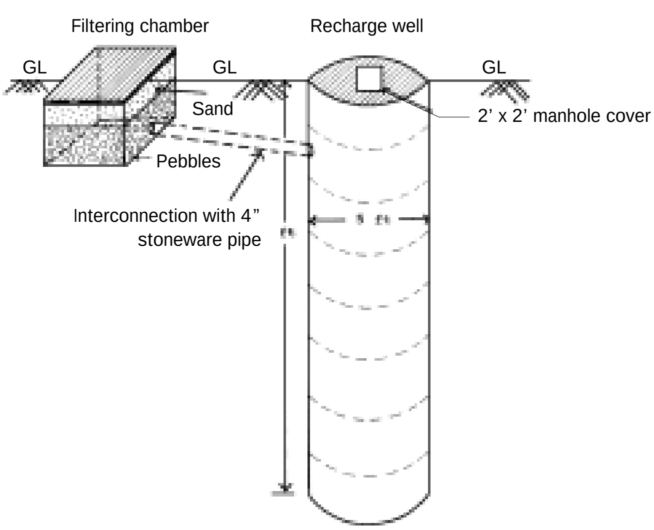
Total cost incurred: Rs 40,000.

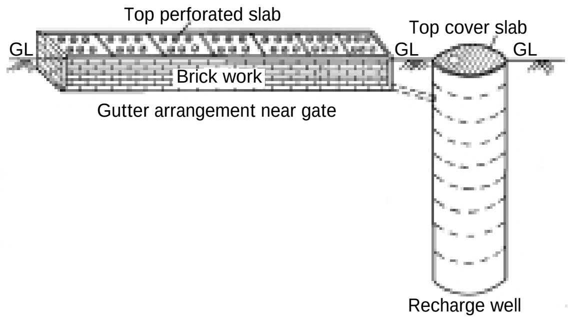


View of gutter arrangement and recharge well



Rainwater harvesting work at Ramaniyam Apartments
No 41, Third Main Road, Kasthuribai Nagar, Chennai





Sketch showing the gutter arrangement and recharge well

■ VASANTHAM — SCHOOL FOR MENTALLY RETARDED CHILDREN, Chennai

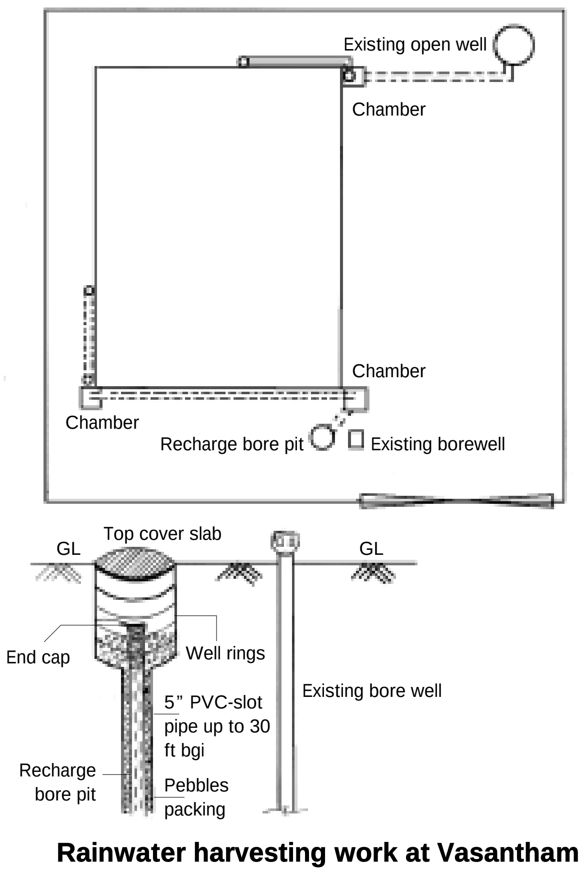
Case background

The total area is 446 square metre (sqm). with a built up area of 204 sqm.

Measures taken for rainwater harvesting

- One roof water downtake pipe is diverted to existing open well. The remaining pipes were diverted to a recharge dug cum bore pit as shown in figure.

Total cost incurred: Rs 11,000.



Rainwater harvesting work at Vasantham, School for Mentally Retarded Childre, Mugappiar East (Near E B Office) Chennai

CHAPTER VIII

Some useful tips for rainwater harvesters

A. To harvest surface run-off it is advisable to go in for recharge wells than percolation bore pits. Surface run-off carries a large quantity of silt and dust. The borepits are clogged when surface run-off flows in and keeping the pits clean is a cumbersome job. In the case of recharge wells, the silt accumulated inside can be easily removed.

Recharge wells are shallow wells dug upto porus strata and provided with PCC rings and can be covered with a RCC slab.

Percolation pits are shallow pits of 2' to 3' depth and 3'x 3' dimension (size as per site conditions) with a bore inside, which is filled with pebbles.

B. Pebbles and gravel must be used as filtering media in percolation pits instead of brick bats. Bricks are made of clay and silt and are eroded over a period of time.

C. Diversion of roof water to existing wells should be facilitated through a filtering chamber. The chamber should be filled with pebbles in the bottom and coarse sand on top, separated by a fine nylon mesh to prevent the sand form entering into the pebble bed. About 1' to 1.5' should be kept vacant at the top of the filter chamber.

D. Surface run-off should not be diverted to service wells or borewells.