RAINWATER HARVESTING DEVICES FOR RODRIGUES

FINAL REPORT OF THE TECHNICAL COMMITTEE

JANUARY 2002

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1. INTRODUCTION

Rainwater harvesting systems (synonymous with rainwater collection systems) normally refer to small-scale systems providing individual households or single communities with a primary or supplementary water supply.

Rainwater harvesting has tended to be the poor cousin of water supply technologies and has been to a considerable extent ignored or neglected. However, in recent years there has been an increasing appreciation that rainwater collection offers advantages over other systems and that in certain situations, it may be the most realistic answer to short and recurring periods of water shortages. Though the capital cost to implement the rainwater harvesting system might be significant, its operating cost is practically nil. This method is very appropriate for poor developing countries, in areas which lack any kind of conventional centralised government supply system and in remote or mountainous regions.

Rainwater harvesting requires a collection surface. Usually, the water is collected on the roof and channelled along a water guidance system such as a rooftop guttering system and downspouts and then filtered into storage tanks. The water is helped along by means of gravity or pumps and purified by chlorine or other simple means before being dispensed for typical uses such as toilet flushing, car washing, chlorinated swimming pools, surface irrigation or any other non-potable uses. Systems can be as simple or elaborate as desired.

The average annual rainfall in the various regions of Rodrigues ranges from 800 mm to 1550 mm, which should normally be quite adequate to meet the requirements of the local population of 36,000. However, the island suffers from acute water shortages due to its sharp topography and lack of water storage infrastructure. The rain water run-off to the sea is very high with consequential damage to the coastal zones and the ecosystem. Although the water shortage problem in Rodrigues has been partially alleviated through the exploitation of groundwater resources since a few years, there are already signs of depletion of the resources at an alarming rate.

The recent decision to introduce desalination plants in Rodrigues will no doubt alleviate the shortage of potable water but this project will require at least two years to become operational. The construction of dams and reservoirs to retain surface water for domestic and agricultural use would also take a long time for completion.

Rainwater harvesting (RWH) has been identified as an appropriate short-term solution to the prevailing acute water shortage in Rodrigues. Furthermore, it is anticipated that widespread RWH will alleviate the stress on overexploitation of groundwater resources.

The Mauritius Research Council (MRC) instituted a Technical Committee to carry out a study with a view to recommend optimum ways of harvesting rainwater, with a particular focus on the design of house-hold RWH devices that would suit the requirements and specificities of the people of Rodrigues.

2. TERMS OF REFERENCE

2.1 To carry out a global literature review of rainwater harvesting devices currently in use.

2.2 To make a critical assessment of existing local rainwater harvesting devices in Rodrigues.

2.3 To conceptualise and design potential devices for rainwater harvesting taking into account the following:

(i) cost;
(ii) quality;
(iii) safety;
(iv) easy implementation to existing household structures;
(v) effectiveness; and
(vi) maintenance.

2.4 To make recommendations on safe and clean water storage and to design the optimum shapes and sizes of tanks that may be constructed, using locally available materials if possible.

2.5 To consider the following two designs:

(i) a relatively cheap but effective system for individual low-cost houses; and
(ii) a more sophisticated system that may service a group of neighbouring houses.

2.6 To propose designs with complete technical details to ensure compatibility with existing household water systems.

2.7 To prepare tender documents for the procurement of Rain Water Harvesting devices.

2.8 To prepare a technical manual for the construction of the tank, and guttering system including instructions for maintenance.

2.9 To assist in the information campaign in Rodrigues, including a visit to Rodrigues for sensitisation sessions.

2.10 To assist in production of a demonstration video for the construction of the tank.

2.11 To assist the building and testing of prototypes, including a visit to Rodrigues.

3. METHODOLOGY

The recommendations and proposals made in this report are based essentially on a literature survey, discussions at the level of the technical committee, and the findings and observations made during two visits by technical committee members to Rodrigues.

3.1 Technical Committee Meetings

The Technical Committee was established with the following members:

Dr Y Maudarbocus	Chairman
Dr V Proag	Civil Engineer, University of Mauritius
Mr D Bunjun	Architect
Mr D Oodit	Engineer, NHDC
Mr K Heeramun	MRC

The Committee held eight meetings from 31st August 2001 to 12th November 2001. The main observations/recommendations of the Technical Committee were, on a regular basis, communicated to, and discussed at the level of, a Steering Committee on RWH in Rodrigues.

3.2 Literature Survey

Several publications on RWH downloaded from the WEB by MRC were reviewed by the Technical Committee. Special attention was paid to devices used for RWH in Uganda, Sri Lanka, Thailand and India.

Moreover, previous studies on RWH carried out by the University of Mauritius were also reviewed.

3.3 Visits to Rodrigues

The first visit to Rodrigues undertaken by 3 members of the Technical Committee from 17 to 19 September 2001, served not only to gauge the requirements and preferences of the local inhabitants with regard to RWH, but also to assess the available facilities and existing infrastructures to implement RWH projects and launch related information campaigns.

Thus, it was observed that the Rodrigues Council of Social Services (RCSS), is the most appropriate institution to coordinate the implementation of the RWH project and to launch the information campaign.

It was also confirmed that the current loan scheme offered by Government through the Development Bank of Mauritius (DBM) could be used in relation to the (RWH) project that is being proposed by the Technical Committee.

The main observations of the Technical Committee members are summarised in Section 4 below.

A second visit to Rodrigues was effected again by 3 members of the Technical Committee from 29 November to 01 December 2001. The RCSS organised a half-day seminar which was attended by about 100 participants, who were fully informed on the rainwater collection system proposed by the Technical Committee as well as the steps to be taken to implement the project. A representation of DBM elaborated in detail on the RWH Loan Scheme.

4. RWH IN RODRIGUES – CURRENT STATUS

4.1 Rodriguans have been using every possible means of collecting water depending on the means available to them. Storage tanks are either in concrete or fibreglass or cans in plastic. Guttering systems range from the basic galvanized sheets to take the shape of a gutter to a system consisting of PVC gutters and PVC downpipes.

4.2 Storage capacities of tanks vary from 1.4 cubic metres to higher capacities depending on the material of the storage tanks.

4.3 In Government quarters the standard size of 1.4 cubic metres have been found and these tanks are invariably in concrete and cylindrical in shape with a concrete cover.

4.4 Public buildings have been observed to be quite poor in rainwater harvesting although these buildings have a lot of potential for rainwater collection because of a substantial roof surface area. The reasons for this shortcoming are the following:

(a) the relatively easy access to water through government channels as and when the need arises,
(b) the collection , guttering and storage system have not been maintained adequately and are therefore out of use,
(c) lack of awareness of the potential of rainwater collection in public buildings.

4.5 The present distribution of water has been observed to be very erratic and the interruption of supply of water from the mains could range from 3 days to 22 days in certain regions. The situation is quite alarming and Rodriguans have somehow adjusted their way of life to this hard reality.

4.6 The collection of water is being carried out by Rodriguans as and when there is rainfall irrespective of the time of the rainfall, even during the night.

4.7 Flushing of the water tank is not very commonly practiced by Rodriguans as there is the apprehension that the rainfall may be indeed very brief and therefore no water may be collected in case of flushing. Some individuals have mentioned that flushing is done but in general Rodriguans prefer to keep their rooftops clean and tidy in anticipation.

4.8 From information gathered in the field, it appears that Rodriguans consume rainwater in general for drinking and cooking and use the water from the water mains for other domestic purposes. The average Rodriguan feels that the water from the mains is not as pure as rainwater and therefore prefer to consume rainwater instead of water from the mains.

4.9 Rodriguans have the apprehension that water from the mains has been contaminated during distribution and thereby the preference for the consumption of rainwater.

4.10 Mixing of both rainwater and water from the mains has been observed to be quite common mainly because of lack of other adequate storage tanks.

4.11 Treatment of rainwater before consumption is quite uncommon although a few cases have been noted wherein “eau de javel” has been mixed in the water prior to consumption and this is done on a regular basis.

4.12 Community Catchment Area for rainwater harvesting under usage earlier have been abandoned presently and therefore water tanks of substantial capacity are also lying idle and without any maintenance.

4.13 New residential construction has no provision for rainwater harvesting especially in areas where inhabitants have the means to procure water from sources other than rainwater.

4.14 The housing scheme proposed by the Trust Fund For The Vulnerable Groups has no provision for rainwater harvesting as should be the case in the scheme.

4.15 Only one commercial/residential building located at La Ferme is self-sufficient in so far as water supply is concerned. Provision has been made for a water tank of over 100 cubic metres capacity along with a water pump. Incidently, this particular development has no connection to the water mains.

4.16 The Anti-Erosion project funded by the European Union has its first project located at Papayes. This project consists of the construction of a small impoundment of 500 cubic metres capacity along with drains and resurfacing of the existing road so as be make it impermeable (area of road surface is 4000 sq. metres. This particular project is to give a boost to the degrading agricultural activity in this region. Five other similar projects will be implemented.

4.17 A first community exercise carried out with moulds, made available through UNICEF, the Australian High Commission and the "Jeune Chambre Economique", enabled the construction of about 3000 concrete water tanks of 315 gallons capacity. However, these moulds, which were made of metal and hence rather heavy and difficult to handle, are now all damaged and out of use.

4.18 1500 water tanks of 1 m^3 each have been built for women-led families at the cost of Rs 2,300 per unit.

4.19 The average built-up area of a house in Rodrigues is of the order of 80-100 sq m.

4.20 Rodriguans prefer the concrete water tank to the fibreglass one for the following reasons:

(a) the prohibitive cost of a fibreglass water tank compared to the concrete one;
(b) the risk of mechanical damage to the fibreglass tank; and
(c) the ease with which a concrete tank may be cast if a good mould is made available; this is a well-tried technology in Rodrigues.

4.21 The European Union has been approached by the RCSS to supply 6 moulds in fibreglass which are expected to be received soon. The cost of each mould of 1.4 m^3 capacity is of the order of Rs 20,000.

4.22 The RCSS is the opinion that if each of the 91 villages in Rodrigues were to be provided with an appropriate fibreglass mould, sufficient concrete tanks could be cast under the Self-Help Scheme to considerably alleviate the water shortage problem.

4.23 Government through the Development Bank of Mauritius in Rodrigues has set up a new loan scheme whereby up to Rs 10,000 may be borrowed at an interest rate of 7% and a repayment period of 36 months for the purchase/construction of a water tank and accessories. Thus, the monthly repayment is about Rs 309. The DBM officer was very receptive to a suggestion of the Technical Committee to extend the repayment period to 5 years to make the loan more affordable to lower income groups.

4.24 A meeting at SMIDO, Port Mathurin, revealed that a "turn-key" solution to the provision of RWH devices in Rodrigues is not a viable option, especially with regard to costs.

5. RELEVANT STATISTICAL DATA ON RODRIGUES

5.1 Population and Housing Units

The population in Rodrigues has not evolved a great deal over the past twenty years. Thus, whereas the number of inhabitants was 32,901 in 1983, it increased to only 35,850 in the year 2000. The small growth is attributed essentially to an important migration to mainland Mauritius.

On the other hand, the increase in households and housing units has been far more substantial, as indicated in Table 1. In the year 2000, there were 8,651 households and 9,254 housing units, as compared to 6,657 households and 6,915 housing units, respectively, in 1983.

5.2 Rainfall

The average annual rainfall in Rodrigues should normally be quite sufficient to meet the requirements of the local population. However, because of a sharp topography and lack of water storage facilities, the run-off rainwater to the sea is very high.

Moreover, the irregular rainfall pattern, as shown in Table 2, can cause a lot of hardships to the local population, as testified by the drought which occurred in 1999.

In general, the average rainfall in the summer months is roughly twice that in the winter months (Table 3).

As expected, the central part of the island receives much more rain than the coastal region, as indicated in Figure 1.

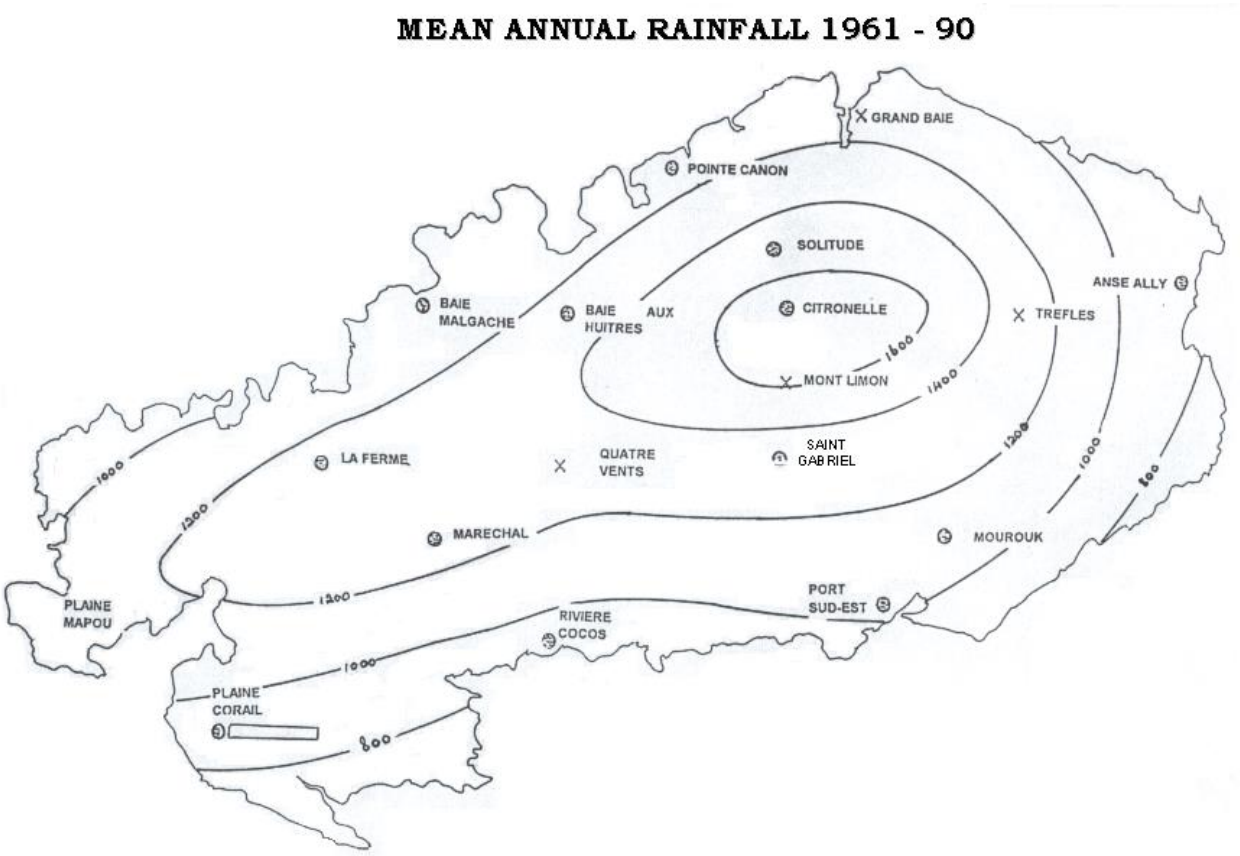


Figure 1: Isohyetal Rainfall Contour Map

TABLE 1A

Evolution of Housing

Year	Population	Housing Units	Households
1983	32,901	6,915	6,657
1990	33,883	7,810	7,268
2000	35,850	9,254	8,651

TABLE 1B

Distribution of Houses by zones

Zone	Name	No. of Houses	Population
1	Baie Topaze	363	1,418
2	La Ferme	327	1,112
3	Baie Malgache	234	872
4	Baie aux Huitres	773	2,575
5	Port Mathurin	1,781	6,130
6	Grand Baie	211	827
7	Roche Bon Dieu	453	2,056
8	Mont Lubin	941	3,782
9	Petit Gabriel	930	3,709
10	Quatre Vents	750	2,951
11	La Fouche Corail	651	2,881
12	Rivière Cocos	740	2,904
13	Port Sud-Est	642	2,699
14	Graviers	498	1,934
Total		**9,294**	**35,850**

TABLE 2

Annual Rainfall (mm) – January to December in Ascending Order
Pointe Canon

Amount	Year		Amount	Year
433	1974		1090	1992
634	1975		1119	1985
684	1977		1138	1986
760	1978		1181	1965
781	1999		1204	1964
810	1993		1266	1970
821	1969		1293	1967
830	1983		1317	1997
845	1961		1339	1994
859	1976		1339	1996
867	1984		1424	1979
914	1981		1429	1968
921	1966		1568	1962
929	1989		1589	1980
931	1998		1594	1995
950	1988		1609	1987
980	1971		1667	1973
982	1990		1693	1982
1023	1963		1931	1972
1027	1991			

TABLE 3

Monthly and Annual Normal Rainfall (mm) for the Period 1961 – 1990

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	SUMMER	WINTER
La Ferme	138	195	161	154	109	90	94	72	46	46	58	125	1295	829	457
Marechal	145	216	168	162	105	90	97	76	49	48	78	99	1331	866	465
Baie aux Huitres	157	213	158	132	83	99	97	80	58	45	74	108	1314	842	472
Citronelle	155	217	218	173	60	87	88	91	59	60	127	83	1346	881	445
Pointe Canon	132	168	150	129	87	73	85	61	41	38	63	90	1117	732	385
Solitude	151	241	197	172	114	107	126	95	61	60	83	135	1542	979	563
Anse Ally	96	155	125	93	52	34	49	33	26	19	35	85	802	589	213
Port Sud Est	139	191	131	113	66	66	62	56	35	32	33	105	1029	712	317
Saint Gabriel	195	215	138	213	86	95	113	62	54	53	115	76	1415	952	463
Rivière Coco	110	153	137	122	88	75	48	39	29	29	41	122	993	685	308
Plaine Corail	102	149	106	107	77	60	55	44	28	29	69	67	893	600	293

6. PROPOSED RWH DEVICE FOR RODRIGUES

The RWH device proposed for RWH in Rodrigues is based essentially on the following considerations:

(a) ***Cost*** – the materials used should be inexpensive and the site preparation and construction costs minimal; it should be noted that a fibreglass tank is more than twice as expensive as a concrete tank of similar size;

(b) ***Preferences of local inhabitants*** - who are not inclined to adopt fibreglass tanks (because of costs) or cheaper options, such as reed structures with plastics (because of durability). In fact, the RWH device proposed by the Technical Committee received unanimous approval by the 100 participants of a seminar on 1st December 2001.

(c) ***Standardisation*** – which favours the utilisation of moulds; for larger houses two or more modules could be connected together.

(d) ***Durability*** – the structure should resist weathering and not deteriorate physically or chemically.

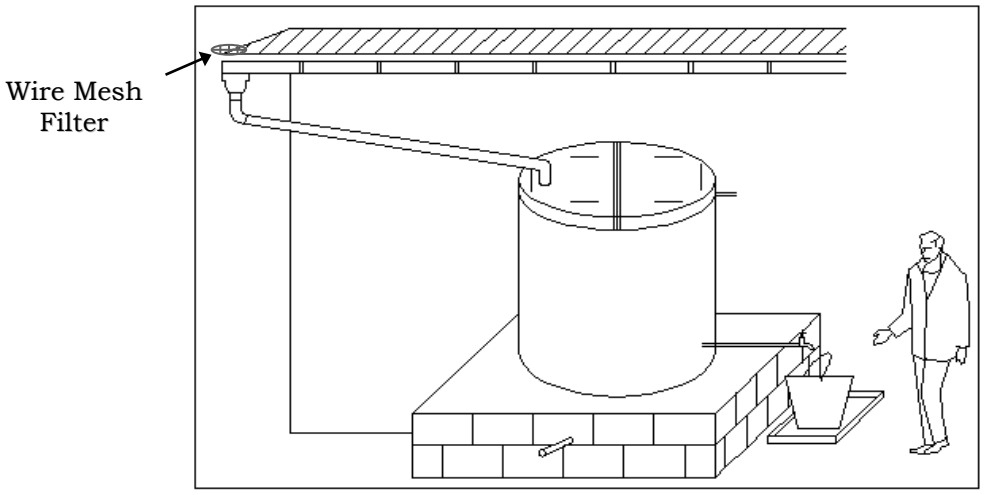
(e) ***Cleanliness and Maintenance*** - the collection surface should be smooth and impermeable and the run-off should be non-toxic; maintenance procedures should be simple and inexpensive.

(f) ***Easy implementation***

(g) ***Maximum impact***

Calculating the available supply and the size of the storage tank required to meet the estimated demand is perhaps the most critical step in designing the catchment system. If the storage tank is too small, the system will run dry and the users will become disenchanted. If the storage tank is made too large, this will greatly increase the costs and reduce affordability.

After a careful analysis of different options, a concrete cylindrical tank of 1.4 m^3 capacity is found to be most appropriate. Fibreglass moulds to cast the cylindrical tanks are being proposed. Fig. 2 gives an overview of the proposed set-up.



Reservoir arrangement with corrugated iron roof.

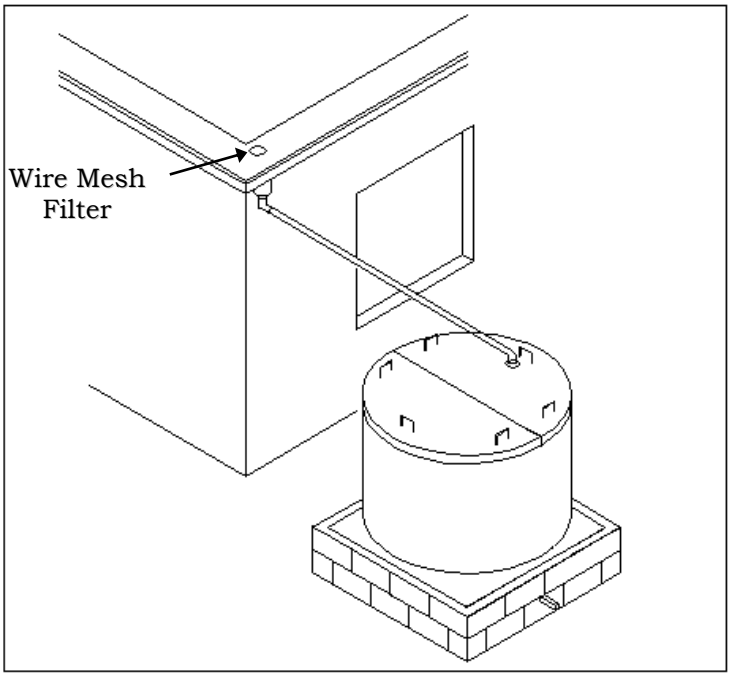


Fig. 2: Reservoir arrangement for concrete slab roof.

7. IMPLEMENTATION PROCEDURES

The implementation strategy is comprised of 4 main components, namely:

(a) Manufacture and supply of fibreglass moulds;

(b) Information campaign;

(c) A well-illustrated technical manual to facilitate the construction of the concrete water tank as an essential component of the RWH device, and

(d) The management and supervision of the actual construction of the water tanks.

7.1 Manufacture and supply of fibreglass moulds

The Technical Committee has designed an appropriate fibreglass mould of 1.4m^3 capacity, to be used to cast concrete reservoirs for the collection of rainwater. It has been estimated that each mould could be used for at least 100 castings, which implies that about 90 such moulds are needed to cater for the requirements of the existing 8,650 household units.

To this effect, a call for bids will be issued by the Ministry of Local Government and Rodrigues, based on a draft tender document prepared by the Technical Committee. Following a preliminary evaluation exercise, all short-listed tenderers will be requested to supply a sample mould, in order that the final evaluation of the bids could be based not only on costs competitiveness but also on technical merits. It is anticipated that each mould will cost about Rs 20,000; thus a budget of Rs 1.8 to 2.0 million will have to be made available for this purpose. It is understood that the Ministry of Local Government and Rodrigues will re-allocate existing funds for this purpose.

7.2 Information Campaign

The following events could form part of the information campaign:

(a) Official launching of the campaign by the Minister for Local Government and Rodrigues preceded by a sensitisation seminar.

(b) A poster campaign in all public places, schools and colleges. A draft poster, proposed by the Technical Committee and refined by the Ministry for Local Government and Rodrigues, is shown in Annex 1. A picture of a prototype tank could be included in the poster, which is meant to raise public awareness on the possibility made available for Rain Water Harvesting.

(c) Radio and TV coverage. It is also proposed to make use of a demonstration video for this purpose.

(d) Intensive use of the RCSS network to access a wider public.

7.3 Technical Manual

A well-illustrated technical manual, Annex 2 has been prepared by the Technical Committee with a view to facilitate the construction of the concrete water tank using the fibreglass moulds. This is especially important as it is anticipated that most of the reservoirs will be constructed on a self-help basis.

The Technical Manual is very comprehensive and includes information on how to prepare the concrete mix and the welded mesh, to construct the base, to assemble the fibreglass mould, to pour the concrete, to remove the mould, to cure the cement and to maintain and clean the reservoir. A waterproofing coat may be applied inside the reservoir if the owner so desires.

Some guidelines for the construction of the guttering system are also provided in the Technical Manual.

Following consultations with the Rodriguan authorities, it was agreed to prepare the manual in French.

7.4 Management and Supervision of the construction of the Concrete Reservoirs

It is anticipated that the 95 fibreglass moulds will be delivered to the RCSS, who will manage and supervise the construction of the concrete reservoirs throughout the island.

The moulds will be made available to the public at a nominal fee or on a cost-free basis to the lower-income group. A mould should not be retained at any one household for more than three days.

The construction of the reservoir itself, including the purchase of cement, sand, welded mesh and plumbing materials should not normally exceed Rs 5,000. The Development Bank of Mauritius has devised a special loan scheme, whereby up to Rs 10,000 could be borrowed in relation to Rain Water Harvesting projects.

8. CONCLUSION/RECOMMENDATIONS

The proposed approach to RWH in Rodrigues is essentially an attempt to obtain the maximum impact at minimum cost. Thus, with a fibreglass mould, to be provided by Government authorities, a concrete tank of 1.4 m^3 capacity can easily be constructed on a self-help basis at an estimated cost of less than Rs 5,000 per unit.

It is proposed to provide 95 such moulds, which could cater for the needs of 9500 households – hence for the entire population of Rodrigues – on the assumption that each mould could be used 100 times on an average. For the larger households, two or more concrete tank modules could be constructed and connected together.

For the smooth implementation of the proposed RWH project in Rodrigues, it is recommended that:

(a) Adequate funds, estimated at about Rs 2 million, should be made available by Government for the purchase of the fibreglass moulds.

(b) The tenderers for the supply of the fibreglass moulds should be requested to provide a sample in order to enable a judicious selection to be made based on both technical and cost considerations.

(c) The Rodrigues Council for Social Services (RCSS) appears to be the most appropriate institution to provide the necessary logistics for the implementation of the RWH project. It is recommended that the fibreglass moulds could be loaned to individuals at a nominal fee for a maximum period of 7 days. The funds thus collected could be used to provide financial assistance to the very low-income groups to construct their water tanks. Once every household is equipped with a water tank, interested parties would be given the possibility to build more tanks.

(d) For the RWH loan scheme, the Development Bank of Mauritius (DBM) should consider extending the maximum repayment period from 3 years to 5 years, in order to benefit a larger proportion of the population.

(e) An appropriate information campaign should be established. This could include radio and TV programmes, posters and seminars.

(f) Funds, estimated at about Rs 200,000, should be made available for the publication of sufficient technical manuals to facilitate the construction of the concrete water tanks using the fibreglass moulds. A demonstration video would also be quite useful for this purpose.

(g) There is a considerable potential for RWH in large public and private buildings. A technical team should be constituted to provide guidance to the owners/occupiers of such buildings, as each case should be considered on its own merit. Much larger reservoirs and a pumping system are envisaged; the set-up used at the co-operative supermarket in La Ferme with a partially underground water tanks could be used as an example.

(h) The RWH project in Rodrigues should be closely monitored and evaluated at regular intervals to ensure its success.

ANNEX 1: DRAFT POSTER