

Rainwater Harvesting Through Tanka in Hot Arid Zone of India



R.K. GOYAL
V.C. ISSAC

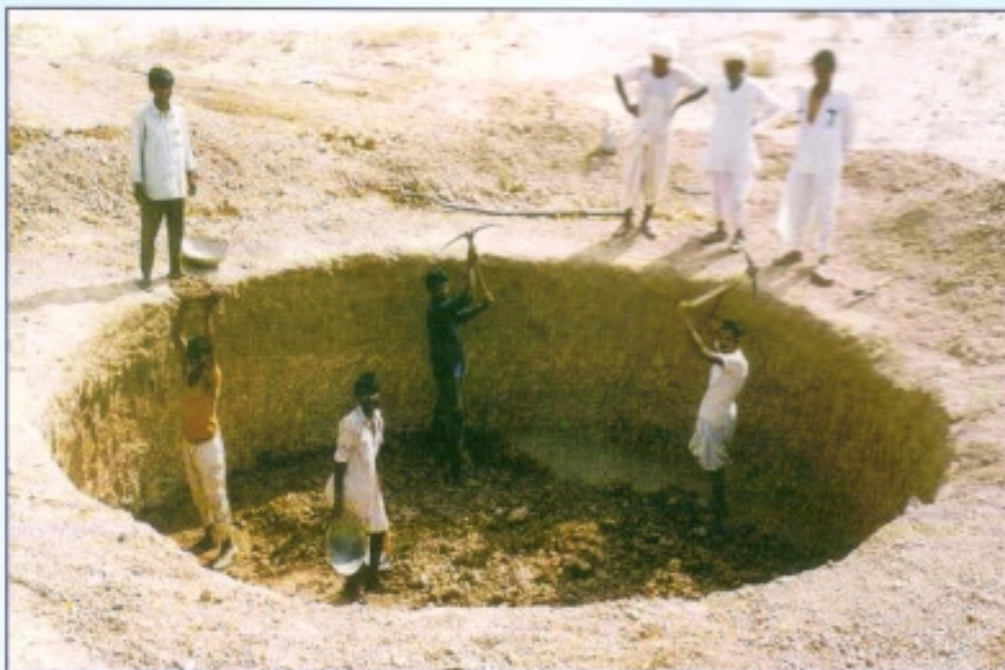


Central Arid Zone Research Institute

JODHPUR- 342003

2009





Construction of improved tanka (50,000 liters) with farmer's active participation at Kalyanpur (Distt. Barmer)



A open tanka of 271 m³ capacity at farmer's field Jhanwar watershed (Distt. Jodhpur)



Rainwater Harvesting Through Tanka in Hot Arid Zone of India

R.K. GOYAL

V.C. ISSAC



Central Arid Zone Research Institute

JODHPUR- 342003

2009

Published by:

Director

Central Arid Zone research Institute

Jodhpur – 342 003 (Raj.) INDIA

Phone: +91 291 2786584

Fax: +91 291 2788706

Web site: www.cazri.res.in

Correct citation:

Goyal, R.K. and Issac, V.C. 2009. Rainwater Harvesting Through Tanka in Hot Arid Zone of India. Central Arid Zone Research Institute, Jodhpur. pp 33

November, 2009

Back page photographs:

Rooftop rainwater harvesting- CAZRI main building

Printed at:

Evergreen Printers

14-C H.I.A. Jodhpur

Tel: 0291-2747767

FOREWORD

Availability and redistribution of available water assume prime importance in the sustainable development of arid regions which if available adequately can support intensive biotic population. The main difficulty associated with water resource planning and management is due to inherent degree of variability associated with rainfall, therefore rainwater harvesting during rainy season and subsequent use in lean period can substantially reduce the risk associated with activities requiring water.

Rainwater Harvesting which is “Conscious collection and storage of rainwater to cater to the demands of water, for drinking, domestic & irrigation purposes” meet about 35% demand of drinking water and also of orchards in hot arid zone through rainwater harvesting using tanka.

The improved tanka designs developed and demonstrated by Central Arid Zone Research Institute (CAZRI) have got wide acceptability in the region. The designs have been replicated in large numbers by different developmental agencies. An attempt has been made in this bulletin to cover all aspects of rainwater harvesting through tankas. The bulletin provides details of designs and estimates for various sizes of tanka. Although written primarily for Indian hot arid zone the bulletin can also be useful for other parts of the globe having similar climatic conditions.



(N.V.PATIL)
Director

Place : Jodhpur
Date : 19 November, 2009

CONTENTS

1. Introduction	-	1
2. Rainwater harvesting	-	2
2.1 Rainfall	-	2
2.2 Catchment	-	4
2.3 Runoff Coefficient	-	5
3. Techniques for enhancement of runoff	-	6
4. Collection/storage of harvested rainwater	-	6
5. Improved tanka	-	7
5.1 Capacity of tanka	-	7
5.2 Design of tanka	-	8
5.3 Construction of tanka	-	9
6. Materials and methods for construction of tanka	-	9
6.1 Tools and laborers	-	9
6.2 Sand	-	10
6.3 Water	-	10
6.4 Cement	-	10
6.5 Mixing of mortar	-	10
6.6 Curing	-	10
7. Repair and maintenance of tanka	-	11
8. Quality of collected Rainwater	-	11

9. Summary of Steps for Design and Construction of Tanka	-	12
---	---	----

10. Design Estimates of Tanka

• 5000 Liters capacity Cement Concrete Tanka	-	14
• 5000 Liters capacity Masonry Tanka	-	16
• 21000 Liters capacity Masonry Tanka	-	18
• 25000 Liters capacity Cement Concrete Tanka	-	20
• 50000 Liters capacity Masonry Tanka	-	23
• 50000 Liters capacity Cement Concrete Tanka	-	26
• 100000 Liters capacity Masonry Tanka	-	28
• 300000 Liters capacity Masonry Tanka	-	31

1. INTRODUCTION

“Water is life”. Good quality potable water is a global issue, particularly in the developing world. With rapid growth in population and improving living standards, the pressure on available water resources is increasing and per capita availability of water resources is decreasing day by day. The per capita availability of water in India has dropped from 5300 m³ in the year 1955 to 2200 m³ in the 2000 compared to 7420 m³ world and 3250 m³ Asian average for the same. The overall national availability of water may not pose a serious problem in near future, but there would be a severe shortage of water in many regions of India particularly in a state like Rajasthan. Rajasthan is the largest state in Indian union (10% of country's total geographical area) but it is the driest state in term of availability of water resources (1% of country's total surface water resources). The annual per capita availability of water in the state is 857 m³ which is much below the threshold value of 1700 m³ considered for water stress conditions. The rainfall in the state is low and varies significantly. There is a very rapid and marked decrease in rainfall in the west of the Aravalli range making western Rajasthan the most arid part of India. The average annual rainfall of the western arid region is 317 mm and that of the rest of eastern Rajasthan is 680 mm with an overall average rainfall of 554 mm for the state. The rainfall is highly variable at different places and it is most erratic in the western half with frequent spells of drought. The coefficient of variation (CV) of rainfall varies between 40 to 60%.

Surface water resources in arid part of Rajasthan are very meager and majority of population depends on groundwater extraction to meet their essential water requirements. The source of drinking/municipal water supply in most parts of the arid Rajasthan is mostly groundwater or borehole based. With frequent droughts and chronic water shortages in many areas, most people pay an increasingly high price for water, the poorer; especially women and children usually pay the highest price for small quantity of water. They also expend more calories for fetching water from distant sources; suffer more in terms of impaired health from contaminated or insufficient water, and also lose more in diminished livelihoods.

In absence of adequate surface and groundwater resources, rainwater plays an important role in the survival and livelihood of arid zone dwellers. The rainwater, if harvested appropriately, can be a reliable source of water for domestic and other purposes. Rainwater harvesting is an ancient practice and has been prevalent for more than 4000 years in many parts of the world. Rainwater harvesting is the collection and storage of rainwater from areas such as roofs and other natural catchments. Rainwater harvesting is a necessity in areas lacking any kind of conventional, centralized government supply system, and also in areas where good quality fresh surface water or groundwater is not available. If rainwater harvesting and its subsequent storage are

designed carefully, it is possible for a family to live for years in areas with rainfall as little as 100 mm per year. Over a period of 4 decades research ‘Central Arid Zone Research Institute, Jodhpur’ has perfected the technology of rainwater harvesting for different purposes.

2. RAINWATER HARVESTING

Rain is the principal source of water, which augments soil moisture, groundwater and surface flows. Agriculture and several of other economic activities in arid areas depend on rain. Rainfall in arid areas is of convective nature and usually occurs for a shorter duration at very high intensity, generating high runoff in response of even very little rainfall. Runoff can be very high particularly in urban areas where buildings and roads forms good catchment for runoff generation. The runoff from a particular area depends on rainfall intensity and catchment characteristics like size, shape, surface roughness, water absorbing capacity and slope etc. Thus runoff from any rainfall event for a particular area can be estimated using Equation 1.

$$R = P * C * A \dots\dots\dots (1)$$

Where R is runoff, P is rainfall, C is runoff coefficient. Runoff coefficient ‘C’ is ratio of runoff to rainfall and varies from minimum of 0 to maximum of 1 and A is the catchment area. By taking appropriate units of R, P and A and selecting suitable runoff coefficient ‘C’, runoff can be estimated.

2.1 Rainfall

The mean annual rainfall over the Indian hot arid region varies from more than 500 mm in the southeastern parts to less than 100 mm in the northwestern and western part of the arid region (Fig. 1). More than 85% of the total annual rainfall is received during the southwest monsoon season from July to September. The withdrawal phase of monsoon start by middle of September in the extreme western part and retreats by the end of September.

The rainy season varies from maximum 50 days in the western part to 80 days in the eastern part of arid Rajasthan. A small quantum of about 7-10 percent of annual rainfall is received during the winter season under the influence of western disturbances.

Rainfall is low and erratic and the coefficient of variation varies from 42 percent to little more than 64 percent. Long term statistical analysis of rainfall data indicates an asymmetric average storm intensity profile for the storms of short duration, with the highest intensities falling in the first part of the storm. The statistical characteristics of high intensity and short duration are essentially independent of location within the region.

A detailed statistical analysis of long term rainfall data of all districts of western Rajasthan has been done to arrive at probable rainfall for three levels of probability i.e.

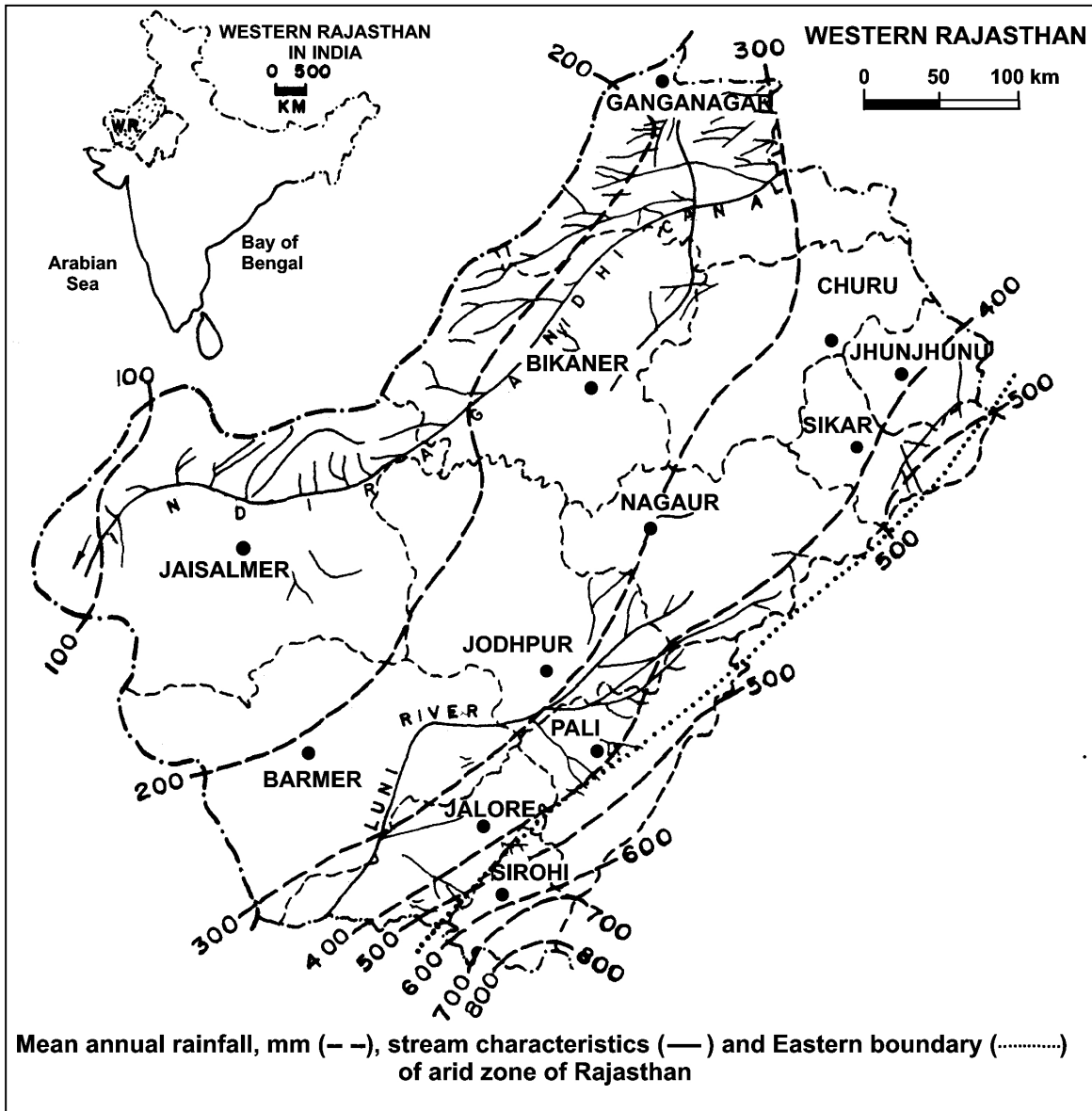


Fig. 1

50, 60 and 70% and presented in Table 1. As the probability of occurrence of rainfall increases (or level of surety/certainty), the magnitude of minimum assured rainfall decreases. Therefore, a balance between risk (cost of structure) and the probability/certainty of rainfall is must for planning any rainwater harvesting system (RWHS).

Rainfall at 60% probability is generally considered safe for designing any RWHS for this region.

Table 1. Minimum assured rainfall at different probability for arid districts of Rajasthan

District	Probable rainfall equation	Correlation coefficient	Rainfall (mm) at probability of		
			50%	60%	70%
Barmer	$R = -172.73 \ln (P) + 892.57$	0.9779	216.8	185.3	158.7
Bikaner	$R = -139.88 \ln (P) + 790.98$	0.9552	243.7	218.2	196.7
Churu	$R = -142.53 \ln (P) + 878.18$	0.9570	320.6	294.6	272.6
Ganganagar	$R = -140.43 \ln (P) + 754.77$	0.9825	205.4	179.8	158.1
Jaisalmer	$R = -124.54 \ln (P) + 639.76$	0.9765	206.5	183.8	164.6
Jalore	$R = -205.26 \ln (P) + 1128.7$	0.9518	325.7	288.3	256.6
Jodhpur	$R = -196.29 \ln (P) + 1078.2$	0.9682	310.3	274.5	244.3
Jhunjunu	$R = -148.61 \ln (P) + 937.36$	0.8954	356.0	328.9	306.0
Nagaur	$R = -196.88 \ln (P) + 1063.8$	0.9649	293.6	257.7	227.3
Pali	$R = -214.62 \ln (P) + 1201.6$	0.9586	362.0	322.9	289.8
Sikar	$R = -207.82 \ln (P) + 1207.2$	0.9602	394.2	356.3	324.3

R= rainfall (mm) for probability (P) and ln is natural logarithm

2.2 Catchment

Catchment is the place where raindrop first strikes. After striking the catchment, subsequent process is entirely dependent on the inherent physical and chemical characteristics of the catchment. Physical characteristics like surface roughness and slope determine the flow of runoff while its textural constituents i.e. proportion of sand, silt and clay determine the water absorbing capacity of the catchment. Certain chemical characteristics of catchment like presence of fertilizers, pesticides on natural surface determine the quality of runoff. The ratio of runoff to rainfall is denoted by the runoff coefficient (C) and is dependent on rainfall characteristics like intensity & duration and physical and chemical characteristics of catchment as mentioned earlier. The shape of given catchment also has a considerable influence on runoff. Roof surfaces of buildings make the best catchment to generate runoff. Studies conducted by CAZRI revealed that roofs made of different lining materials such as corrugated GI sheet, stone slab, lime concretion etc. can generate as high as 50 to 80% runoff. Of the most common roof types the single pitch roof is the most appropriate for rainwater harvesting, since the entire roof area can be drained into a single gutter on the lower side and one or two down pipes can be provided depending on the area. Based on three levels of probable rainfall and three catchment characteristics represented by runoff coefficient (C), catchment area (A) required for generation of 1000 liters (1 m³) of runoff (R) has been calculated for all districts of western Rajasthan (Table 2). For desired quantum of

runoff and existing catchment characteristics, the necessary catchment area can be calculated or with known catchment area, expected runoff can be determined.

Table 2. Catchment area required for 1 m³ of runoff (m²) at different rainfall probability for three catchment conditions.

District	Catchment area required for 1 m ³ of runoff (m ²)								
	Rainfall at 50% P			Rainfall at 60% P			Rainfall at 70% P		
	C- 0.2	C-0.3	C- 0.4	C- 0.2	C-0.3	C- 0.4	C- 0.2	C-0.3	C- 0.4
Barmer	23.10	15.40	11.50	27.00	18.00	13.50	31.50	21.00	15.80
Bikaner	20.50	13.70	10.30	22.90	15.30	11.50	25.40	16.90	12.70
Churu	15.60	10.40	7.80	17.00	11.30	8.50	18.30	12.20	9.20
Ganganagar	24.30	16.20	12.20	27.80	18.50	13.90	31.60	21.10	15.80
Jaisalmer	24.20	16.10	12.10	27.20	18.10	13.60	30.40	20.30	15.20
Jalore	15.40	10.20	7.70	17.30	11.60	8.70	19.50	13.00	9.70
Jodhpur	16.10	10.70	8.10	18.20	12.10	9.10	20.50	13.60	10.20
Jhunjhunu	14.00	9.40	7.00	15.20	10.10	7.60	16.30	10.90	8.20
Nagaur	17.00	11.40	8.50	19.40	12.90	9.70	22.00	14.70	11.00
Pali	13.80	9.20	6.90	15.50	10.30	7.70	17.30	11.50	8.60
Sikar	12.70	8.50	6.30	14.00	9.40	7.00	15.40	10.30	7.70

C= 0.2 for untreated natural catchment; C= 0.3 for compacted natural catchment, C=0.4 for compacted artificially treated catchment

2.3 Runoff Coefficient

The runoff coefficient (C) as mentioned above is ratio of runoff to rainfall for a given catchment and depends on rainfall and the catchment characteristics. Various studies have been conducted by CAZRI and others to estimate the runoff percentage. These studies suggest that the average run-off generation from arid Rajasthan is between 1 and 15 per cent of rainfall because most of the terrain is sandy. However, due to the spatial variations in rainfall and terrain type, deviations from this range are expected. In less than 200 mm rainfall zone, the dominantly interdunal area under undisturbed conditions with adequate vegetation cover can generate 10 to 15 percent runoff. The rocky/gravelly surfaces, on the other hand, can generate between 20 and 25 percent. In the 200 to 400 mm rainfall zone the micro-catchments in the plains with sandy loam to loamy sand can generate as much as 30 to 40 per cent runoff, although the larger catchments can generate between 15 and 20 percent. The rocky/gravelly surfaces in this zone can generate between 20 and 30 percent of rainfall as runoff. In the more than 400 mm rainfall zone, the hills and rocky uplands are able to generate 40 to 60 percent as runoff, while the alluvial and other sandy plains can generate between 20 and 30 percent runoff. Runoff from a catchment can be enhanced by improving the catchment conditions.

3. TECHNIQUES FOR ENHANCEMENT OF RUNOFF

Catchment characteristics can be modified to a certain extent for higher runoff generation. The extent of modification depends on the investment available and the expected use of runoff water. In the area where there is no source of water neither any accessibility to alternative water sources, higher initial investment is justified on long term.

- Simple earth smoothing and compaction helps increasing runoff from catchment areas. Success is generally greater on loam or clay loam soils. Care must be taken to smooth the slope and/or the length of slope to lessen runoff velocity and thereby collecting more runoff.
- Small amounts of sodium salts - particularly NaCl, NaHCO₃ applied to desert soils where vegetation has been removed- causes dispersion of the surface soil, reducing infiltration and increases runoff. However, this type of treatment requires a minimum amount of expanding clays in the soil.
- Removal of stones and boulder and unproductive vegetation from catchment helps in uninterrupted flow, enhances runoff to collection site.
- Land shaping into roads and collection of water in channels.
- Sandy soils have low water holding capacity. Spreading of clay blanket to the soil surface reduces the infiltration and consequently accelerates runoff.
- Chemical treatments like wax, asphalt, bitumen and bentonite prevent downward movement of water, which augments runoff.

4. COLLECTION/STORAGE OF HARVESTED RAINWATER

Rainwater harvesting/storage in an underground cistern locally known as *Tanka* is an age old common practice of this region. The people in the region by and large reside in scattered settlements, so *tanka* is an important component of integrated rural water supply system in western Rajasthan. The first known *tanka* in this region was constructed in year 1607 AD by Raja Sursinghji in village Vadi-ka Melan. *Tanka* was so important that till year 1895 its construction was considered as a very religious service by the Kings and their people. Water from *tanka* was used for worship in the temples. Almost all the forts and palaces were having *tanka* at strategic and secret places for the army and others. Various types of *tanka* from rectangular to circular in shape and capacity ranging from as small as 1000 liters to 500,000 liters are prevalent in this region. Every house generally had at least one *tanka* for storage of rooftop rainwater and water from other sources. Traditionally the number and size of *tanka* in house used to be status symbol of a particular family.

The availability of water in these tankas was usually round the year for drinking purposes for the whole family. The traditional construction of tanka varies from simple mud plaster to lime mortar, however wide variations have been observed.

5. IMPROVED TANKA

Central Arid Zone Research Institute – Jodhpur over a 4 decades research has perfected the technology of *tanka* construction for various types of users. CAZRI has developed improved design of *tanka* for capacity ranging from 5000 liters for individual family to 600,000 liters for community use. The most common construction material for improved tanka is stone masonry with cement plaster and cement concrete. However Ferro-cement and prefabricated PVC tanks are also used in some modern buildings in urban areas. In improved design of tanka provision has been made for silt trap at inlet to control inflow of silt in flowing runoff. Construction procedure has been improved for cost efficiency and longer life span. The improved tanka design developed and demonstrated by CAZRI has got wide acceptance in the region. The designs have been replicated in large numbers by different developmental agencies. The number of improved tanka in different capacity ranges constructed in the region are 11,469 with a total storage capacity of 4,75,200 cubic meters and are sufficient to meet the drinking and cooking water requirements for a population of 1,32,000 throughout the year. Detailed design, drawing and estimates for different capacities of tanka have been presented at the end of bulletin for direct use and reference.

5.1 Capacity of Tanka

Capacity of tanka is dependent on the need of individual family or community, purpose of harvested water and the capital available for the investment. The designed capacity must match with the available runoff as estimated above by the equation 1. For individual family water requirement can be worked out considering the family size, daily water requirement and time period using Equation 2.

$$V = N \times Q \times T \dots\dots\dots(2)$$

Where V is volume or Capacity of *tanka*, N is number of persons dependent on *tanka*, Q is daily water requirement and T is number of days for which water is required. Daily minimum water requirement of a person varies from 7 liters to 10 liters depending upon the season and work stress. Additional requirement of water for other purposes like animals (about 40 liters per day) and raising small nursery etc. can be worked out using Equation 2 separately and total capacity can be estimated by adding all individual water requirements. The total capacity should be multiplied by a factor of 1.1 taking in to consideration of evaporation and seepage losses if any to arrive at final capacity of *tanka*.

A *tanka* of 21 m³ capacity is sufficient to meet the drinking water requirement of a family of 6 persons for whole the year. CAZRI has constructed many such *tankas* in different villages of arid Rajasthan for meeting drinking water requirements of individual families. A bigger *tanka* of 50 m³ can be constructed for domestic and livestock requirement of 6-7 animals or a small nursery of 200 plants for round the year. A community *Tanka* of 100 m³ or 200 m³ capacity can be constructed to cater the demand of a group of 5-6 families.

5.2 Design of Tanka

Once the capacity of *tanka* is decided, its shape and other dimensions can be worked out. Evaporation losses are higher in *tankas* with wider opening and shallow depth but are more stable and easy to construct. However cost to cover the opening of such *tanka* is more. On the other hand narrow opening *tanka* with deeper depth causes less evaporation but needs extra strengths in bottom for stability in terms of material and cost of excavation is high at deeper depth. Therefore, opening and depth of *tanka* should be optimized for minimum evaporation loss and construction cost. For circular *tanka*, depth and diameter should ideally be equal and can be calculated by using Equation 3.

$$D = (1.27 \times V)^{0.33} \dots\dots\dots(3)$$

Where D is the diameter as well as depth in meters and V is capacity in cubic meters.

Table 3. Diameter (= depth) for circular *tanka* for different capacities

Capacity (m ³)	1	5	10	15	20	25	30	35	40	45	50	100	200	300
Diameter (m)	1.08	1.85	2.33	2.67	2.94	3.17	3.37	3.54	3.71	3.85	3.99	5.03	6.34	7.25

For designing rectangular *tanka*, two dimensions of either length, width or depth are first decided on the basis of local site conditions and third dimension is calculated using Equation 4.

$$V = L \times B \times H \dots\dots\dots (4)$$

Where L, B, H and V are length (m), Width (m), depth (m) and Volume (m³) respectively. For known volume (V) and two pre-decided dimensions of length, width or depth, third unknown dimension can be worked out using Equation 4.

5.3 Construction of Tanka

Tanka should be constructed at appropriate site. If rainwater is to be collected from rooftop, its location should be near to the place of intended use. If rainwater is to be collected from natural catchment then tanka should be constructed at one side of the depression area for maximum runoff and safe disposal of excess water. In the arid area of western Rajasthan, a murrum layer is observed in sub surface strata at many places. Special care is needed when tanka is to be constructed at such sites. Murrum has a tendency of swelling after getting some moisture and causes cracks especially in sidewalls. To avoid these cracks, the surrounding of whole tanka should have 5 cm thick envelope of sand around sidewalls. In case of some leakage from sidewall, the sand envelope of 5 cm thickness will absorb the pressure exerted by the swelling of murrum around sidewalls and will prevent the cracks in sidewalls. Circular tanka is more economical in comparison to rectangular *tanka* for the same capacity in term of cost of materials. Moreover a rectangular tanka has the tendency to develop cracks in the four corners due to uneven distribution of pressure whereas in circular tanka pressure distribution is even thus there are less chances of cracks in sidewalls. Cement concrete is preferred over masonry construction due to cost and life span especially for tankas of larger capacity i.e. 100000 liters or more. However, masonry construction is equally good for small capacity tanka and does not require trained workers for construction as in case of cement concrete.

6. MATERIALS AND METHODS FOR CONSTRUCTION OF TANKA

It is imperative to first create favorable site conditions for good quality work. This means that the place where the mortar is to be mixed should be clean, flat, smooth and large enough. If possible, some flat metal sheets should be laid on the ground. If the working ground is only a soil surface, it must be swept. If the soil surface is not hard, it is possible to prepare an area with stamped clay. The working area must be clean before the mixing of the sand and cement can start. Likewise, it is necessary for all material to be on site before the preparation of plaster is started. All material not only means the sand, cement and water for the entire job, but also all curing agents and tools.

6.1 Tools and laborers

Tools must be clean and free of old mortar; this also applies for all buckets to be used. If some sort of scaffold is needed, it must be tried out before the work starts. It must always be remembered that once the plastering of a structure has started, there must be no break until the first coat is finished. Organizing the job is also important to achieve smooth hand-in-hand working.

6.2 Sand

The sand to be used should be clean and well graded. This means having grains of many sizes, but 90% should still pass through a mosquito wire sieve. Sand must be clean, because like water it may have some impurities that weaken the cement bond, such as clay, silt and organic matter. Dirty sand can be washed by repeatedly rinsing with water. Rub a moist handful of sand between your palms. Suitable sand will leave hands only slightly dirty.

6.3 Water

Clay, silt, salt, mica or organic matter as well as certain invisible chemicals in the water, weaken concrete and ferro-cement. Water that is fit for drinking is usually fit for mixing cement mortar. The quality of unknown water can be tested by comparing it with water known to be good.

6.4 Cement

Cement bonds and harden in the presence of water. Therefore careful storage is imperative to avoid moisture reaching cement before use. The bags of cement should be stored in a closely packed pile, no more than ten bags high. The pile should be on a raised platform in a room with little air circulation. In rooms with open windows and doors, the pile should be covered with plastic sheeting.

6.5 Mixing of mortar

The correct method of measuring the different aggregates of concrete or cement mortar is to weigh them, but this is not possible at most sites. The commoner way is to measure the volume. Although this is not a precise method, it is efficient enough if performed carefully. Measuring by the shovelful is not acceptable since this is too inaccurate. Measuring must be done with buckets or wooden boxes, all of equal size. A 1:3 mixture means three measurements of sifted sand to one measurement of cement. These two dry components have to be mixed by shoveling a pile of sand with the required amount of cement added from one side of the mixing platform to the other and then back. This procedure has to be repeated 4-6 times until the dry mixture is of equal color.

6.6 Curing

It must be realized that as little water as possible should be used for mixing, but the use of water should be generous for curing. Cement plaster, ferro-cement and concrete should be kept wet for at least 28 days, never being allowed to dry since the process of hardening will stop as soon as the mortar/ concrete dries. If waterproof

plaster has to be achieved, the material must be kept wet for one year. But even after a year cement plaster should not be allowed to dry off. Remember curing is as important as material and mixing the right composition of mortar or concrete.

7. REPAIR AND MAINTENANCE OF TANKA

Repairing a tanka is easy but should not encourage casual work. If the structure is finished and cured as described, then no leaks are likely to occur. Small leaks which create only a wet stain need not be attended to, since they will close after some time. Only leaks where water flows out have to be repaired. The major problem is not the repair work as such, but the fact that leaks usually cannot be identified until the tanka is filled. As mentioned, curing after the structure is finished as well as while it is still under construction is just as important as the quality of craftsmanship and material. This will not only preserve the structure, making curing unnecessary, but also furnish immediate evidence of any leaks. If there is no rainfall some days after the structure is finished, and the necessary amount of water is not available, a minimum filling of 100 mm is a must irrespective of whether it is of masonry or a cement concrete structure. This water serves as a long-term curing agent and will keep the plaster moist. In addition, especially in hot arid climates, the structure must be covered on all sides such a way that the moisture of the mortar cannot evaporate.

Experience shows that negligence is often found if contractors are employed. The reason lies in the time factor where profit is expected. It is therefore better to stop the work entirely and employ another contractor than to allow an ill-prepared job to start. It should also be realized that leaking or cracking tanks give the whole technology a bad reputation. This is especially important in all those places with no prior experience. Leaking storage tank can discredit the Rain water harvesting system.

A properly constructed tanka serves for around 30 years if maintained. Its maintenance includes; keeping catchments clean and clear of moss, lichen, debris and leaves; cutting back trees and branches that overhang roofs; cleaning of tanka inlets and screens every 3–4 months; disinfecting the tanka if contamination is apparent, inspecting tanka annually and cleaning them out if necessary and; testing the water periodically.

8. QUALITY OF COLLECTED RAINWATER

The cleanest water is always that which falls freely from the sky. The natural water cycle is very efficient in screening out contaminants that are normally found in ground water and other sources. Rainwater does not come in contact with the soil, and so it does not contain contaminants such as harmful bacteria, dissolved salts, minerals or heavy metals. Rainwater is healthy and is soft water so, among other things, you will

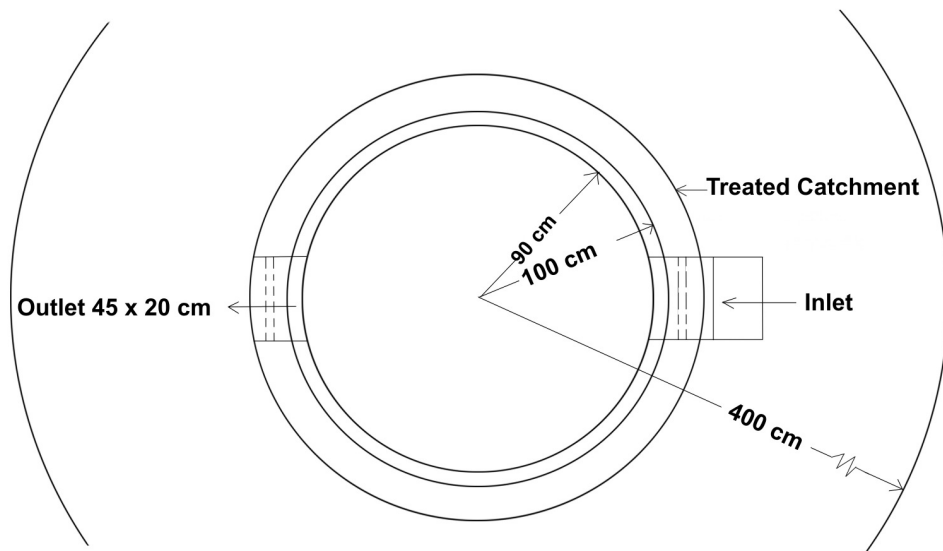
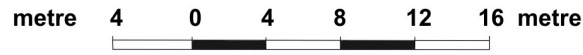
use less soap. Roof-collected rainwater can be made safe and potable by adopting some simple measures such as cleaning of rainwater storage structure and catchment, diversion of first flush and coarse rainwater filters. The quality of rainwater further improves with time after the rain, mainly due to sedimentation and bacteria die-off. It takes an average of 3.5 to 4 days to achieve a 90% reduction in *E.Coli* numbers. It has been proved that people drinking tank rainwater are at lower risk of many diseases than those drinking public mains water.

9. SUMMARY OF STEPS FOR DESIGN AND CONSTRUCTION OF TANKA

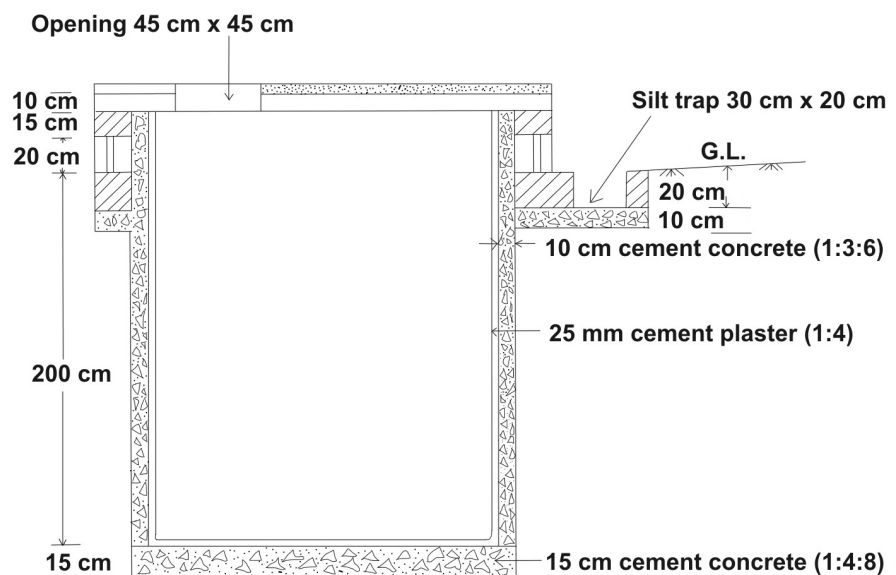
1. Estimate domestic water requirement of a family based on 7-10 liters of water per day per person.
2. Estimate water requirement for livestock (40 liters per day per animal).
3. Estimate other water requirements like nursery raising or life saving irrigation to nearby plants based on the number of plants and average daily water requirement of individual plant /tree species.
4. Determine total daily water requirement by adding water requirement as estimated above for domestic, livestock and other needs.
5. Determine annual water requirement by multiplying the total daily water requirement as estimated above by 365 or no. of days for which water is required.
6. Estimate Tanka Capacity by multiplying annual water requirement as estimated above by a factor of 1.1 to take into account the possible seepage and evaporation losses.
7. If tanka capacity as estimated above is in liters, determine tanka capacity in cubic meter by dividing tanka capacity by 1000.
8. Determine annual rainfall at 60% probability for district particular using Table 1.
9. Select suitable area preferably at lower side of field if it is to be constructed in field or near to the intended use.
10. Determine catchment area needed for 1 m³ runoff based on catchment conditions using Table 2.
11. Determine total catchment area by multiplying the capacity of the tanka to the catchment area as determined above for 1 m³ runoff.

12. Ascertain whether required catchment area as estimated above is available or not. If not, reduce the tanka capacity or improve the catchment conditions.
13. For circular tanka, depth (or diameter) can be determined by $D = (1.27 \times V)^{0.33}$ where D is diameter as well as depth in meters and V is capacity in cubic meters or use Table 3.
14. For rectangular tanka, decide any two dimensions from length, width and depth and determine the remaining third dimension by using the equation $V = L \times B \times H$ where L, B, H and V are length (m), Width (m), depth (m) and Volume (m^3) respectively.
15. Above calculated dimensions are inner dimensions of tanka. Add appropriate quantities keeping in view the construction type i.e. masonry or cement concrete. Add extra allowance of 5-10 cm for filling sand envelope around tanka.
16. First step for construction of tanka is excavation as per dimensions determined above. Excavated sand should not be dumped far away as same can be used for preparation of catchment.
17. Construction details for 5 to 300 m^3 capacity tankas are given at the end of this bulletin; same can be used as guidelines for construction. Local minor variation within limit is acceptable as per site specific needs.
18. Good quality construction material should be used in exact proportion and construction should be thoroughly supervised by a responsible person.
19. After construction, curing is very important for the strength and lifespan of the structure.
20. For proper maintenance of tanka, some quantity of water should always remain in the tanka.
21. Tanka catchment should be properly cleaned atleast once in year before monsoon.
22. Tanka should be desilted atleast once in a year before monsoon.
23. Tanka should be covered from top for the safety and economy of water.
24. Whenever there is any doubt on quality of water, it should be checked by nearest water quality testing centre and acted on as per advice.
25. A good tanka is a wealth for generations; its water should be used economically.

5,000 Liters capacity cement concrete Tanka



PLAN



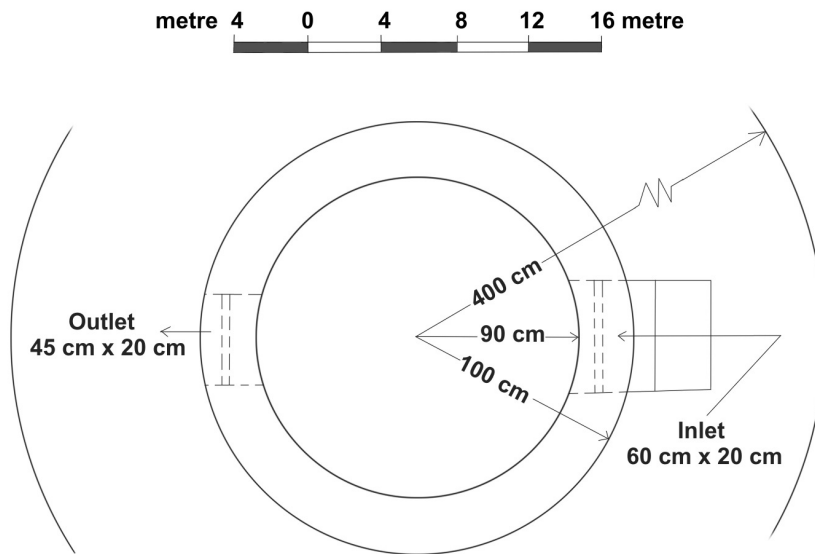
CROSS SECTION

Estimate for 5000 Liters capacity Tanka (Cement Concrete)

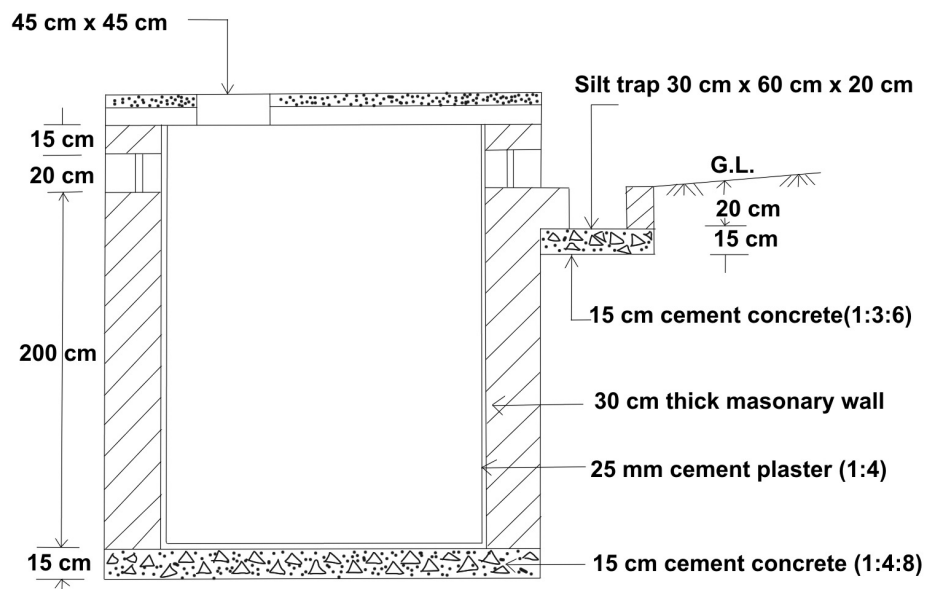
S.N.	Description	Quantity Estimation	Quantity	Rate	Cost (Rs.)
1.	Earth work for excavation in hard soil for harvesting tank (a) GL to 1.5 m (b) 1.5 m to 2.15 m	1 x 3.14 x (1.0) ² x 1.5 1 x 3.14 x (1.0) ² x 0.65	4.71 m ³ 2.04 m ³	99.00 109.00	466.29 222.36
2.	Cement concrete (1:4:8) with 40 mm nominal size aggregates for bottom	1 x 3.14 x (1.0) ² x 0.15	0.471 m ³	1455.00	685.30
3.	Cement concrete(1:3:6) with 20 mm nominal size aggregates (100 mm) (a) Sidewalls (b) Around for masonry (c) Silt trap	3.14 x 1.90 x 2.00 x 0.10 3.14 x 2.20 x 0.20 x 0.10 0.6 x 0.9 x 0.10 Total	1.19 m ³ 0.14 m ³ 0.05 m ³ 1.38 m ³	3552.00	4901.76
4.	Course Rubble stone masonry in cement mortar (1:6) at GL (a) Sidewalls (b) Silt trap	3.14x2.10 x 0.30 x 0.65 1.50 x 0.30 x 0.30 Total	1.29 m ³ 0.14 m ³ 1.43 m ³	1324.00	1893.32
5.	Roofing with stone slabs including jointing with cement mortar (1:3)	1 x 3.14 x (1.20) ²	4.52 m ²	808.00	3652.16
6.	Cement plaster (1:4) - 25 mm thick (a) Side and parapet wall (b) Tanka bottom (c) Rooftop (d) Silt trap Sidewall (e) Bottom	3.14 x 1.80 x (2.35+0.45) 3.14 x (0.90) ² 3.14 x (1.20) ² 1.80 x 0.50 0.60 x 0.30 Total	15.83 m ² 2.54 m ² 4.52 m ² 0.90 m ² 0.18 m ² 23.97 m ²	98.00	2349.06
7.	Providing inlet and outlet (30 x 45 cm) with frame made of angle iron (30 x 30 x 4 mm) and weld mesh (25 mm cross)	2 Nos.	2 Nos.	200.00	400.0
8.	Openable door/lid (45 x 45 cm) for drawl of water made of angle iron frame and MS sheet	1 No.	1 No.	400.00	400.0
Total Rs.					14970.25
or Say Rs.					15000.00
Cost per liter Rs.					3.0

Note: The rates are based on PWD BSR w.e.f. 16 January 2008 applicable to Jodhpur district

5,000 Liters capacity masonry Tanka



PLAN



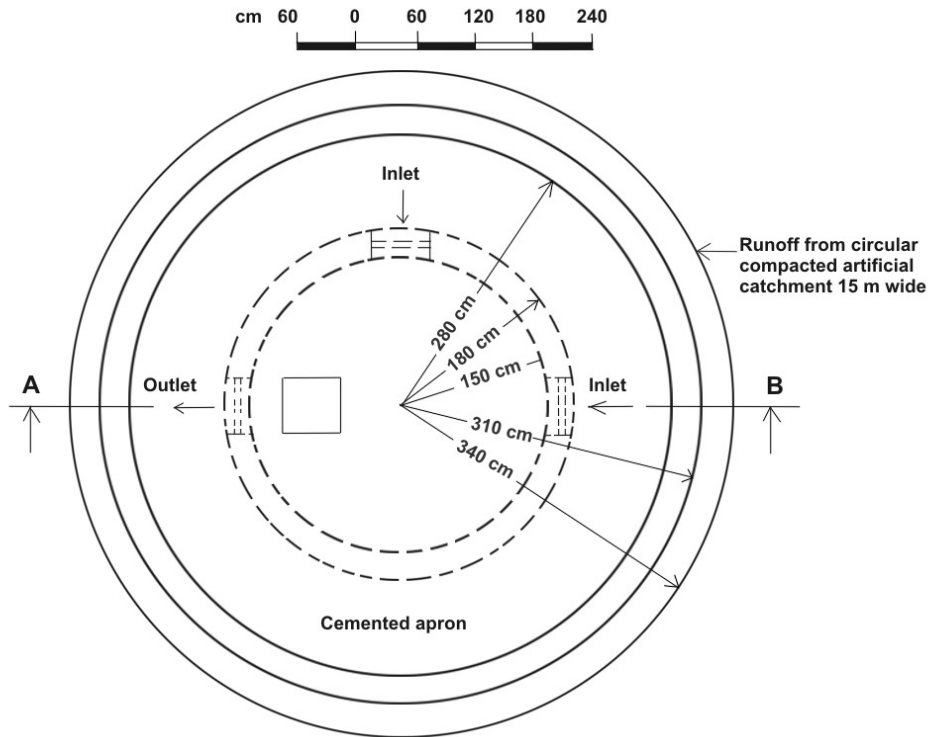
CROSS-SECTION

Estimate for 5000 Liters capacity Tanka (Masonry)

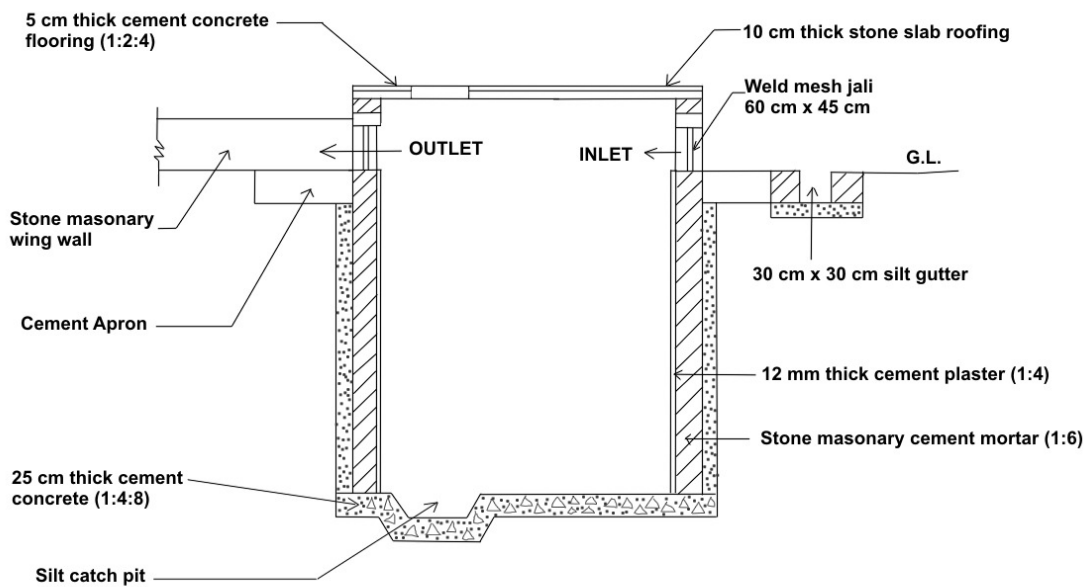
S.N.	Description	Quantity Estimation	Quantity	Rate (Rs.)	Cost (Rs.)
1.	Earthwork excavation in hard soil for Tanka (a) G.L. to 1.5 m (b) 1.5 m to 2.15 m	3.14 x (1.2) ² x 1.5 3.14 x (1.2) ² x 0.65	6.78 m ³ 2.94 m ³	101.00 111.00	684.78 326.34
2.	Cement concrete foundation (1:4:8) with 40 mm size nominal size aggregate (a) Tanka (b) Silt trap	3.14 x (1.20) ² x 0.15 1.20 x 0.90 x 0.15 Total	0.68 m ³ 0.16 m ³ 0.84 m ³	1455.00	1222.20
3.	Coarse rubble masonry for side walls in cement mortar (1:6) (a) Side walls (b) Silt trap	3.14 x 2.10 x 0.30 x 2.35 (0.60 + 0.90) x 0.30 x 0.30 Total	4.65 m ³ 0.135 m ³ 4.78 m ³	1324.00	6328.72
4.	Providing & fixing ashlar lintels and bed plates, 15 cm thick for inlet and outlet	2 x 0.90 x 0.30 x 0.15	0.080 m ³	1784.00	142.72
5.	Course rubble facing (a) I Sort (b) II Sort	3.14 x 1.80 x 2.35 3.14 x 2.40 x 2.35	13.28 m ² 17.71 m ²	135.00 96.00	1792.80 1700.16
6.	Stone slab roofing 100 mm thick	3.14 x (1.20) ²	4.52 m ²	808.00	3652.16
7.	Cement plaster (1:4) 25 mm thick (a) Side walls (Inside) (b) On parapet (outside) (c) Silt trap- sides (d) Silt trap- bottom	3.14 x 1.80 x 2.35 3.14 x 2.40 x 0.50 1.8 x 0.50 0.60 x 0.30 Total	13.28 m ² 3.768 m ² 0.90 m ² 0.18 m ² 18.13 m ²	98.00	1776.74
8.	25 mm thick Cement concrete flooring (1:2:4) with 12.5 mm aggregate (a) Tanka bottom (b) Top of tanka roofing	3.14 x (0.90) ² 3.14 x (1.20) ² Total	2.54 m ² 4.52 m ² 7.06 m ²	106.00	748.36
9.	Providing inlet/outlet (45 x 20 cm) made of angle iron frame 25 x 25 x 4 mm and weld mesh jali 25 x 25 mm cross	2 Nos.	2 Nos.	200.00	400.00
10.	Providing and fixing openable door/lid on roofing for drawl of water (45 cm x 45 cm) made of angle iron frame 35 x 35 x 3 mm and iron sheet 11 gauge	1 No.	1 No.	400.00	400.00
GRAND TOTAL					19174.98
or Say Rs.					19500.00
Cost per liter Rs.					3.90

Note: The rates are based on PWD BSR w.e.f. 16 January 2008 applicable to Jodhpur district

21,000 Liters capacity Masonry Tanka



PLAN



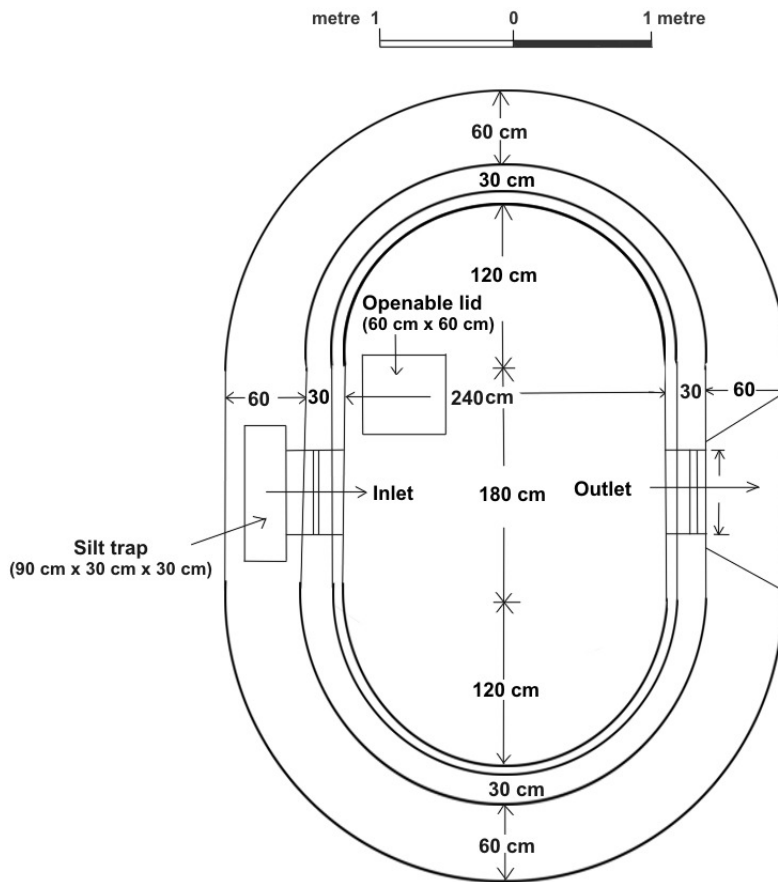
SECTION AB

Estimate for 21,000 Liters capacity Tanka (Masonry)

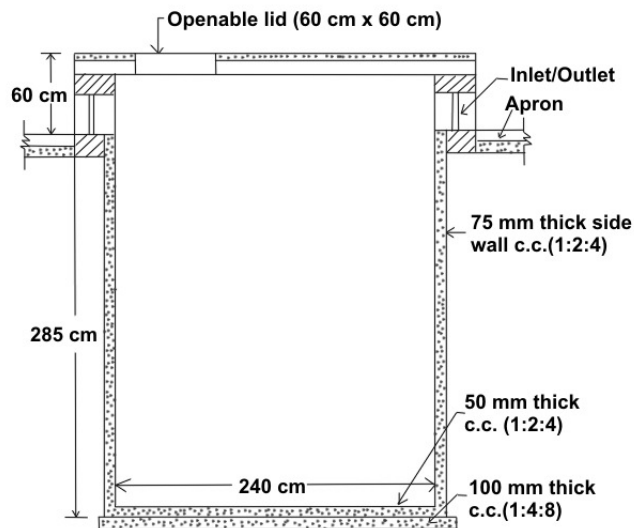
S.N.	Description	Quantity Estimation	Quantity	Rate	Cost (Rs.)
1.	Earthwork excavation in hard soil for Tanka (a) G.L. to 1.5 m (b) 1.5 m to 3.0 m (c) 3.0 m to 3.2 m (d) Foundation	3.14 x (1.8) ² x 1.50 3.14 x (1.8) ² x 1.50 3.14 x (1.8) ² x 0.20 3.14 x 3.30 x 0.60 x 0.30	15.26 m ³ 15.26 m ³ 02.03 m ³ 01.87 m ³	101.00 111.00 121.00 121.00	1541.26 1693.86 245.63 226.27
2.	Cement concrete foundation (1:4:8) with 40 mm size nominal size aggregate (a) Tanka (b) Silt trap	3.14 x 3.3 x 0.60 x 0.30 2 x 1.20 x 0.90 x 0.15 Total	1.87 m ³ 0.32 m ³ 2.19 m ³	1455.00	3186.45
3.	Coarse rubble masonry for side walls in cement mortar (1:6) (a) Side walls (b) Silt trap	3.14 x 3.30 x 0.30 x 3.80 2 x 3.0 x 0.30 x 0.30 Total	11.81 m ³ 0.54 m ³ 12.35 m ³	1324.00	16351.40
4.	Providing & fixing ashlar lintels and bed plates, 15 cm thick for inlet and outlet	3 x 0.75 x 0.30 x 0.15	0.101 m ³	1784.00	180.18
5.	Course rubble facing (a) I Sort (b) II Sort	3.14 x 3.00 x (3.8+0.60) 3.14 x 3.00 x 3.20	41.45 m ² 30.14 m ²	135.00 96.00	5595.75 2893.44
6.	Stone slab roofing 100 mm thick	3.14 x (1.80) ²	10.17 m ²	808.00	8217.36
7.	Cement concrete bed (1:3:6) with 20 mm size aggregate at bottom	3.14 x (1.50) ² x 0.15	1.06 m ³	3552.00	3765.12
8.	50 mm thick Cement concrete flooring (1:2:4) finished with 20 mm size aggregate	3.14 x (1.50) ²	07.06 m ²	149.00	1051.94
9.	Cement plaster (1:4) 25 mm thick (a) Side walls (Inside) (b) Silt trap- sides (c) Silt trap- bottom	3.14 x 3.00 x 3.60 2 x 0.8 x 0.3 2 x 0.6 x 0.3 Total	33.92 m ² 0.48 m ² 0.36 m ² 34.76 m ²	98.00	3406.48
10.	Cement pointing (1:3) on parapet	3.14 x 3.6 x 0.60	6.78 m ²	80.00	542.40
11.	100 mm thick Cement concrete protection floor (1:5:10) with 40 mm normal size aggregate	3.14 x 4.20 x 0.60 x 0.10	0.791 m ³	1303.00	1030.67
12.	25 mm thick Cement concrete flooring (1:2:4) with 12.5 mm aggregate (a) Tanka protection floor (b) Top of tanka roofing	3.14 x 4.20 x 0.60 3.14 x (1.90) ² Total	7.91 m ² 11.33 m ² 19.24 m ²	106.00	2039.44
13.	Providing inlet/outlet (45 x 45 cm) made of angle iron frame 25 x 25 x 4 mm and weld mesh jali 25 x 25 mm cross	3 Nos.	3 Nos.	300.00	900.00
14.	Providing and fixing openable door/lid on roofing for drawl of water (60 cm x 45 cm) made of angle iron frame 35 x 35 x 3 mm and iron sheet 11 gauge	One	One	600.00	600.00
GRAND TOTAL Rs.					53467.65
or say Rs.					54000.00
Cost per liter Rs.					2.57

Note: The rates are based on PWD BSR w.e.f. 16 January 2008 applicable to Jodhpur district

25,000 Liters Capacity Cement Concrete Tanka



PLAN



CROSS SECTION

Estimate for 25000 Liters capacity Tanka (Cement Concrete-Capsule shaped)

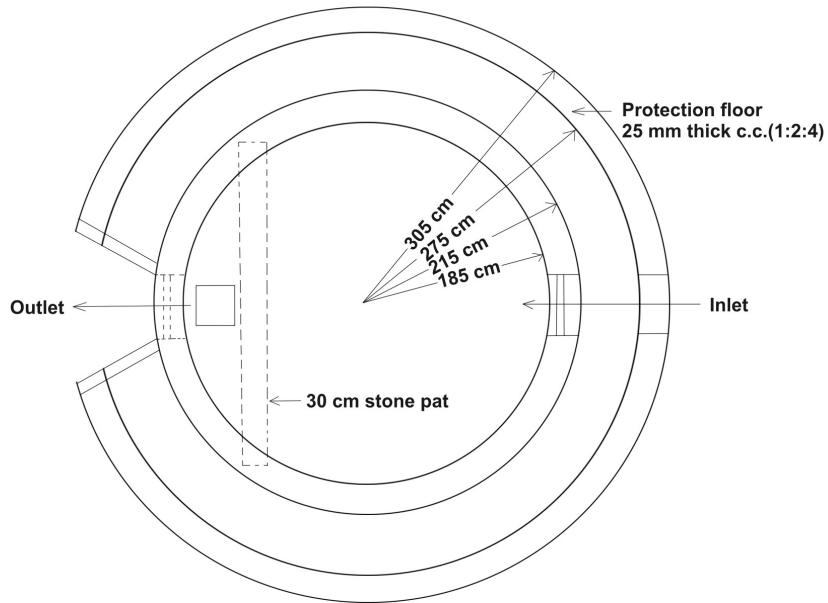
S.N.	Description	Quantity Estimation	Quantity	Rate	Cost (Rs.)
1.	Earth work for excavation in hard soil for harvesting tank G.L to 1.5 m (a) Both ends (b) Middle 1.5 m to 3.0 m (a) Both ends (b) Middle	$1 \times 3.14 \times (1.275)^2 \times 1.5$ $1 \times 2.40 \times 1.80 \times 1.5$ Total $1 \times 2.40 \times 1.80 \times 1.5$ $1 \times 3.14 \times (1.275)^2 \times 1.5$ Total	7.65 m^3 6.48 m^3 14.13 m^3 6.48 m^3 7.65 m^3 14.13 m^3	99.00 109.00	1398.87 1540.17
2.	Cement concrete (1:4:8) with 40 mm nominal size aggregates for bottom-100 mm thick (a) Both ends (b) Middle	$1 \times 3.14 \times (1.3)^2 \times 0.1$ $1 \times 2.70 \times 1.80 \times 0.1$ Total	0.530 m^3 0.486 m^3 1.02 m^3	1455.00	1481.10
3.	Cement concrete(1:2:4) with 20 mm nominal size aggregates for bottom and side walls (75 mm) Floor (a) Both ends (b) Middle Side Walls (a) Both ends (b) Middle	$3.14 \times (1.2)^2$ 1.80×2.40 $3.14 \times 2.40 \times 2.85$ $2 \times 1.80 \times 2.85$ Total or 40.58×0.075	4.52 m^2 4.32 m^2 21.48 m^2 10.26 m^2 40.58 m^2 3.0435 m^3	2066.00	6287.87
4.	Course Rubble stone masonry in cement mortar (1:6) at GL for periphery wall (a) Both ends (b) Middle	$3.14 \times 2.70 \times 0.30 \times 0.90$ $2 \times 1.80 \times 0.30 \times 0.90$ Total	2.29 m^3 0.97 m^3 3.26 m^3	1324.00	4316.24
5.	Roofing with stone slabs including jointing with cement mortar (1:3) (a) Both ends (b) Middle	$1 \times 3.14 \times (1.5)^2$ $1 \times 1.80 \times 3.0$ Total	7.065 m^2 5.4 m^2 12.46 m^2	808.00	10067.68
6.	Cement plaster (1:4)- 25 mm thick Side and parapet wall (a) Middle (b) Both ends	$2 \times 1.80 \times 4.10$ $1 \times 3.14 \times 2.40 \times 4.10$ Total	14.76 m^2 30.89 m^2 45.65 m^2	98.00	4473.70
7.	Providing inlet and outlet (60 x 45 cm) with frame made of angle iron (30 x 30 x 4 mm) and weld mesh (25 mm cross)	2 Nos.	2 Nos.	300	600.0

8.	Providing apron around tanka Cement concrete apron 100 mm thick under layer (1:5:10) with 40 mm nominal size aggregate (a) Both ends (b) Middle	1 x 3.14 x 3.60 x 0.60 x 0.10 2 x 1.80 x 0.60 x 0.10 Total	0.678 m ³ 0.216 m ³ 0.894 m ³	1303.00	1164.88
9.	Cement concrete flooring (1:2:4) 40 mm thick with 20 mm nominal size aggregates Top floor roof (a) Both ends (b) Middle Apron (a) Both ends (b) Middle	1 x 3.14 x (1.5) ² 1 x 1.80 x 3.0 1 x 3.14 x 3.60 x 0.60 2 x 1.80 x 0.60 Total	7.065 m ² 5.4 m ² 6.78 m ² 2.16 m ² 21.41 m ²	140.00	2997.40
10.	Openable door/lid (60 x 60 cm) for drawl of water made of angle iron frame and MS sheet	1 No.	1 No.	600.00	600.0
11.	Catchment Making catchment of 400 m ² putting murrum layer of 15 cm thick, spreaded over whole catchment – water and compacting with rammer- including necessary soil work for making 4% uniform slope	400 m ²	400 m ²	15.00	6000.00
				Total	40927.91
				or Say	41000.00
				Cost per liter Rs.	1.64

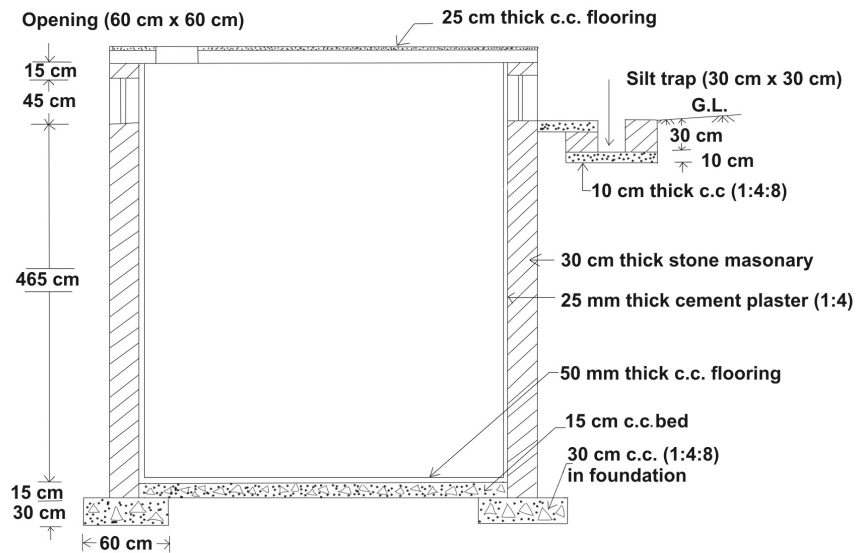
Note: The rates are based on PWD BSR w.e.f. 16 January 2008 applicable to Jodhpur district

50,000 Liters Capacity Masonry Tanka

cm 60 0 60 120 180 240 cm



PLAN



CROSS SECTION

Estimate for 50000 Liters capacity Tanka (Masonry)

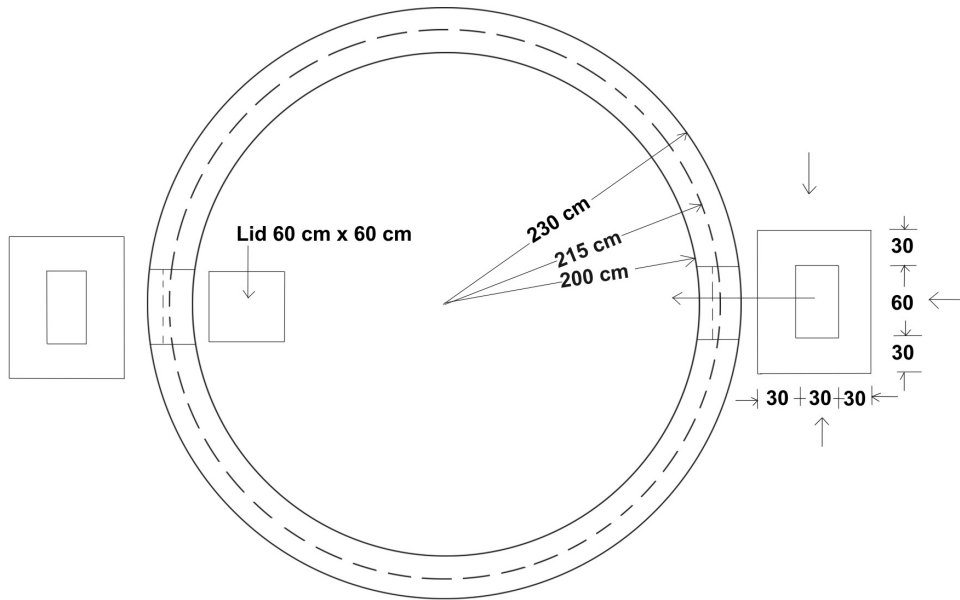
S.N.	Description	Quantity Estimation	Quantity	Rate	Cost (Rs.)
1.	Earthwork excavation in hard soil for Tanka (a) G.L. to 1.5 m (b) 1.5 m to 3.0 m (c) 3.0 m to 4.5 m (d) 4.5 m to 4.95 (e) Foundation	3.14 x (2.15) ² x 1.5 3.14 x (2.15) ² x 1.5 3.14 x (2.15) ² x 1.5 3.14 x (2.15) ² x 0.45 3.14 x 4.00 x 0.60 x 0.30 Total	21.77 m ³ 21.77 m ³ 21.77 m ³ 6.53 m ³ 2.26 m ³	101.00 111.00 121.00 131.00 131.00	2198.77 2416.47 2634.17 855.43 296.06 8400.90
2.	Cement concrete foundation (1:4:8) with 40 mm size nominal size aggregate (a) Tanka (b) Silt trap	3.14 x 4.00 x 0.60 x 0.30 3.14 x 5.80 x 0.90 x 0.10 Total	2.26 m ³ 1.64 m ³ 3.90 m ³	1455.00	5674.50
3.	Coarse rubble masonry for side walls in cement mortar (1:6) (a) Side walls (b) Silt trap	3.14 x 4.00 x 0.30 x 5.55 2x 3.14x 5.80 x 0.30x0.30 Total	20.91 m ³ 03.28 m ³ 24.19 m ³	1324.00	32027.56
4.	Providing & fixing ashlar stone (a) Lintel and bedplate (b) Pats	4x 0.90 x 0.30 x 0.15 1 x 3.00 x 0.30 x 0.30 Total	0.16 m ³ 0.27 m ³ 0.43 m ³	1784.00	767.12
5.	Course rubble facing (c) I Sort (d) II Sort	3.14 x 3.70 x 5.55 3.14 x 4.30 x 4.95	64.48 m ² 66.83 m ²	135.00 96.00	8704.80 6415.68
6.	Stone slab roofing 100 mm thick	3.14 x (2.15) ²	14.51 m ²	808.00	11724.08
7.	Cement concrete bed (1:3:6) with 20 mm size aggregate at bottom	3.14 x (1.85) ² x 0.15	1.61 m ³	3552.00	5718.72
8.	50 mm thick Cement concrete flooring (1:2:4) finished with 20 mm size aggregate	3.14 x (1.85) ²	10.75 m ²	149.00	1601.75
9.	Cement plaster (1:4) 25 mm thick (a) Side walls (Inside) (b) Silt trap- sides & bottom	3.14 x 3.70 x 5.25 3.14 x 6.10 x 1.20 Total	60.99 m ² 22.98 m ² 83.97 m ²	98.00	8229.06
10.	Cement pointing (1:3) on parapet	3.14 x 4.30 x 0.60	8.10 m ²	80.00	648.00
11.	100 mm thick Cement concrete protection floor (1:5:10) with 40 mm normal size aggregate	3.14 x 4.90 x 0.60 x 0.10	0.92 m ³	1303.00	1198.76
12.	25 mm thick Cement concrete flooring (1:2:4) with 12.5 mm aggregate (c) Tanka protection floor (d) Top of tanka roofing	3.14 x 4.90 x 0.60 3.14 x (2.20) ² Total	09.23 m ² 15.19 m ² 24.42 m ²	106.00	2588.52
13.	Providing inlet/outlet (60 x 45 cm) made of angle iron frame 25 x 25 x 4 mm and weld mesh jali 25 x 25 mm cross	2 Nos.	2 Nos.	300.00	600.00
14.	Providing and fixing openable door/lid on roofing for drawl of water (60 cm x 60 cm) made of angle iron frame 35 x 35				

	x 3 mm and iron sheet 11 gauge	1 No.	1 No.	600.00	600.00
				GRAND TOTAL	94899.45
				Say Rs.	95000
				Cost per liter Rs.	1.90

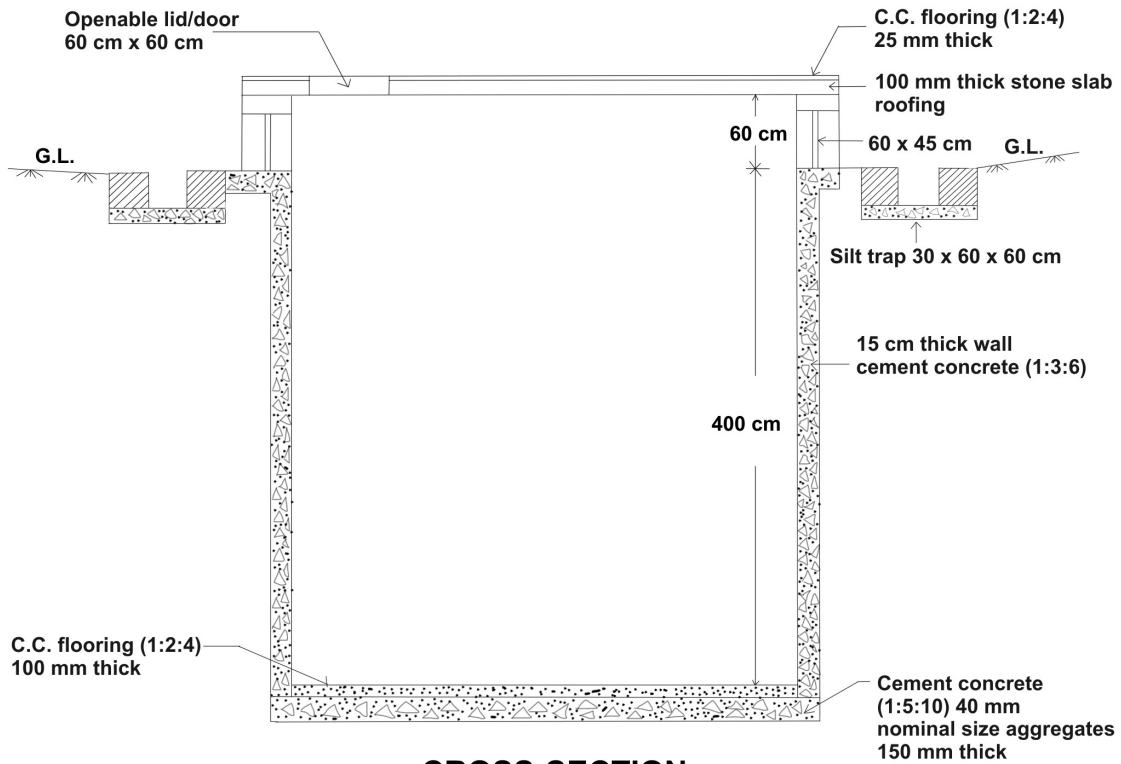
Note: The rates are based on PWD BSR w.e.f. 16 January 2008 applicable to Jodhpur district

50,000 Liters capacity Cement Concrete Tanka

metre 1 0 1 2 metre



PLAN



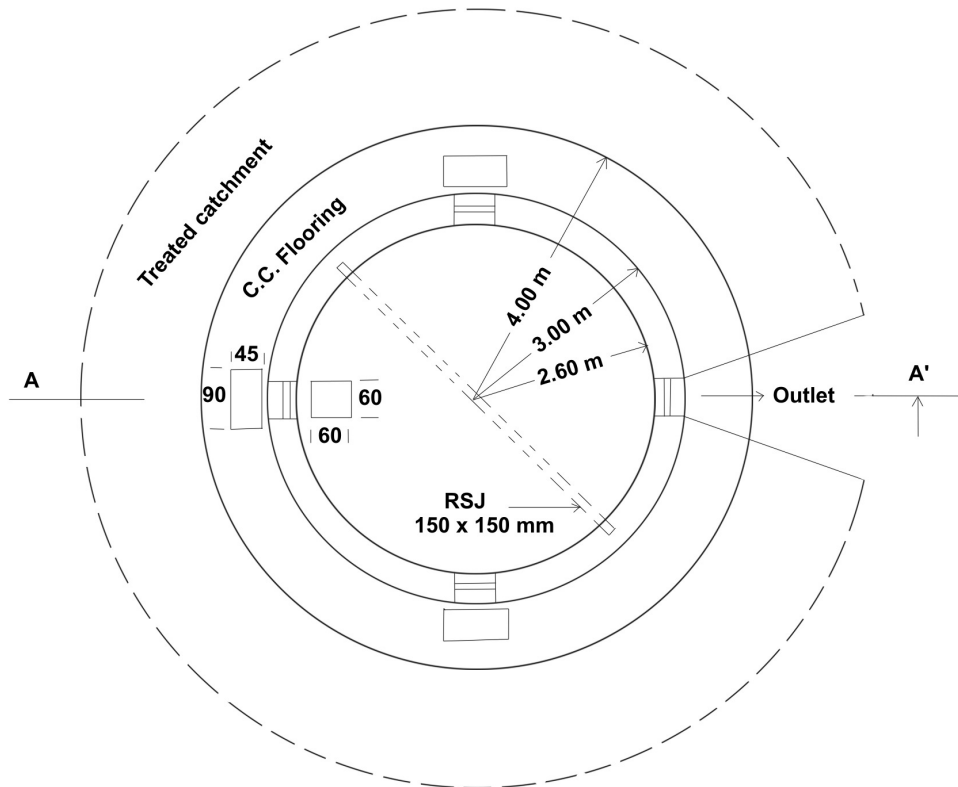
CROSS-SECTION

Estimate for 50000 Liters capacity Tanka (Cement Concrete)

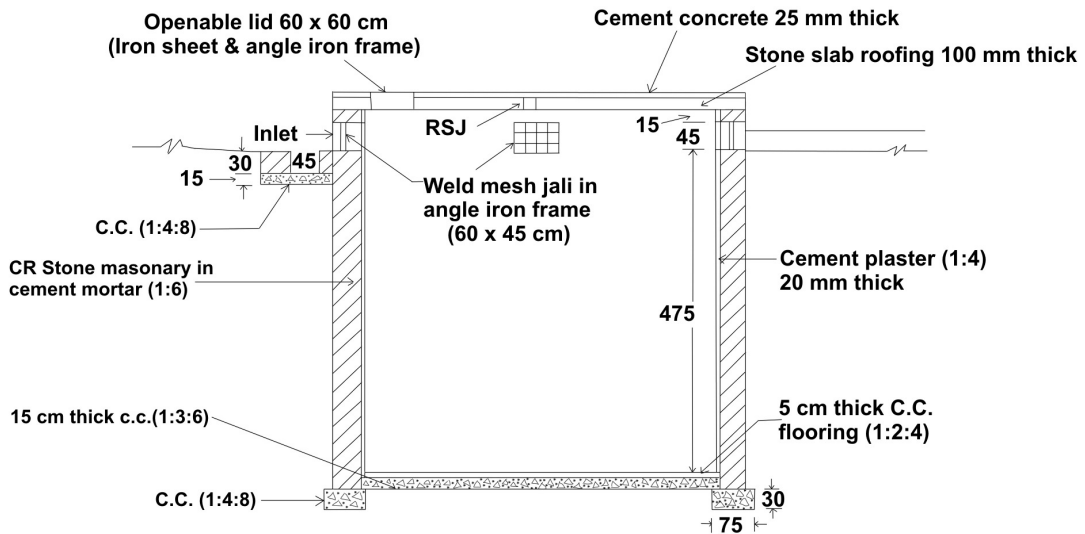
S.N.	Description	Quantity Estimation	Quantity	Rate (Rs.)	Cost (Rs.)
1.	Earth work for excavation in hard soil for harvesting tank (a) G.L to 1.5 m (b) 1.5 m to 3.0 m (c) 3.0 m to 4.25 m	$1 \times 3.14 \times (2.15)^2 \times 1.50$ $1 \times 3.14 \times (2.15)^2 \times 1.50$ $1 \times 3.14 \times (2.15)^2 \times 1.25$	21.77 m ³ 21.77 m ³ 18.14 m ³	99 109 119	2155.23 2372.93 2158.66
2.	Cement concrete (1:5:10) with 40 mm nominal size aggregates for bottom	$1 \times 3.14 \times (2.15)^2 \times 0.15$	2.18 m ³	1303	2840.54
3.	Cement concrete(1:3:6) with 20 mm nominal size aggregates (100 mm) (a) Sidewalls (b) Bottom (c) Around Tanka (d) Silt trap	$3.14 \times 4.15 \times 0.15 \times 4.00$ $3.14 \times (2.15)^2 \times 0.10$ $3.14 \times 4.50 \times 0.20 \times 0.10$ $2 \times 1.20 \times 0.90 \times 0.10$ Total	07.82 m ³ 0.145 m ³ 0.282 m ³ 0.216 m ³ 8.46 m ³	3552	30049.92
4.	Course Rubble stone masonry in cement mortar (1:6) at GL (a) Sidewalls (b) Silt trap	$3.14 \times 4.30 \times 0.30 \times 0.90$ $2 \times 3.00 \times 0.30 \times 0.30$ Total	3.65 m ³ 0.54 m ³ 4.19 m ³	1324	5547.56
5.	Roofing with stone slabs including jointing with cement mortar (1:3)	$1 \times 3.14 \times (2.30)^2$	16.61 m ²	808	13420.88
6.	Cement plaster (1:4) – 25 mm thick (a) Side and parapet (b) Silt trap Sidewall (c) Silt trap bottom (d) Silt trap top	$3.14 \times (2.0)^2 \times (4.60+1.00)$ $2 \times 1.50 \times 0.30$ $2 \times 0.60 \times 0.30$ $2 \times 3.0 \times 0.30$ Total	70.34 m ² 0.90 m ² 0.36 m ² 1.80 m ² 73.40 m ²	98	7193.2
7.	Cement concrete flooring (1:2:4) 25 mm thick with 12.5 mm aggregates (a) Tanka bottom (b) Tanka Top	$3.14 \times (2.00)^2$ $3.14 \times (2.30)^2$ Total	12.56 m ² 16.61 m ² 29.17 m ²	106	3092.02
8.	Providing inlet and outlet (60 x 45 cm) with frame made of angle iron (30 x 30 x 4 mm) and weld mesh (25 mm cross)	3 Nos.	3 Nos.	200	600.00
9.	Openable door/lid (60 x 60 cm) for drawl of water made of angle iron frame and MS sheet	1 No.	1 No.	800	800.00
Total					70230.94
or Say Rs.					70500.00
Cost per liter Rs.					1.41

Note: The rates are based on PWD BSR w.e.f. 16 January 2008 applicable to Jodhpur district

100,000 Liters capacity Masonry Tanka



PLAN



SECTION AT AA'

Estimate for 100000 Liters capacity Tanka (Masonry)

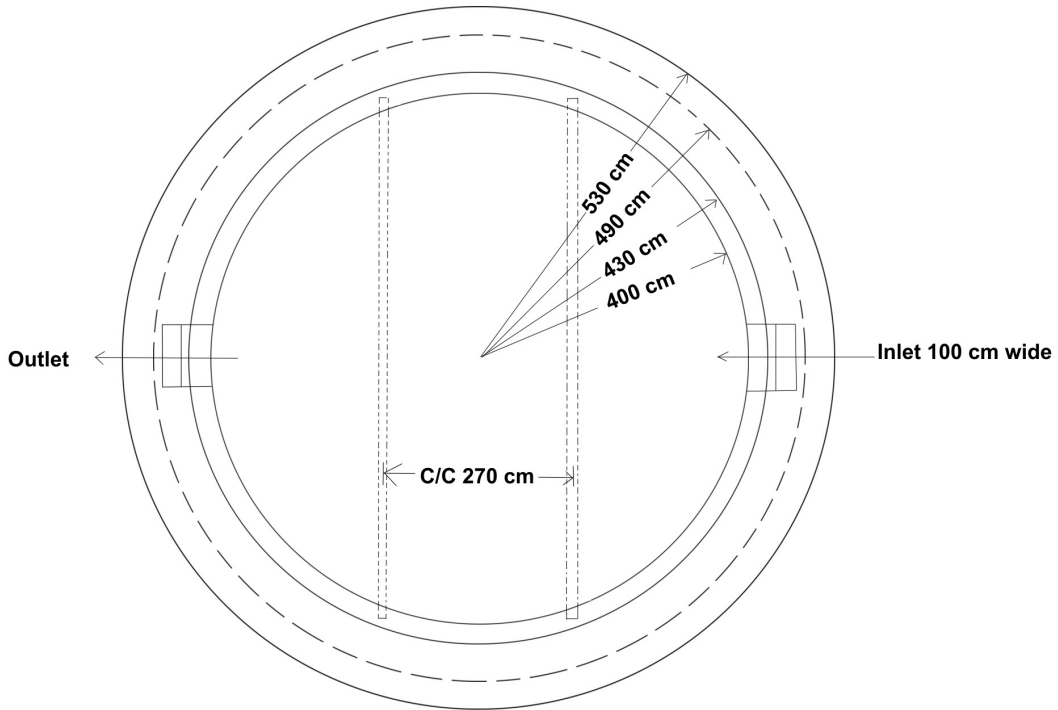
S.N.	Description	Quantity Estimation	Quantity	Rate	Cost (Rs.)
1.	Earthwork excavation in hard soil for Tanka (a) G.L. to 1.5 m (b) 1.5 m to 3.0 m (c) 3.0 m to 4.5 m (d) Foundation	$3.14 \times (3.0)^2 \times 1.5$ $3.14 \times (3.0)^2 \times 1.5$ $3.14 \times (3.0)^2 \times 1.5$ $3.14 \times 5.60 \times 0.75 \times 0.30$	42.39 m^3 42.39 m^3 42.39 m^3 03.95 m^3	101.00 111.00 121.00 131.00	4281.39 4705.29 5129.19 0517.45
2.	Cement concrete foundation (1:4:8) with 40 mm size nominal size aggregate (a) Tanka (b) Silt trap	$3.14 \times 5.60 \times 0.75 \times 0.30$ $3.00 \times 1.50 \times 0.90 \times 0.15$ Total	3.95 m^3 0.61 m^3 4.56 m^3	1455.00	6634.80
3.	Coarse rubble masonry for side walls in cement mortar (1:6) (a) Side walls (b) Silt trap	$3.14 \times 5.60 \times 0.40 \times 4.95$ $2.00 \times 3.90 \times 0.30 \times 0.30$ Total	34.81 m^3 00.70 m^3 35.51 m^3	1324.00	47015.24
4.	Providing & fixing ashlar lintels and bed plates, 15 cm thick for inlet and outlet	$6.0 \times 0.90 \times 0.30 \times 0.15$	0.243 m^3	1784.00	433.51
5.	Course rubble facing (a) I Sort (b) II Sort	$3.14 \times 3.00 \times 6.15$ $3.14 \times 3.60 \times 4.35$	57.93 m^2 49.17 m^2	135.00 96.00	7820.55 4720.32
6.	RSJ 150 x 200 mm 16.5 Kg/Rft	6 Rm	53.62 Kg /Rm	33.00 /Kg	10616.76
7.	Stone slab roofing 100 mm thick	$3.14 \times (3.0)^2$	28.26 m^2	808.00	22834.08
8.	Cement concrete bed (1:3:6) with 20 mm size aggregate at bottom	$3.14 \times (2.60)^2 \times 0.15$	3.183 m^3	3552.00	11306.02
9.	50 mm thick Cement concrete flooring (1:2:4) finished with 20 mm size aggregate	$3.14 \times (2.60)^2$	21.22 m^2	149.00	3161.78
10.	Cement plaster (1:4) 25 mm thick (a) Side walls (Inside) (b) On parapet (outside) (c) Silt trap- sides (d) Silt trap- bottom	$3.14 \times 5.20 \times 5.35$ $3.14 \times 6.00 \times 0.75$ $3 \times 2.70 \times 0.30$ $3 \times 0.90 \times 0.45$ Total	87.35 m^2 14.13 m^2 02.43 m^2 01.21 m^2 105.12 m^2	98.00	10301.76
11.	100 mm thick Cement concrete protection floor (1:5:10) with 40 mm normal size aggregate	$3.14 \times 7.00 \times 1.00 \times 0.10$	02.20 m^3	1303.00	2866.60
12.	25 mm thick Cement concrete flooring (1:2:4) with 12.5 mm aggregate (e) Tanka protection floor	$3.14 \times 7.00 \times 1.00$ $3.14 \times (3.0)^2$	21.98 m^2 28.26 m^2		

	(f) Top of tanka roofing	Total	50.24 m ²	106.00	5325.44
13.	Providing inlet/outlet (60 x 45 cm) made of angle iron frame 25 x 25 x 4 mm and weld mesh jali 25 x 25 mm cross	4 Nos.	4 Nos.	300.00	1200.00
14.	Providing and fixing openable door/lid on roofing for drawl of water (60 cm x 60 cm) made of angle iron frame 35 x 35 x 3 mm and iron sheet 11 gauge	1 No.	1 No.	600.00	600.00
GRAND TOTAL					149470.18
Say Rs.					150000.00
Cost per liter Rs.					1.50

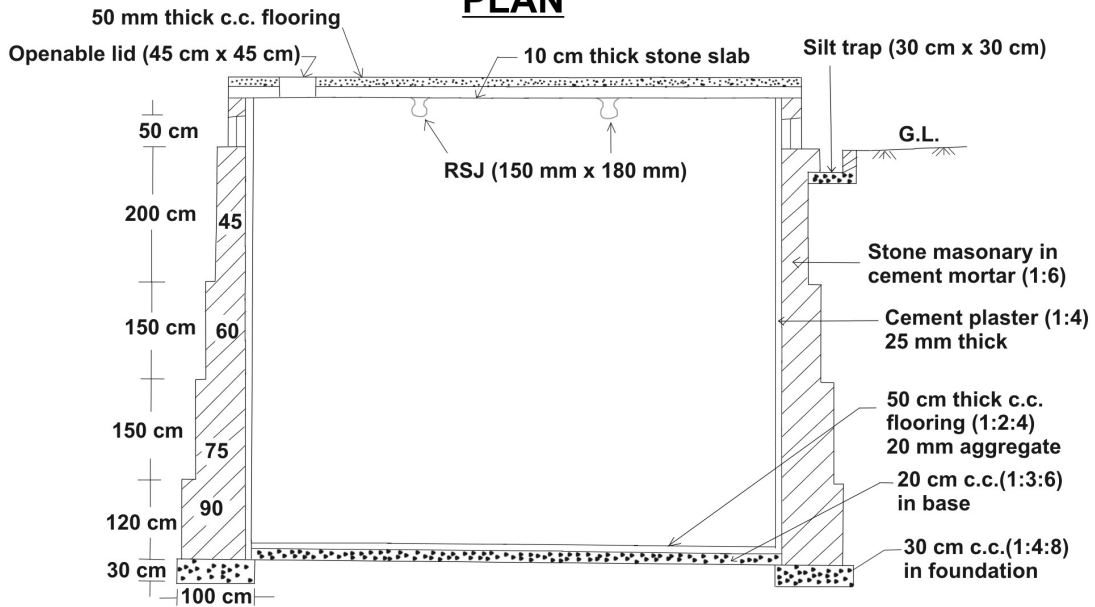
Note: The rates are based on PWD BSR w.e.f. 16 January 2008 applicable to Jodhpur district

300000 Liters capacity Masonry Tanka

metre 1 0 1 2 3 4 metre



PLAN



CROSS SECTION

Estimate for 300000 Liters capacity Tanka (Masonry)

S.N.	Description	Quantity Estimation	Quantity	Rate	Cost (Rs.)
1.	A. Earthwork excavation in hard soil for Tanka				
	(a) G.L. to 1.5 m	$3.14 \times (4.9)^2 \times 1.5$	113.08 m ³	101.00	11421.08
	(b) 1.5 m to 3.0 m	$3.14 \times (4.9)^2 \times 1.5$	113.08 m ³	111.00	12551.88
	(c) 3.0 m to 4.5 m	$3.14 \times (4.9)^2 \times 1.5$	113.08 m ³	121.00	13682.68
	(d) 4.5 m to 6.2 m	$3.14 \times (4.9)^2 \times 1.7$	128.16 m ³	131.00	16788.96
	(e) Foundation wall	$3.14 \times 10.80 \times 1.0 \times 0.30$	10.17 m ³	141.00	1433.97
	B. Earthwork excavation in hard soil for				
(a) Silt trap	$1 \times 0.9 \times 2.0 \times 0.45$	0.81 m ³	101.00	81.81	
(b) Chap pitching around tanka	$2 \times 3.14 \times 4.9 \times 1.0 \times 0.1$	3.07 m ³	101.00	310.07	
2.	Cement concrete foundation (1:4:8) with 40 mm size nominal size aggregate in foundation wall	$3.14 \times 10.80 \times 1.0 \times 0.30$	10.17 m ³	1455.00	14797.35
3	Cement concrete (1:2:4) with 40 mm size nominal size aggregate for tanka floor	$3.14 \times (4.0)^2 \times 0.20$	10.04 m ³	2066.00	20742.64
4.	Course rubble masonry for super structure in cement mortar (1:6)				
	(a) 6.2 to 5.0 m	$2 \times 3.14 \times 4.45 \times 0.9 \times 1.2$	30.18 m ³	1324.00	120947.40
	(b) 5 to 3.5 m	$2 \times 3.14 \times 4.375 \times 0.75 \times 1.5$	30.90 m ³		
	(c) 3.5 to 2 m	$2 \times 3.14 \times 4.30 \times 0.60 \times 1.5$	24.30 m ³		
	(d) 2 to 1.5 m	$2 \times 3.14 \times 4.225 \times 0.45 \times 0.5$	5.97 m ³		
Total		91.35 m ³			
5.	Course rubble stone masonry for side walls in cement mortar (1:6)				
	(a) Depth 0 to 1.5 m	$2 \times 3.14 \times 4.225 \times 0.45 \times 1.5$	17.90 m ³	1324.00	29379.56
	(b) Periphery wall	$2 \times 3.14 \times 4.15 \times 0.3 \times 0.5$	3.90 m ³		
	(c) Silt Trap	$1 \times 0.90 \times 2 \times 0.45$	0.81 m ³		
	<u>Deduction</u>	$2 \times 1 \times 0.3 \times 0.5 = 0.30 \text{ m}^3$	(-) 0.30 m ³		
Inlet and outlet	$1 \times 0.3 \times 1.4 \times 0.3 = 0.12 \text{ m}^3$	(-) 0.12 m ³			
Total		22.19 m ³			
6.	Providing & fixing ashlar lintels and bed plates, 15 cm thick for inlet and outlet and slabs				
		$2 \times 1.30 \times 0.30 \times 0.15$	0.12 m ³	1784.00	499.52
		$4.0 \times 0.90 \times 0.30 \times 0.15$	0.16 m ³		
Total		0.28 m ³			
7.	Course rubble facing				
	(a) I Sort	$2 \times 3.14 \times 4.00 \times 7.20$	180.86 m ²	135.00	24416.10
(b) II Sort	$2 \times 3.14 \times 4.30 \times 6.20$	167.42 m ²	96.00	16072.32	
8.	RSJ 150 x 200 mm 16.5 Kg/Rft	$2 \times 8.0 \text{ m}$	53.62 Kg	33.00	28311.36
			/Rm	/Kg	
9.	Stone slab roofing 100 mm thick	$3.14 \times (4.3)^2$	58.05 m ²	808.00	46904.40
10.	Cement concrete bed (1:3:6) with 20 mm size aggregate at bottom	$3.14 \times (4.0)^2 \times 0.20$	10.05 m ³	3552.00	35697.60
11.	50 mm thick Cement concrete flooring (1:2:4) finished with 20 mm size aggregate	$3.14 \times (4.0)^2$	50.24 m ²	149.00	7485.76

12.	Cement plaster (1:4) 25 mm thick (a) Side walls (Inside) (b) Side walls (outside) (c) Silt trap- sides (d) Silt trap-	2x 3.14 x 4.0 x 6.7 2x 3.14 x 4.30 x 0.5 1 x 2x 0.90 x 0.30 5 x 0.30 x 1.4 Total	168.30 m ² 13.50 m ² 0.54 m ² 2.1 m ² 184.44 m ²	98.00	18075.12
13.	Supply and fixing of Stone chap flooring 30- 50 mm thick with cement pointing 1:3 including in lime mortar 1:2 complete	2 x 3.14 x 4.90 x 1	30.77 m ²	808.00	24862.16
14.	25 mm thick Cement concrete flooring (1:2:4) with 12.5 mm aggregate at Top of tanka roofing	3.14 x (4.3) ²	58.06 m ²	106.00	6154.36
15.	Providing inlet/outlet (100 x 45 cm) made of angle iron frame 25 x 25 x 4 mm and weld mesh jali 25 x 25 mm cross	2 Nos.	2 Nos.	600.00	1200.00
16.	Providing and fixing openable door/lid on roofing for drawl of water (60 cm x 60 cm) made of angle iron frame 35 x 35 x 3 mm and iron sheet 11 gauge	1 No.	1 No.	600.00	600.00
GRAND TOTAL					452416.10
Say Rs.					453000.00
Cost per liter Rs.					1.51

Note: The rates are based on PWD BSR w.e.f. 16 January 2008 applicable to Jodhpur district



An improved multipurpose tanka (50,000 liters) with handpump for safe water withdrawal at a farmer's field - Kalyanpur (Distt. Barmer)



Improved tanka or 21000 liters capacity with catchment at Bambore (Distt. Jodhpur)

