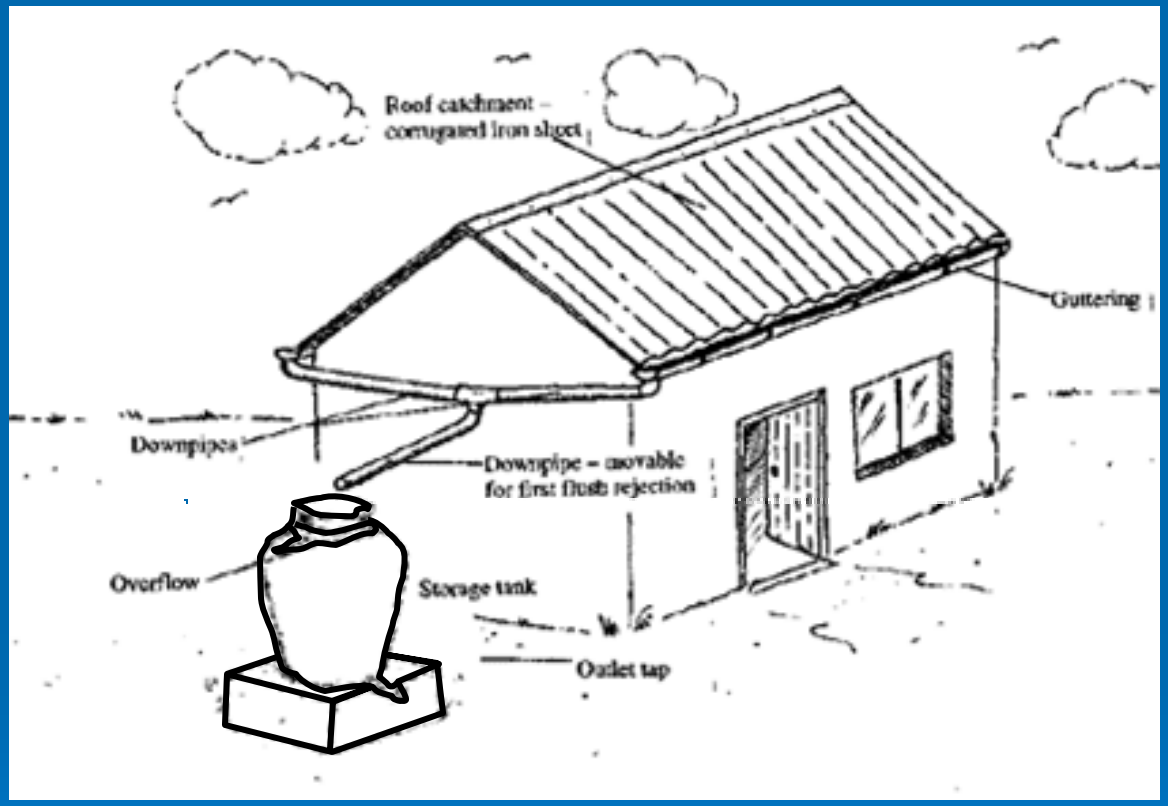
Rooftop Rainwater Harvesting



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The Basics: a 20 square meter rooftop, in an area with 500 mm annual rainfall, can potentially produce enough drinking and cooking water for a family of 5 for a year. [2]

The Basic Calculation

roof area in square meters (horizontal plane)

4m by 5m = 20 m^2

x

total annual rainfall in mm

500 mm

x

efficiency factor / runoff coefficient

0.9

=

annual water supply in liters

20 x 500 x 0.9 = 9000 liters

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=

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÷

family size x days in year

(5 x 365)

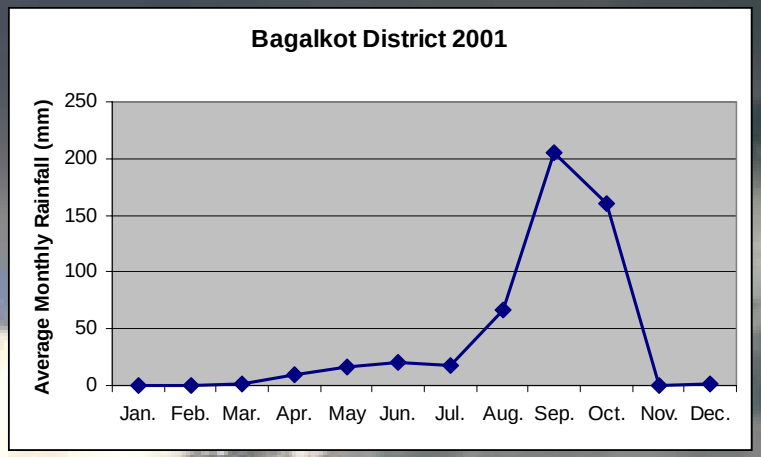
=

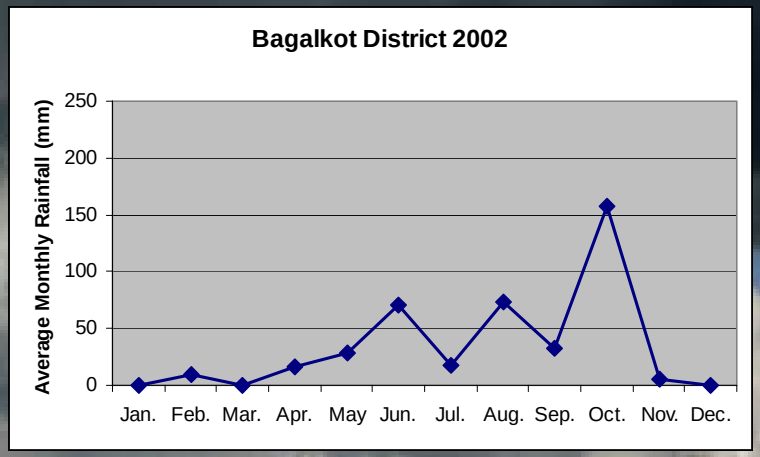
liters per person per day

5 liters

It Begins With Rain…

You need to know how much rain falls, and when.





Bagalkot Normal Annual Rainfall = 562 mm Total

Monthly rainfall averages for the years 1991 through 2002 are available for districts in Karnataka from the State Department of Agriculture. [3]

Photo by Kenn Kiser

Next, what are your needs?

- Do you have access to another water source, or do you want to meet all your needs from rooftop harvesting?
- How much water do you use per day as the year goes by? For drinking, cooking, washing, gardening, etc.
- Will you use the rainwater for some uses only?
- Do you want to store water for just a few weeks, or to last through a long dry season?
- How much money can you spend for the system?

Estimating Water Needs [2]

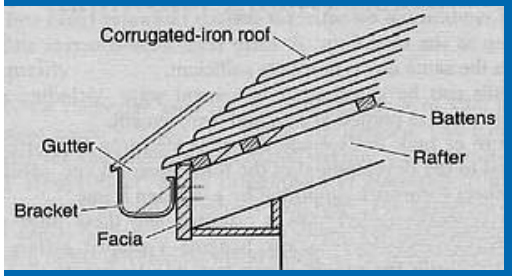
Estimates for City of Bangalore	Liters/ person
Drinking	3
Cooking	4
Bathing	20
Flushing	40
Washing Clothes	25
Washing Utensils	20
Gardening	23
Total	*135*

Water Usage Estimates for Two Schools	Simikere High School	Chikka Shellikeri Primary School
Number of Students	200	300
Midday Meals	No	Yes
Toilet	Broken	Yes
Total Daily Usage	250 Liters	1500 Liters

Consumption range
50 Ltrs to 300 Ltrs per person per day

Components of a Rooftop System

- Catchment (Rooftop)
- Conveyance (Pipes)
- First Flush Separator
- Filtration
- Storage
- Usage
- Recharge



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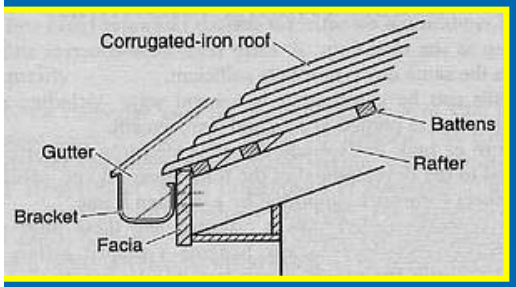

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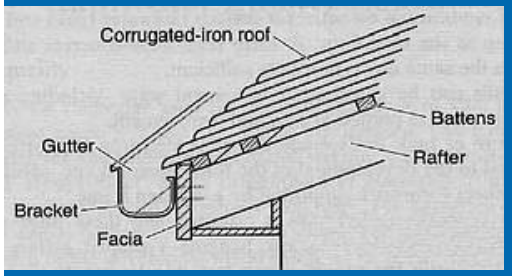

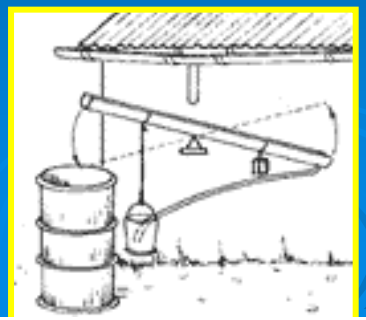

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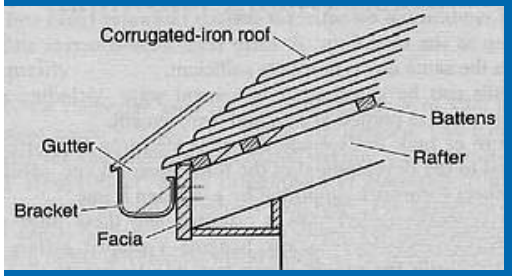

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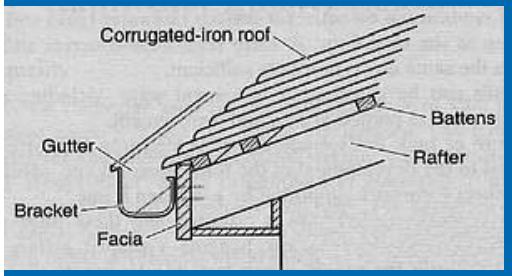

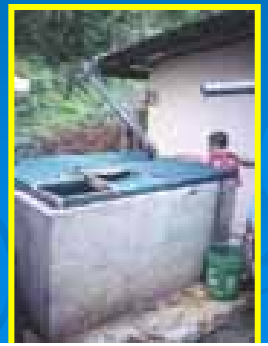

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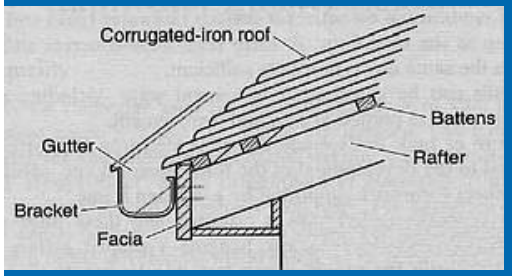
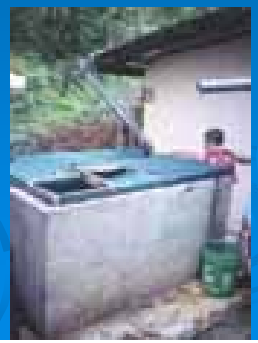
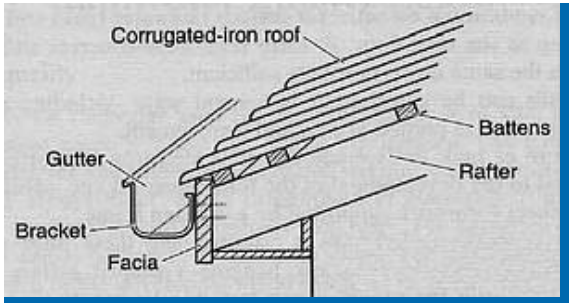






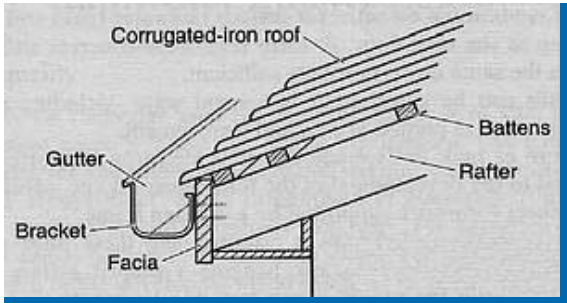
Materials Choices

Rooftops

- Types
  - Cement
  - Corrugated Steel
  - Tile
  - Thatch
- Issues
  - Slope
  - Runoff Coefficient
  - Bacteria
  - Availability and Cost

Pipes and Gutters

- Types
  - Plastic (PVC, etc.)
  - Folded Steel Sheeting
  - Wood / Bamboo
  - Other metal / ceramic
- Issues
  - Longevity
  - Ease of joining
  - Attachment to house
  - Environmental Impacts of PVC – Issue at Scale



Materials Choices

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- Types
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PVC Info - Dangers in Making PVC - Microsoft Internet Explorer

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Address http://www.pvcinformation.org/links/index.php?catid=1 Go Links

PVCInformation.org

- Home
- Dangers in Making PVC
- PVC Products and non-PVC alternatives
- PVC and Fire
- Disposing of PVC
- Resources
- PVC In The News

Dangers in Making PVC

Home | Dangers in Making PVC

PVC, commonly known as vinyl, is used in a variety of common consumer products. What buyers may not be aware of is that no other plastic poses such direct environmental and human health risks as PVC. The problems start at the production site.

Click **here** for a graphic of PVC hazardous production.

In their own words: Residents speak about life next to PVC production sites in Louisiana, USA

The state of Louisiana in the United States is home to half the PVC production facilities in the USA. Studies by the U.S. Agency for Toxic Substances and Disease Registry tested blood samples from 28 residents in Mossville for dioxin, a known human carcinogen and the most dangerous toxic known to science. The results proved what residents have known for years -- the people of Mossville, Louisiana are being poisoned. The average Mossville resident has three times more dioxin in her/her blood than the average U.S. citizen.

environmental poisoning from P
From local residents near a PVC pla

environmental poisoning from P
Also from local residents near a PV

a worker tells his story (Part III
The testimony of a PVC industry wo
teaching children about PVC in a cla

accidents in the community (Part IV) - hits:38 | Last modified: August 30 2005

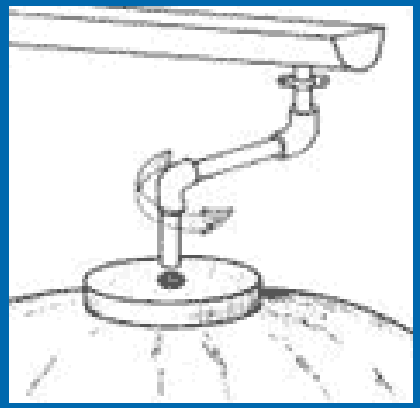
INDIA: Tamil Nadu campaign against proposed PVC plant - hits:64 | Last modified: September 10 2005
A global alliance of 500 organizations from 77 countries are supporting a network of Indian groups against a proposed PVC facility.

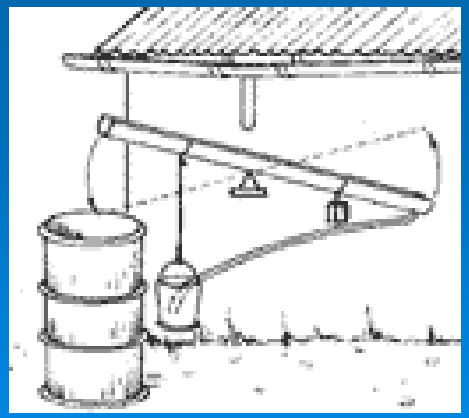
Alternatives to PVC Pipes - Concrete, steel, galvanized iron, copper, clay, chlorine-free plastics, including high-density polyethylene (PE), polypropylene (PP) and polyisobutylene.
Need to research and create demand in India

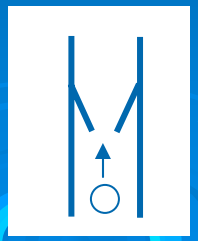
Internet

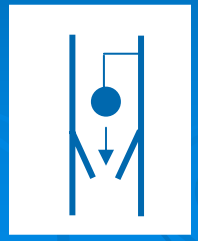
Materials Choices

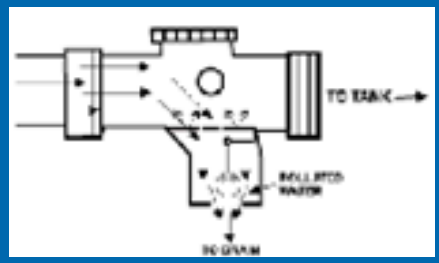
First Flush Separation (5 liters and varies)

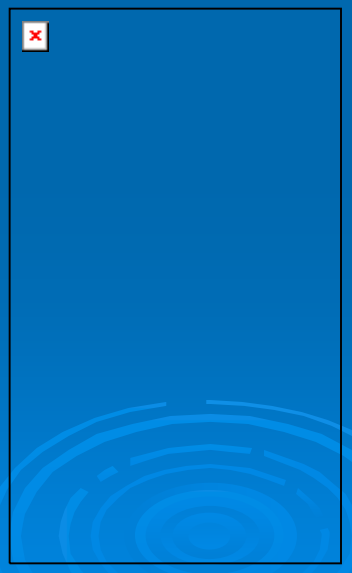






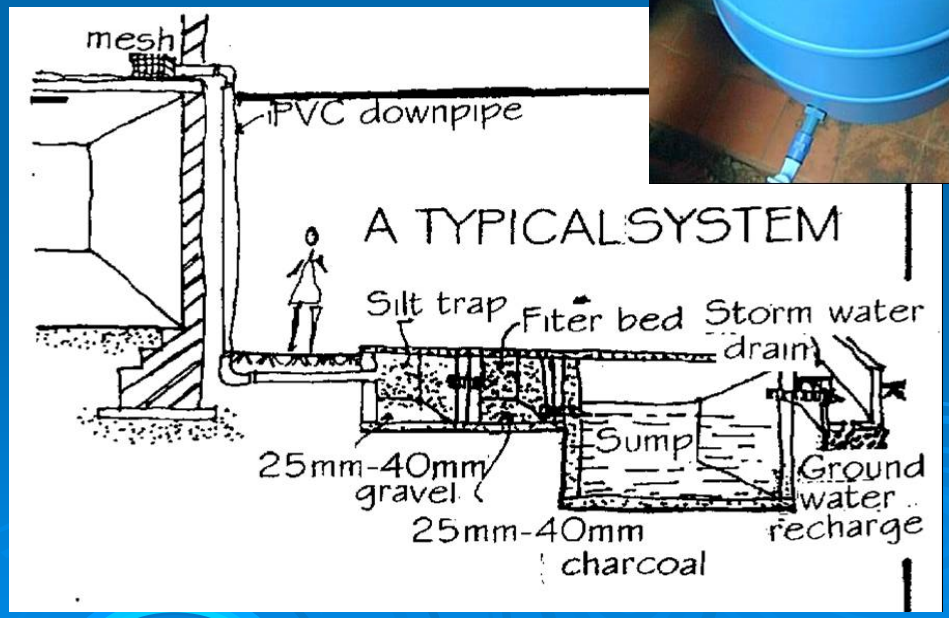




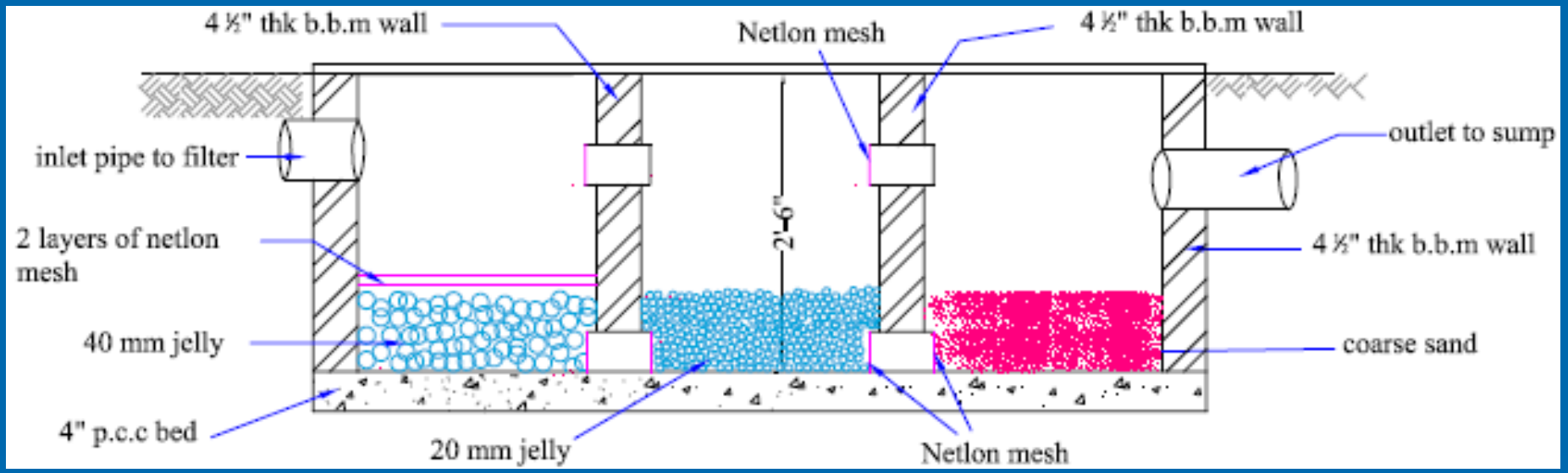


Materials Choices

Filtration



Filtration Structure Example



Design by Rainwater Club – filter for Simikere School in Bagalkot District

Materials Choices

Storage

precast concrete

steel

plastered brick

brick

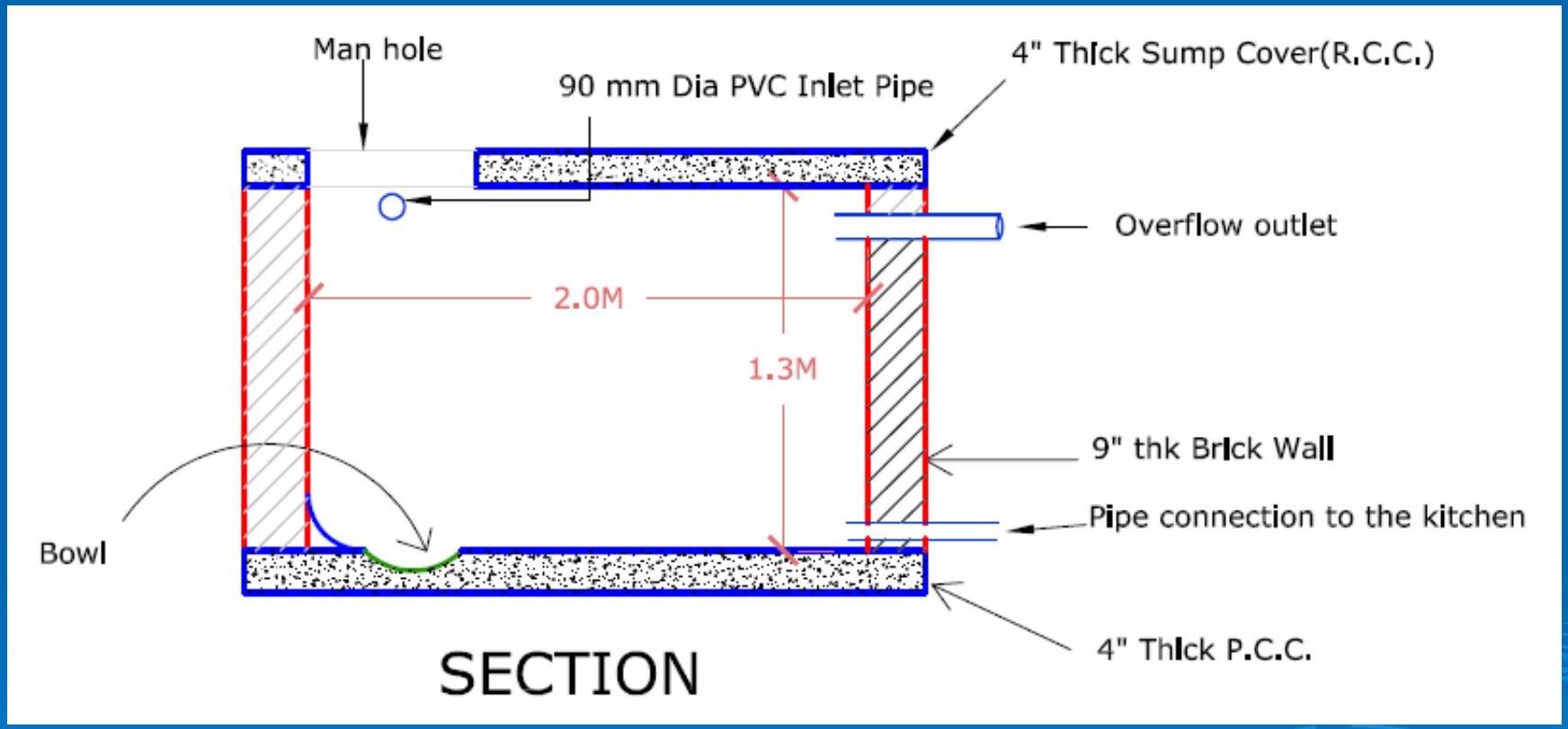
plastic

ferro-cement

Underground:

- rectangular, semi-spherical, cylindrical
- lined with cement, clay, mud, plastic, brick
- less expensive, but harder to maintain
- requires pump or other method to access water

Storage Structure Example



Design by Rainwater Club – sump for Shillikere School in Bagalkot District

Storage Principles

- safely allows excess water to overflow
- excludes vermin and mosquitoes
- excludes light (so that algae do not grow and larval growth is inhibited)
- ventilation to prevent anaerobic decomposition of any washed in matter
- easy access for cleaning
- structural strength to withstand wear and tear, and occasional large natural forces
- no drowning hazards to passers-by or small children
- not giving the water an unacceptable taste / toxicity
- method to withdraw water (faucet, pump, piping, etc.)

Quality of Harvested Water

Remember – compare with alternate sources

- Rainwater Quality
  - heavy metals are low, acidity is ok, unless specific industrial source nearby (Thomas and Greene 1993)
- Rooftop / Gutter Contamination
  - leaves, dust, bird droppings => bacteria
  - smooth roof is better, tiles less good, thatch will yield high counts
  - careful about lead on roof and some paints
  - First flush removal – often 5 liters, but depends on roof size, type, location, etc.
  - cleaning of roof and gutters

- Tanks
  - filter at entrance reduces organic matter
  - dark prevents algae growth
  - seal well to keep out insects and other creatures
  - don't leave the top open – mosquitos can breed
  - tap should be high enough not to draw bottom sediment
  - careful of contamination from flood waters or high water table
  - over time bacteria die off, sediment settles
  - bacterial tests even in poorly designed systems often better than other sources

Cost of Materials

Material Requirement:	Quantity	Amount (Rs.)
Cement	3 bags (50 kg each)	**495**
Bricks	300	**900**
Fine sand	1/3 tractor load	**400**
50 mm Jelly	20 *bandli*	**100**
Kadapa Stone slabs 2' * 4'	3 numbers	**336**
Perforated Aluminium basin, 8" dia.	1	**60**
Iron mesh	6 m * 1 m	**60**
2" Nails	1/2 kg.	**20**
Tap 1"	1 number	**50**
GI Pipe with Collar 1 1/2" length	1 number	**50**
20 mm gauge PVC Pipe 6" dia. 20 ft. length **	1 number	**1400 (700)**
Iron angle for holding the pipe	5 numbers	**350**
3" PVC pipe 10 ft. length	1 number	**150**
PVC Collar, cap, bend, metal cramp & 3-valve collar		**500**
Transport cost for materials (approx.)		**100**
Labour Charges:		
Masons	3 numbers	**450**
Helpers	3 numbers	**300**
Total		**5721**

Costs recorded by Manohar for village household in Bangalore region. Tank external dimensions: 6'x4'x3' equals 1960 liters storage

Sizing Calculations

Sizing Calculations for 2 Schools	Simikere High School	Chikka Shellikeri Primary School
Total Annual Rainfall	562 mm	562 mm
Roof Area	640 m^2	600 m^2
Total Liters (using 0.8 efficiency)	2,87,744 liters	2,69,760 liters
Average Available Per Day	788 liters	739 liters
Estimated Daily Need	250 liters	1500 liters
Needs Met?	Exceeds Need	Half Met

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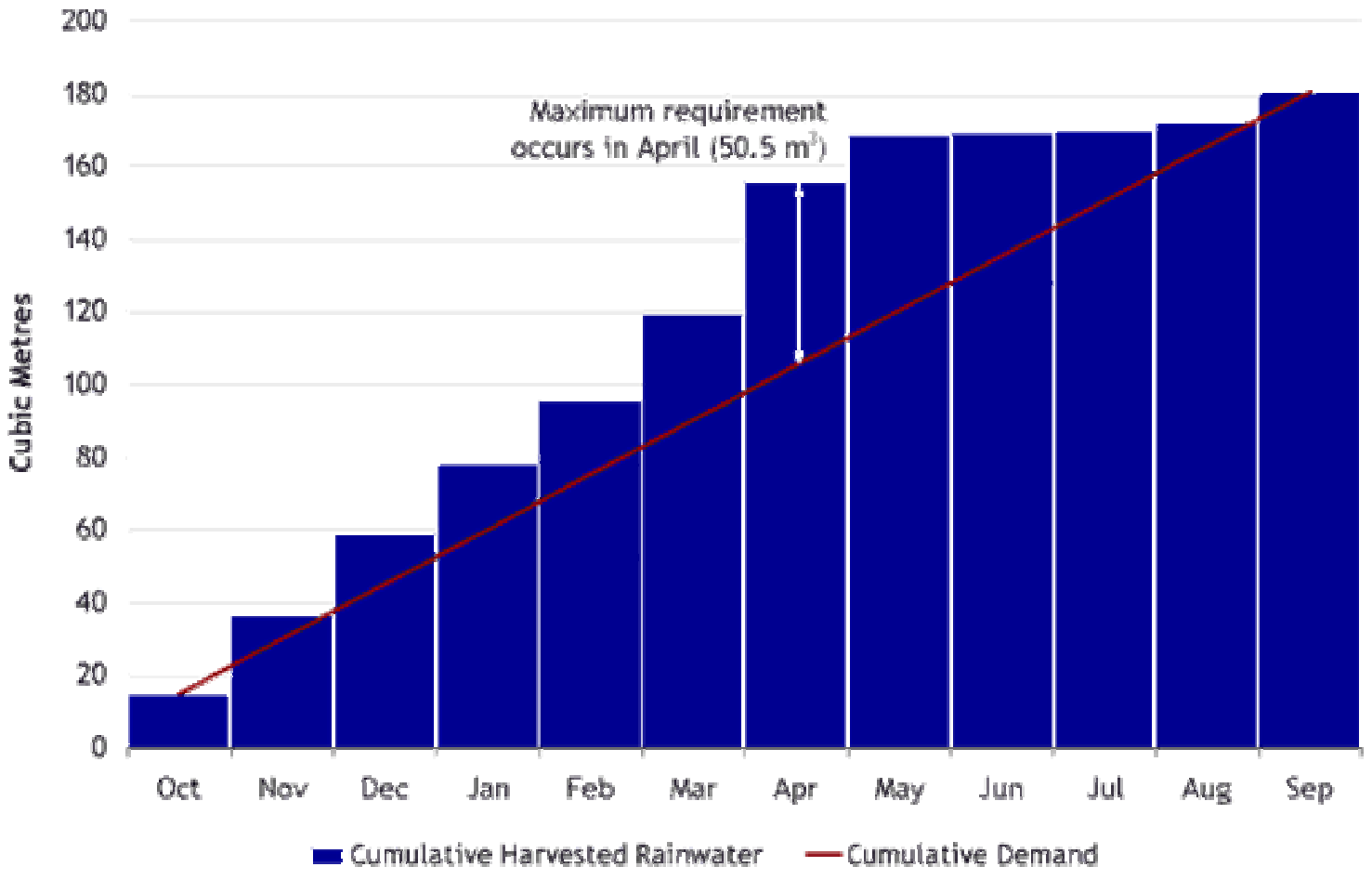
How Big to Make the Tanks?

Use for drinking and cooking only? Or use only part of the year?

Sizing Calculations



Sizing Calculations

RAINWATER TANK PERFORMANCE CALCULATOR: RESULTS

Location Bagalkot District, Karnataka **Simikere High School**
Roof area 640 m^2
Nominal demand 250 litres
Mean daily runoff 870 litres
Water management strategy Constant Demand

Using the nominal demand and tank size that you specified of 250 litres per day:

	Your Tank	**Comparisons**		
Tank Volume (litres)	**20000**	**4400[4]**	**17400[4]**	**69600[4]**
Reliability[1]	76%	55%	73%	97%
Satisfaction[2]	77%	57%	74%	97%
Efficiency[3]	22%	16%	21%	28%

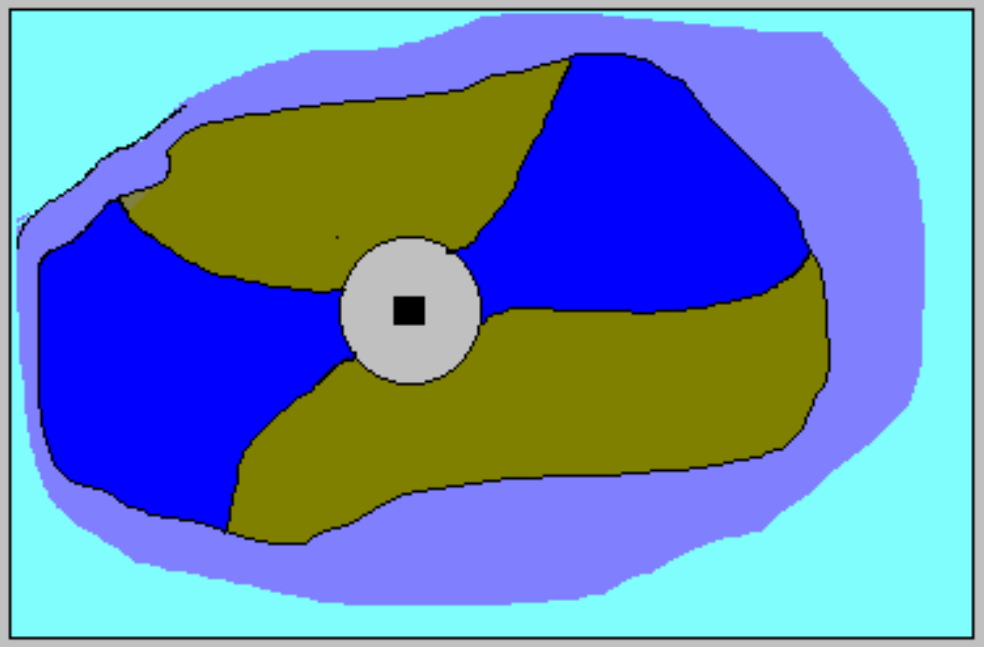
1. Reliability is the fraction of days the total demand will be met by the system
2. Satisfaction is the fraction of the total water demand that can be met by the system
3. Efficiency is the fraction of the runoff from the roof captured by the system
4. The comparison tank volumes are based on the average daily roof runoff multiplied by 5 days, 20 days and 80 days respectively

SimTanka


Please pirate this software
SimTanka
Version 1.1.0
Copyright held by Vikram Vyas
The Ajit Foundation...396 Vasundhara Colony...Tonk Road...Jaipur...India
Software for simulating rainwater harvesting system with covered tank - Tanka

The Ajit Foundation - SimTanka - Start

SimTanka is a program for simulating performance of rainwater harvesting systems with covered tank - Tanka - under fluctuating rainfall. It can be used for designing an optimum system that will meet your water needs reliably



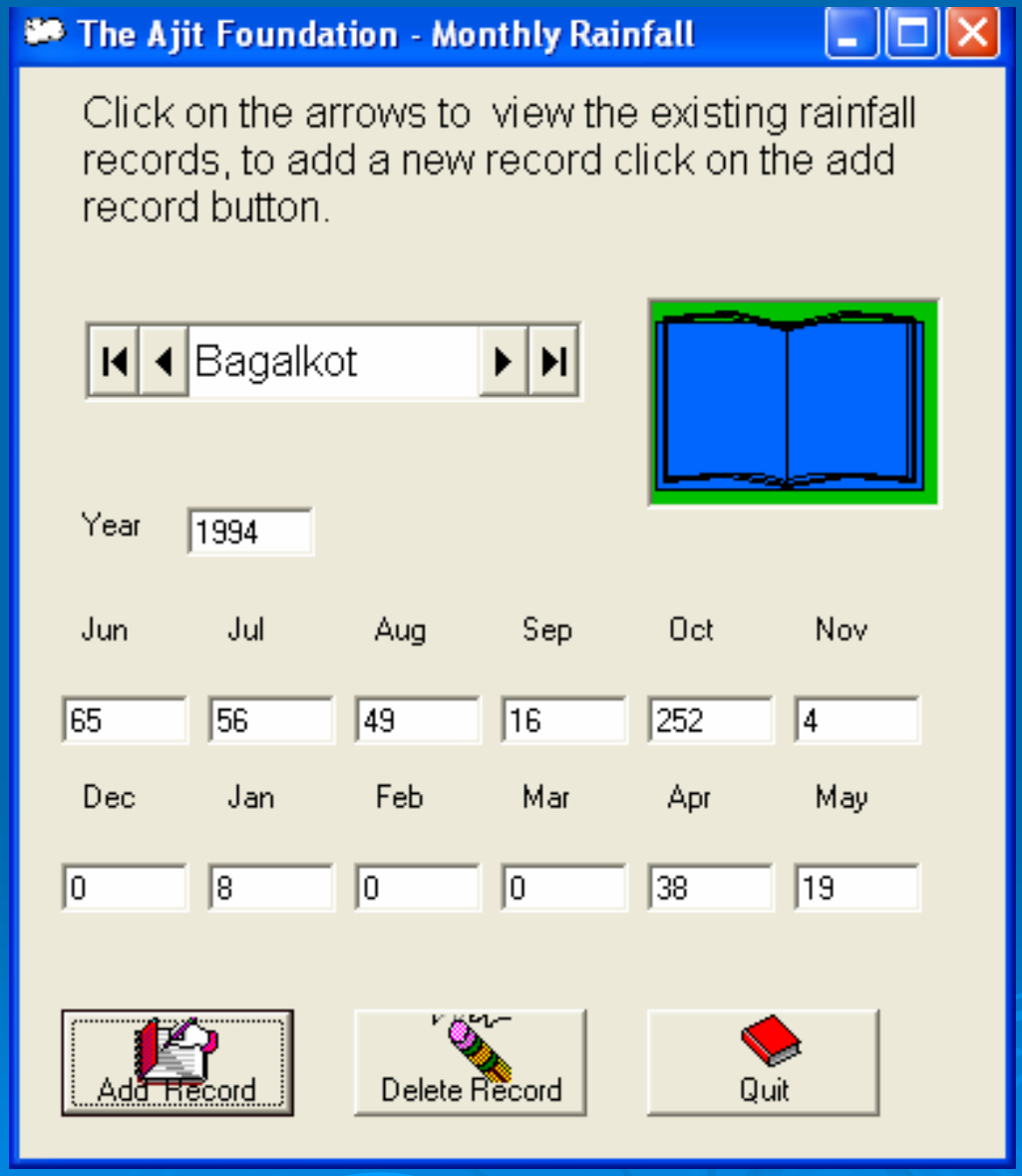
Please enter the location of the Tanka:

Bagalkot

How reliable would you like your system to be?

- Extremely Reliable (95%)
- Reliable (85%)
- Tolerable (75%)

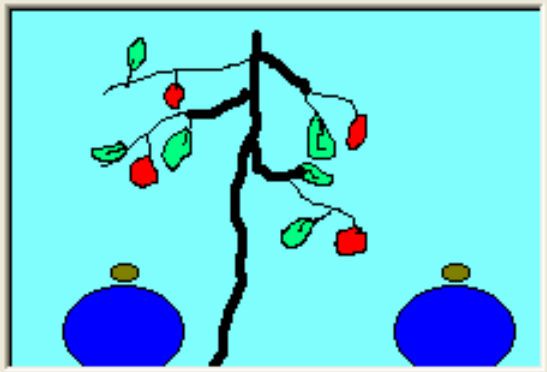
Rain Start Cancel


The Ajit Foundation - Monthly Rainfall
Click on the arrows to view the existing rainfall records, to add a new record click on the add record button.
Bagalkot
Year
1994
Jun
Jul
Aug
Sep
Oct
Nov
65
56
49
16
252
4
Dec
Jan
Feb
Mar
Apr
May
0
8
0
0
38
19
Add Record
Delete Record
Quit

The Ajit Foundation - SimTanka - Your Water Demand

Please enter the following information and then click Continue

Number of person who will use the Tanka for drinking water	200
Number of fruit trees to be irrigated	0



Daily water demand (liters)	Jun	Jul	Aug	Sep	Oct	Nov
Per Person	1.25	1.25	1.25	1.25	1.25	1.25
Per Fruit Tree	0	0	0	0	0	0

Daily water demand (Liters)	Dec	Jan	Feb	Mar	Apr	May
Per Person	1.25	1.25	1.25	1.25	1.25	1.25
Per Fruit Tree	0	0	0	0	0	0

Continue

Cancel

The Ajit Foundation - SimTanka - Tell me about your Tanka

Do you know the size of the Catchment area, or would you like SimTanka to determine it.

Yes, I know the Area

No, find the Area

Please Enter the Catchment area in square meter

640

Do you know the Volume of the storage Tank or would you like SimTanka to determine it.

Yes, I know the Volume

No, find the Volume

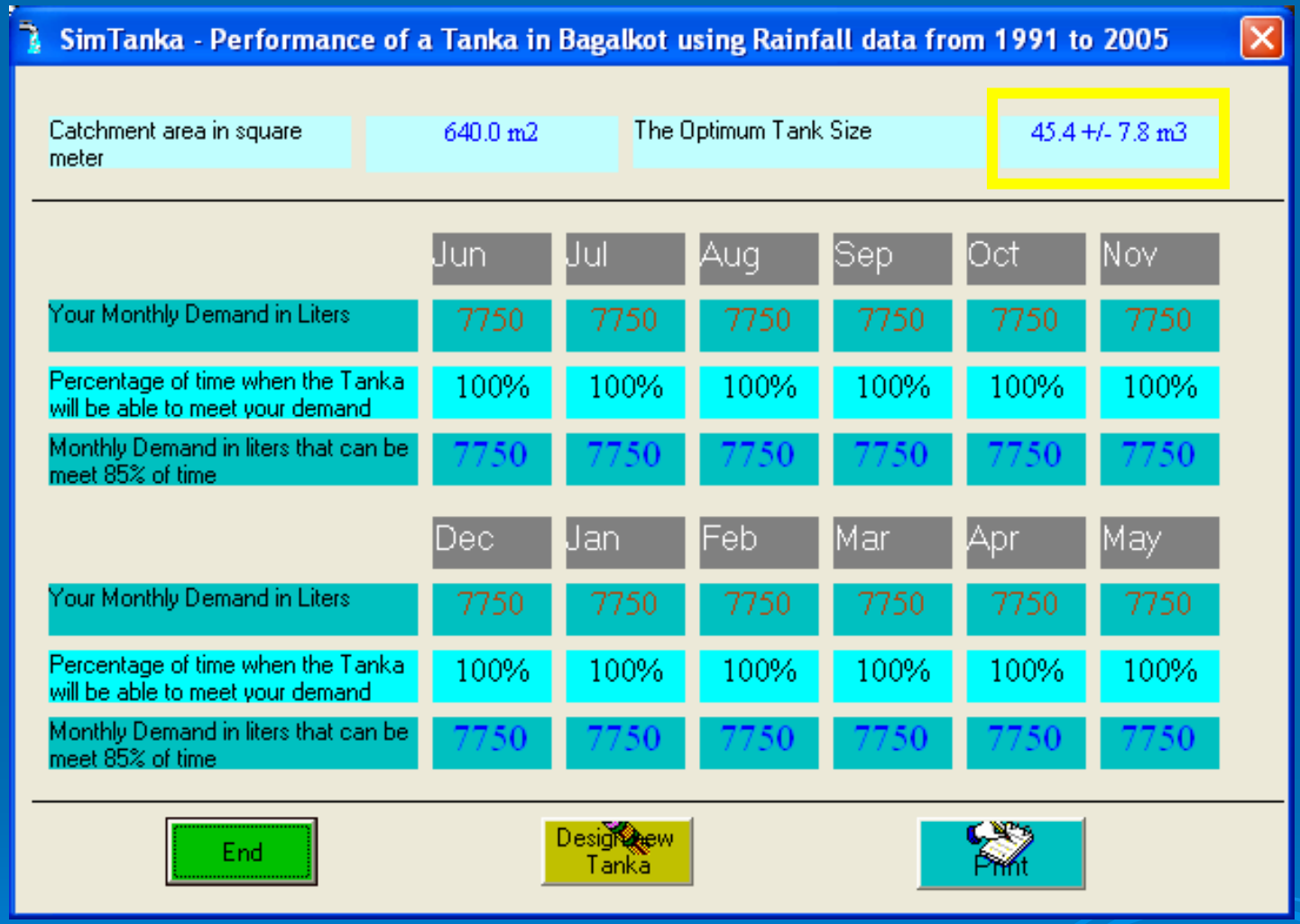
Please, describe your catchment area

- Roof
- Concrete
- Plastic Sheeting
- Brick
- Compacted and Smoothed soil
- Clay/Cow-dung
- Soil treated with Lime
- Rocky Natural Catchment

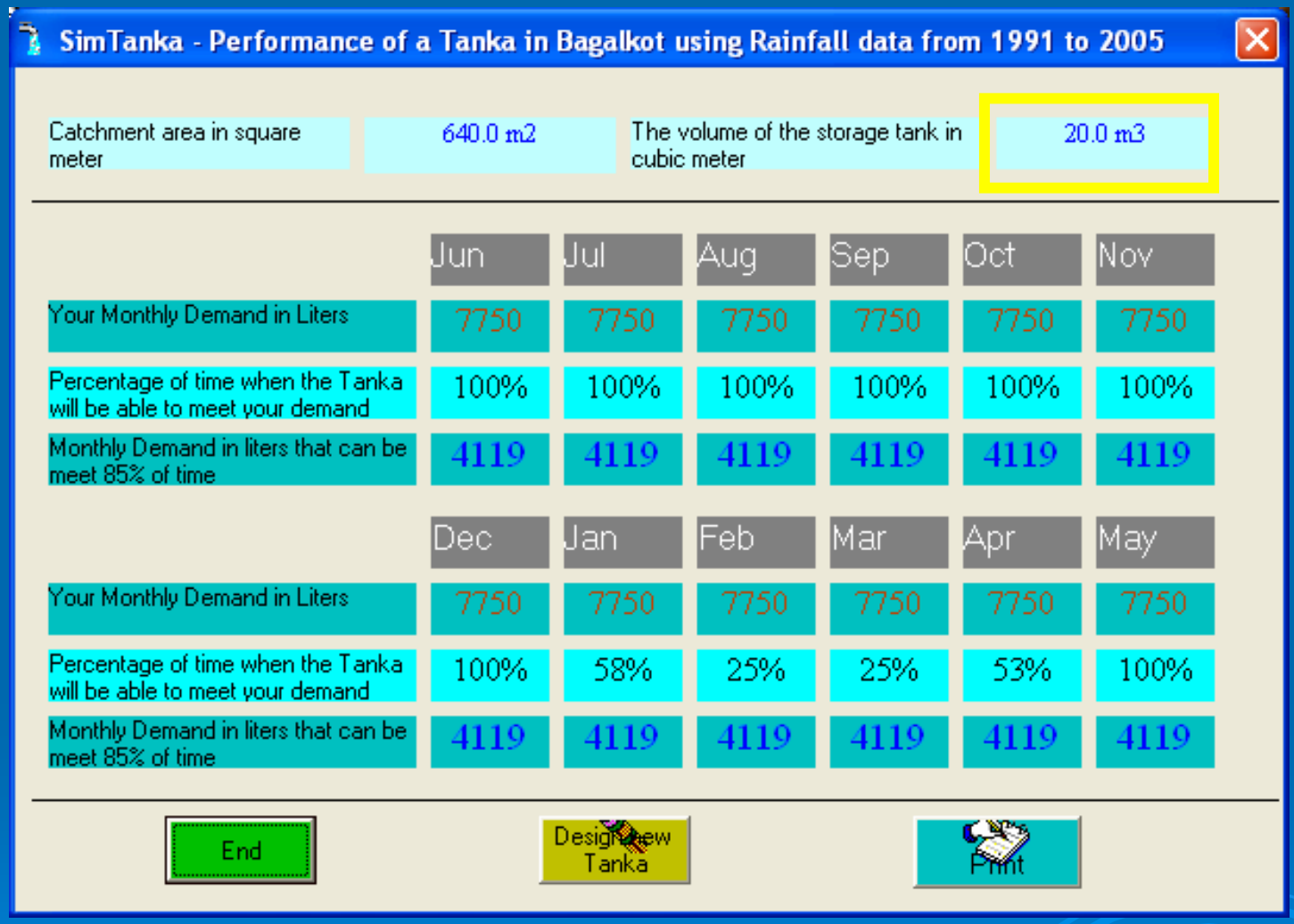
Go Back

Tell me how good is my tanka?

Stop



45 cubic meters = 45,000 liters = tank about 3.6m x 3.6m x 3.6m


SimTanka - Performance of a Tanka in Bagalkot using Rainfall data from 1991 to 2005
Catchment area in square meter
640.0 m2
The volume of the storage tank in cubic meter
20.0 m3
Jun
Jul
Aug
Sep
Oct
Nov
Your Monthly Demand in Liters
7750
7750
7750
7750
7750
7750
Percentage of time when the Tanka will be able to meet your demand
100%
100%
100%
100%
100%
100%
Monthly Demand in liters that can be meet 85% of time
4119
4119
4119
4119
4119
4119
Dec
Jan
Feb
Mar
Apr
May
Your Monthly Demand in Liters
7750
7750
7750
7750
7750
7750
Percentage of time when the Tanka will be able to meet your demand
100%
58%
25%
25%
53%
100%
Monthly Demand in liters that can be meet 85% of time
4119
4119
4119
4119
4119
4119
End
Design New Tanka
Print

Maintenance and Security

Maintenance Tasks

- If first flush requires manual operation or emptying, must be done
- Roof and gutter cleaning after dry spells (need access to roof)
- Filter inspection and cleaning
- Tank inspection and cleaning (though sediment may actually aid in decomposition)
- Inspect gutters and pipes
- Maintain pumps / faucets

Lessons from Schools

- Identify who is responsible for maintenance and repair
- Parts may be stolen, especially over summer break – appoint a watchdog committee
- Hire someone to clean roof if there is no staircase
- Time is limited – design a lower maintenance system
- Common problems are breakage of faucets / pump handles

Maintenance and security is improved when community perceives value of the project

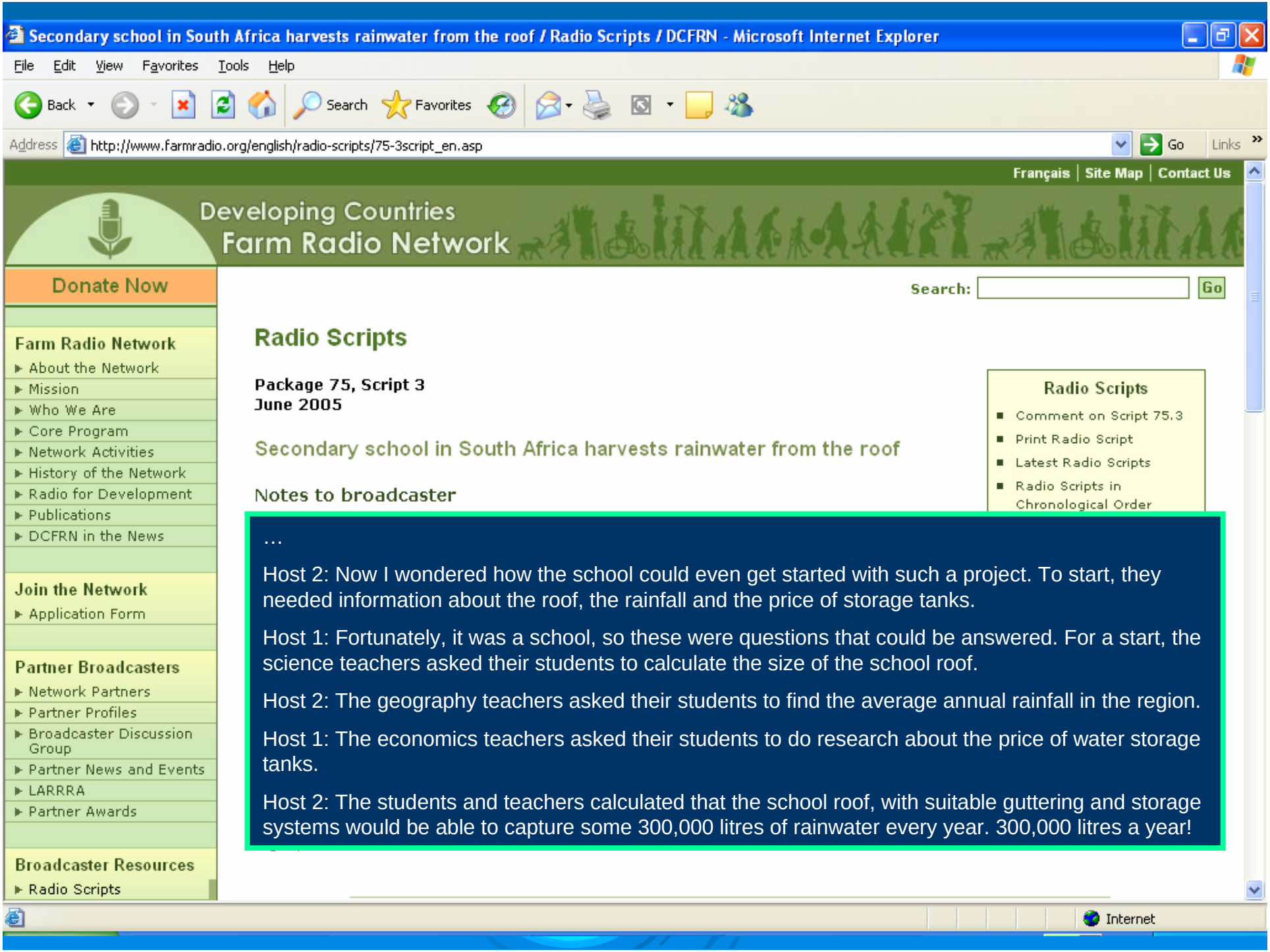
School Curriculum Ideas

- 10th standard textbooks for Karnataka have units on: water conservation, resources of India, pollution, statistics, and geometry – all related to rainwater harvesting.
- Curriculum ideas can be shared from other programs, for example:

RainCatcher - "a pilot project that brings together government representatives, school administrators, teachers, and students to teach, by example, the methods and value of rain harvesting at selected schools in Israeli, Jordanian, and Palestinian communities." http://www.watercare.org/

Rain harvesting model prepared by a student at Abu Gosh Middle School.

Student at Abu Gosh Middle School showing some of the weather graphs and charts she posted on the school bulletin board.


Secondary school in South Africa harvests rainwater from the roof / Radio Scripts / DCFRN - Microsoft Internet Explorer
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Broadcaster Discussion Group
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Partner Awards
Broadcaster Resources
Radio Scripts
Radio Scripts
Package 75, Script 3
June 2005
Secondary school in South Africa harvests rainwater from the roof
Notes to broadcaster
Radio Scripts
Comment on Script 75.3
Print Radio Script
Latest Radio Scripts
Radio Scripts in Chronological Order
…
Host 2: Now I wondered how the school could even get started with such a project. To start, they needed information about the roof, the rainfall and the price of storage tanks.
Host 1: Fortunately, it was a school, so these were questions that could be answered. For a start, the science teachers asked their students to calculate the size of the school roof.
Host 2: The geography teachers asked their students to find the average annual rainfall in the region.
Host 1: The economics teachers asked their students to do research about the price of water storage tanks.
Host 2: The students and teachers calculated that the school roof, with suitable guttering and storage systems would be able to capture some 300,000 litres of rainwater every year. 300,000 litres a year!
Internet

Information Sources

1. Domestic Roofwater Harvesting Research Program http://www.eng.warwick.ac.uk/dtu/rwh/index.html
2. Rainwater Club – Vishwanath and Karan www.rainwaterclub.org
3. Karnataka Department of Agriculture http://raitamitra.kar.nic.in/statistics.html#B24
4. eToolkit on Rainwater Harvesting http://www.rainwater-toolkit.net/index.php
5. Information on PVC Plastic PVCInformation.org
6. SafeRain Separator http://www.saferain.com.au
7. German Filters http://www.wisy.de/eng/eng/products.htm

Information Sources (cont.)

8. SimTanka (download at rainwater toolkit site http://www.rainwater-toolkit.net/index.php?id=57 produced by Vikram Vyas, Ajit Foundation, Jaipur)
9. Karnataka Textbooks Online http://www.dsert.kar.nic.in/textbooksonline/first.asp
10. RainCatcher School Program http://www.watercare.org
11. Farm Radio Network http://www.farmradio.org/english/radio-scripts/75-3script_en.asp

Sizing Calculations

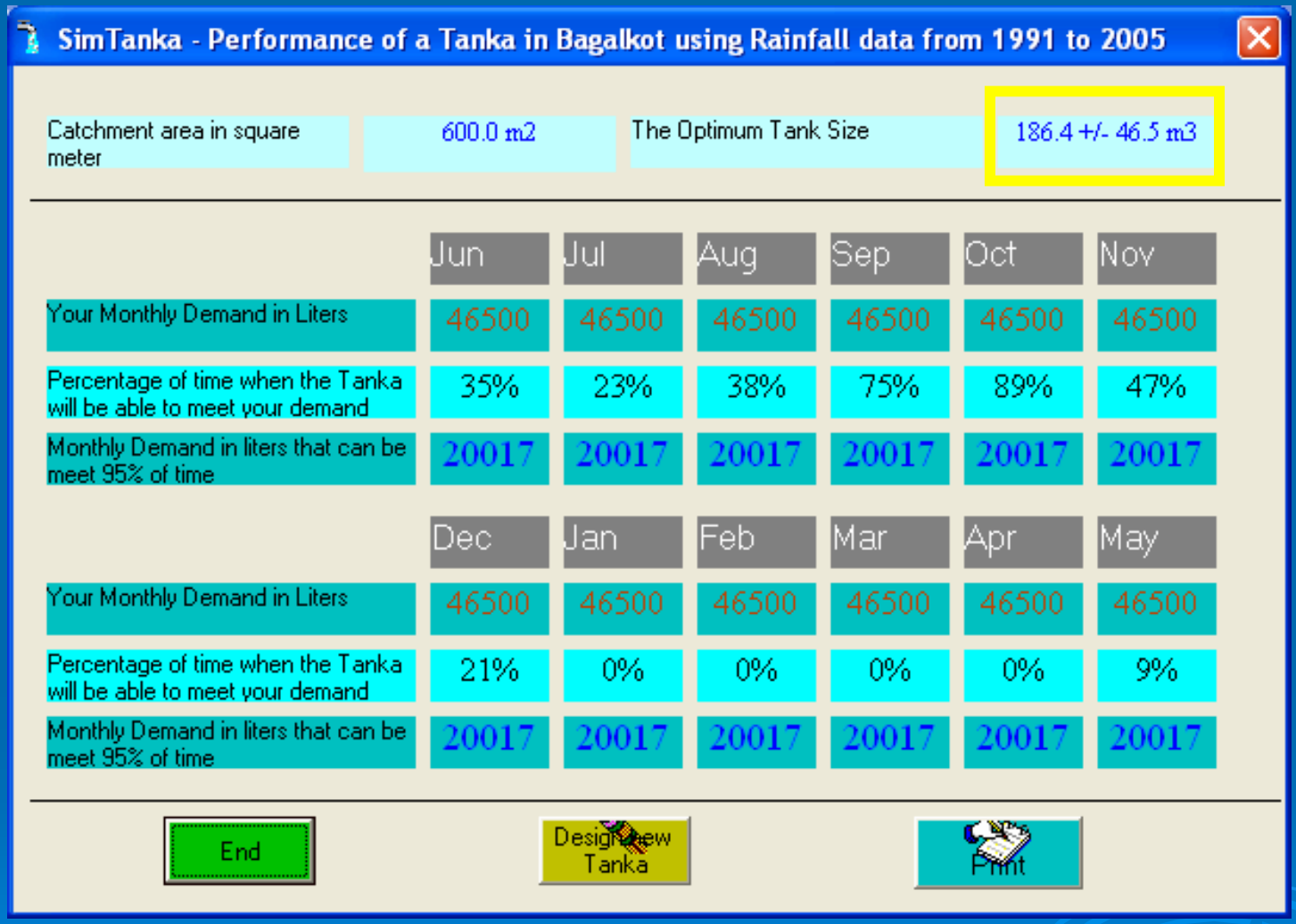
RAINWATER TANK PERFORMANCE CALCULATOR: RESULTS

Location Bagalkot District, Karnataka **Shellikeri Primary School**
Roof area 600 m^2
Nominal demand 1500 litres
Mean daily runoff 816 litres
Water management strategy Constant Demand

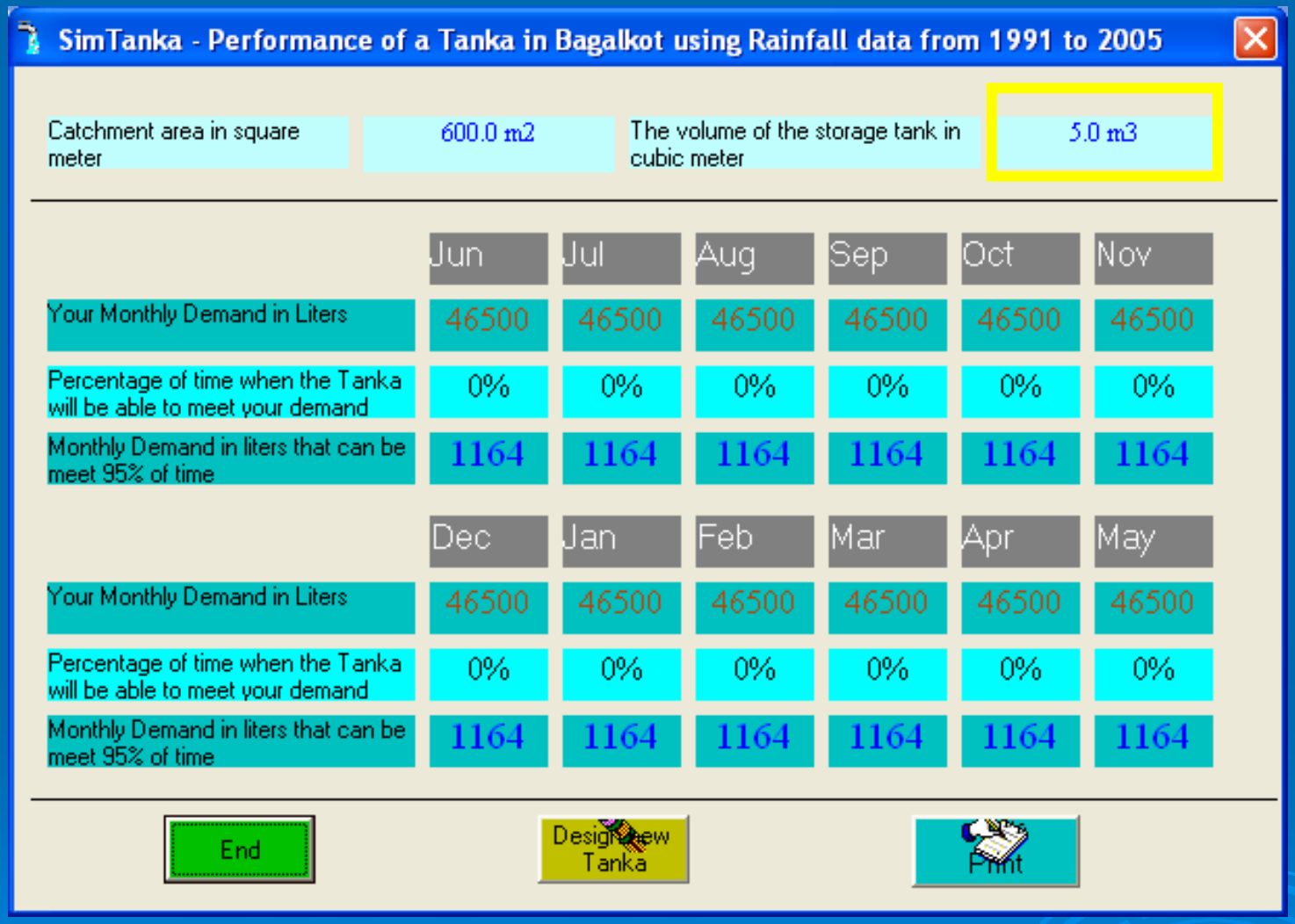
Using the nominal demand and tank size that you specified of 250 litres per day:

	Your Tank	Comparisons		
Tank Volume (litres)	**5000**	**4400[4]**	**17400[4]**	**69600[4]**
Reliability[1]	11%	11%	31%	43%
Satisfaction[2]	19%	17%	35%	45%
Efficiency[3]	35%	31%	64%	82%

1. Reliability is the fraction of days the total demand will be met by the system
2. Satisfaction is the fraction of the total water demand that can be met by the system
3. Efficiency is the fraction of the runoff from the roof captured by the system
4. The comparison tank volumes are based on the average daily roof runoff multiplied by 5 days, 20 days and 80 days respectively



Shellikeri - Optimum



Shellikeri - Actual