# CCAT rainwater catchment system

**From Appropedia**

## Spring 2008 content

## Background

The old Rainwater Catchment system that was at CCAT.

Humboldt State University's Campus Center for Appropriate Technology (CCAT) was started in 1978 and has been going strong since. With three live in students per year, and 18 student employees, CCAT is a “live in demonstration

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home" where the students of Humboldt State University and the local community actively partake in creating and maintaining a home in a sustainable way, by incorporating many aspects of Appropriate Technology (http://www.humboldt.edu/~ccat/drupal-5/?q=node/5#What) .



CCAT is in need of a reinstallation of their rainwater catchment system. A system had been installed at the original Buck house, but due to construction and relocation, it was dismantled. With many supplies ready for reuse, and the advantage of hindsight, it is now time to reinstall an efficient and aesthetically pleasing rainwater catchment system. Also, the CCAT house has just recently (January 2009) finished installing a new metal roof that will work wonderfully for a rainwater catchment system.

# What an Opportunity!

With CCAT striving to be a live-in demonstration of a sustainable home, and being located in coastal Humboldt County, California, it is just waiting for the water flowing out of the downspout to be redirected into a storage tank for later use for watering in the garden, the greenhouse that is being built, and any other needs except for drinking.

Two students from Spring 2008 ENGR 305 began working on the rainwater catchment system, but it was not completed. One student, Lauren, in Spring 2009 ENGR 305 class continued the work on this project. Once the plan was laid out, the complete construction of the system took place. The opportunity to learn about the application and installation of this type of system will be further spread to those who visit CCAT. There, people will be able to learn directly about how the system works through interpretive signs and other literature. As such, this project will benefit not only those who live in CCAT, but anyone who visits the demonstration home, as well as through this site for more information.

# Criteria

Aesthetic

Because CCAT is a demonstration home, the system should look well built and maintained for the public. It must also be have a non-intrusive design, and be out of the way.

Budget

Initial cost should be reasonable for this type of system, especially since the main tank is already purchased. Hopefully, many materials will be found that are not in use, but can be reused, so as to help keep the expense as low as possible.

Durability

The system needs to be able to withstand the weight of the water in the storage tank when it is full, and the tank should be secured so it won't blow away when it is empty. Care must be taken to ensure the tank will be stable when it is full and empty. It must be made well so that there will be little maintenance required later on, and it will be able to last a good amount of time for the CCAT house.

Educational Value

The system must have some educational value for the public. Again because of the CCAT house being an educational demonstration home, the system will have an education poster that explains the system as a whole, and how other community members may pursue their own construction if desired.

Efficiency

The retained water needs to be easily accessible for daily agricultural use. The tank needs to be sited in such a way that creates the maximum amount of head to decrease the amount of pumping necessary to move the water uphill.

Functional Design

It has to work. The tank must not leak, everything must work and be able to be maintained easily. The tank must be accessible and out of the way. The filter system must work, and the overflow should be directed to a useful area, while the water stored is able to be accessed easily as well.

Purity of Water

The first flush system must also work well by rejecting the first amount of rainwater, keeping it free of dust, debris, bugs, and dirt, so that the water is as pure as possible.

CCAT approval

The rainwater catchment system is designed especially for CCAT's water needs. It is important to make it to help the house and surrounding area, while being able to expand on the system and make changes as needed later on, as they arise.

# Literature Review

Small Community Water Supplies

This book has a lot of good information concerning many different aspects of water, including planning, management, quality, spring water tapping, pumping, groundwater, dams, treatment, aeration, coagulation, sedimentation, filtration, disinfection, distribution, flouride removal, and numerous examples to accompany these topics. Chapter 7, (129-147) "Rainwater harvesting" is what was most pertinent for my project. The chapter was outlined into eight sections: Introduction, Collection surface, Filtration systems and settling tanks, Storage provisions, Sizing a rainwater harvesting system, Health and water quality, Integrated and holistic nature of rainwater harvesting, Conclusions and recommendations. I found it very helpful and rather thorough in its explanation of different parts of a rainwater catchment system, giving a holistic perspective on the issue.

Smet, Jo, and Christine van Wijk. Small Community Water Supplies: Technology, People and Partnership. Delft, The Netherlandds: IRC International Water and Sanitation Center, 2002.

Water Harvesting- A Guide for Planners and Project Managers

This book is divided into ten chapters including Introduction, Approach to Water Harvesting, The Arid

and Semi-Arid Lands Environment, Water Harvesting Technology Options, Assessing Water Harvesting Potential, Programme Development with the Community, Financial and Economic Issues, Rooftop Harvesting Systems, Surface Catchment Systems, and Groundwater Dams. The book also includes relevant tables within each chapter that are done well to compliment the information. Chapter eight "Rooftop Harvesting Systems" (54-70) contained the most valuable information for my project. This section mainly focused on the tank, from criteria for understanding what size, type and how to construct it. It did not focus much on the construction of the entire system.

Lee, Michael D., and Jan Teun Visscher. Water Harvesting: A Guide for Planners and Project Managers. The Hague, The Netherlands: IRC International Water and Sanitation Center, 1992.

Rain and Stormwater Harvesting in Rural Areas

This entire book is focused on rainwater harvesting, thus it has been an extremely helpful source. There are many international examples of harvesting which has been interesting to read. The book is organized into fourteen chapters: Rainwater Harvesting for Domestic Use- Early History, Rainwater Harvesting for Agriculture- Early History, Collection and Storage of Rainwater from Roofs, Collection of Rainwater from Ground Catchments, Storage and Utilization of Rainwater from Ground Catchments, The Ground Catchment on Manda Island, Rain and Stormwater Harvesting by Contour Terracing, Rain and Stormwater Harvesting by Silt Traps- Check Dams and Canals, Rain and Stormwater Harvesting in China, Harvesting Water from Dew Mist and Snow, Designand Evaluation of Rainwater Harvesting Schemes, Recommendations and Criteria for Rainwater Harvest Pilot Projects. It is very informative and goes into good detail in all of the sections. The examples may be especially helpful for those looking to construct a system in rural, off the grid areas, or less economically developed places. It does not go into detailed explanation for someone interested in constructing a system for their own home.

Programme, United Nations Environment. Rain and Stormwater Harvesting in Rural Areas (Water resources series). Port Washington. New York: Tycooly Intl, 1984.

Online Resource Site:

I found this website very helpful when I first began my research. It serves as a good introduction to rainwater catchments and harvesting. It provides information on tanks, roofs, cisterns, collection, storage, filtration, and basic background needed to help understand how a rainwater catchment system works and why they are useful. It also has a rainwater calculator with appropriate equations for each person to fill in and figure out what will work best for their own system.

The Environmental Directory. "Harvesting | Rainwater Harvesting Guide." Rainwater Harvesting Guide. http://www.rain-barrel.net/category/rainwater-harvesting (accessed February 2, 2009).

## Tank

The most expensive component of a rainwater catchment system is the storage tank[1]. Luckily, we are able to reuse the original tank that was donated to CCAT. It is made of grey corrugated polypropylene. As with any material, there are advantages and disadvantages:

### Advantages or polypropylene

- Relatively inexpensive
- Lightweight
- Durable
- Long lasting

### Disadvantages of polypropylene

- Must be installed above ground, as standard tanks cannot withstand soil expansion and contraction

- The plumbing fittings might leak[2]

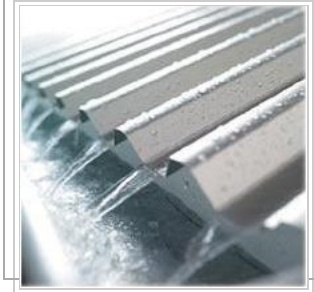
The tank is 7ft tall with a diamiter of 5ft, cylindrical in shape. According to John Gould, cylindrical or spherical shaped tanks optimize the use of materials and increase the strength of the tank walls[3].

## Roof

The potability of the harvested rainwater is dependent on many factors. The most obvious is the material of the catchment surface, or, in this case, the roof. CCAT's roof was made of asphalt shingles, which is not ideal for potable water usage due to leaching of chemicals, and the rainwater collected in such a system would only be suitable for irrigation use. Due to the deteriorating condition of the current roof, CCAT built a new one made of metal, and finished construction on it in January 2009. This makes an even more ideal situation for utilizing a new rainwater catchment system. The CCAT roof is 1568 sq. ft. in size which was attained by calculating the length by width of the CCAT house: 49' x 32'= 1568 sq. ft. The efficiency on a metal roof is estimated to be at about .9 which is very good for rainwater catchment.

### Ideal Roof Materials

| Metal |
| --- |
| The smoother the catchment surface, the better. Metal roofing materials, whether galvanized corrugated steel or aluminum, provide a smooth, bacteria un-friendly surface for rainwater to flow down. There are many options of various styles, alloys, and colors of metal roofing. Care should be taken on all re-roofing to not use lead flashings, as these will contaminate the water supply[4]. |
| |



Metal roof

## Arcata, CA Average Percipitation

| January | Febury | March | April | May | June | July | August | September | October | November | December | A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.97 in. | 5.51 in. | 5.55 in. | 2.91 in. | 1.62 in. | 0.65 in. | 0.16 in. | 0.38 in. | 0.86 in. | 2.36 in. | 5.78 in. | 6.35 in. | **3** |

To calculate the collection available for any rainwater catchment system, one can use the formula found on appropedia listed as Basic rainwater collection calculations. However, for this project I understood that we would be using the 1500 gallon tank already available, so sizing issues were not of concern.

MSN Weather (http://weather.uk.msn.com/monthly_averages.aspx?wealocations=wc:USCA0360) - Yearly, Monthly Temperature and Percipitation Averages and Records for Eureka, US:

## Roof Footprint

**Calculating Container Volumes**

### Proposed time line

February

Work with CCAT to determine location of the tank and begin a proposed budget once that is decided.

March

Finalize the location of the tank and design, acquire all materials, clean out gutters, patch any holes in gutters, coordinate with CCAT on all of the tiny details.

April

Construct the concrete pad over a sunny weekend, install all plumbing and fixtures,and complete installation. Test as much as possible and make necessary adjustments to the design. Write a report and finish this page.

May

Fix any unforeseen problems, and prepare to present the project to the class.

# Design

### Tank

CCAT has a tank already which will be used for this project. It is 7 feet tall, and 5 feet in diameter. This

results in about 1500 gallons, which weighs about 12000lbs. when filled. We will need to excavate an area were the tank is to be placed. Originally, we thought of putting a 6ft x 6ft x 8in concrete pad down to support the tank. However, it was decided that for tis project we would not use concrete. Instead, I dug down about 8" in the area where the tank would be placed. Then I compacted the Earth down, put a layer of bricks (approximately 4" thick)on top, and then about 2" of gravel on the top of the bricks to support the tank.

There was a good deal of debate and concern over where the best place for the tanks location would be. It was finally decided that the best location would be outside the main entrance of the CCAT home, near the bike rack, and directly next to the tires. Though this spot is obvious to the public, it is not in the way of any foreseeable future projects, and will attract attention to the project and heighten peoples awareness of rainwater harvesting. The tank is up high, and it will be easy to attach a hose to it, so that access to the water for gardening purposes is very accessible. Th tank does not get any shading in its location, which is often considered a more ideal situation to help prevent heating, and additional leaching of chemicals through the plastic.

## First Flush Catchment System

After a few different attempts to create a first flush, I found a system that has seemed to work well so far.

The collected rainwater will be gathered in the roof gutter and then pass through a small leaf catcher that is meant to separate the larger debris from going into the piping. Then the PVC piping will carry the water down towards the tank. Then it will reach the first flush device, where the water will fill a small 15 gallon tank that I purchased at Resale Lumber Products. The water will flow into the small tank until it fills. Then there is a small racquetball that is held up by a small piece of wire to keep it from falling into the tank. When it becomes full, the ball will move up through the clear piping piece. Then there is a ABS piece that converts the piping from 3" to 2" where the ball will fill up this smaller space. The water will then continue to flow and be diverted into the large 1500 gallon tank.

This will allow any smaller leaves, bird droppings, and general sediment that may have built up on the roof to be initially diverted into this flush system, so that the clean rainwater can be stored in the large tank.

To size the amount of water that should be used for a first flush: It is estimated that for every 1000 square feet of collection surface, the first flush should divert a minimum of 10 gallons.(Kinkade- Levario) This is a standard rule of thumb that usually works. For this roof the surface area was approximately 49' X 32', equaling 1568 $ft^2$, so a 15 gallon tank seemed most appropriate.

Fig 1: This is the top view of the 15 gallon tank used for first flush

Fig 2: 15 gallon tank with hose bib attachment at bottom

Fig 3: connection up from tank to piping

Fig 4: racquetball in place that will rise as water fills the tank

Fig 5: this is the piping that the ball will fill into, then divert to the large tank

Fig 6: This is the complete view of the first flush

## Delivery System

The Delivery system is simple, a length of 3” PVC pipe directed from the Roof Washer to the First Water Catchment System. I used some ABS piping pieces for connectors also( these are the black ones pictured). I put up a 4" X 4" cedar post into the ground next to the cement curb driveway to keep extra support for the piping.

Fig 1: This is the cedar post to help support the piping

Fig 2: This is part of the process of putting the post into the cement- tightening

Fig 3: This is the post put in place into the cement

Fig 4: Here you can see the piping coming out from leaf catcher towards tank

### Roof Washer

The roof washer is mounted to small pieces of wood attached to the side of the housing. I used a small recycled detergent bucket and cut it at an angle, then placed a screen on top of it. To secure the screen I put four small hitch pins into the sides so that it would be possible to remove. This is meant to keep the larger debris out of the system. Then I put in the 3" PVC coming out of it which would bring the water down towards the first flush.

Fig 1:This is the original gutter siding that later had a downspout put into it for the water to come out

Fig 2:This is the final product

## Budget

Budget: This is the budget for what was spent on this project.

| Qty | Material Needed | Source | Cost | Total cost |
|---|---|---|---|---|
| 1 | 1500 gallon Tank | CCAT | Already available $0 | $0 |
| 1 | 20 ft. 3" PVC | Piersons Hardware | Donated $0 | $0 |
| 1/3 yard | #2 Rock | Wes Green Landscape Materials | $40.00/yard | $13.33 |
| 1 | 15 gallon bucket | Resale Lumber | $25.00 | $25.00 |
| 2 ft. | 1/8” Screen filter | Hensel's ACE Hardware | $2.00/ft. | $6.62 |
| 1 | Hose bib attachment for 15 gallon tank | Resale Lumber Products | $18.90 | $18.90 |
| 1/2 ft. | Tube Spa Piping | Hensel's ACE Hardware | $4.49/ft. | $2.25 |
| 1 | Silicone Caulk | Hensel's ACE Hardware | $4.99 | $4.99 |
| 1 | Plastic Funnel | Hensel's ACE Hardware | $7.49 | $7.49 |
| 1 | 3" Bulk head fitting | ACE Hardware- Thrifty | $30.50 | $30.50 |
| 2 | 5x7 tin shingle | Piersons | $.39 | $.78 |
| 1 | ABS 90 degree elbow | Piersons | $5.75 | $5.75 |
| 1 | masonry bit | Piersons | $4.99 | $4.99 |
| 2 | Shelf and Rod bracket | Piersons | $2.99 | $5.98 |
| 1 | circle cutter | Piersons | $10.99 | $10.99 |
| 1 | copper coi | Piersons | $2.89 | $2.89 |
| 1 | no-kink faucet 3/4in Male IPS | Piersons | $5.95 | $5.95 |
| | | | | |

| | | | | |
|---|---|---|---|---|
| 1 | PVC bushing | Piersons | $1.49 | $1.49 |
| 1 | fasteners bolts screws and nuts | Piersons | $1.69 | $1.69 |
| 1 | ABS 3" adapter | Piersons | $4.19 | $4.19 |
| 1 | Strong-tie post cap/base | Piersons | $3.34 | $3.34 |
| 1 | Bushing PVC 1.25M/4FPT | Piersons | $2.79 | $2.79 |
| 1 | power pro 10x 3 1/2 | Piersons | $4.49 | $4.49 |
| 1 | ABS knockout closet flange | Piersons | $2.75 | $2.75 |
| 1 | Front Elbow Galvnz | Piersons | $1.99 | $1.99 |
| 1 | PVC Cement | Piersons | $3.99 | $3.99 |
| 1 | ABS 3" cleanout adapter | Piersons | $3.69 | $3.69 |
| 1 | ABS 90 degree elbow | Piersons | $3.99 | $3.99 |
| 1 | flexible coupling 3x3 | Piersons | $6.99 | $6.99 |
| 1 | flexible coupling 3x 1 1/2 | Piersons | $7.49 | $7.49 |
| 1 | teflon tape | Piersons | $.99 | $.99 |
| 2 | fasteners bolts screw and nuts | Piersons | $1.69 | $3.38 |
| 10 | screws | Piersons | $.12 | $1.20 |
| 10 | screws | Piersons | $.19 | $1.90 |
| 1 | 4x4 cedar post | Piersons | $29.43 | $29.43 |
| 1 | ABS coupling | West Coast Plumbing | $2.49 | $2.49 |
| 1 | ABS sanitary tee | West Coast Plumbing | $7.89 | $7.89 |
| 3 | ABS coupling 3x2 | West Coast Plumbing | $3.95 | $11.85 |

| | | | | | |
|---|---|---|---|---|---|
| 1 | ABS pipe | West Coast Plumbing | $.79 | $.79 | |
| 1 | ABS pipe | West Coast Plumbing | $1.79 | $1.79 | |
| 2/2 | Hitch pins | Hensels ACE | $.19/ .23 | $.84 | |
| 1 | approximate total tax | all stores combined | $19.96 | $19.96 | Total: $281.79 |

# Lessons Learned

Through out this project I made some unnecessary mistakes and came across issues that wasted time and money, but I guess that is all part of the learning process. To begin with, I had very little experience building and none with rainwater catchment so I found myself second guessing my choices all the way through. The location of the tank was the first obstacle that I encountered, and it was finally decided that it should be put up higher so it could access more locations for the water use. I went through a couple of different designs on the first flush system, and I feel comfortable with the end result of what was shown here, but I had ended up getting some materials in the meantime that went unused. This included extra piping that was donated by Piersons, and later returned, as well as a bucket and funnel that was going to be used for an earlier design version of the the first flush that ended up going to waste. Hopefully it will find a purpose and use in something else in the future! Lonny, my instructor ended up giving me a contact of his- Cody- who proved to be incredibly helpful in both the design and construction. I feel like it was important to have someone else to work with on a project like this, and would recommend others to have another head and pair of hands to help out! Thanks so much for all your help Cody!

Plastic Appropriateness: I used a lot of plastic through this project, which is an unsustainable material, but I could not find anything else that would work as well and was available and within cost.

Aesthetics: Due to time constraints near the end of the project, and my own time management problems, I was not able to make it as aesthetically pleasing as I had originally hoped. I still want to paint the piping and the large catchment tank. Then I would be interested in putting some grape vines or peas along the

piping, as the older picture shows from the previous catchment system. I think that would be wonderful and help to make it more pleasing to the eye.

# Conclusions

I really enjoyed doing this project, even though it was incredibly frustrating at times. However, I feel that the project has a good end result and will work well when the rains start up again next season, providing CCAT with an additional appropriate and sustainable resource for water. I would recommend everyone to look at their own local weather conditions and see if a rainwater catchment system may be appropriate for your needs!

I also want to thank Lonny and Cody for all their help with this project. They were both essential elements to it, and without Cody I would have had a very difficult time making it as sturdy as it turned out! Infinite thanks to you both.

# References

1. ↑ The Texas Manual on Rainwater Harvesting
2. ↑ ibid.
3. ↑ Rainwater Catchment Systems of Domestic Supply
4. ↑ http://www.greenbuilder.com/sourcebook/RainwaterGuide3.html#catchment