Tree Olla

The hybridization of drip systems and traditional ollas creates a revolutionary product that focuses on saving water. The hexagonal, modular design mimics a natural system that can be used as a space to sit and reflect. In addition, these ollas have been elevated to the surface as a reminder that water is the most prominent and invaluable resource for all living species.

By Steven Erb

Multi-disciplinary Design, University of Utah

DES 3520-001 Design Product Studio 2, Tsoutsounakis

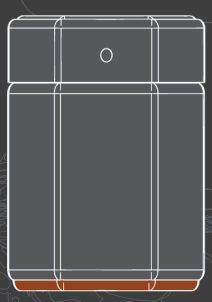
Spring 2021

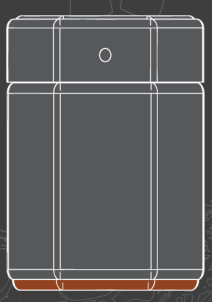
In partnership with

YESTERMORROW

DESIGN/BUILD SCHOOL

Table of Contents





Why Focus on Water?

The unequal distribution of freshwater resources has implications for people's access to water, economic development, and global geopolitics.

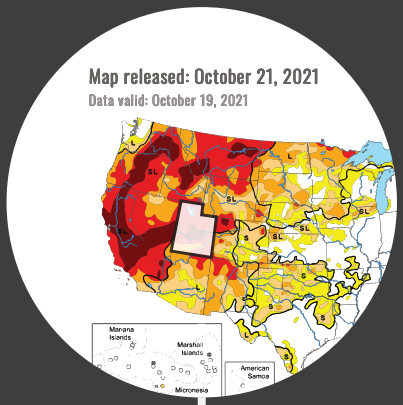
"In modern America, we have access to clean, fresh water every day. Each time we turn on the tap, plumbing systems instantly bring this important resource into our homes. Despite its importance for life, though, fresh water is an extremely rare resource on Earth. Less than 3 percent of the water found on Earth is fresh water, and the remaining 97 percent is salt water, such as what is found in the ocean.

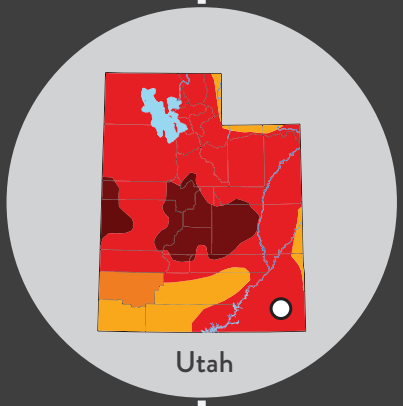
Most of the world's fresh water is not easily accessible to humans. Approximately 69 percent of Earth's freshwater is locked away in the form of ice in glaciers and polar ice caps, and another 30 percent of Earth's fresh water is under the surface in the form of groundwater. That leaves only about 1 percent of Earth's fresh water as readily available for human use.

Unfortunately, the available surface fresh water is not equally distributed throughout the world. Brazil, Russia, Canada, Indonesia, China, Columbia, and the United States have most of the world's surface freshwater resources. As a result, approximately one-fifth of the world's population lives in water scarce areas where, on average, each person receives less than 1,000 cubic meters (35,315 cubic feet) of water a year. This lack of water affects people's access to clean, usable water, as well as the economic development and geopolitics of different areas."- National Geographics

Bluff, Utah is located in an **Extreme Drought** Zone. While not a new issue, the water supply is currently at an all time low, and many residents in San Juan County still do not have access to modern day plumbing. Additionally, the drought has both stressed native vegetation and increased wild fire risk.

Regional Drought





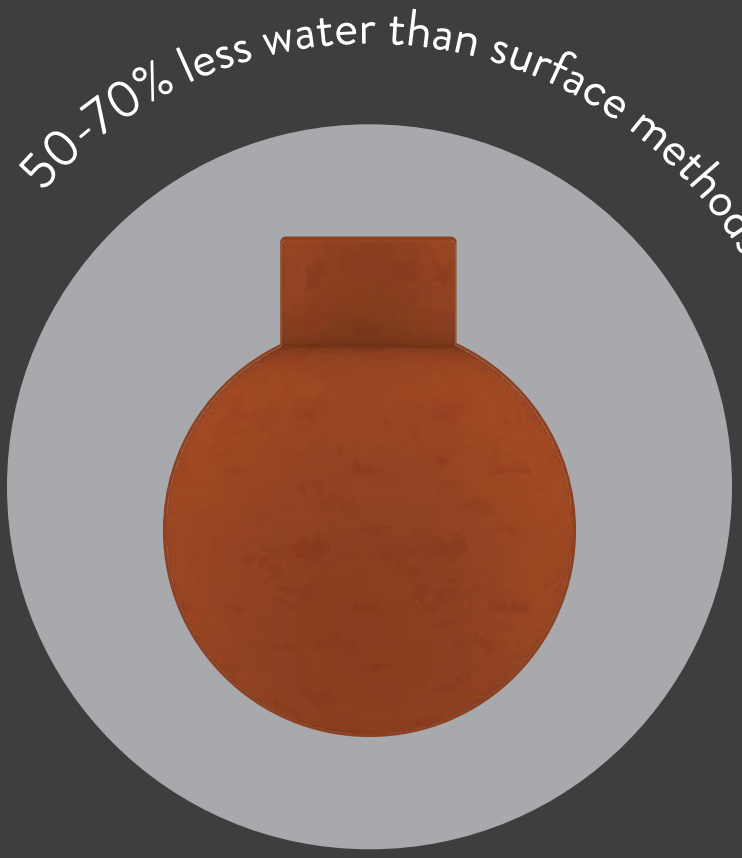
Utah

Bluff, Utah

YESTERMORROW
DESIGN/BUILD SCHOOL

National Geographic Society. (2019, June 21). Freshwater Resources. National Geographic Society. Retrieved December 2, 2021, from
Utah. Drought.gov. (n.d.). Retrieved November 1, 2021, from https://www.drought.gov/states/utah.

Method for Arid Landscapes



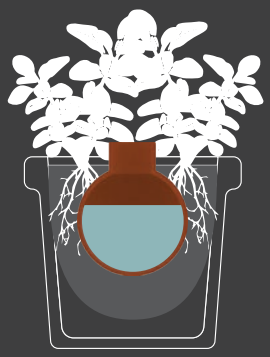
"In order to save water, a minimum water dose and maximum efficiency in water applications are desirable and these two factors make irrigation by suction ideal for arid regions." - Martinez

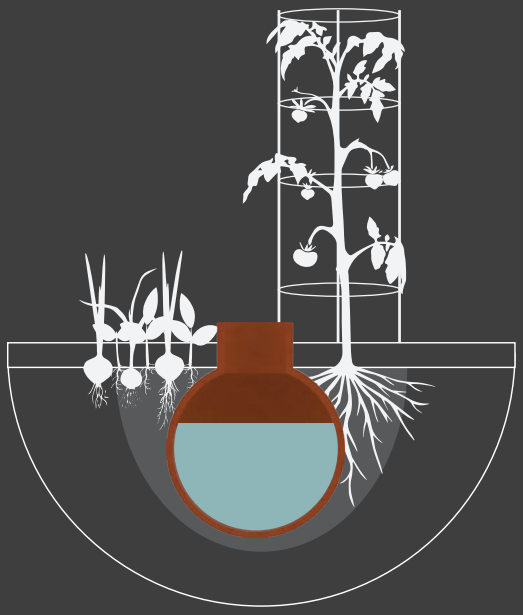
An olla (pronounced oh-yah) is a handcrafted terracotta clay pot used for in-the-ground crop irrigation. Agrarian communities in desert regions have relied on olla irrigation practices for many years. The method is believed to have originated 4,000 years ago in Africa, and was documented 2,000 years ago in Asia, in the book, Fan Sheng-Chih Shu (one of the first known agricultural texts). There is also evidence that the conquistadors first brought & implemented the olla to the Americas.

Bainbridge, David A. "Buried Clay Pot Irrigation: a Little Known but Very Efficient Traditional Method of Irrigation." Agricultural Water Management, vol. 48, no. 2, 2001, pp. 79–88.
Martínez de Azagra Paredes, A, and J Del Río San Jose. "Pitcher Irrigation: Some Theoretical and Practical Aspects." Irrigation and Drainage, vol. 68, no. 3, 2019, pp. 542–550.

Benefits

Ollas of different sizes are versatile enough to incorporate individual pots, permaculture, food forests, walipini, hoop houses, & cold frames. Traditional ollas deliver water directly to the root structure, eliminating stress cycles on plants increases their ability to thrive, and dramatically increasing crop yield.





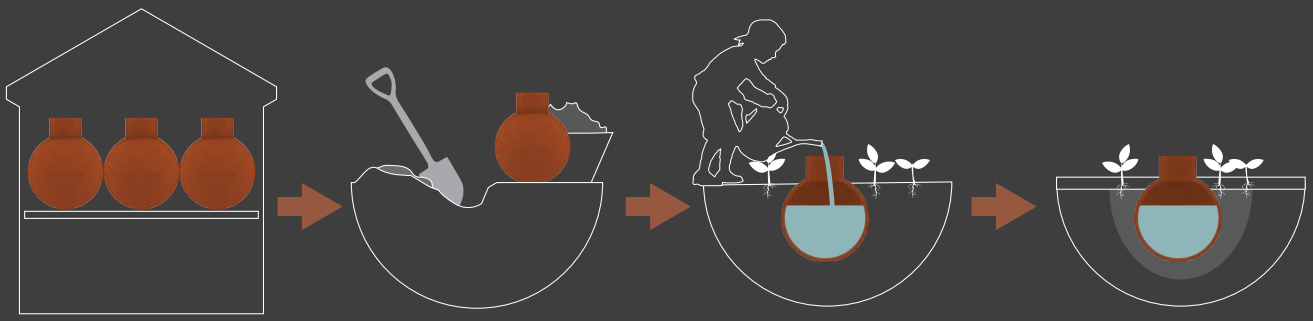
"This leads to very high efficiency, even better than drip irrigation, and as much as 10 times better than conventional surface irrigation." -Bainbridge

Crop Yield per (m^3) of equal water usage

Irrigation Method	Yield
Closed Furrow (basin)	0.7
Sprinkler	0.9
Drip	1-2.5
Porous Capsule (pressure)	1.9+
Porous Capsule (no pressure)	2.5+
Buried Clay Pot	2.5-7

Bainbridge, David A. "Buried Clay Pot Irrigation: a Little Known but Very Efficient Traditional Method of Irrigation." Agricultural Water Management, vol. 48, no. 2, 2001, pp. 79–88.

Garden Application

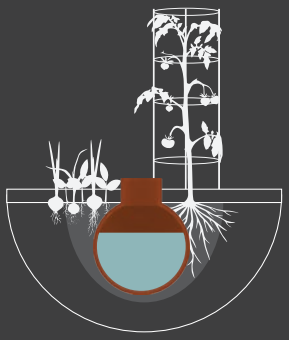


remove from dry storage

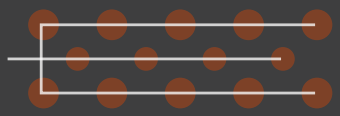
amend soil & bury

plant seedlings & fill ollas

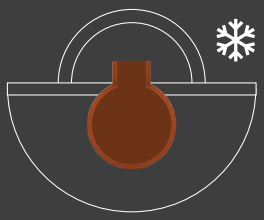
add mulch layer



refill ollas every 2 to 8 days, depending on climate stressors



ollas can be connected & filled simultaneuosly



in dry winter climates, dried terracotta may be insulated & left in place

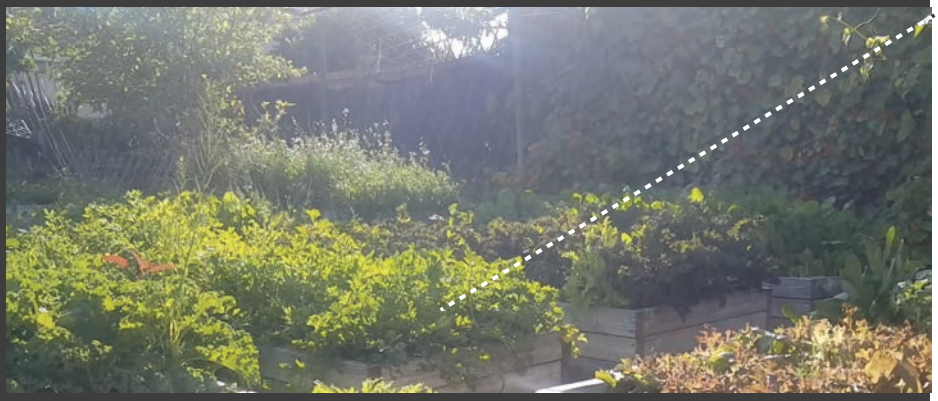
The relatitonship of installing and maintaining a traditional olla is vital. The first step is to amend the soil, dig the hole, and bury the olla with a few inches of the neck sticking out of the ground; this will assist in keeping debris from dropping into the olla. Plant your seedlings and fill the olla. Next, add a few inches of mulch, not to exceed the height of the olla. Mulch mitigates evaporation and increases moisture retention in the soil. Ollas will need to be refilled every 2 to 8 days, depending on climate stressors. Keeping water in the olla prevents plant stress. Ollas can also be simultaneously filled by connecting them with water lines. Some have automated the process of filling ollas with the installation of a float valve connected to a pressure system. Ollas can be removed from the ground or and placed in dry storage, or overwintered while in the ground if they are properly dried, insullated, and covered.

Ollas in Action

"We've been increasing this effective clay pot irrigation method on the urban homestead. In addition, to conserve even more water by adding more oyas to our raised beds and containers. Having first used this irrigation method about three years ago, we have noticed a considerable difference in the growth of plants near the ollas. The plants are healthier, and their growing season is slightly extended since they don't seem stressed due to the constant flow of underground moisture." -UrbanHomestead

The UrbanHomestead is a farm that was established in 1985. It is also a non profit organization that implemented ollas for irrigatiton and empowers others by educating on olla implementation to provide increased access to local food.

UrbanHomestead in Pasadena, California



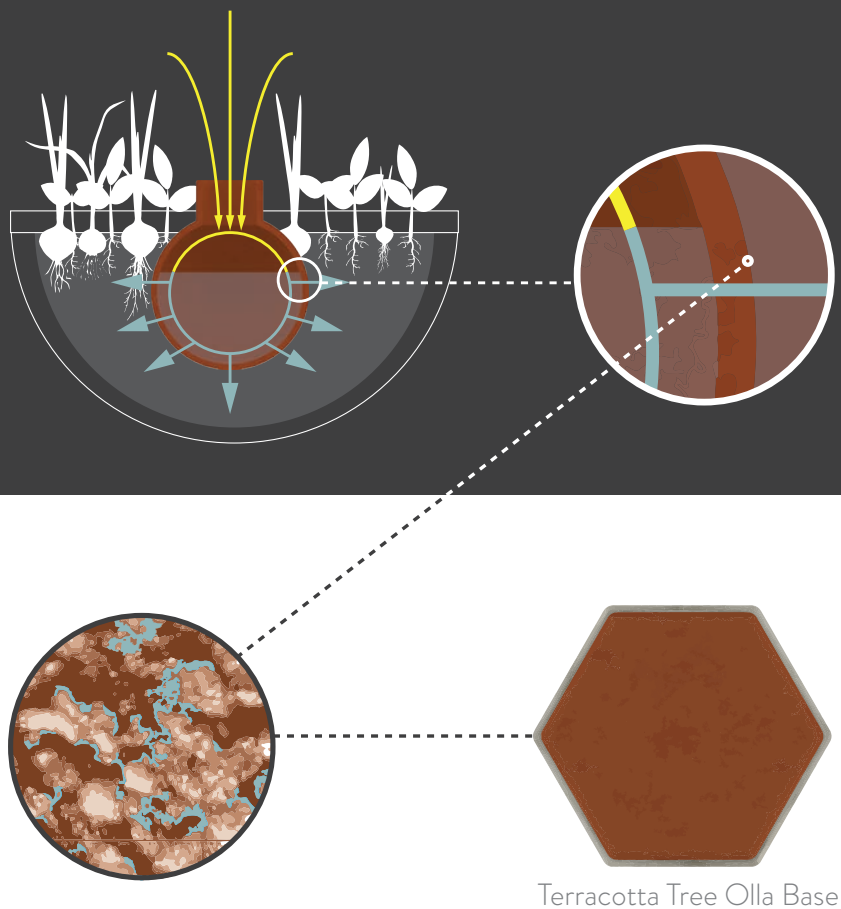
Pioneering a journey to self sufficiency ... one step at a time. The Urban Homestead. (n.d.). Retrieved October 21, 2021, from https://urbanhomestead.org/.

Pioneering a journey to self sufficiency ... one step at a time. The Urban Homestead. (n.d.). Retrieved October 21, 2021, from https://urbanhomestead.org/.

How Ollas Work

Atmospheric pressure and the **terracotta's porous structure** facilitate the **water concentration gradient** in a continuous ebb and flow. A straightforward way to estimate how much water an established tree needs per week in an arid landscape is eight to ten gallons of water for every inch of the tree's diameter, measuring roughly twelve inches from the ground. This diagram also shows how over time, tree ollas can be added to the watering system to meet the volume needs of a tree as it grows.

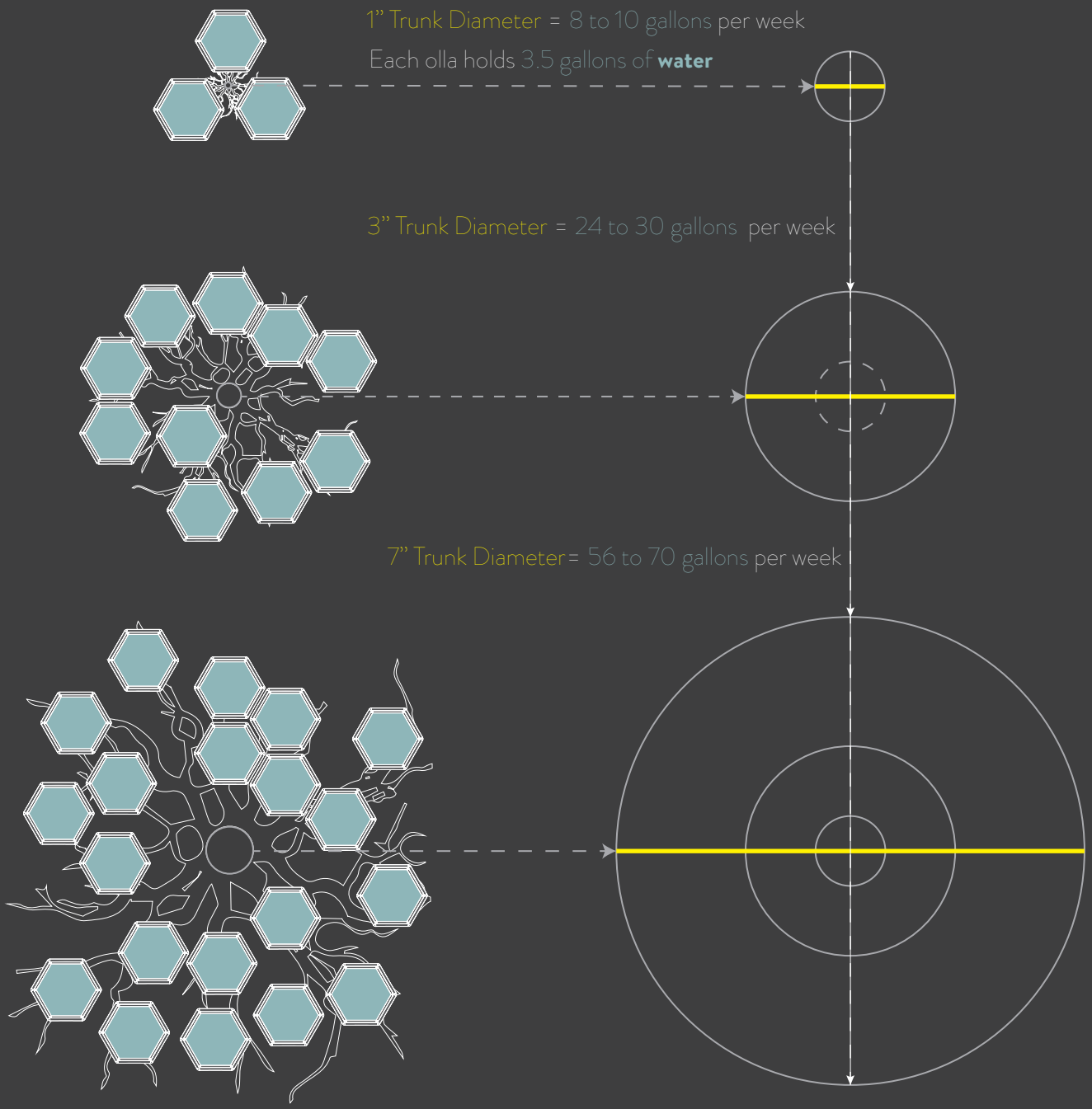
Ollas works through a suction method made from terracotta, a porous, unglazed clay. Due to Soil Moisture Tension, the water is drawn out through the pot's wall when filled with water. Plant roots aid in the creation of suction by absorbing available water, drying up the soil, and producing tension in the earth against the olla's water (a good visualization is to think of how a dry paper towel behaves when it encounters water, the paper towel absorbs the water). As a result, a direct supply and demand system is the result. The roots will eventually develop around the olla, allowing it to water steadily and consistently, avoiding the over and under-watering vegetation. If the is heavy rainfall, water can flow back into a partially full olla via gravity.



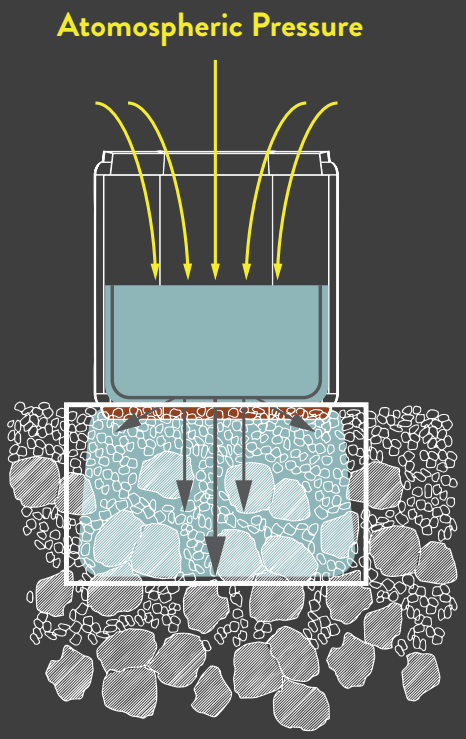
Terracotta Tree Olla Base

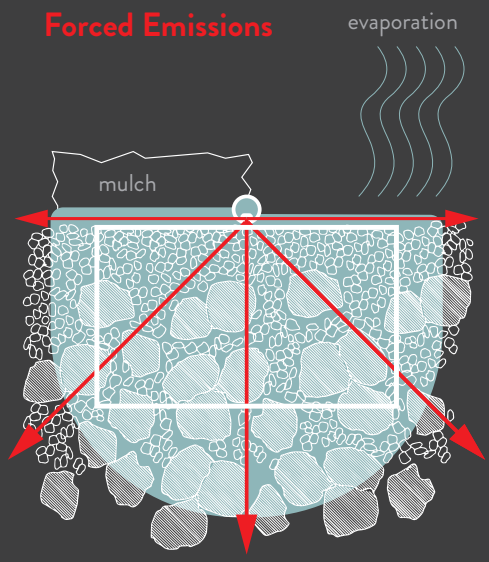
Water Requirements of a Tree Over Time

An easy way to gauge how much water an established tree needs per week in an arid landscape is eight to ten gallons of water for every inch of the tree's diameter, measuring roughly twelve inches from the ground. This diagram also shows how over time, tree ollas can be added to the watering system to meet the volume needs of a tree as it grows.



Water Efficiency: Olla vs Dripline





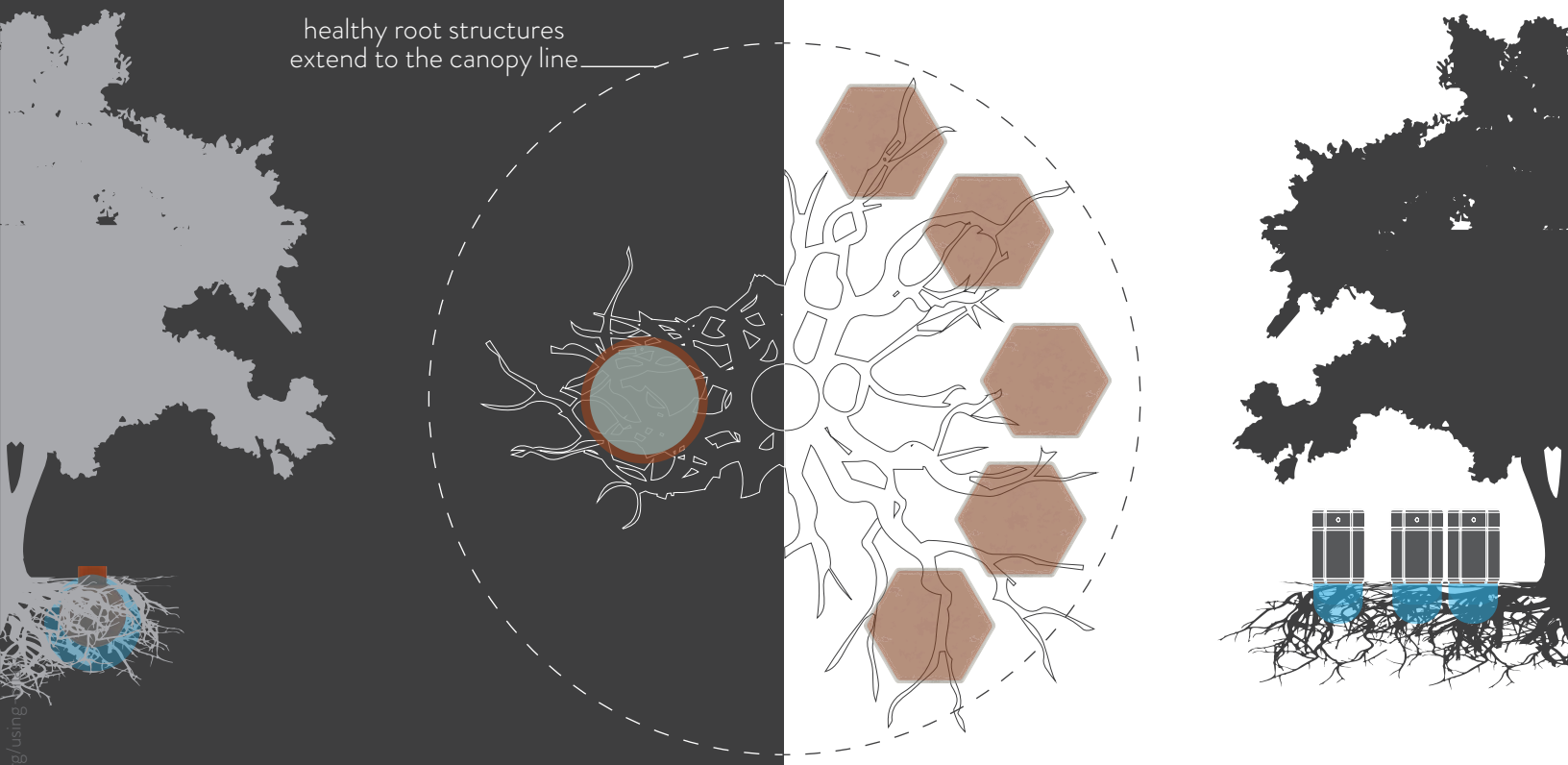
The tree olla takes advantage of atmospheric pressure and is self governing, due to the terracotta's porous structure which facilitates the water concentration gradient, and eliminates the issue of inconsistent watering. The forced emission from a dripline however, is not self-governing and leads to 50% to 70% in wasted water when compared to the efficiency of an olla.

Bainbridge, David A. "Buried Clay Pot Irrigation: a Little Known but Very Efficient Traditional Method of Irrigation." Agricultural Water Management, vol. 48, no. 2, 2001, pp. 79–88.

Olla Redesigned

Traditional Olla

Tree Olla

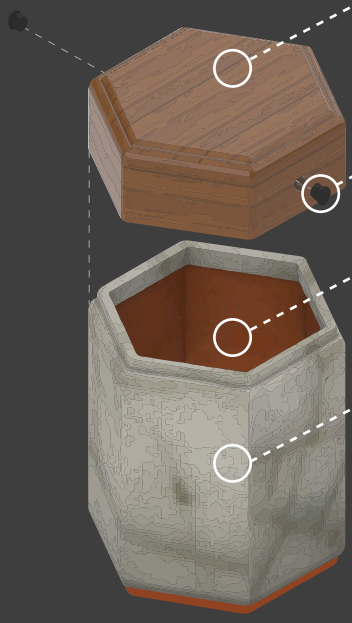


I wanted to utilize the traditional olla's ability to conserve water while supporting the existing vegetation in Bluff, predominantly mature trees. Unfortunately, the traditional in-ground olla isn't an ideal tree watering companion for two reasons: One, the woody roots of a tree may eventually break the terracotta and render it useless. Two, the in-ground olla discourages healthy root structure for perrenials and the roots tend to cluster near the olla, affecting the tree's health and ability to withstand gusts of wind as it ages. With this knowledge, I designed the tree olla, a hybrid of the drip system's above ground approach and the olla's delivery method. The tree olla pairs healthy root structure with water efficiency.

In general, nutrient and water absorption occurs within the top 12" of soil. Trees may absorb between 10 and 150 gallons of water per day, but only about 5% of the water taken by plants is retained for food production and growth. The remaining 95% is used for temperature regulation via transpiration. Xylem and phloem are the tree's vascular system which use passive water movement to allow water columns within a tree to reach extraordinary heights. Some trees are able to vertically transport water 92 feet per hour. The ebb and flow of water is self managed by the tree, and is only dependent on the bio availability of water. So next time you are standing under a tree in the summertime, see if you can detect the humidity that the tree is giving off while it maintains it temperature.

Smith, C. w. (n.d.). Using ollas. The Urban Homestead. Retrieved December 2, 2021, from https://urbanhomestead.org/using

Materials & Specs

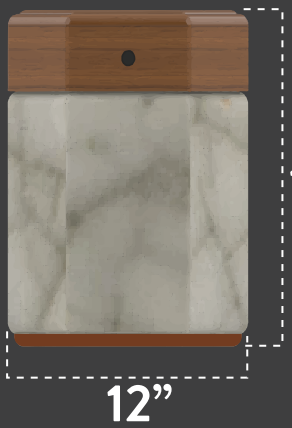


Durable and lightweight **teak sealed with cowboy wax**; a mixture of parafin and linseed oil. Teak is commonly used in ship building for finishwork due to its durability. The lid offers easy access to the inside of the vessel.

Dual openings allow the option to connect multiple ollas for ease of filling. A **latex** stopper seals the opening when not in use.

Terracotta, or "baked earth" naturally manages the ebb & flow between water and earth.

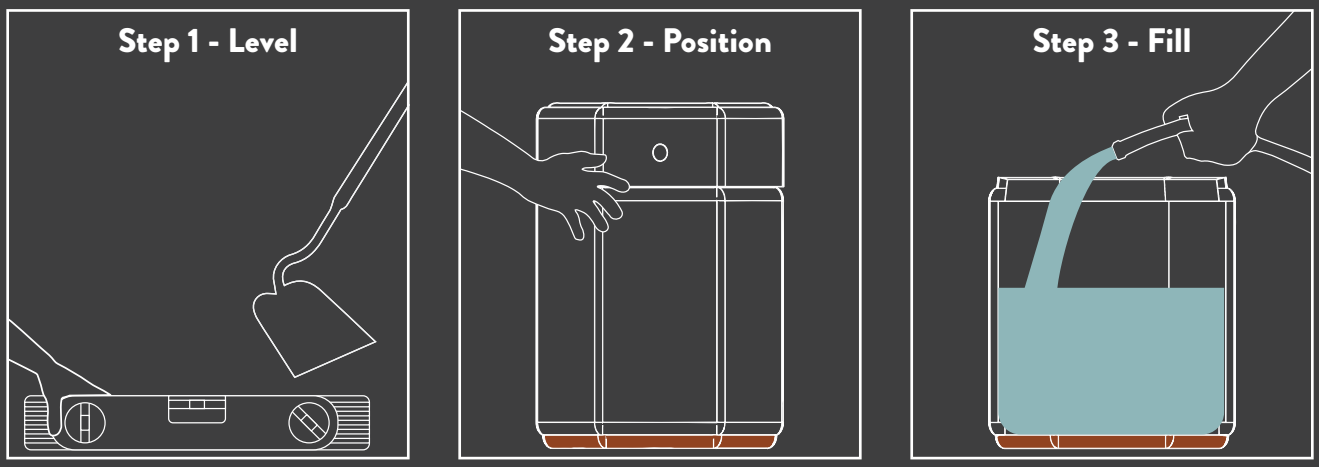
The external **plaster-crete** coating delivers 8,500+ psi of compression strength, and resistance to impact, abrasion, mold, mildew, freezing, & thaw damage. The **enamel** finish allows for custom color variations. These two materials together direct water transfer to occur only at the base.

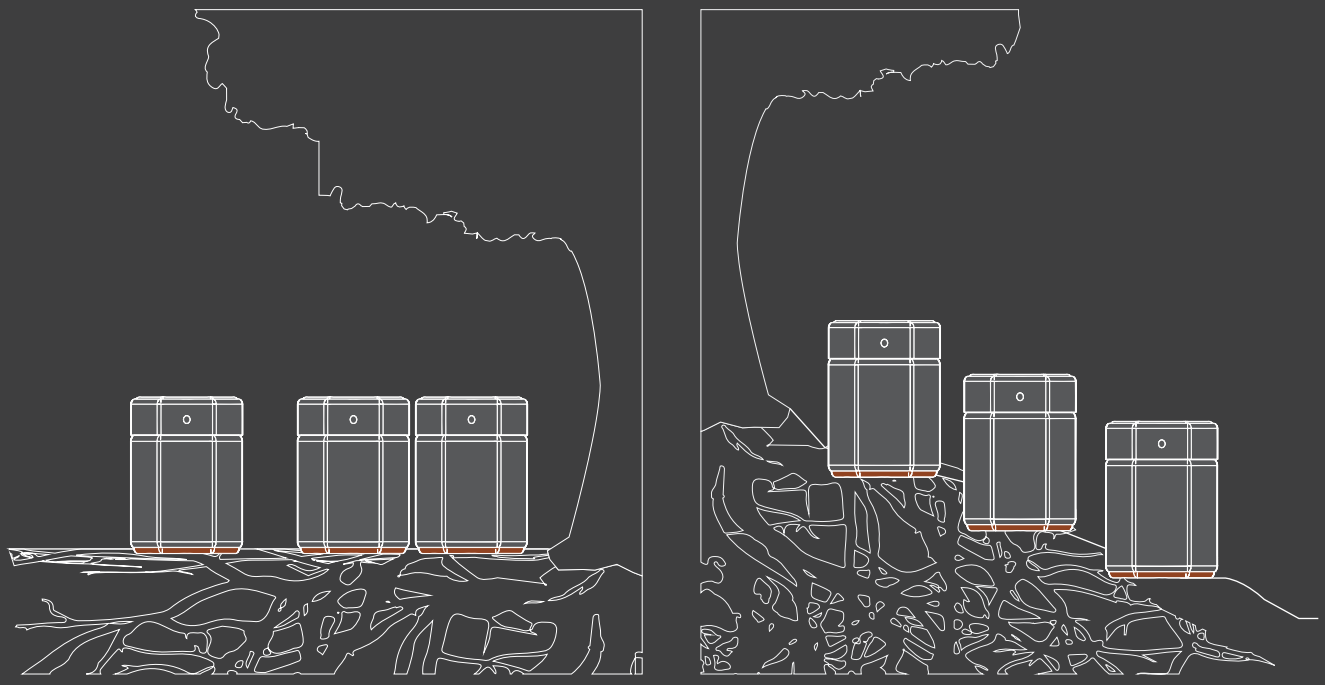


The ergonomic **sitting height** presents the **modular** tree olla as an invitation to sit and reflect, while allowing the user to create a desired sitting area. The size and shape facilitate a modular system that can be configured according to each tree's watering needs.

TREE OLLA

Installation

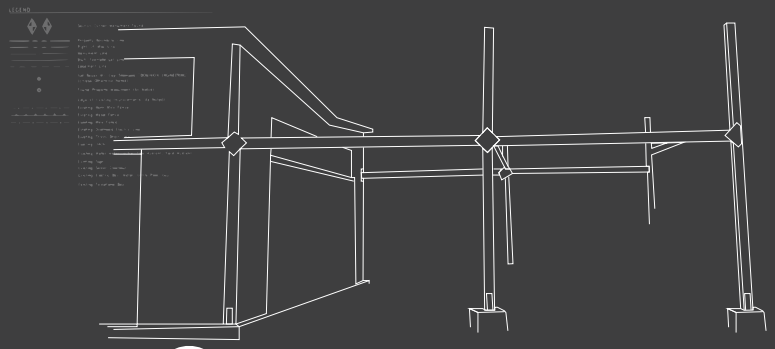




The installation of a tree olla begins with selecting the location and leveling the soil. Next, position the olla and fill with water. The modularity of this system allows the user to position the vessels on flat ground or on leveled sections of an incline.

YESTERMORROW
DESIGN/BUILD SCHOOL

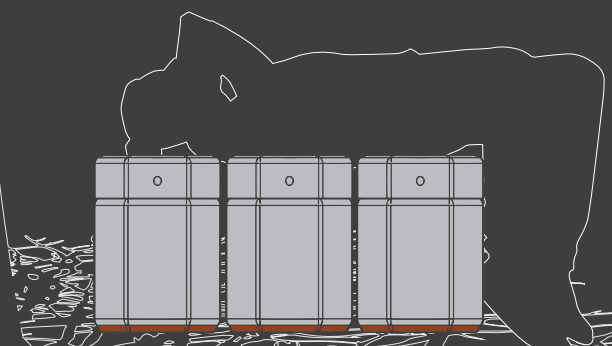
A Hub of Ecopsychology & Sustainable Water Practices

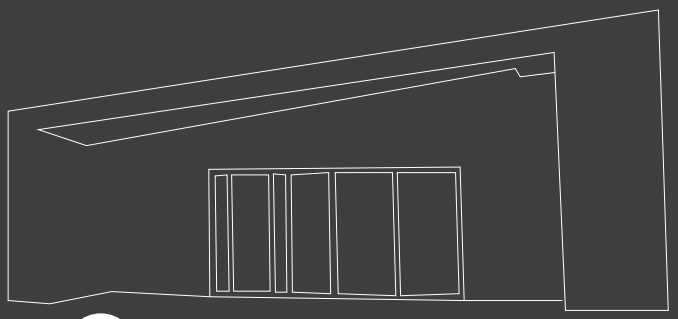


Phase 1 Create & / or Source the Production of Ollas

Imagine Yestermorrow as a hub for ecopsychology & sustainable water practices through reviving a viable age-old watering system for San Juan County and other arid landscapes.

Phase 2 Incorporate Ollas on Yestermorrow's Bluff





Phase 3 Teach Sustainable Water Practices

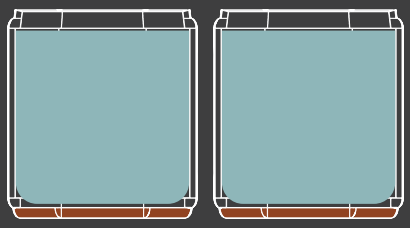
Yestermorrow Design/Build School. (n.d.). Retrieved December 2, 2021, from https://yestermorrow.org/.

Water Saved

Weekly water pick up in San Juan County, using two 55 gallon drums

The Navajo Nation and Clean Water: The Story of Two Sisters. Mrs Greens World. (2021, August 17). Retrieved November 17, 2021, from

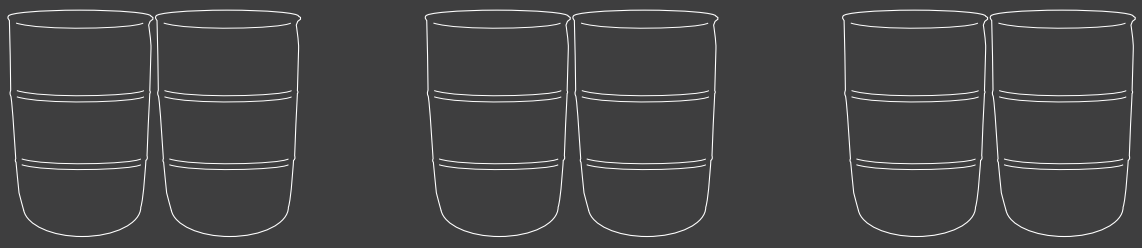
Though fresh water is a limited resource, many still take water for granted. Thousands of San Juan County residents take weekly trips to water stations, as shown in the above image. Using tree ollas would decrease the need for additional trips and save residents' gas, time, and energy by increasing efficient watering for trees in the region.



Per year using 2 ollas saves:

- 364 gallons of water
- 3 Weekly trips

1 drum = 459 lbs



Bibliography

Bainbridge, David A. “Buried Clay Pot Irrigation: a Little Known but Very Efficient Traditional Method of Irrigation.” Agricultural Water Management, vol. 48, no. 2, 2001, pp. 79–88.
This journal informed my thinking about the science and efficiency of olla—I used the research & data in this journal in this design project.

Ballisticrete. GigaCrete. (n.d.). Retrieved December 2, 2021, from https://www.gigacrete.com/ballisticrete.
The materials mentioned on this product site are similar to the plaster-crete used for the exterior coat of the tree olla design.

Martinez de Azagra Paredes, A, and J Del Rio San Jose. “Pitcher Irrigation: Some Theoretical and Practical Aspects.” Irrigation and Drainage, vol. 68, no. 3, 2019, pp. 542–550.
This journal informed my thinking about the science and efficiency of olla—I used the research & data in this journal in this design project.

National Geographic Society. (2019, June 21). Freshwater Resources. National Geographic Society. Retrieved December 2, 2021, from https://www.nationalgeographic.org/article/freshwater-resources/.
This web article addresses the access issues around freshwater and it being a limited resource.

Navajo Nation continues to experience drought. Navajo-Hopi Observer News. (n.d.). Retrieved December 1, 2021, from https://www.nhonews.com/news/2021/oct/12/navajo-nation-continues-experience-drought/.
This article is where I derived the image & knowledge about weekly water pick up and other issues related to access to water.

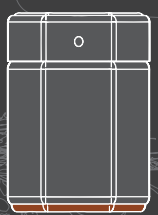
Pioneering a journey to self sufficiency ... one step at a time. The Urban Homestead. (n.d.). Retrieved October 21, 2021, from https://urbanhomestead.org/.
This website has water recommendations for trees.

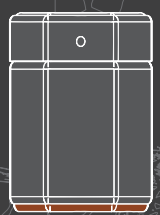
Slc.gov. Public Lands Department. (n.d.). Retrieved December 2, 2021, from https://www.slc.gov/parks/urban-forestry/tree-care-information/.
This website has water recommendations for trees.

Smith, C. w. (n.d.). Using ollas. The Urban Homestead. Retrieved December 2, 2021, from https://urbanhomestead.org/using-ollas/.
IN THIS ARTICLE, Curtis W. Smith, NMSU Extension Horticulture Specialist, about ollas and their preferred use while also covering the issues related to woody roots.

Utah. Drought.gov. (n.d.). Retrieved November 1, 2021, from https://www.drought.gov/states/utah.
Drought data was pulled from this website.

Yestermorrow Design/Build School. (n.d.). Retrieved December 2, 2021, from https://yestermorrow.org/.
This is the partners website.





I want to thank everyone who contributed to this project with their suggestions and input, including Professor Elpitha Tsoutsounakis & the partner YESTERMORROW DESIGN/BUILD SCHOOL
A Hub of Ecopsychology & Sustainable Water Practices

The hybridization of drip systems and traditional ollas creates a revolutionary product that focuses on saving water. The hexagonal, modular design mimics a natural system that can be used as a space to sit and reflect. In addition, these ollas have been elevated to the surface as a reminder that water is the most prominent and invaluable resource for all living species.

Tree Olla