OLLA PODS

Olla Pods by Poured Earth Collaborative (PEC) proposes a circular relationship among earth, sky, humans, and non-humans designed to walk in tandem with the journey of Modern Elder Academy's curriculum. The trilogy of interventions provides soulful contemplation in conjunction with both wild and equine inhabitants of the site. The project is built with soil materials that come from the site to carve spaces for humans who are going through the life changing curriculum of the Modern Elder Academy, to MEET one another in a larger setting, to BOND with one or two other participants, and then to REFLECT in a solitary manner on the journey of the week. The trilogy of experiences lies along a loop walk from the central point between the two MEA campuses, along the road tangent to the saddle for which Saddleback Ranch is named, and up into the highest prospect view of the entire campus, providing a contemplative experience of the landscape. MEET, BOND, and REFLECT meet the sky in a roof plane to collect solar power and water. The project redistributes these sky resources to the ground, to the plants, the animals, and the humans, providing a drinker at each site, sized to different animals' needs, a seepage from each drinker provides water for native pollinator forbs and grasses, and a filter at each site allows humans to fill water bottles. The project seeks to provide MEET, BOND, and REFLECT experiences among human attendees of Modern Elder Academy, the non-human sentient beings, and the elemental forces of the New Mexico landscape.

Regeneration

The olla is a traditional method of water distribution employing a terracotta gourd like shape placed underground with an open neck to the sky. The olla is filled with water and plant roots create a network in the soils adjacent to transfer water from the porous terracotta to the plant itself. We chose this analog technology of water distribution as the metaphor for our design, using the capacity of materials underground to promote health and resilience aboveground. The landscape of Saddleback Ranch has the common scars of overgrazing and drought found in northern New Mexico. While over-grazing has stopped due to MEA ownership

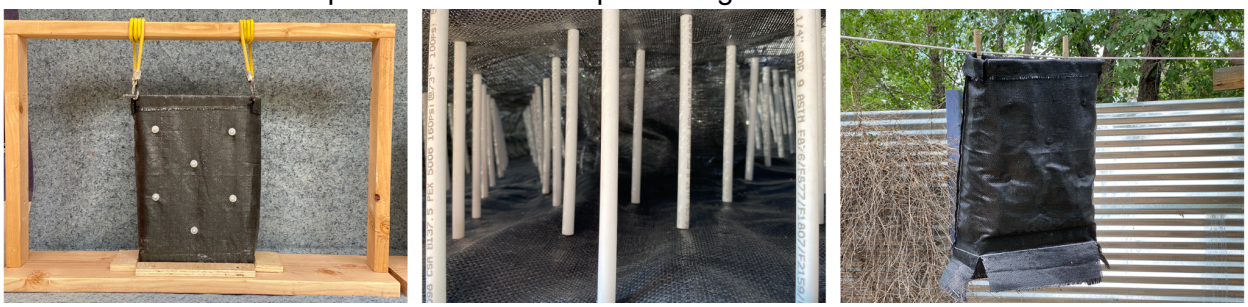
and new management by Lee Johnson, the ongoing challenges of restoration, climate change, and drought require resilient design. Olla Pods proposes a distributed approach to engaging with the landscape. The trilogy of sites suggests that different treatments can be scaled to soil types and different levels of human use. Olla Pods employs a version of “plug and spread" - borrowing Bill Zedyck’s terminology for holding water in surface treatments that allow for slower surface absorption and root availability – to develop and extend seed banks of grasses and forbs that provide forage, pollinator habitat, and increased soil health. The two literal terracotta drinkers will act as ollas, spreading water at the root zone of plants, while the terracotta slices that spread water on the surface of the adjacent areas from roof drips, spread water in areas mulched and seeded with native perennials. Soil covers, after construction disturbance, will be all mulches from on-site harvested materials – chipped shrub, tree trimmings, and cholla. These soil covers will be inoculated with microbes and fungi beneficial to the range of grasses and perennials chosen to create underground networks of support. Thus, the Olla Pods regenerate soil, community, soul, and local culture.

Technologies

- Poured earth - poured earth allows for the use of site soils with roughly 30% clay content as infill panels for construction with a method like pouring concrete, instead of creating a two-step brick process. This site has soils with a 29-30% clay content per soil sample testing by GEO. Through extensive testing (see image below) the optimal mix formula so far determined by the authors is a 52% aggregate (with a gradation of sizes from sand to ¼” gravel), 28% clay, and 20% water mix, which is mixed mechanically and allowed to soak for at least 24 hours and at most two weeks before pouring. At two weeks, the mix needs to be rehydrated. The poured earth process uses formwork and conventional mixing equipment to pour the material.

- Fabric forms - fabric forming allows the poured earth to swell and then shrink in a liquid and flexible manner. Fabric formwork also is light, easy to carry to a site, and easy to reuse with earthen materials, which do not adhere to the material. Fabric forms used with pouring concrete posts and beams allows for a light formwork that generally is not reused, because of adherence issues. In both cases, fabric formwork creates a smaller carbon footprint due to needing to bring less heavy material to a site. Fabric formwork allows for exterior vibration of the material, which removes air pockets in the pour. The fabric is sewn with triple

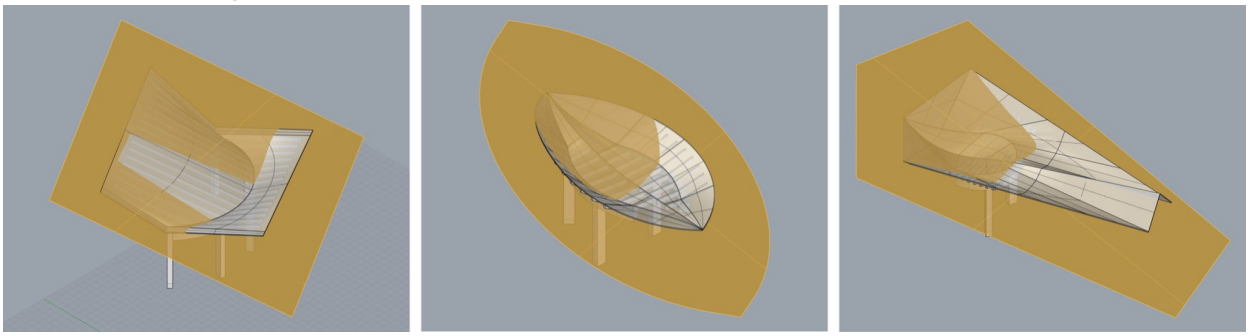
seam zig zag stitching and requires hemming to reduce frayed material sticking inside the poured material and preventing form removal.



- Rafter rotated supports for fabric forms - Using a central plate and rotating rafters to support the fabric forms allows the entire piece to be cast using materials that will stay on site as part of the installation, rather than materials that need to be hauled off-site. (a) below rafters self-supporting, (b) fabric bag suspended from rafters and affixed to ground plate, (c) fabric bag loaded with wet soil mix, and (d) final piece with rafters extended.

- Olla direct transfer of water to soils and plant roots – the drinkers are designed to use terracotta tiles to allow water to infiltrate into surrounding soils and in symbiosis with plant roots. Downcutting of arroyos and more infrequent and heavier storm events removes water from surface roots. The olla technology returns water to the root zone by using the naturally porous quality of terracotta.
- Rainwater harvesting – the roofs of the trilogy of interventions are all optimized for rainwater collection as well as solar collection. The roofs are sized for storage for the drinkers on site. Drinkers are sized to attract different scales of animals. The water will be stored at roof level in custom tanks supported by the roof rafter system. This provides water pressure to run the water through particle filters and UV filters for human consumption. The particle filter will also lengthen the lives of the pumps. See rainwater calculations in addendum.
- Flexible solar cells- these ultra-thin solar cells are laminated to metal panels for use in the optimized roof design. “Soltronix solar panels are designed and engineered to be the most durable semi-flexible crystalline silicon panels on the market. They are made from high-efficiency SunPower solar cells and paired with a proprietary encapsulation system that ensures the best durability and environmental protection. All modules are tested at the end of the manufacturing process to ensure they exceed the advertised performance. The encapsulation

stack used in the Soltronix panels offers protection from hot, humid environments, icing, water immersion, and saltwater spray. Additionally, the encapsulation stack has been engineered to withstand ½" hail with no degradation in panel performance." https://www.powerfilmsolar.com/products/soltronix-solar-panels



MEET, BOND, and REFLECT showing roof configuration and solar angle

- Solar charger powered wildlife camera will be set up at each drinker to provide a record of wildlife and an ongoing archive to study the effects of improved land management on the wildlife populations. MEA participants will have a chase to view footage from dusk and dawn visitors, and the wildlife cameras will keep a record of visitors even when MEA is not in session. Reconyx Hyperfire 2 Cellular Camera - Verizon with Solar Charger battery pack transfers imagery to computer or phone for viewing at MEA education centers.

Reconyx wildlife camera images, Sevilleta National Wildlife Refuge, daytime, and nighttime Harris 2016

Activities

Human activities include:

- Viewing clouds and landscape
- Drinking filtered rainwater
- Shaded resting on a hike
- Meeting fellow retreat attendees
- Bonding with fellow retreat attendees
- Reflecting on the experiences of retreat
- Wildlife watching - pollinators and birds, kangaroo rats, bats, coyotes both in the field and at the learning facilities
- Reflection on water and power relationships to square footage of roof - on site LED screen keeping track of water storage and battery charge will also include facts about the roof design and square footage
- Charging cell phones or lights
- Reflection on the earth's ability to provide shelter

Non-human activities include:

- Horses and other larger animals drinking water at MEET
- Bats, coyotes, kangaroo rats, vultures, antelope, and others drinking water at BOND
- Small birds and kangaroo rats drinking water at REFLECT
- Perennial plants sharing water and sugars through roots due to more moist soils
- Mulches nurturing microbial life and mycelia to enrich soils and further create resilient opportunities for plants to extend their drought resistance
- Mycelia exchanging and sequestering carbon below ground in grassland areas.
- Male longhorn native bees sleeping in perennial sunflower blooms
- Pollinators and bird species multiplying due to scattered oasis effect on landscape
- Seed bank in soils on site increasing in diversity after long overgrazing simplified planting palette
- Kangaroo rats moving seeds into nests and fermenting and sprouting rice grass and gramma grass seeds.

System inputs and maintenance

Maintenance:

- Change particle filters on rainwater collection tanks - annually
- Trim / maintain perennial vegetation for benefit of pollinators - annually
- Check thermal containers for solar power components biannually - before first frost and after last frost
- Check UV drinking water filters for water dispensers - quarterly
- Check float switches to make sure pumps are being maintained - quarterly
- Check solar pack on wildlife cameras, update computer access in campus buildings to allow MEA participants to view wildlife images - quarterly

System outputs

- **Solar power:** MEET, BOND, and REFLECT each produce 52 kwh/yr. This capacity is above the needs of the pump and filters and can be used for charging devices, providing lights for MEET, and running LED interpretive panels. No lighting is suggested at BOND and REFLECT to improve non-human experiences. See spreadsheet attached.
- **Water collection:** MEET, BOND, and REFLECT each collect rainwater based on the scale of each roof. See attached spreadsheets for rainwater harvesting design. The amount of collection is sized to the needs of each drinker.
- **Biomass**: Each installation grows biomass based on reuse of water collected. The biomass will consist of grasses and perennials. See attached planting sheet for pollinator friendly and rangeland friendly grasses and forbs.
  MEET - 300 gallons of storage will water roughly 12 square feet of area, or 12 cubic ft of biomass
  BOND - 150 gallons of storage will water roughly 7 square feet of area, or 7 cu ft. of biomass
  REFLECT - 10 gallons of storage will water roughly 1 square foot of area, or 1 cu. ft. biomass.

Primary materials and dimensions

MEET:

- Fabric Formed Poured Earth infill panels 8’ x 4’ in 20’ diameter partial arc
- Low Carbon Concrete posts and bond beam - concrete with slag and fly ash to reduce Portland cement. (Slag and Fly ash are by-products from other industries. The ⅓ slag, ⅓ fly ask, ⅓ Portland cement mix for 10% of overall concrete formula along with aggregates, reduces Portland cement by 2/3rds. This special mix to be delivered to site in bags.)
- 2” x 6” x ⅛” wall steel rafters
- 1/16” cold rolled sheet metal roof in overlapping shingles
- 9.5” x 6.6” x 6’-0” = 10-gal stainless steel tanks x 30 for 300 gallons of rainwater storage, with copper piping
- 6’ diameter horse trough drinker - off the shelf, galvanized steel

BOND:

- Fabric Formed Poured Earth infill panels - 8’ x 4’ arranged in 24’ diameter arcs
- Low Carbon Concrete posts and bond beam - concrete with slag and fly ash to reduce Portland cement. (Slag and Fly ash are by-products from other industries. The ⅓ slag, ⅓ fly ask, ⅓ Portland cement mix for 10% of overall concrete formula along with aggregates, reduces Portland cement by 2/3rds. This special mix to be delivered to site in bags.)
- 2” x 6” x ⅛” wall steel rafters
- 1/16” cold rolled sheet metal roof in overlapping shingles
- 9.5” x 6.6” x 6’-0” = 10-gal tank x 10 with copper piping

- Custom fabricated terracotta tiles from site clay to form “bat drinker”
- “Bat drinker” 10’ x 30” x 6” with corner slopes for animals to self-rescue if they fall in.

REFLECT:

- Fabric Formed Poured Earth infill panels - 8’ x 3’ arranged in 7’ diameter arcs
- Low Carbon Concrete posts and bond beam - concrete with slag and fly ash to reduce Portland cement. (Slag and Fly ash are by-products from other industries. The ⅓ slag, ⅓ fly ask, ⅓ Portland cement mix for 10% of overall concrete formula along with aggregates, reduces Portland cement by 2/3. This special mix to be delivered to site in bags.)
- 2” x 6” x ⅛” wall steel rafters
- 1/16” cold rolled sheet metal roof in overlapping shingles
- 9.5” x1’-0” x 6’-0” = 10-gal tank x 1 for 10 gallons of storage
- Bird bath drinker 10” diameter shallow slope for animal self-rescue

Environmental impact statement

The central technology of Olla Pods is Fabric Formed Poured Earth (FFPE) developed to use site materials, reduce transportation of material to a site, engage with southwestern and worldwide histories of earthen architecture, and expand the lyric possibilities of earth as a material. Poured Earth Collaborative has published in ARCC, will be presenting at Earth USA conference, and has articles pending at Council of Educators in Landscape Architecture's Landscape Record and at Technology Architecture and Design. FFPE cuts the Portland cement content of a structure from 10% to 1% by replacing poured concrete forms with poured earth infill panels. (O'Geen and Harris, ARCC 2022) PEC's research weighing form materials for panelized (conventional concrete forms) and fabric forms suggests that fabric formwork cuts the weight of formwork in half in comparison. (O'Geen and Harris, Earth USA 2022) This savings of material movement to the site is extended by reusing the rafters as fabric bag supports, rendering the emissions of the FFPE system with rotating rafters approximately 10% of a conventional formwork system, due to reuse of the material in the built form itself. The only materials brought to the site and not used as part of the structure are cross bracing.

FFPE is not a structural material; concrete posts and beams are required. Olla Pods seeks to mitigate the impact of these structural elements by reducing the content of Portland cement by specifying concrete formula will be ⅓ slag, ⅓ fly ash, ⅓ Portland cement. This special mix will be delivered to site in bags and have roughly one third the carbon footprint for material. (Per US Concrete Low CO2 Concrete Fact Sheet)

Steel, while requiring heavy inputs of heat and impacts of mining ores, also has a high recycled content. "In November 2009, Nucor Steel released a memo related to recycled content in its steel products. The average recycled content (sum of the post-consumer and pre-consumer steel) for the company's steel is Steel Bar 97.7% Steel Plate 92.5% Steel Beams 76.2% Sheet Metal 70.2%. For all Nucor products combined, the amount of post-consumer recycled content used is 78%, and the amount of pre-consumer recycled content used is 11%. While these numbers can vary based on the fabricator and the availability of scrap metal, they can serve as preliminary values for determining LEED criteria and comparing the sustainability impact of various structural systems." Olla Pods uses steel for tanks, roof sheathing, and structure. Sheet metal can be up to 100% recycled material, including for stainless tanks.

Locally harvested clays will be used for the terracotta drinkers. Olla Pods proposes to work with Jane Gordon who fabricates for Jami Porter Lara, using indigenous derived pit firing methods. While involving carbon release through burning wood, this biomass-based firing method is much less energy intensive than a conventional electric kiln and is appropriate to the temperatures for terracotta materials, retaining porosity.

Addenda:

Soil tests for sites selected
Rainwater harvesting worksheets

Electrical balance sheet for solar energy
Plant list

References:

Rangeland grasses source: New Mexico Range Plants
Circular 374
Revised by Christopher D. Allison and Nick Ashcroft
College of Agricultural, Consumer and Environmental Sciences, New Mexico State University
https://pubs.nmsu.edu/_circulars/CR374/

Pocket Guide to the Native Bees of New Mexico
Tessa R. Grasswitz, New Mexico State University, Agricultural Science Center, Los Lunas, NM
David R. Dreesen, Natural Resources Conservation Service Plant Materials Center, Los Lunas, NM

PLANT MATERIALS TECHNICAL NOTE NO. 71 (Final Revision) Pollinator Plant Recommendations for New Mexico David R. Dreesen, Agronomist/Horticulturist Los Lunas Plant Materials Center Tessa R. Grasswitz, Assistant Professor, Urban/Small Farms IPM Specialist New Mexico State University

Research on Fabric Formed Poured Earth:

Fabric Formed Poured Earth: Using Urban Site Soils in Fabric to Eliminate Portland Cement
Architectural Research Consortium Conference (ARCC) - Miami 2022
Charlie O'Geen, Kendall College of Art and Design, Grand Rapids, MI
Catherine Page Harris, University of New Mexico, Albuquerque, NM

Full papers pending acceptance for publication:

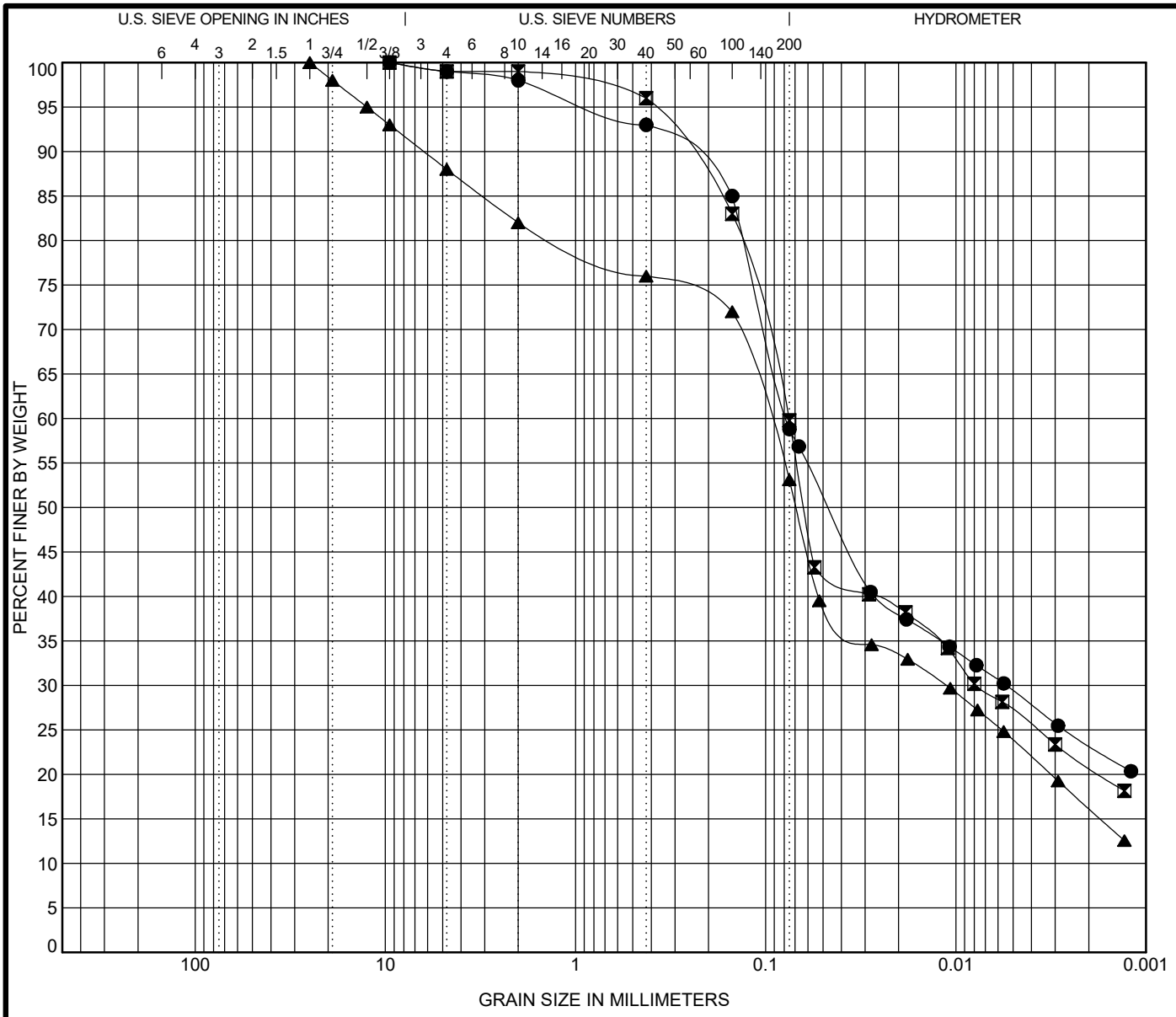
Poured earth formwork: limiting transportation by using fabric and temporary staging as permanent structure, Earth USA, 2022

Fabric formed unstabilized poured earth: four-dimensional wall systems, Technology, Architecture and Design, "Tectonics Issue" 2022

POURED EARTH: SITE SOIL: A POETICS OF TERROIR, Landscape Research Record, Proceedings of the Council of Educators in Landscape Architecture, 2022

Credits:

Catherine Page Harris
Charlie O'Geen
Andrew Dancer
Julia Jeffs
Aaron Ketner
Jennifer Rudgers



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**H20 Bottle**	**4523.0**						
⊠	**Sample B**	**4524.0**						
▲	**Sample C**	**4525.0**						

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**H20 Bottle**	**4523.0**	**9.5**	**0.077**	**0.005**		**1.0**	**40.2**	**29.4**	**29.4**
⊠	**Sample B**	**4524.0**	**9.5**	**0.075**	**0.008**		**1.0**	**39.2**	**32.6**	**27.2**
▲	**Sample C**	**4525.0**	**25**	**0.097**	**0.011**		**12.0**	**34.9**	**29.2**	**23.9**

GEO-TEST

GRAIN SIZE DISTRIBUTION

Project: Miscellaneous Testing

Location: Client Delivered

Number: 3-20411

US GRAIN SIZE 3-20411.GPJ GEO TEST.GDT 4/20/22

MEET Rain Harvesting Design Worksheet - Horse Drinker

Design Parameters

Catchment Size	430	square feet
Collection Efficiency	85%	
Drinker	1	drinker
Per Drinker Demand	4.7	gallons/day
Monthly Demand	141	gallons/month
Storage Tank	300	gallons
Initial Storage	300	gallons

Monthly Water Balance

Month	Drinker demand	Outdoor Water Demand (gal)	Total Demand (gal)	Rainfall (in)	Water Supply (gal)	End of Month Storage (gal)
January	141	1	142	0.5	113.3	158
February	141	1	142	0.3	68.0	84.0
March	141	1	142	0.6	136.0	77.9
April	141	1	142	0.6	136.0	71.9
May	141	1	142	0.6	136.0	65.9
June	141	1	142	0.4	90.6	14.5
July	141	1	142	2.3	521.2	393.7
August	141	1	142	1.9	430.6	682.3
September	141	1	142	1.8	407.9	948.2
October	141	1	142	1.2	271.9	1078.1
November	141	1	142	0.5	113.3	1049.4
December	141	1	142	0.7	158.6	1066.0

Delta Storage -766.0

assumptions:

water evaporates at 1" per day per surface square foot

drinker is 70 cubic feet (6' diameter trough, 2.5' deep)

roughly 140 gallons in drinker

340 sq in evaporates per day

2.35 sq. ft evaporates per day

2 gallons per day evaporates up, 2.7 gallons evaporates down into soil

BOND: Rain Harvesting Design Worksheet - Bat Drinker

Design Parameters

Catchment Size	170	square feet
Collection Efficiency	85%	
Drinker	1	drinker
Per Drinker Demand	2	gallons/day
Monthly Demand	60	gallons/month
Storage Tank	150	gallons
Initial Storage	150	gallons

Monthly Water Balance

Month	Drinker demand	loor Water Demand	Total Demand (gal)	Rainfall (in)	Water Supply (gal)	End of Month Storage (gal)
January	60	1	61	0.5	45	89
February	60	1	61	0.3	27	55
March	60	1	61	0.6	54	48
April	60	1	61	0.6	54	40
May	60	1	61	0.6	54	33
June	60	1	61	0.4	36	8
July	60	1	61	2.3	206	153
August	60	1	61	1.9	170	262
September	60	1	61	1.8	161	363
October	60	1	61	1.2	108	409
November	60	1	61	0.5	45	393
December	60	1	61	0.7	63	395

assumptions:

water evaporates at 1" per day per surface square foot

drinker is 250 sq. ft (10' x 2.5' x 1' deep)

roughly 190 gallons in drinker

250 sq in evaporates per day

1.7 sq. ft evaporates per day

2 gallons per day, + water into ground .3 gal per day

Delta Storage -245

REFLECT Rain Harvesting Design Worksheet - bird bath

Design Parameters

Roof Size	56	square feet
Collection Efficiency	85%	
Drinker	1	drinker
Per Drinker Demand	0.5	gallons/day
Monthly Demand	15	gallons/month
Storage Tank	75	gallons
Initial Storage	75	gallons

Monthly Water Balance

Month	Drinker demand	water evaporation (gal)	Total Demand (gal)	Rainfall (in)	Water Supply (gal)	End of Month Storage (gal)
January	15	1	16	0.5	14.8	59.0
February	15	1	16	0.3	8.9	51.9
March	15	1	16	0.6	17.7	53.6
April	15	1	16	0.6	17.7	55.3
May	15	1	16	0.6	1.8	41.0
June	15	1	16	0.4	11.8	36.8
July	15	1	16	2.3	6.8	27.6
August	15	1	16	1.9	5.6	17.2
September	15	1	16	1.8	53.1	54.4
October	15	1	16	1.2	35.4	73.8
November	15	1	16	0.5	14.8	72.5
December	15	1	16	0.7	20.7	77.2

Delta Storage -2.2

assumptions:

water evaporates at 1" per day per surface square foot

drinker is 12" diameter and shallow for drop sounds and bird bathing

roughly 1 gallons in drinker

12 sq in evaporates per day

1 sq. ft evaporates per day

.5 gallons per day,

Plant List - MEA LAGI 2022

Grasses:

Blue Gramma - Bouteloua gracilis

Description

Low-growing, 6 to 12 inches tall, with seed stalks occasionally reaching 4 feet. Grayish-green curing to gray or straw yellow. Leaves basal, fine, 2 to 5 inches long, with hairs at the junction of the leaf blade and stem. Seeds most commonly in two comb-like, purplish spikes on each seed stalk.

Hairy Gramma - Bouteloua hirsuta

Description

One to 2 feet tall. Closely resembles blue grama. Bluish-green while growing, cures to gray or straw color. Leaves, fine and narrow with tiny pimple-like projections containing hairs along the margins. Hairs often found along the midrib. Comb-like flower heads, usually two, remain on leafless flower stalks throughout winter. A beak-like naked projection extends about 1/4 inch beyond flower head.

Rice Grass - Oryzopsis hymenoides

Description

Leafy, tufted. One to 2 feet tall. Rigid, erect stems. Dark green while growing, cures to a light straw color. Numerous long, slender, and inrolled leaves. Loose, widely spreading seedheads with main branches divided into two wavy branchlets, each supporting an oval, hairy, black seed at the end.

Flowering plants (forbs) - from NMSU pollinator friendly list

white:

Yarrow: Achillea millefolium

Yarrow is an aromatic perennial with clusters of small white or pink flowers, ferny foliage to 1 ft. or more. Invasive in wet places. Tolerates light traffic and mowing. Leaves pressed together were used to staunch wounds. Named for Achilles whose wound, sadly, could not mend. Blooms all season. Barely cover seed, light helps germination. Sow anytime. Zones 2-8.
https://www.wildflower.org/gallery/species.php?id_plant=ACMI2 - for images

Basin fleabane: Erigeron pulcherrimus

Erigeron pulcherrimus grows with compact tufts of vertical basal leaves. Stem leaves clasp and are reduced upward or are not present. Leaves and stems have appressed, short, scattered hairs oriented vertically. Phyllaries are often imbricate (overlapping, shingle-like, in several rows). Dried, straw-colored leaves, upright flower stems, and conspicuous phyllaries persist for months after flowers fade.
https://www.wildflower.org/gallery/result.php?id_image=2171 - for images

Sacramento Mountains southwestern prickly poppy: Argemone pleiacantha ssp. pinnatisecta

Argemone pleiacantha is a species of flowering plant in the poppy family known by the common name **southwestern prickly poppy**. It is native to Arizona and New Mexico in the United States and Chihuahua, and Sonora in Mexico, where it occurs in dry woodlands and slopes of foothills and mountains. It is an annual or perennial herb with branching, erect stems up to 1.5 meters tall. The plant is covered in prickles, often densely. The blue-green leaves are divided into sharp, toothlike lobes. The flower buds are up to 2 centimeters long and covered in prickles. They bloom into showy white-petalled flowers which may be up to 16 centimeters wide. The fruit is a capsule up to 4.5 centimeters long which is covered in prickles. Plant away from humans, good for pollinators and rare. https://nmrareplants.unm.edu/node/14 - images

Blues:

MacDougal Verbena: Verbena macdougalii
Harshly hairy plant with 4-sided stems, and thick, dense, long, erect spikes each with a ring of small, lavender to blue-violet bilaterally symmetrical flowers at one level. This species resembles members of the mint family, but lacks the aromatic odor. There are several species of tall Verbena, with thick or slender spikes of flowers, that are usually not easy to distinguish from one another. New Mexico Vervain has relatively thick spikes; it is common in the southern Rocky Mountain region. https://www.wildflower.org/gallery/result.php?id_image=85404 images

Wasatch penstemon: Penstemon cyanothus
Wasatch Penstemon bears handsome, 1" long, tubular blue flowers above thick, waxy leaves. It grows to 3 ft. and blooms spring to early summer. One of the most beautiful blues available. Sow in fall, or cold stratify. Zones 3-8.
https://www.wildflower.org/gallery/result.php?id_image=5888 - for images

Aromatic Aster: Symphyotrichum oblongifolium
This perennial's rigid stems, usually less than 20 in. tall, are much-branched from the base. The narrow leaves and stems are sparsely covered with short hairs. Pink or lavender-blue flowers are many-petaled and aromatic with a yellow center.
https://www.wildflower.org/gallery/result.php?id_image=31088 - for images

yellow:
Red dome blanketflower: Gaillardia pinnatifida
Red-dome blanket-flower or yellow gaillardia is a slender-stalked perennial, reaching an unbranched height of 2 ft. Pinnately divided leaves grow on the lower portion of the plant. The flower heads are up to 2 in. across and made up of yellow, three-lobed ray flowers surrounding a purplish-red dome of disk flowers. The yellow rays are purple-veined on their undersides and sometimes fade to pale red near their bases.
https://www.wildflower.org/gallery/species.php?id_plant=GAPI

Coreopsis lanceolata: lanceleaf tickseed
Lance-leaf tickseed grows in small clumps but forms extensive colonies. It is 1-2 1/2 feet tall and has leaves 3-4 inches long, opposite, sometimes alternate near the top where the leaves are fewer. Some of the leaves are deeply cut, almost forming 3 leaflets. Flower heads are yellow, 1-1 1/2 inches across. The yellow center or disk flowers stand out distinctly from the ray flowers,

which appear to be attached just below them. Ray flowers are 4-lobed. The yellow, daisy-like flowers occur singly atop long, naked peduncles.
https://www.wildflower.org/gallery/species.php?id_plant=COLA5 images

Helianthus petiolaris: prairie sunflower
A showy, 3-5 ft. annual sunflower with many-branched, erect stems. Foliage is dark green. Flower heads grow terminally on 3-4 in. peduncles. Ray flowers are yellow; disk flowers are red-purple. The seeds of this sunflower attract birds. Also male native bees sleep in the flowers.
https://www.wildflower.org/gallery/species.php?id_plant=HEPE

Helianthus maximiliani: Maximilian sunflower
The several tall, leafy, unbranched stems of michaelmas-daisy or maximilian sunflower grow to a height of 3-10 ft. Leaves are long and narrow, up to 10 inches near the bottom and as short as 2 inches near the top. They are alternate, coarse and hairy, slightly wavy on the edges, often folded lengthwise, slightly toothed and very pointed. Numerous yellow flower heads grow on their own stalks terminally and from leaf axils. The flower head is up to 5 inches across, with 15-19 ray flowers, deeply veined and slightly toothed on the tip. The center is 1 inch or more across, green to dark brown. These perennial plants can form large colonies.
https://www.wildflower.org/gallery/species.php?id_plant=HEMA2 images

Red

Firecracker penstemon: Penstemon eatonii
This perennial's striking feature is its scarlet flowers. Five to ten long, narrow, tubular blossoms top each of the numerous 2 ft. high stems. Leaves are tough, leathery, and deep green, arranged in pairs along the coarse, purplish stems.

Penstemon eatonii attracts hummingbirds to its tubular red flowers.

https://www.wildflower.org/gallery/species.php?id_plant=PEEA images

Mexican Hat: Ratibida columnifera
A plant branched and leafy in lower part with long leafless stalks bearing flower heads of 3-7 yellow or yellow and red-brown, drooping rays surrounding a long, red-brown central disk. Its sombrero-shaped flower heads, is usually 1 1/2 ft. tall but can reach 3 ft. Flower petals range from dark red and yellow, to all red or all yellow. The flowers central brown disk protrudes 1/2 to 2 in. above the drooping petals. Leaves on the lower portion of the stem are feathery and deeply cleft.
https://www.wildflower.org/gallery/result.php?id_image=65829 for images

The colorful flower heads, resembling the traditional broad-brimmed, high-centered hat worn during Mexican fiestas, often bloom by the thousands. Green Prairie Coneflower (*R. tagetes*) has a spherical or oblong central disk and leaves closer to the flower head.

Energy Harvesting Design Worksheet

Design Demands						
1 Water Pump (5w) for 12 hrs	0.06	kwh		Location Coordinates: 35 25'56.21" N 105 54'30.09" W		
RainFlo 0.6 GPM 12 VDC LED UV	0.18	kwh			Latitude	35.25 degrees
5 lights (0.5w) - 12 hrs	0.03	kwh				
device charger (2 device/day)	0.02	kwh		**Optimum Angles**		
safety factor (85% eff.)	1.15	%	typical for invert	Magnetic Declination (SW USA)	10 deg rotation towards east is optimium east/west alignment	
Daily average load	0.33	kwh/day		Equal Summer/Winter demands	35 degrees optimum angle	
Weekly average load	2.33	kwh/week		Favoring summer production	22 degrees	
Monthly	10.01	kwh/month		Favoring winter production	45 degrees	
Yearly	121.73	kwh/year				

Design Storage Sizing				
Battery Power Station (Anker)	0.26	kwh capacity	3,000 cycle lifecycle - 32F to 104F operating temps... can be off when outside temps	
Days of backup power	0.77	days		
100 Ah LiFe Deep Cycle Battery	1.20	kwh capacity	similar lifecycle	similar price points
Days of backup power	3.60	days	more of a custom build setup - will need electrical type cabinet	

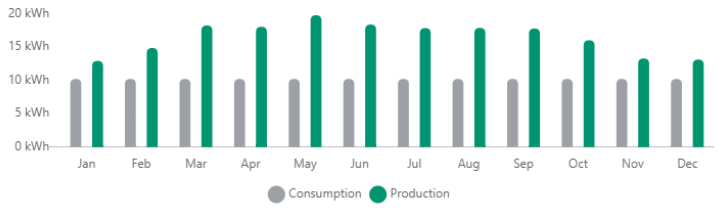
Design Production Sizing

110w PowerFilm Semi-Flex Marine	0.11	kW system
... 13.75 watts/sf for this product		

Simulation Results		
(1) 110w PowerFilm panel	0.11 kW PV Array	System Size: 6.6 SF, but could plan for at least 8 SF of space
Setup Parameters:		
Angle from south	10 degrees towards east	
Panel tilt - favor summer	22 degrees from flat	

Annual Production	197.7	kWh/year
Energy Demand Offset	161%	of annual demands
Yield	1,797	kWh/kWp

MONTHLY PRODUCTION (KWH)



SYSTEM LOSSES