INNOVATIVE APPROACHES TO DELIVERING WATER

Stephen Hawkins, Assistant Director,
Purdue University Agricultural Centers
(765) 494-8360
E-mail: shawkins@purdue.edu

Intensive or managed grazing usually results in changes in animal traffic patterns as compared to traditional whole field grazing systems. Increased stocking rates or the desire to utilize pastures where water sources are limited can challenge producers to provide clean water while balancing the need to protect land from erosion and water sources from contamination.

Traditionally, animals were allowed direct access to a natural source of water or a pond. Livestock should be excluded from streams, ponds, wetlands and ditches to ensure animal performance and maintain good herd health. Damage to the riparian zone from the destabilizing of the vegetation, bed and banks of the watercourse and the contamination of the water from pathogens and excessive nutrients should be avoided. Limited access water sites into a stream or pond can reduce the above concerns. However, alternative-watering systems can be developed to provide water when excluding livestock from surface water sources. These alternative systems can also be adapted to intensive grazing systems to provide flexibility and improved grazing efficiency.

When considering alternative livestock watering systems, several factors will need to be evaluated to determine if existing water sources can be used or if other sources should be developed.

- water quality
- rate of flow
- water storage volume
- differences in elevation
- depth of water
- accessibility
- distance from water source to pastures

When evaluating an alternative watering system, producers should evaluate the cost, installation, maintenance required overflow management requirements, and environmental effects of the alternatives.

The drinking process

Normally a cow drinks by inserting its muzzle approximately 1 to 2 inches into the water with her head inclined at about a 60^{o} angle (Figure 1). A cow can consume between 3 to 5 gallons of water per minute in this position. In order for a cow to drink naturally, from either a tank or bowl, a water surface of 0.65 square feet (94 square inches) should be allowed (CIGR, 1994). Watering devices and the surrounding area should be

designed for animals to drink water easily.

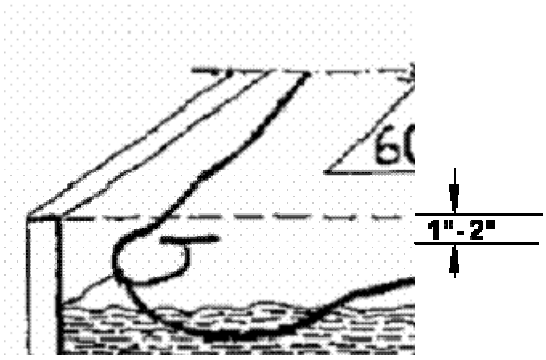


Figure 1. The position of cow muzzle during drinking, Metzner (CIGR, 1994).

Water tank considerations

When considering watering facilities, determine the proper size of the watering tank based on the grazing system used and animal type. One of the best references can be found in the Indiana NRCS FOTG *Conservation Practice Standard – Watering Facility*. (No.) CODE 614. A segment is excerpted below.

Watering Tank Considerations
NRCS (2003)

"The Watering Facility practice may adversely affect cultural resources. Water quality for livestock should meet the standards listed in the NRCS National Range and Pasture Handbook, Chapter 6, Table 6-8.

Livestock facilities should be sized as follows:

Where livestock are rotational grazing within 600 feet of the water facility:
• Cattle, horses and dairy:
Round or oval tanks or tanks should provide a minimum of 15 inches per head of perimeter tank space for 1/10 of the herd. (Diameter equals circumference divided by 3.1416) Square or rectangle tanks or tanks should provide 20 inches per head of straight side tank space for 1/10 of the herd.
• Sheep, goats and swine or similar livestock:
Round or oval tanks or tanks should provide a minimum of 10 inches per head of perimeter tank space for 1/10 of the herd. Square or rectangle tanks or tanks should provide 14 inches per head of straight side tank space for 1/10 of the herd.

Where livestock are grazing over 600 feet from the water facility:
• Cattle, horses and dairy:
Round or oval tanks should provide a minimum of 15 inches per head of perimeter tank space for 1/3 of the herd. Square or rectangle tanks or tanks should provide 20 inches per head of straight side tank space for 1/3 of the herd.
• Sheep, goats and swine or similar livestock:
Round or oval tanks or tanks should provide a minimum of 10 inches per head of perimeter tank space for 1/3 of the herd. Square or rectangle tanks or tanks should provide 14 inches per head of straight side tank space for 1/3 of the herd."

Locating watering tanks away from waters surface water sources will help reduce contamination. Avoid sloping terrain to prevent erosion and run-off. Select a level and well-drained site to minimize trampling of vegetation and creation of a muddy area.

Water consumption will also need to be determined for the species of animal and the stocking density. Daily water consumption will vary significantly with air temperature and humidity, water content of the diet, and water temperature.

Utilizing an existing well

Where an existing can be used to supply water, additional underground or seasonal surface piping can be installed. Keep in mind the multiple uses of the water source and determine if all other uses such as a house or milking operation can be supplied while extend the use of the water to grazing areas.

Sizing water lines and water pressure tanks is another discussion by itself. At this point a reminder is needed; do not skimp on pipe size and let friction loss drop line pressure to unusable levels.

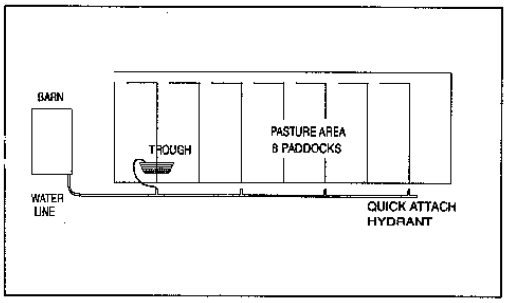


Figure 2. Utilizing a well as a watering source.

Once a layout has been tried for a season or two, the supply lines from the barn or well can be buried. Lateral lines used seasonally can be laid on top of the ground. Plastic pipe resistant to ultra violet light should be used above ground. Quick attach hydrants and portable tanks of 25 to 50 gallons equipped with full flow or high-output valves allow sufficient water flow. Traditional float valves often do not allow rapid water recovery. Rapid recovery is the key to making small tanks work. It is also important to install them near the grazing cattle so that they do not all move together as a group for water.

Gravity Fed System

A low cost watering system is to let gravity provide the power for water delivery. A pond or developed spring of suitable sized can be used. Determine the capacity of the water source and the change in elevation from the water source to the watering sites in order to develop a system. The supply pipe should be installed on a uniform grad so that airlocks do not develop. Grades of less than 0.2% should not be used. Grades from 0.2% to 1.0%, use at least 1.5-inch diameter pipe. For grades over 1.0%, a minimum of 1.25-inch pipe should be used.

Watering tanks can be equipped with float valves or with an overflow mechanism. When installed correctly, gravity fed systems are very reliable and require minimal maintenance.

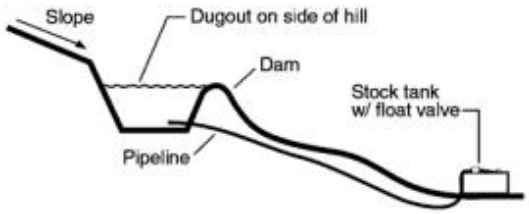


Figure 3 Gravity system.

Nose Pump

The nose pump is livestock operated. The pumping action is provided by a single cow when it pushes on a lever

with its muzzle. Water is lifted through a 1-inch line and foot valve to a small water bowl below the lever. The pump must be anchored and be in a level position so that water is retained in the bowl. Water sources where a nose pump can be used are springs, streams, ponds, or shallow wells. Cattle quickly learn how to operate the pump if all other water sources are removed from the pasture. Watering capacity is limited to 20 to 30 cows and if groups of cows attempt to drink at one time, there may not the capacity for all to drink in a timely manner. Locating the nose pump close to the grazing area will reduce the grouping nature of animals when drinking.

The pasture pump can be relocated quickly and easily. For small herds this is a cost-effective watering system.

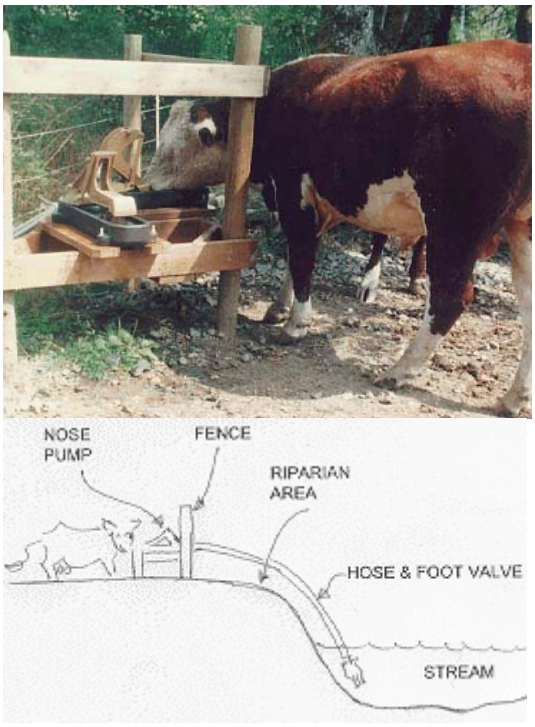


Figure 4. Nose pump use (Aquamat brand).

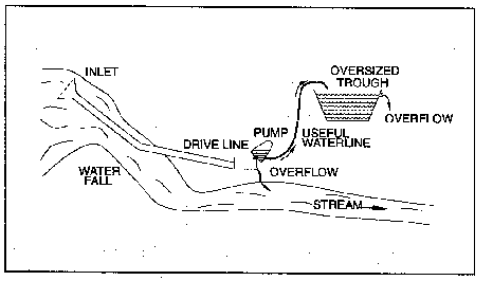
Blue Skies West
110 Michigan Hill Road
Centralia, WA 98531
Phone: 1-888-NOSEPUMP
360-736-2475

Farm'Trol Equipment
409 Mayville Street
Theresa, WI 53091
Phone: 920-488-3221

Hydraulic Ram Pump

Hydraulic ram pumps have been around since the 1770's and are not new technology. Versions of these pumps can be found constructed from cast iron and steel, however, pump constructed from newer materials, such as plastic and stainless steel are available.

Hydraulic ram pumps utilize falling water acting against a large diameter piston to compress air into a surge tank that is subsequently used to drive a smaller piston. The smaller piston is used to drive water uphill. This cycle occurs at 25 to 100 compressions a minute. Proper installation and tuning of the system is required for optimal operation. The water driving the system has to be drained away to a pond, stream or can be piped using gravity to another watering site.



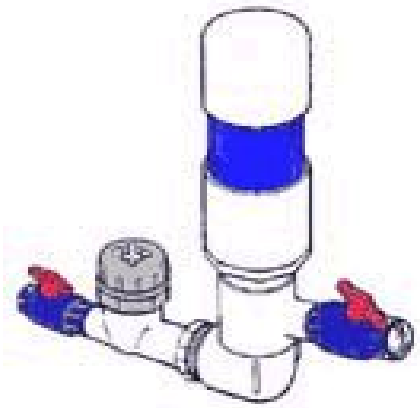


Figure 5. Hydraulic ram water pump, (B & L).

B & L Associated Ind.
Rt 1 Box 118-B
Rusk, TX 75785
903-743-5555

Blake Hydram
Ar & Do Sales Co.
4322 Mt. Vernon Rd. SE
Cedar Rapids, IA 52403

Columbia Hydraulic Ram
Skookum Co., Inc.
8524 N. Crawford St.
Portland, OR 97203

Pacific Hydro Corp.
400 Forbes Blvd.
San Francisco, CA 94080

Rife Hydraulic Engine Mfg. Co.
316 W. Poplar St.
PO Box 790
Norristown, PA 19401

C.W. Pipe, Inc.
PO Box 698
Amherst, VA 24521

Sling pump

A floating pump utilizes flowing water in a stream to drive a propeller to pump water. As the propeller turns, water and air alternately enter a coiled hose and are forced into a delivery pipe. The pump is anchored in the stream to prevent it from drifting. This type of pump is not suited for seasonal streams or where a stream carries heavy debris load. Seasonal use to prevent freezing is another consideration.

The depth and flow rate of the required stream varies with models. Water velocity of 2 ft/sec will generate adequate pumping. A minimum water depth of 10 to 16 inches, depending on the model, is necessary for the pump to turn freely.

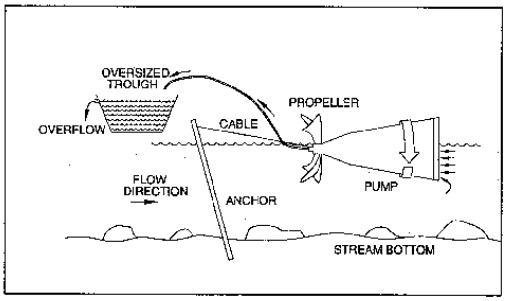


Figure 6. Sling pump system.

Rife Hydraulic Engine Mfg. Co. Inc.
PO Box 95, Nanticoke, PA 18634
570-740-1100 Fax 570-740-1101

Solar Powered Pump

A photovoltaic panel converts sunlight into DC electricity, which operates a pump, controlled by an electric float switch. For water supply during the night and on cloudy days, it is imperative either to use a deep cycle battery to store electricity or to store water in large quantity in a reservoir or an oversized watering tank.

This system can be adapted for any cattle water requirement.

Manufacturers generally prefer to custom design the system to suit the client's needs. Installation and maintenance require some expertise.

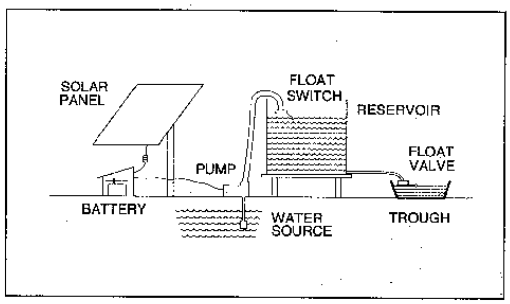


Figure 7. Solar powered water pumping system.

Solar Water Technologies Inc.
4329 Roanoke Parkway; Suite 2-S
Kansas City, Missouri 64111
800 952-7221
816 531-6151

Farm Products Direct
Highway 9 North, Box 181
Herman, MN 56248
800-669-9314

SolarJack Division of Photocomm, Inc.
P.O. Box 14230
Scottsdale, AZ 85267-4230
602-951-6330

Sun Electric Co.
P.O. Box 1499
Hamilton, MT 59840
Order Line: 800-338-6844
Tech Line: 406-363-6924

Robinson Solar Systems
404 Loomis Road
Weatherford, OK 73096
580-774-2200

Dankoff Solar Products, Inc.
1807 Second St., Unit #55
Santa Fe, NM 87505
505-820-6611

Sierra Solar Systems
109 Argall Way
Nevada City, CA 95959
888-667-6527

Ozark Solar
314 East Spring Street
Neosho, MO 64850
800-711-4756
417-451-4756 or 0053

Jetstream Power International
P.O. Box 98
Holmesville, OH 44633
330-279-4827

Wind Powered Pump

Windmills can be used to pump water, aerate dugouts, and generate electricity. There are two types of wind powered water pumps. The traditional reciprocating pump has the windmill situated directly over the water source. It offers the best pumping capacities, but requires periodic maintenance and part replacement.

Compressed air pumping systems use a windmill-driven pump to compress air that in turn, activates a pump located in the water. Water enters the pump until the floating valve rises to close the inlet opening, at which time the compressed air displaces water out of the pump and up to the tank. The air exhausted aerates the water source so that good water quality is maintained.

Because wind is a variable energy source, windmill-pumping systems

require sufficient water storage to maintain a constant supply of water during calm periods.

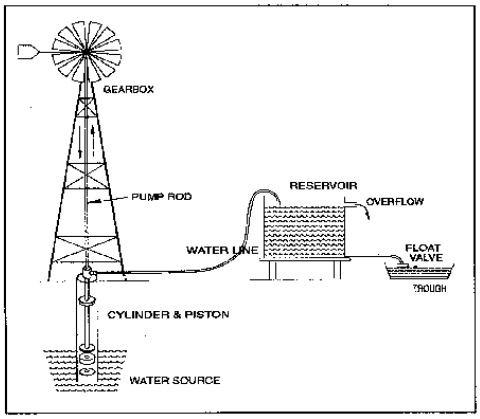


Figure 8. Wind powered reciprocating water pumping system.

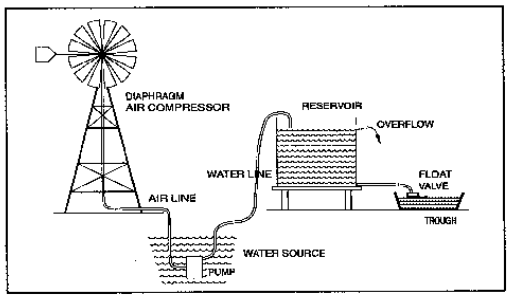


Figure 9. Wind powered air activated water pumping system.

CISolar Supplies Co.
P.O. Box 2805
Chino, CA 91710
909-628-6440
909-628-6440 FAX
http://www.cisolar.com/

Other Methods

Hauling water with a transportable tank is another option producers can utilize. This system generally consists of a trailer-mounted tank that supplies water by gravity to a portable watering tank. The tank is fitted with a float valve. To avoid frequent handling, specially designed tanks are available which can be installed on the trailer. Transportable tanks are well suited for intensive pasture management because the watering site can be moved to various areas of the pasture as cattle rotationally graze. This method does require more management and time to deliver water, but may be less costly for smaller operations.

There are many reasonably priced fuel and battery-activated pumps capable of satisfying different requirements. These pumps can be used to deliver water to livestock watering stations or to fill up transportable tanks.

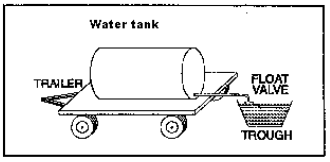


Figure 10. Portable water tank.

Water Storage and Overflow Management

Some of the systems described (i.e. gravity fed, hydraulic ram, sling pump, and windmill pump) offer inadequate short-term water supply to meet the needs of several animals drinking at once, but operate continuously. To ensure that water is always available, a sufficient amount must be stored in an oversized tank or a reservoir. If a reservoir is used the water can gravity feed to a tank.

Any overflow should be evacuated away from the watering area through a pipe. This will keep the site as dry as possible.

Large flowing springs may provide flowing water year-round like a stream. Smaller springs may have to be

developed to collect water to be accessed directly or piped by gravity or pumped to other locations. For details on spring development contact your NRCS office or see MWPS-14, *Private Water Systems Handbook*.

Annual maintenance and evaluation

Water systems serving livestock can be designed to survive the abuse and daily wear animals impose. The obvious damage to tanks and controls can be corrected. Problems that develop over time such as water intakes becoming plugged with algae, tadpoles and debris, cracked supply lines or corroded pipes creep up slowly and diminish water flow over time. Not until a hot July day do we realize a problem might exist. A few preventative maintenance measures can eliminate many of these situations.

1. Pressurize line or open gravity systems before the pasture is occupied. Inspect for leaks in above and below ground installations.

2. Inspect valves and controls for leaks or plugging - low flow water sources or ponds may not withstand wasting of water and be able to supply throughout the season.

3. Gravity systems from surface water sources have the potential for moss algae, insects or small animals to enter the intake. A lesson taken from dry fire hydrant maintenance is to back flush annually to remove this debris. Old intake pipes may not be fitted to allow a back-flushing operation. Rebuilt or new systems offer the opportunity to include a removable cap on a standpipe or a spring-loaded or weighted flap over the end of the intake. Back flushing requires a pump, clean water source such as a portable tank or a suction line into the pond and a point where a connection can be made to introduce the flushing water.

4. Re-evaluate your tank size, location and float valves. If problems existed last year with water volume or flow and the supply lines are adequate, revisit the tank size used. Does it provide enough capacity for the animals to drink freely. Low-flow/low pressure water sources may not provide rapid refill capacity to utilize small tanks. Overly large tanks may become algae filled and reduce animal consumption. Portable locations need to be flexible to minimize bare muddy areas and allow some recovery of the forage between grazing cycles. If the water supply was adequate and the tank was the right size and refill time is not what it should be, examine the float valve. Smaller valves up to 3/4" in diameter work well with pressurized water systems. Larger float valves, up to 2", are available and cost from $25 to $45. Also, a larger valve is less likely to become plugged by debris when using a surface water source and an intake strainer.

5. Water source maintenance is also important. Information on protecting private wells can be found in the water quality publications below. Public water sources are monitored and provide minimal maintenance if these are available. Ponds, springs and streams are the most susceptible to contamination.

Summary

Animal producers can utilize new technology to provide water to animals in intensive grazing systems or in areas previously underutilized for grazing. Not every watering system will look the

same or cost the same, but by using creativity and planning, animal producers can develop suitable watering systems. Initial costs and maintenance vary with design

The preservation of watercourses through environmentally responsible management is an important part of maintaining good water quality. Farmers have come to recognize the importance of water quality for livestock and its contribution towards a successful operation.

Selected References

Purdue Forage Information, http://www.agry.purdue.edu/ext/forages/index.html,

Agricultural Waste Management Field Handbook. Part 651, National Engineering Handbook. Washington, D.C.: Natural Resources Conservation Service, U.S. Department of Agriculture, 1992.

CIGR. 1994 "The design of dairy cow housing". *CIGR Design Recommendations for Dairy Cow Housing*. United Kingdom: ADAS Budgets Dairy Research Centre Farm Buildings Research Team.

Livestock Management in Grazed Watersheds, Publication 3381. UCD Animal Agriculture Research Center & UC Agricultural Issues Center, Division of Agriculture and Natural Resources, Communication Services-Publications, University of California, Oakland, Calif. 1996.

Frankenberger, J., C. Janssen, and D. Nauth. 1999. *Water testing Laboratories, WQ-1.* http://www.ces.purdue.edu/extmedia/WQ/WQ-1-W.pdf.

Ladd, B. and J. Frankenberger. *Pasture Assessment for Water Resource Protection, WQ-39.* http://www.ecn.purdue.edu/SafeWater/farmasyst/surveys/WQ-39.pdf.

Meyer, K. B. *Water Quality for Animals, WQ-9*. 1990. http://www.ces.purdue.edu/extmedia/WQ/WQ-9.html.

Midwest Planning Service. 2001. MWPS-14, *Private Water Systems Handbook.*

NRCS Indiana FOTG, 2003. *Conservation Practice Standard – Watering Facility*. (No.) CODE 614. Natural Resources Conservation Service.

Sutton. A. L. 1999. *Animal Agriculture's Effect on Water Quality Pastures and Feedlots, WQ-7.* http://www.ces.purdue.edu/extmedia/WQ/WQ-7.html.

Stockman's Guide to Range Livestock Watering from Surface Water Sources. Humbolt, Saskatchewan: Prairie Agricultural Machinery Institute, 1995.

Turner, W.M. 1996. *Watering Livestock with Solar Water Pumping Systems*. Jefferson City, Mo.: Missouri Department of Conservation.

Watering Systems for Grazing Livestock. Great Lakes Basin Grazing Network and Michigan State University-Extension.

Livestock Watering Systems						
SYSTEM	**ENERGY SOURCE**	**WATER SUPPLY**	**CAPABILITY**	**Estimated Cost**		**ADDITIONAL INFORMATION**
				Initial Pump system	Watering system plus pump	
Existing well	electrical	well, etc.	Depends on well and pump size	$0	$700+	Very reliable. Low cost. Suitable for intensive grazing.
Gravity fed	gravity	Spring, Drainage tile, cistern, pond	depends on water source	$0	$700+	Airlock problems Requires elevation surveying. Overflow management at water source and/or tank. Continuous pumping system.
Nose pump	livestock	Shallow water sources	20 - 30 head, 23 ft lift or 126 ft distance	$350	$400	Keep foot valve clean. Suitable for small herds. Low cost & maintenance.
Hydraulic ram pump	falling water	Stream, Spring	15 to 100 ft lift per 3 ft fall depending on model	$300-$1,000	$1000+	Requires a waterfall or a good slope. Detailed installation requirements. Continuous pumping system. Overflow mgt at pump & tank.
Sling pump	flowing water (or wind)	River (lake)	800-4,000 gal/day 26 82 lift (water powered models)	$1,000-$1,700	$1,700+	Requires sufficient water speed. Continuous pumping system. Overflow mgt at tank.
Solar powered pump	sun	All	depends on design	$1,500 +	$2,200+	Requires technical skills for installation and maintenance. Requires energy storage (battery or reservoir).
Wind powered pump air activated	wind	pond, shallow well, etc.	20 ft lift to 980 ft distance	$1,100+	$1,800+	Requires some skill for installation. Requires water storage. Continuous pumping system. Overflow mgt at tank or reservoir.
Portable water tank	electrical or fuel	All	depends on tank capacity	$0+	$1,100+ or about $0.01/gal	Labor intensive. Suitable for intensive grazing. Requires good water source for fill up.
Gas or battery powered pump	fuel or batteries	All	depends on model	$200-$900	$900+	Labor intensive. Requires water storage. Requires good water source for fill up.