Watering Points for Livestock Producers

Water the most important nutrient!

Cattle need 4 to 6x more water than food!

Increase Gains

Reduce Disease

Improve Fertility

Improve Water Quality

NRCS Natural Resources Conservation Service

TDA

Tennessee Grazing Coalition

LIVESTOCK WATER

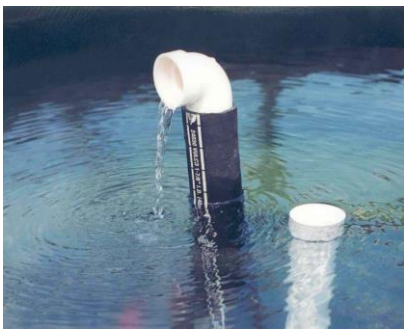
Commonly the weakest link in the grazing system

Water the most important nutrient!

- Largest quantity requirement for beef and dairy cattle (e.g. 15 gal/day = ***125 lb/day***)
- Commonly the weakest link in grazing systems
- Key to grazing distribution (Overgrazing and under utilization)
- Key to manure distribution (natural fertilization)
- Reason for excessive trailing

Location of water points:

- ***Separate water from other attractants like shade, mineral and hay***
- Place water on knob with good drainage, sunshine and air flow
- ***Place water point central*** so it can ultimately serve multiple paddocks
- ***Estimate average paddock*** size so water placement fits your goals (***see reference in back***), get it right the first time



Water Considerations:

- Animals weight is 50 to 80% water
- Milk is almost 90% water
- Universal solvent- nutrients need water for absorption
- Pregnancy rates, disease, rate of gain, and dry matter intake are all associated with water intake
- Zebu (Bos indicus) breeds such as Brahma have lower water requirements than European (Bos Taurus) breeds
- Dairy breeds usually have a higher daily water need than beef breeds
- ***Mature cows need 0.5 gallons (4.2 lb) of water per pound of dry matter, 4x >water than food!***
- ***Calves need 0.75 gallons (6.2 lb) of water per pound of dry matter, 6x more water than food***
- Animals drink more water if it is readily available, 15% more if water is in every paddock versus traveling down lane to get water
- Water is a necessity for all body function and performance

Units of Measure- Water

- 62 pounds/cubic ft
- ***8.33 pounds/gallon***
- 0.036 pounds/cubic inch
- 1 gallon = 4 quarts = 8 pints = 128 fluid ounces = 231 cubic inches
- 27,000 gallon/ acre inch
- 1 acre = 43,560’ (roughly 209’ x 209’)

Pumping Plant (Well House)
Common list of materials

- *Cut off valves*
- *Unions*
- *Backflow preventers*
- *Pressure tank*
- *Pressure switch and gauge*
- *Faucet*
- *Power switch*
- *110 outlet*
- *Light outlet for heat lamp or light*
- *Thermometer*
- *Drain outlet*
- *Tile (French)drain to remove ground water*

Wire pressure switch so outside light comes on when pump comes on

Pressure water systems are preferred particularly for serious grazers due to the fact that water points can be located in the most ideal location without having to be concerned with the source location and gravity for flow

Pipelines:

- One pump is easier to maintain than multiple pumps
- Considering cost and maintenance of water sources such as ponds, access ramps, spring developments, typically it is best to ***extend the existing pipeline in lieu of additional water developments*** (e.g. $1500 for a ramp/ $1.50/ ft of pipeline = 1000' of dependable low maintenance quality water in a preferred location)
- Travel distance to water for beef cattle and small ruminants 800', dairy 400'
- ***Water points*** ideally located ***in every other fence line***
- ***Tee off the main line and install a cutoff valve to every permanent water trough***
- Due to cost ***quick couplers or frost proof hydrants are recommended to serve a high percentage of the water points*** with just a few permanent water tanks like ball waterers (e.g. ball waterer and heavy use area cost $1500 and quick coupler cost $15 each plus installation cost)
- Concerning sizing the pipe and pump, elevation water is pumped is more important than distance between the water point and the source of water
- ***One psi = 2.31 ft of elevation***
- Place a ***vent*** or outlet like quick coupler in ***low and high points on the pipeline***
- Place pipeline a distance from fence so that livestock don't trail down pipeline or trucks don't drive on pipeline. Also it is easier to fill trench if it is offset from the fence about 8'
- ***Bury the pipeline a minimum of 18" deep*** public water supplies may require 30" burial.
- Black polyethylene pipe is typically not recommended, check with Conservationist
- Where rock is encountered use a rock saw or sleeve the pipe and install a cut off valve before the shallow area, plan with Conservationist and/or Conservation engineer.
- Size of pipe is based on design however typically no less than ¾" and no larger than 2"
- Contact Tennessee One Call System, Inc. (811 or 1-800-351-1111) http://www.tnonecall.com/

Table 1 - Minimum Requirements of Individual Watering Facilities

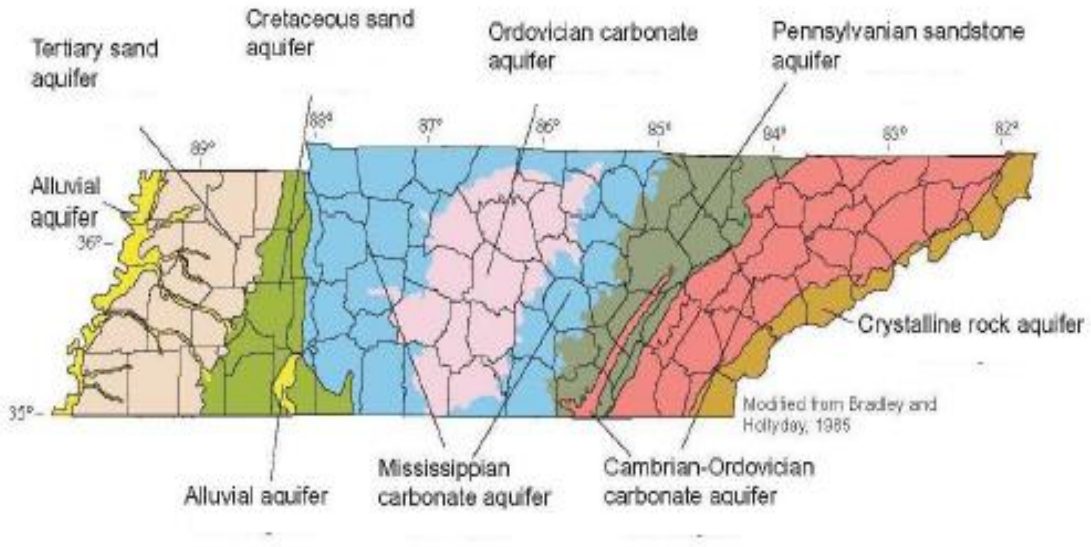
Kind of Livestock	Water Facility Capacity (gals.)	Recommended Depth (inches)	Daily Requirement [1/] (Gal/hd/day)	Maximum Height above Normal Ground (inches)
Beef Cattle	100 (25) [2/]	12	12-20	30
Horse	100 (25) [2/]	12	6-14	30
Yearly Bovine	100 (25) [2/]	12	10-20	30
Dairy Cattle (drinking only)				
Lactating	100 (25) [2/]	12	25-30	30
Non-lactating	100 (25) [2/]	12	10-15	30
Sheeps & Goats [3/]	15	6	2-3	18
Swine	15	6	2-4	18

[1/] These requirements vary with climatic conditions, kind of feed, size of animals, and other factors and may be increased as necessary.

[2/] The minimum capacity of individual watering facilities may be reduced to 25 gallons, provided all of the following conditions are met.
1. The pasture is 14 acres or less.
2. Water supply into the watering facility is at least 5 gpm.

3/ Where small ruminants and wildlife are likely to use the trough install an escape ramp or concrete blocks to allow animals to escape if they fall in. Step should be installed on outside of tank where small ruminants or wildlife are expected to use the trough

General Water Supply Well Characteristics



Modified from Carmichael and Bennett, 1993

Aquifer Name	General Water Supply Well Characteristics				General Water Quality Problems
	Depth (feet)		Yield (gallons per minute)		
	Common Range	May Exceed	Common Range	May Exceed	
Alluvial	10 - 75	100	20 - 50	1,500	High iron concentrations in some areas.
Tertiary Sand	100 - 1,300	1,500	200 - 1,000	2,000	High iron concentrations in some areas.
Cretaceous Sand	100 - 1,500	2,500	50 - 500	1,000	
Pennsylvanian Sandstone	100 - 200	250	5 - 50	200	High iron concentrations in some areas.
Mississippian Carbonate	50 - 200	250	5 - 50	400	Water generally hard; high iron, sulfide, or sulfate concentrations in some areas. Aquifer susceptible to contamination.
Ordovician Carbonate	50 - 150	200	5 - 20	300	Water generally hard; high iron, sulfide, or sulfate concentrations in some areas. Aquifer susceptible to contamination.
Cambrian-Ordovician Carbonate	100 - 300	400	5 - 200	2,000	Water generally hard.
Crystalline Rock	50 - 150	200	5 - 20	1,000	Low pH and high iron concentrations in some areas.

List of Tennessee Licensed Well Drillers: call 1-800-523-4873 *or*

http://www.state.tn.us/environment/dws/pdf/dril&inst.pdf

Storage Tank: When using a less dependable source of water such as solar, generator, ram pump, sling pump a storage tank is needed. Typically pump to a point above the water point and gravity flow from the storage tank to water points. A minimum of 1.25" pipe is needed for gravity flow systems typically 1.5" or 2" pipe is installed. See pg seven for additional information on pressure- gravity flow combination systems.

Replenishment Rate. The ***inflow of water in a three-hour period plus the individual watering facility (watering facility/tank) capacity shall equal or exceed one-half the daily requirement for the livestock using the facility***. E.g. 25 cows x 20 gal. (pg4) = 500 gal/2 (1/2 day) = 250 gal. needed. If gpm = 0.5 gpm x 180 (3 hr. x 60 min.) = 90 gal. 250 gal needed – 90 gal. inflow = 160 gal minimum tank needed. Credit water tanks too, if they have much water holding capacity. Highest points on pipeline are best to be larger tanks.

Emergency water supply- contingency plan: Although it is ideal to have access control (fence) around water areas and other sensitive areas a good contingency plan is to have potential access to these areas in cases where pressure systems are in need of repair. A gate into ponds or streams can be invaluable. Portable corral panels are ideal in that they are mobile and can be installed quickly to provide access control to the water without significant impacts to the entire water area. Lands enrolled in CRP like Marginal Pasture must receive approval from USDA/FSA prior to use.

Backflow Protection. Watering facilities that have a potential to cross-connect with the public water supply system shall have a properly installed backflow prevention device or air gap as required by the local water utility's Cross-Connection Control Program (Tennessee Code Annotated § 68-221-711 and Tennessee Department of Environment and Conservation (TDEC), Division of Water Supply, Rule 1200-5-1-.17(6).

Watering facilities connected to potable well systems shall include measures to prevent backflow or back-siphonage to the well. Acceptable measures to prevent backflow are the use of an air gap or double check valve.

Air Gap. Air gaps shall be a minimum of two times the diameter of the supply line above the crest or overflow device of the watering facility. (Example: If the supply line is 1 inch, then the minimum air gap required is 2 inches above the crest of the overflow device.) The supply line and air gap shall be protected from contact by livestock. This shall include measures to protect the air gap from inadvertent splashing by the livestock during watering.

Gravity Flow Water System on Timer

Water is pumped to a storage tank and gravity flowed to water points. The minimum size pipe for gravity flow systems is 1.25", pipe size needs to be designed. The benefit of this system is ***less energy use***, with a back flow preventer the same pipe can be used as the delivery and supply pipe. A ***timer or timer and mercury switch can be used instead of a pressure tank and pressure gauge***. To use the mercury switch a wire must be run from the pump to the storage tank. A timer can be used alone but settings need adjusting for different seasons. Since the pump runs less and timing is appropriate pump life is extended. Elevation difference to operate a float is 12' (for approx 5 psi) between the elevation of the inlet / outlet in the storage tank and elevation of the float. ***Pictures clockwise:***

1. Underground storage tank recessed on steep hill, water tanks can be done this way as well installing a retaining wall above or below them.
2. Electrical hookup from storage tank to pump, this set up is on a timer with mercury switch
3. Float with rod on top through top of tank to show water level from a distance
4. Mercury switch(optional), conserves water and controls tank level, down side is you need electricity to the storage tank

Lid and Ball Freeze-Proof Tanks:

There are many different types and styles of plastic and metal freeze- proof water tanks. Some have lids (hog waterers) or floating balls that cover the openings where livestock have access to water. Some models use electric heaters to keep the water from freezing; others have sensors and valve systems which circulate water to overflow when it reaches a preset temperature. Manufacture's recommendations on the number of openings needed vary somewhat. For example beef cattle recommendations are: one opening serves 25-30 head; ***two openings serve 75-100 head***; four opening serve 200-250 head and six openings serve 300-350 head. Distance to water and terrain impact number of head served by a tank as well.

Water storage in these models range from 5 to 70 gallons. The smaller water storage causes more frequent movement of fresh water when animals drink. The water movement helps keep water from freezing in energy-free models. Many of these tanks come with valve options that can increase flow.

Balls on waterer need to be set with about a 5/8" gap. Models with balls elevated are harder to push in but do not tend to catch water like models with sunken balls. When rainfall occurs it will elevate the balls. The biggest problem with the balls being too tight is when livestock drink the balls get wet and freeze to the cover restricting livestock access to water. The elevated balls can be seen from a long distance away whereas sunken balls can only be seen when you are close by. ***Tanks must be bolted to concrete.*** Balls can be held down with a rod or removed to train livestock to tanks or lids can be lifted initially to orient livestock to these types of tanks. Training livestock to use these types of tanks is usually not an issue. *Important: with all these tanks use geothermal heat wells that are 12 inches or larger in diameter. Refer to manufacturers installation procedures.*


Tire Tank Installation, choose a tire that doesn't have steel belts, typically biased ply

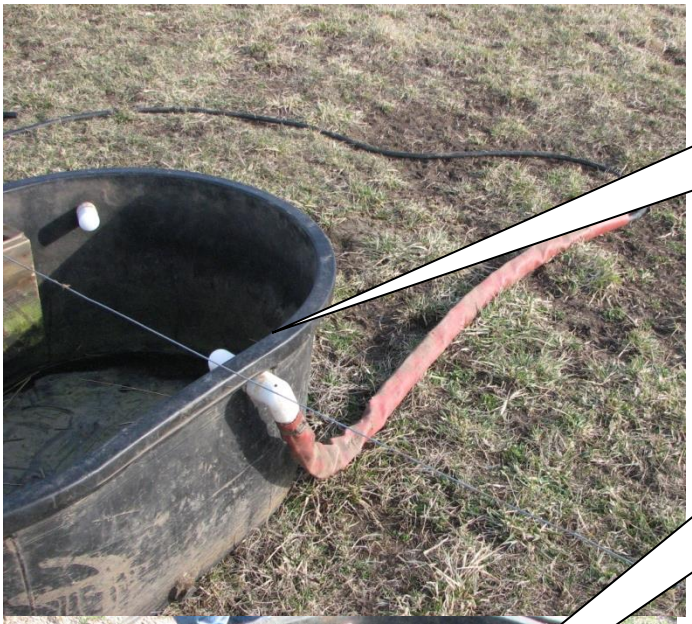
- Tires are very heavy, with many over 1,000 pounds. So never get under tires being installed. Tires can be ***picked up by inserting a bar inside the tire*** connected to a chain and front end loader.
- Pre-cut tires are available in some areas. Lay the tire on its side and cut one sidewall out of the tire ideally all the way back to the tread of the tire.
- Cut the tire with a reciprocating saw or chainsaw. When cutting the sidewall angle the blade down and towards the outside of the tire so the sidewall is less likely to bind. Another option is to lift the sidewall being cut out with a chain and front end loader to keep it from binding. Wedges can also open up the split.
- ***Fine toothed blades on reciprocating saws*** work better than coarse toothed blades
- Keep a small steady flow of water on the saw blades and the area being cut to cool it down. Dish washing detergent works well in lieu of water.
- Another option is to cut holes in top of tire to increase freeze protection, some cover center of tire for even more freeze protection.
- Clean tires before use because they may have been filled with chemicals.
- Install pipes in the ground before placing tires, leaving an extra length of inlet pipe that can be cut later. A faucet installed in inlet pipe is very handy for cleaning or additional water source.
- An ***overflow pipe is needed to allow tank to trickle water in winter to prevent freezing*** discharge water to an area well away from the trough so it doesn't cause a mud out. Overflow pipe can also serve as a drain pipe by installing a threaded coupling in bottom of tank.
- Keep the top edge of tires 12 inches out of the ground to keep small livestock from falling in.
- Fill the bottom center bead area of tires with concrete, and tamp it to seal tight around the edges. Some producers place clay under the tire prior to filling with concrete. Bentonite is not recommended due to the chance it will swell and break pipes. Filling the bottom sidewall requires much more concrete but does make cleaning the tank easier.
- A ***rack or guard needs to be installed to keep livestock from getting in the tank.***
- ***Blocks and or a escape ramp need to be installed where small ruminants use open tanks***, they will drown in tanks deeper than 12"

Disk blades work very well for covering cut off valves and quick couplers

Male portion of quick coupler, just need one male portion for each portable trough

Female quick coupler needs to be placed in a minimum 8” diameter geothermal heat well

Frost proof hydrants need to be protected from livestock rubbing on them and breaking them



Inlet and outlet pipes come in the same hole. Route overflow away from the livestock concentration area

Trickle valve bubbler to prevent freezing

Brass valve more durable than plastic

Reinforced eye bolt for pulling with 4-wheeler

Portable, Seasonal Tanks (not eligible for cost share)

Portable watering tanks are an excellent way to improve the flexibility and cost effectiveness of a grazing system. Portable tanks can be made at home from plastic barrels or purchased at local farm supply store.

- ***25 to 55 gallon tanks are easier to move*** and typically adequate on pressure systems since the paddocks are small and the entire herd doesn't come to water at the same time.
- ***Full flow valves are recommended***, if the trough doesn't fill fast is becomes a toy and will be torn up. Placing the trough under the electric wire reduces problem.
- Water hose can be used from one quick coupler or frost proof hydrant to serve four or more paddocks.
- ***Burst proof pipe is another option for surface laid pipe***, usually placed in fence line so it is not run over and grass over grows it keeping it cooler. Crossing a road lay the pipe between two boards.

Alternative sources of water

The standard pump is submersible

Submersible Pump *–turbine pumps that operate below water level therefore they are less likely to freeze. They are often used in deep wells and are typically more expensive than jet pumps.*

Jet Pump - *Provide high volume where pressure and lift requirements are low. The pump can be located some distance from the water source. Foot valves are needed in the bottom of the well. These are prone to losing prime.*

Nose Pump – *livestock push paddles out of the way to get the water in a small bowl activating a diaphragm pump. Nose pumps can lift water a vertical distance of about 26 feet. One pump will serve about 30 cow-calf pairs. Not recommended for small calves or small ruminants.*

Sling Pump *– powered by moving water, intaking air and water pulsing water, the pump is turned by a propeller. Down side is it takes good water flow and depth to turn the pump and stream flows are typically down when water is needed the most. Stream debris will clog propeller, requires constant maintenance. Requires a continuous stream flow with 2' minimum depth.*

Ram Pump- *invented in the 1700's they use energy of falling water to pump a small percentage of falling water to an elevation higher than the original. At least five feet of fall and a flow rate of 1-3 gallons per minute is required to drive the systems. Only 15% of the incoming water is pumped to tanks.*

Solar Pump- *pump when the sun is shining, marine batteries can be used to store power or utilize water storage tanks that will store enough water for several days. Larger storage tanks also allow the use of smaller, more economical pumps. Solar panels can be located some distance from the pump. Tracking mechanisms that rotate the panels to face the sun also greatly improve efficiency. Virginia NRCS has put in several solar systems that pump continuously allowing excess water to discharge in a safe outlet.*

Windmill – *rarely have a site in Tennessee with consistent enough wind to operate effectively. Windmills are expensive to install but cheap to operate. Large storage tanks are needed for times when the wind is not blowing.*

Need picture of trough with retaining wall, come on East TN you have to have one of these

On steep slopes recess trough in Slope to make site level and reduce loss of rock

Steep slopes make it difficult to level tanks and to keep rock in place also it is a challenge to keep livestock trails from eroding the landscape.

Railroad ties, telephone poles or other material may be needed to construct retaining walls above and below the heavy use area.

Fence can be useful to direct livestock flow away from the steep area below or above the water point reducing trailing.

Trails can serve as a water conveyance between the feeding area (manure pile) and water source. If the water source is a pond water quality can be severely impaired lowering livestock performance as well as public water quality.

The ideal slope for the heavy use area is 3% and slightly mounded a couple of inches in the center.

Vegetation around Heavy Use Areas

Turf type grasses like bermudagrass or ky 31 tall fescue are best around heavy use areas because they can take abuse. Bermudagrass is the preferred species since it revegetates so well after heavy use and tolerates close grazing better than other species. Ten to fifteen pounds of bermudagrass per acre is recommended and seeding date is May through June.

Seeding in the spring or fall tall fescue is the species to plant, 50 pounds per acre February through March or September.

The ***best media to sow into is fresh dozer tracks***. For maintenance seeding disking may be required. A cultipacker or roller is very beneficial in getting seed soil contact and quick germination.

Permits

Water associated practices such as: stream crossings, pipelines, pumping plant and stream stabilization ***may require permits*** from: TDEC, FWS, TVA and the CORP of Engineers. Permits may also be required for ground disturbing practices that potentially impact Threatened and Endangered Species and Cultural Resources. Visit with local Conservationist about permit needs.

http://www.state.tn.us/environment/

http://www.lrn.usace.army.mil/

http://www.fws.gov/cookeville/docs/endspec_widlak.htm

http://www.tva.gov/river/26apermits/index.htm

Heavy Use Areas

Areas around permanent troughs become muddy, eroded and dangerous to livestock and potentially impairing water quality.

These areas can be protected by installing gravel and geotextile or concrete around the trough.

Ball waterers need to be bolted to concrete.

Area around all permanent waterers is recommended to have a 2' border of concrete around the trough to keep the area from being dug out when livestock turn.

Another 8 to 13' of geotextile and rock surrounding the trough is required. The heavy use area needs to extend a minimum of 10' from the edge of the watering facility.

Geotextile is a fabric underlayment to prevent rock from sinking in mud. Geotextile needs to be nonwoven, needle punched, 6 oz. minimum.

Gravel pads should be 8" deep compacted to at least 6" thick. We have found rolling or packing crusher run rock stays in place much better and needs less maintenance.

Rock needs to be inspected annually, typically rock needs to be added about every three years. If geotextile is exposed it is easily compromised and the pad fails.

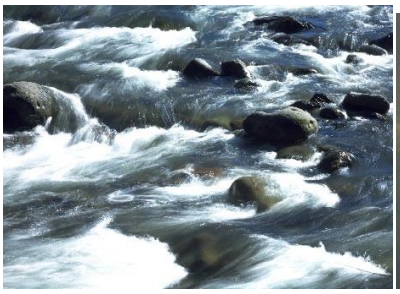
Approach Ramps (Stream Crossing)

Limited access points improve water quality, stability and longevity of pond or stream banks. Ramps should extend into the water. Typically crusher run rock is used on the area livestock travel. Geotextile fabric is placed under the rock.

Access ramps need to be on a 5:1 slope (5' out and 1' of drop) or flatter. ***Water needs to be diverted at the top of the ramps***. Water from the field and trailing allows water from the field to run down the ramp destroying the ramp. This is the biggest reason for access ramps failing.

Rock surface is level with normal stream bed. Trenches are dug around stream crossings and filled with rock to prevent water from under cutting the ramp. This technique is called keying it in, water takes the least path of resistance.

Steeper side slopes adjacent to the ramp need to have rip rap on them to protect them from stream velocity and livestock travel. Conservationist or engineer should size the rock.




Water Quality (see tables in back):

- Clean water is very important
- Clean all troughs at least four times a year
- To improve water quality, ***add Chlorine tablets in a perforated bottle***. You can stabilize the bottle with a rope and block in a pond, in a trough just let it float. Chlorine at source cleans water in pipeline as well. See disinfecting a well on page 22.
- Cooler water has shown improved milk production
- ***Cattle typically prefer water at temperatures between 40°F (4.4°C) and 65°F (18.3°C)***
- Significant improvements in water quality can result in weight gains of 16% to 19%
- Alberta research found steers provided with fresh water gain 2.6 lb/day compared to 2.0 lb/day when provided pond water
- Best for animals to not drink from puddles, ponds, streams and other surface water. Bacteria and other pathogens can contaminate surface runoff, which can also be a source of parasite infestation
- Bacteria cause diseases such as leptospirosis and brucellosis (Bangs)
- Sheep and goats tend to be more particular about water quality than cattle
- Incidence of foot scald, foot rot and other feet and leg problems also increase in wet and muddy conditions
- Environmental mastitis increases in muddy conditions
- Energy requirements of livestock increase significantly when animals are wet and muddy
- Other diseases such as coccidiosis, E. coli, salmonellosis, cryptosporidiosis, anthrax can be carried in water. Young animals are most susceptible
- Animal waste contributes to over 150 diseases

Water Quality (continued)

- Water contaminated with manure may develop toxic, blue green algae which can poison livestock, causing muscle tremors, liver damage and death
- ***Treatment for algae afflicted animals is large quantities of medical-grade charcoal and mineral oil***
- High nitrates interfere with the animals ability to absorb oxygen heavy upstream stocking rates, especially when the ground is frozen, can lead to dangerously high spikes in nitrate levels following rainfall events.
- High sulfate concentrations also help development of polioencephalomalacia (PEM), a neurological disorder characterized by weakness, muscle tremors, lethargy, and even paralysis and death.
- Sulfate is present in most water sources and is commonly found in the form of calcium, iron, sodium, and magnesium salts. Elevated levels of these salts can make the water taste objectionable to cattle
- Sulfur is antagonistic to copper causing cattle performance issues similar to tall fescue endophyte
- Preferred pH range for cattle is 6.0 to 9.0 for humans it is 6.5 to 8.5
- High iron concentrations (greater than 0.3 mg/L) can affect cattle health and performance by impacting copper and zinc absorption.
- Research suggests that levels of dietary calcium greater than 12.5 g/kg can reduce selenium absorption
- Leaving good cover of green and

Potential Water Borne Diseases	***Visual Symptoms***	***Status***
Anthrax		
Brucellosis	Aborted calf	Tennessee is currently Brucellosis free
Coccidiosis	Scours	Common
Cryptosporidiosis		
E. coli	Scours	
Foot scald	raw area between hoofs	Common in wet conditions
Foot rot	raw missing flesh in hoof	Common in wet conditions
Leptospirosis	Aborted calf	Common Nine or more strains
Salmonellosis		
Tall fescue endophyte		

Ponds at one time were the main supply of water on farms. In recent years with more interest in grazing management and water quality for livestock and the public ponds are typically used as a back up supply of water or supply source for gravity flow or pumping water.

- Ponds limit location of water point
- Cost of a pond is typically high and in some areas of the state assurance of ponds holding is 50% or less. In West Tennessee and on the Cumberland Plateau ponds typically hold well.
- Pond water quality for livestock is typically lower than other sources of water
- Biggest concern with ponds is water quality, do not feed above ponds water flowing through manure to pond carries disease contaminating water.
- Access ramps can be put into the pond to save banks of pond but typically cost is too high relative to pumping water to a more ideal location. Most ponds fill in due to cattle access wearing down the banks at the waterline of the pond.
- Ponds can be limit grazed for vegetation management and to compact soil to keep the pond sealed

Caution when treating livestock for insect control some substances are deadly to aquatic species including fish in ponds and streams

Sensitive areas:

- Any areas that increase vulnerability of water quality in runoff or ground water
- Drainage ways even if they are not perennial water flow should not travel through the water point
- Karst or sinkholes open or closed, the water point needs to be 50’ from top edge of depression
- Water areas including streams, ponds, lakes, wetlands or springs
- Water wells, gas wells or oil wells need to be protected so surface water doesn’t flow down the outside of the casing
- In difficult sites runoff may be diverted away from the site or the site graded in such a way that water flows away from the sensitive area
- Locate watering point 50’ or more away from sensitive areas or have an access control filter area that is 20’ or wider.
- Grazing sensitive water areas should be very limited. Regrowth of vegetation in these areas is very slow. Grazing once or twice a year is the most recommended and even then for short duration.

Grass Filter Strips

Practice	**Minimum Width to Protect Sensitive Areas***
Animal Trails and Walkways Exclusion Buffer	***20’***
Heavy Use Area- Feed Area- Exclusion Buffer	**35’**
Grazed Buffer	**70’**
Manure Stacking Area- Exclusion Buffer Grazed Buffer	 **100’** **300’**
Watering Facility within 50’ of sensitive area Exclusion Buffer Grazed Buffer	 **20’** **50’**
Loafing (Exercise) Lots	**30’**
Cropping	**20’**
*** Width increases as watershed and steepness increase**	

Fencing Streams

Stream crossing fencing depends on the flooding potential of the stream on smaller streams a swinging welded wire panel can work well or framed tin panels swinging from a swivel. For streams more prone to flooding a support wire above the flood plain with electrified dangling horizontal chains, pipe or rods can work well.

Flood controllers and switches are useful when using electric fence across streams. ***A separate wire from the flood gate should serve as a delivery of electricity to the other side of the stream.***

Fencing across Troughs

Fencing across permanent water troughs needs to be sturdy and connected with lag bolts or equivalent a minimum of 2" in the post. Boards two inches thick eight inches apart horizontally with post no further than 6' apart. If brace posts are located at the water point use 6" diameter post with an H brace. Welded wire can also be used across the water trough. With welded wire panels top and middle 2" x 4" boards are needed for extra support.

Electric wires are best insulated when crossing troughs however often times portable tanks are placed under an electric wire to prevent damage to the trough.

Water Systems for Small Ruminants

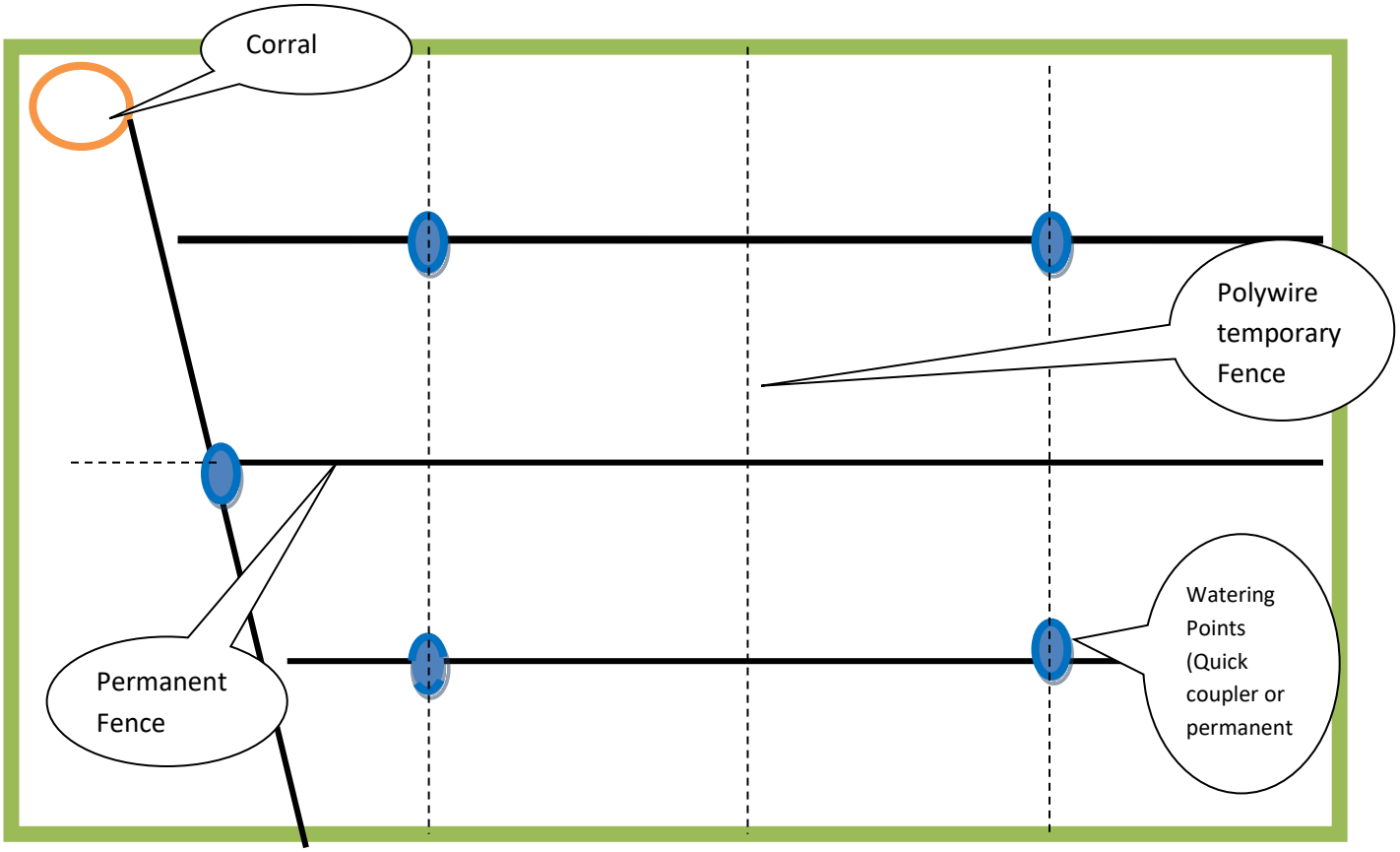
Due to their small stature goats and sheep are prone to falling in troughs deeper than 18" and drowning so ***escape ramps*** or something as simple as brick o blocks need to be placed in deeper troughs. Troughs split by fence need an escape ramp or blocks on all sides of the watering trough. Either open water tanks, lid covered tanks or small ball waterers are appropriate for small ruminants.

Goats don't typically like to stand in water but love to play on banks and can cause severe damage to the riparian area. Small ruminants do not loaf at the water point as much as cattle unless they are using the banks as a playground.

Ideal layout of water points:

Long parallel fences with water points placed in every other fence row where paddocks can be cross fenced again with temporary fence and travel distance for livestock to water is not further than 800' from anywhere in the paddock. Suggested distance between fences is 435' then if posts are on 50' spacing every 100' = one acre. An angled paddock directed toward the corral improves cattle flow. The following conceptual layout provides five permanent paddocks that can be easily cross fenced with temporary wire to make 18 or more temporary paddocks. This ***layout is very flexible allowing land to be grazed, cut for hay, or even cropped with little interference by the fence***. Long paddocks are best run with the contour of the land.

Another option is to get control of all water and rotate water points this can be done with permanent fence or corral panels. It is ok to allow livestock to back graze for 4 days or less in the growing season; you can back graze longer in the dormant season. This means small paddocks may not need a water point just access through the previously grazed paddock. ***It is best to leave additional cover in the paddock you plan to back graze.*** Note: geared reels and braided polywire make temporary fence much easier and durable.



Prescribed Grazing "Acres per Paddock",

"Cowboy Math"

Knowing acres per paddock is extremely useful for correctly locating fence and water

When planning for the proper location of fence and water plan for the shortest rotation

Recommended paddock size for large animals (i.e. cattle and horses) Based on the Rotation Frequency and Head/ Herd circle appropriate paddock size if variables differ from notes in table multiply by an adjustment factor (see table foot note).

Rotation Frequency[1] (Days)	Grazing Efficiency[2] (%)	Head/ Herd	10	20	30	40	50	60	70	80	90	100	150	200	250	300
			----------Acres per Paddock----------													
3.5	65%	------	1	2	3	4	5	5.5	6.5	7.5	8.5	9.5	14	19	23	28
7	50%	------	2.5	5	7	10	12	15	17	19	22	24	36	49	61	73
14	35%	------	7	14	21	28	35	42	49	56	62	69	104	139	173	208

This table assumes 5 inches of growth at turn in and good to excellent forage weighing 300 pounds per acre inch. Livestock numbers are based on 1,000-pound animals with a calf up to 300 pounds. Consumption rate is based on an average of 2.6 percent of body weight consumed per day throughout the year. Paddock size is an estimate that is best kept within 30% of recommended size. Recommended paddock size is based on the assumed production information in the table.

Adjust recommended acres per paddock by an appropriate factor (i.e. for 900 lb animal multiply by 0.9 for a 1200 lb animal multiply by 1.2), if forage is thinner and lower quality multiply by 0.8 or for real dense high quality forage multiply acres per paddock by a factor up to 1.3.

For more specific determination, enter data in USDA/NRCS/TN Cowboy Math Excel spreadsheet or use the following formula:

$$\text{Acres/Paddock} = \frac{\text{(Animal Wt.) X (Intake Rate in \% Body Weight) X (Animal No.) X (Days on Paddock)}}{\text{(Inches) X (Pounds per Acre Inch) X (\% Grazing Efficiency)}}$$

Example 1

Where should I locate water in a 16-acre or smaller field? Given: 50-head cow herd weighing 1,000 pounds, turn cattle in field at 5" height on good forage, rotation is seven days.

Answer: The best location for water would be in the middle of a fence line, because for a seven-day rotation, 12-acre paddocks are recommended. Placement in center of fence line also allows additional cross fencing with temporary or permanent fencing. If all fields are of similar size and production, water

could be placed in every other fence line provided that travel distance to water is less than 800' (water point's 1,600' apart[3]).

Rotation Frequency[1]			
Livestock	**Daily Forage Intake in % of body wt.**	**Recommended Rotation Days**	**Number of Paddocks**
Lactating Dairy	3-4%	0.5-1 day	15-45
Stocker Cattle, Dairy Heifers,	2.5-3.5%	1-3 days	6-45
Beef, Dry Dairy, Swine, or Horse	2-3%	3-7 days	3-16
Sheep, Goats	3.5-4 %	3-7 days	3-16

Grazing Efficiency[2]		
Number of Paddocks	**Approximate Days on Each Paddock**	**Grazing Efficiency for use in formula** **(Includes Maintaining Minimum Stubble)**
Continuous	-------	40% or less or (80% over-grazed, low yield)
4 to 6 paddocks	7 to 9 days	40 to 55%
8 to 10 paddocks	4 days	55 to 65%
24 to 45 paddocks	1 day or less	70 to 80%
Hay	-------	70 to 80%

Recommended Travel Distance to Water[3] (additional consideration)		
Lactating Dairy	**400-600'**	Herd's water as a group if travel distance is over 800' or lead cow travels over hill or leaves shade for water.
Beef Cows, Stockers, Horses, Sheep, or Goats	**800'** **1000' flat land**	

Reference: USDA/NRCS eftog: http://www.tn.nrcs.usda.gov/technical/grazing/index.asp select grazing tools and cowboy math;Agronomy Technical Note No. 26,

Water Quality Testing
Toxic Compounds:
Generally considered safe levels of potentially toxic substances

Substance	Upper-limit Guideline (mg/L)
Aluminum (Al)	5.0
Arsenic (As)	0.2
Boron (B)	5.0
Cadmium (Cd)	0.05
Chromium (total) (Cr)	1.0
Cobalt (Co)	1.0
Copper (Cu)	0.5
Fluorine (F)	2.0
Lead (Pb)	0.1
Manganese (Mn)	0.05
Mercury (Hg)	0.01
Selenium (Se)	0.05
Vanadium (V)	0.1
Zinc (Zn)	24.0

Maximum recommended sulfate (SO4) and sulfate sulfur (SO4–S) levels.

SO4 (mg/L)	SO4-S (mg/L)	Types
<500	<167	Calves
<1,000	<333	Adults

Sulfur in the form of hydrogen sulfide can lead to reduced water intake at levels as low as 0.1 mg/L.

Guidelines for nitrates (NO3) and nitrate nitrogen (NO3-N).

NO3 (mg/L)	NO3-N (mg/L)	Comments
0-44	0-10	Safe for consumption
45-132	11-20	Safe with low nitrate feeds and balanced diet
133-220	21-40	Potentially harmful if consumed for long periods
221-660	41-100	Cattle at risk of death
>661	>101	Unsafe for consumption

Fecal Coliform: Some sources recommend livestock drinking water contain less than 1 CFU (colony forming unit) per 100 mL for calves and 10 CFU per 100 mL for adult cattle, but these values may be difficult to achieve in the presence of cattle. Total coliform and E. coli are common in surface water.

Water Hardness Guidelines

Hardness (mg/L)	Category
0-60	Soft
61-120	Moderately hard
121-180	Hard
181-350	Very hard
>350	Brackish

Normally hard waters don't interfere with livestock performance

Water Sampling: Follow water sampling protocol or information will be useless. The laboratory will specify the type of container to use, what forms to complete, and how the sample should be packaged and shipped. http://www.state.tn.us/environment/dws/pdf/dwa_labs.pdf

General sample collection and handling guidelines:
Location Sample should be representative of water that animals drink; grab samples from the stream should be taken at the mid-channel and mid-depth; flush watering lines for 3 to 5 minutes before sampling.

Container should be clean and free of contaminants; do not pre-rinse; open container only to collect sample. Label Specify name, date, time and sample location Holding Time Check with laboratory or manufacturer; varies with contaminant; pH must be analyzed in the field. Holding Temperature Store at 4°C (39°F).

Volume Fill container full for organic compound determination; leave space for aeration and mixing for inorganic and microbiological determinations; amount should be sufficient to conduct all required tests.

Preservation: Check with laboratory or manufacture care should be taken to add specified volume of sample to maintain correct sample to preservative ratio

Disinfecting a well (Shock Chlorinate):
To disinfect the well, pour into the well one (1) gallon of chlorine bleach or one (1) ounce HTH super chlorinated solution for every fifty (50) feet of well depth.

Once the chlorine is in the well, the faucets in the home should run until a chlorine odor is noticed. The water is then turned off and allowed to remain in the well and pipes for at least twelve (12) hours.

After twelve (12) hours, the water should be pumped out of the well until the chlorine odor is gone. Do not run heavily chlorinated wastewater through a septic tank system or discharge into a surface water body.The disinfection procedure should be repeated each time the well, pump or pipes are serviced.

Design Questions

Conservationist can assist you

Step 1 – Where is electricity available? _____ _____

Step 2 – What is the existing source of water? _____

Step 3 - What is the current water quality (Good, Fair, Poor)? _____

Step 4 – What are the water needs of your livestock?

Number and weight of livestock _____

Number of herd's _____

Daily water needs _____

Step 5 – What is the elevation difference between the source of water and planned water point? _____

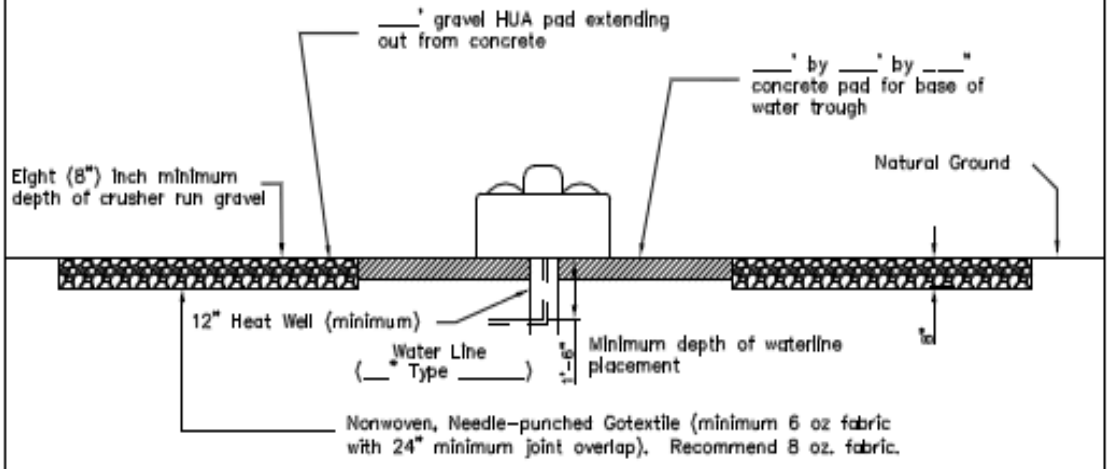
Step 6 – What is the distance planned for pipeline? _____

Step 7 - Is electricity available? _____

Step 8 – Will dips be present in the pipeline where vents are needed? _____

Step 9- Do you plan to increase your herd in the future? _____

Step 10 – Do you expect to extend your pipeline in the future? _____



– SECTION A–A –

Notes:

1) Crusher run stone or graded shall be a minimum of 8" in depth before compaction. If graded stone is used it shall be a minimum of 6" in depth with 2" of crusher run or lime over dressing. If other material is used refer to the Heavy Use Area Protection Standard (No. 561) and contact design engineer before installation.

2) Concrete pad shall be a minimum of 5" thickness. All concrete poured on or against soil or stone shall have 6 mil. plastic barrier placed between the concrete and subgrade. Optional 8" concrete pad may be used to match grade with crusher run backfill.

3) The Watering Facility Standard (No. 614) requires a 10' minimum distance outside of tank for heavy use area protection.

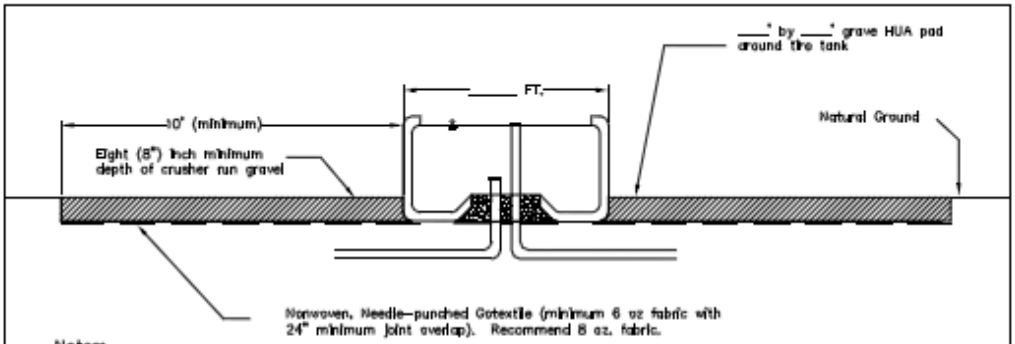
4) Geotextile required has a minimum weight of fabric of 6 oz./sq.yd. and must be installed with a minimum overlap of 24" (refer to Heavy Use Area Protection Standard). recommend using 8 oz. fabric if available.

5) Trough and tank must be located a minimum of 150' from well head for well head protection.

6) Water facility and components shall comply with all the following Practice Standards: Watering Facility (No. 614), Heavy use Area Protection Standard (No. 561), and Pipeline (No. 516.)

7) Water Line and heat well location may vary by manufacturer. Refer to the manufacturer's installation guide when forming concrete to insure placement of the tank in the center of the Heavy Use Area.

NRCS	_____ Farm Four – Ball Water Tank _____, TN Tank / HUA Side View	Date Designed _____ Drawn J.C. Zimmerman 04/09 Checked _____ Approved _____	FILE NAME DRAWING NUMBER Standard Drawing Sheet of



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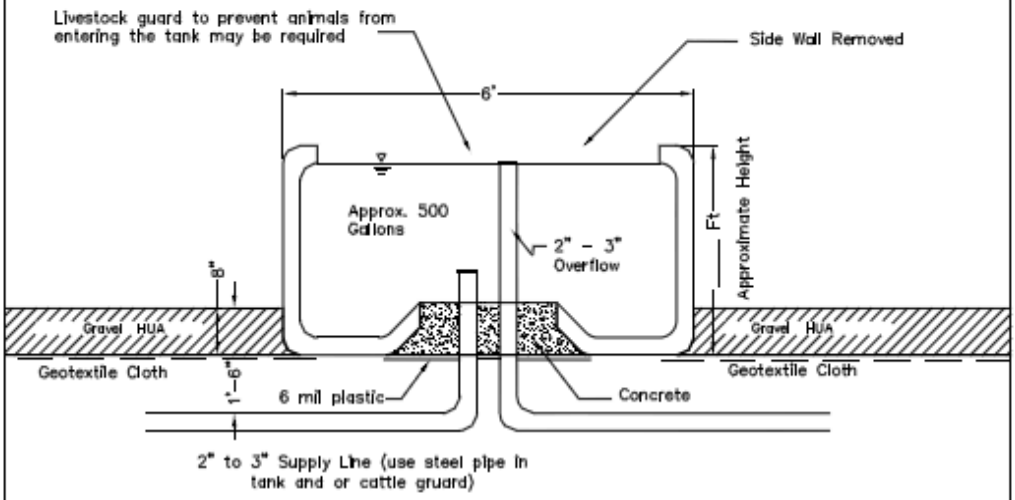
2) All concrete poured on or against soil or stone shall have 6 mil. plastic barrier placed between the concrete and sub-grade.
3) The Watering Facility Standard (No. 614) requires a 10' minimum distance outside of tank for heavy use area protection.
4) Geotextile required has a minimum weight of fabric of 6 oz./sq.yd. and must be installed with a minimum overlap of 24" (refer to Heavy Use Area Protection Standard). recommend using 8 oz. fabric if available.
5) Trough and tank must be located a minimum of 150' from well head for well head protection.
6) Water facility and components shall comply with all the following Practice Standards: Watering Facility (No. 614), Heavy use Area Protection Standard (No. 561), and Pipeline (No. 516.)

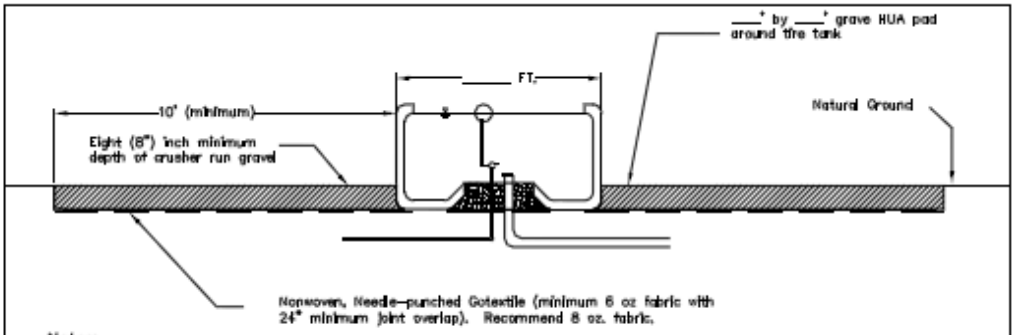


NRCS

_____ Farm Equipment Tire Water Tank _____, TN
Tank / HUA Side View

Designed _____ Date
Drawn J.C. Zimmerman 04/09
Checked _____
Approved _____

FILE NAME
DRAWING NUMBER
Standard Drawing
Sheet of



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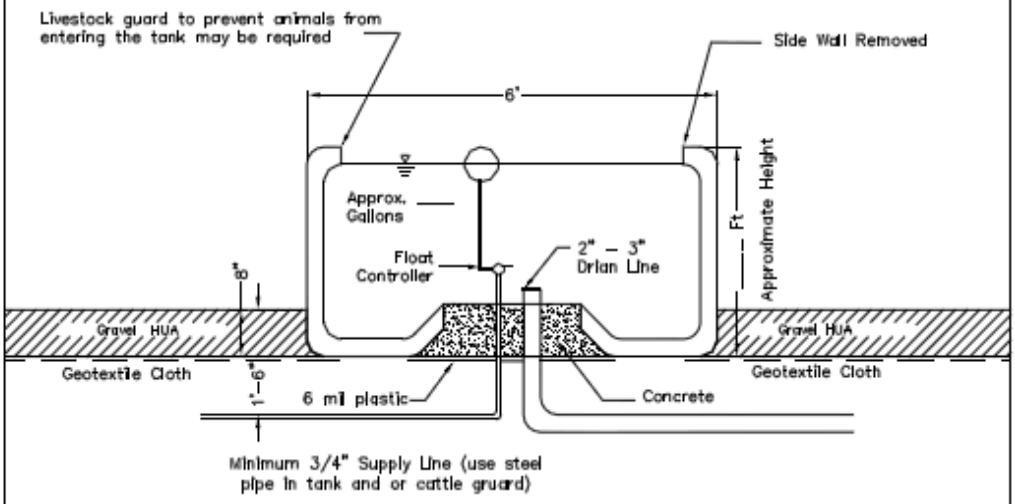


NRCS

_____ Farm Equipment Tire Water Tank _____, TN
Tank / HUA Side View

Designed _____ Date
Drawn J.C. Zimmerman 04/09
Checked _____
Approved _____

FILE NAME
DRAWING NUMBER
Standard Drawing
Sheet of

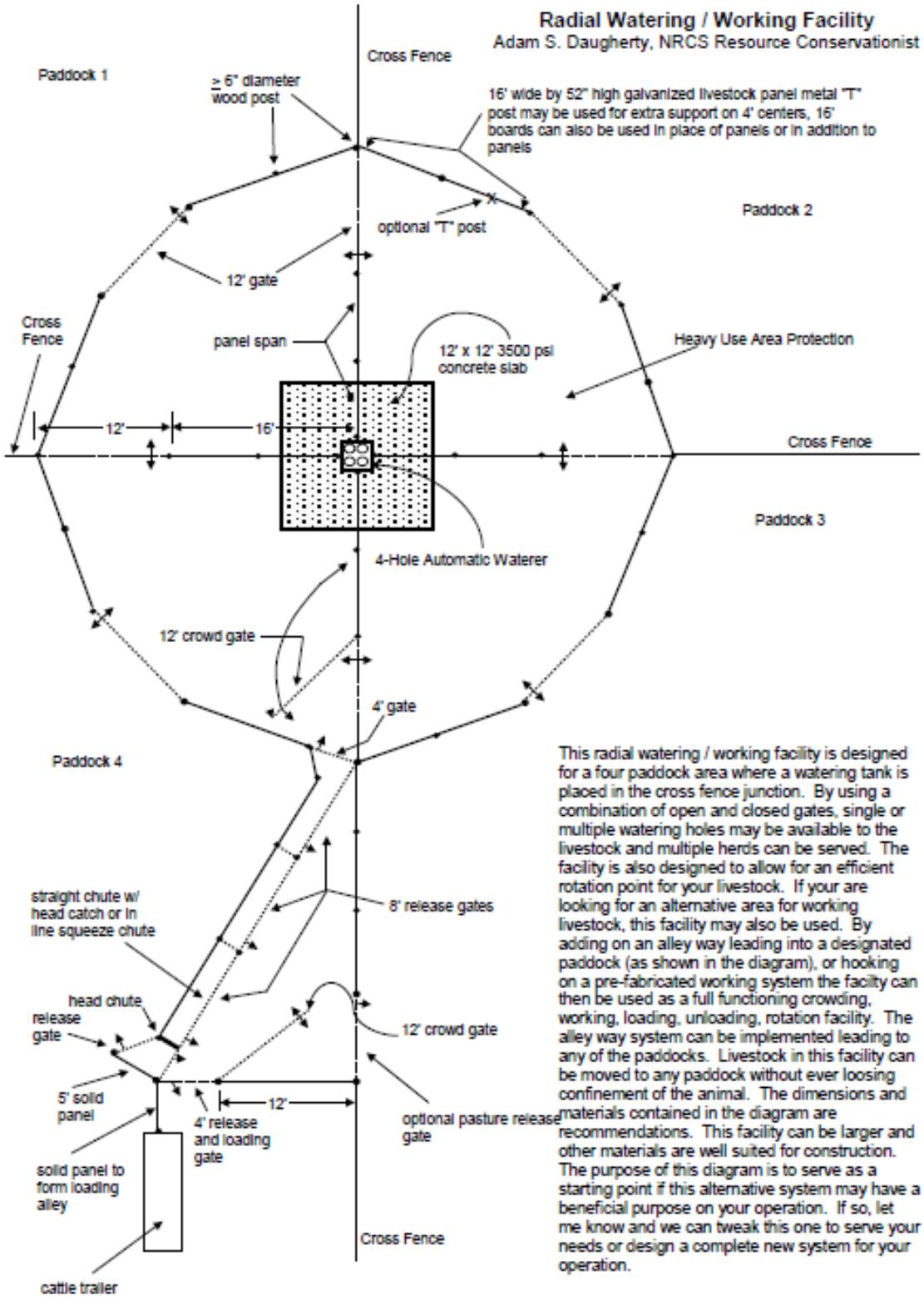
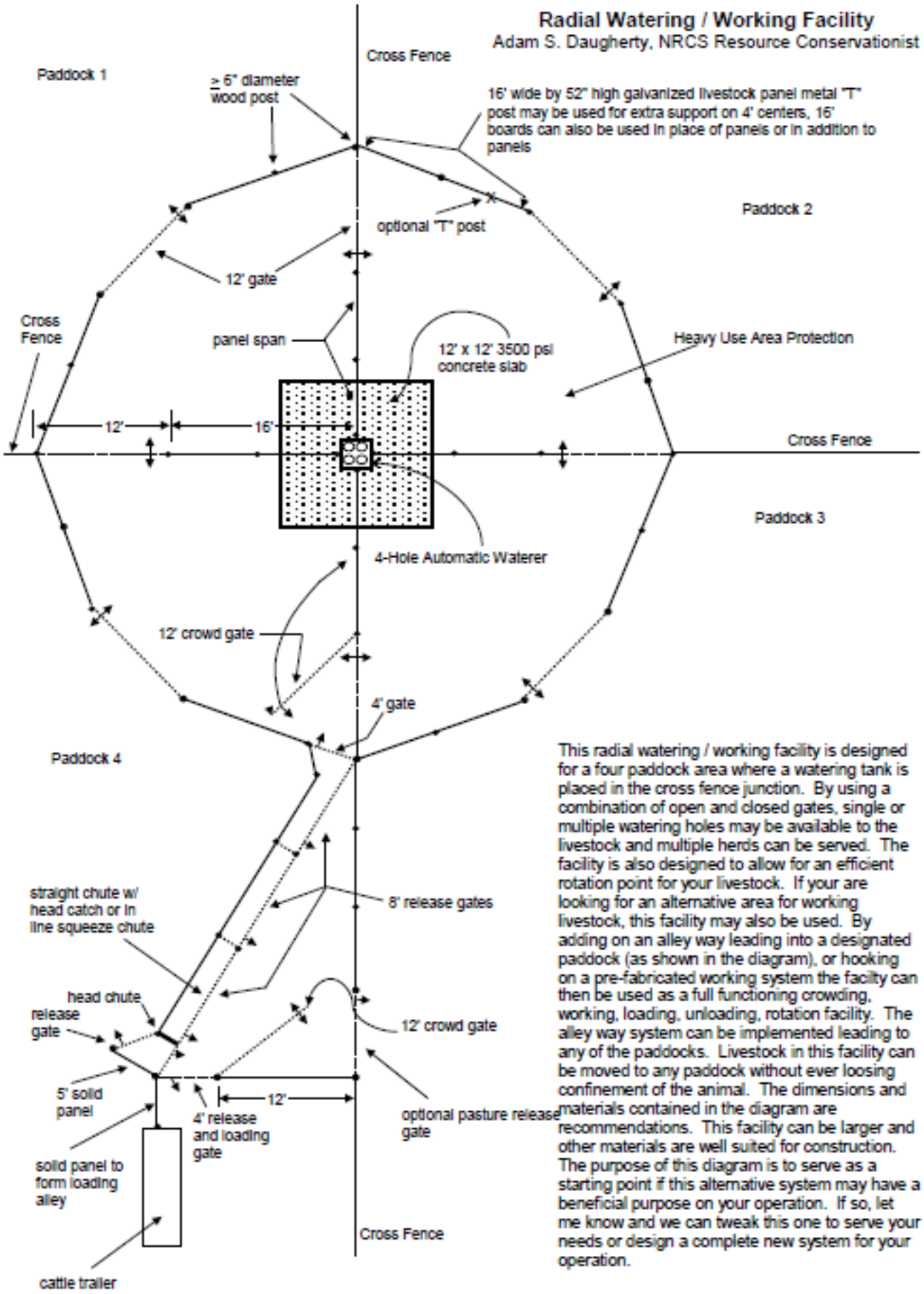


Diagram is Not To Scale. Approximate diameter is 60 feet. Approximate area is 2800 square feet.

This radial watering / working facility is designed for a four paddock area where a watering tank is placed in the cross fence junction. By using a combination of open and closed gates, single or multiple watering holes may be available to the livestock and multiple herds can be served. The facility is also designed to allow for an efficient rotation point for your livestock. If your are looking for an alternative area for working livestock, this facility may also be used. By adding on an alley way leading into a designated paddock (as shown in the diagram), or hooking on a pre-fabricated working system the facilty can then be used as a full functioning crowding, working, loading, unloading, rotation facility. The alley way system can be implemented leading to any of the paddocks. Livestock in this facility can be moved to any paddock without ever loosing confinement of the animal. The dimensions and materials contained in the diagram are recommendations. This facility can be larger and other materials are well suited for construction. The purpose of this diagram is to serve as a starting point if this alternative system may have a beneficial purpose on your operation. If so, let me know and we can tweak this one to serve your needs or design a complete new system for your operation.

Radial Watering / Working Facility

Adam S. Daugherty, NRCS Resource Conservationist



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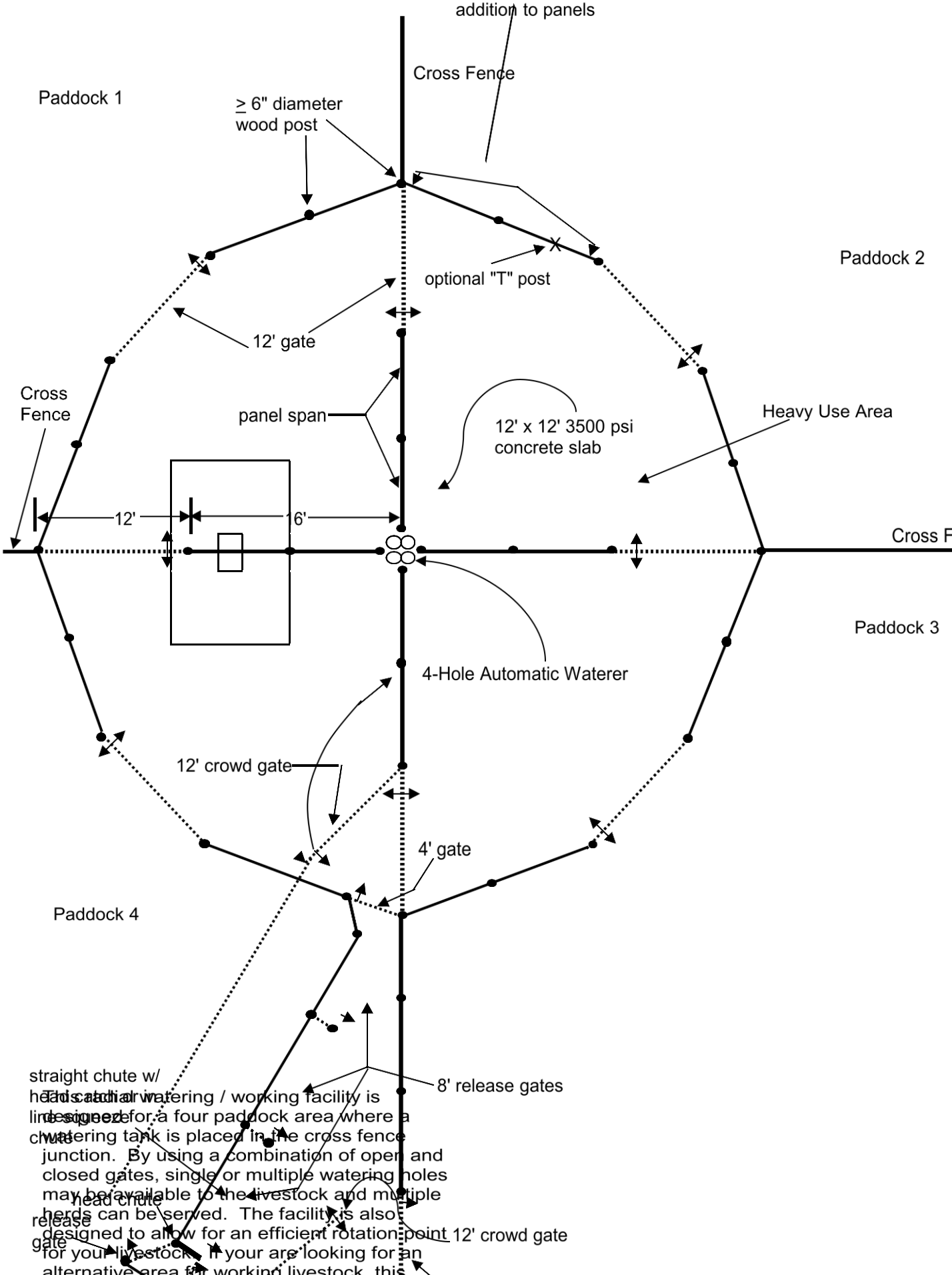
Radial Watering / Working Facility

Adam S. Daugherty, NRCS District Conservationist



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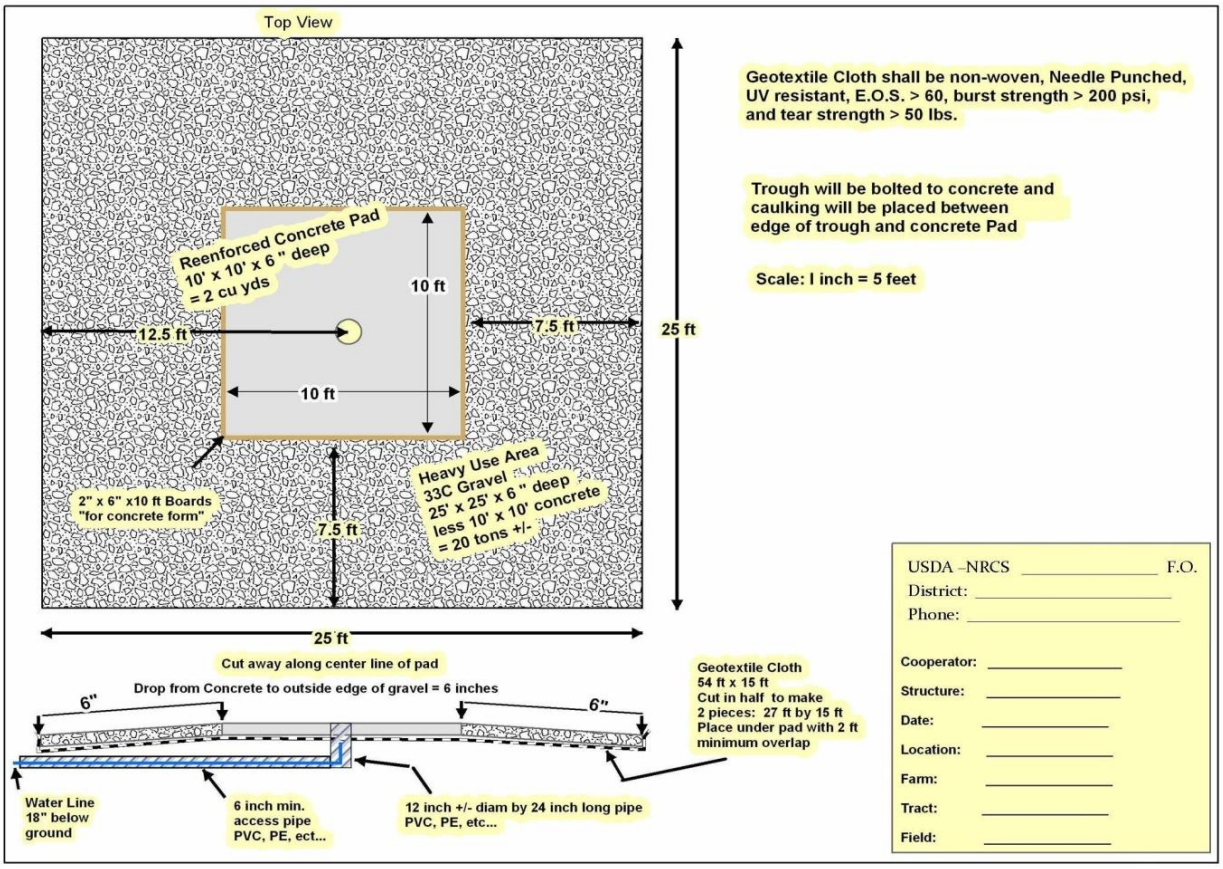

Program Opportunities

The Conservation grazing plan comes first then the contract for cost share program opportunities. Technical assistance is available through NRCS even if cost share is not provided. All practices that NRCS constructs are required to meet our standards and specifications so it is very important you pay special attention to your individual plan and contract.

Eqip- http://www.tn.nrcs.usda.gov/programs/eqip2011/index.html

TDA- http://www.tn.gov/agriculture/water/index.html

GRP- http://www.tn.nrcs.usda.gov/programs/GRP/grp-index.html

CRP- http://www.tn.nrcs.usda.gov/programs/CRP/CRP.html

CSP- http://www.tn.nrcs.usda.gov/programs/CSP/csp-index.html

Whip- http://www.tn.nrcs.usda.gov/programs/WHIP_2011/index.html

Additional Funding opportunities in designated areas may be available
Nature Conservancy of Tennessee, World Life Fund, TVA, TWRA and others

Design and Layout:

Greg Brann, State Grazing Lands Specialist, NRCS, Tennessee

Joe Zimmerman, design engineer, NRCS, Tennessee

References:

Missouri Watering Systems for Serious Graziers, USDA – NRCS

Tennessee, NRCS Field Office Technical Guide, Section IV, Conservation Practice Standards and Specifications

Drinking Water Quality Guidelines for Cattle, University of Kentucky, Stephen F. Higgins, Carmen T. Agouridis, Biosystems and Agricultural Engineering, and Amanda A. Gumbert, Agricultural Programs

http://www.tn.nrcs.usda.gov/technical/tntechnotes/docs/tn-26.pdf

http://efotg.sc.egov.usda.gov//references/public/TN/Stream_Crossing_CTST-STR-578-1.pdf

http://www.state.tn.us/environment/dws/

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