Watering Facility (614) Engineering Design Guide

This engineering design guide adheres to WV NRCS Conservation Practice Standard 614. The guide provides engineering planning and design information and guidance.

DEFINITION OF WATERING FACILITY

A permanent or portable device (trough or tank) which provides an adequate amount and quality of drinking water for livestock and or wildlife.

PURPOSE

To provide access to drinking water for livestock and/or wildlife in order to:

- Meet daily water requirements
- Improve animal distribution

Introduction

All livestock require unlimited access to fresh water. Water for livestock is supplied from many sources such as wells, ponds, streams, springs or municipal water supplies. Municipal and other public sources of water can be cost prohibitive. Although it is often convenient, it is not ideal for livestock to drink directly from surface water because of the potential of contamination from manure, bacteria, and pathogens as well as the potential for stream bank destabilization which causes increased sediment transport and bank erosion. When livestock are forced to drink stagnant water or out of puddles, their health may be impacted by exposure to foul water, parasites or liver flukes. A well designed and suitably placed trough is important to water quality, quantity and overall livestock health.

The selection of the most effective trough is more than selecting a size or type, information must be gathered about the following:

- Water Source: dependability, adequacy, source rate (GPM), source yield (GPD) and water trough water fill rate (WFR in GPM).
- Amount of Water: daily water consumption volume required by livestock and/or herds (GPD), drink rate of livestock (GPM), drink rate of herd (GPM).
- Location: type of pasture or paddock where livestock are confined, placement of the watering facilities in the field, and distance livestock will travel to water.

- Watering Facility Type: Open top which are traditional tanks and closed or on-demand facilities.

[Note: All acronyms used in the design guide are defined on the last page of the guide.]

Source

The source of water is critical, especially if a single source cannot provide the daily volume of water required by the livestock. Document who is reliant on the water source and if there are multiple uses, estimate the volume available to the livestock.

The dependability and adequacy of the water source are also important. The water source is considered "Dependable" if it provides continuous, year around water (water wells, year round ponds, streams, rivers or permanent flowing springs). "Non-Dependable" sources are systems that use solar or wind energy power or intermittent springs.

The volume of water produced is typically adequate for most livestock operations when the source is a large stream, pond, or high volume well. The adequacy of the water provided is calculated by showing that the volume of water produced will meet or exceed the volume of water the herd will consume in one day (HCV).

When relying on a spring (where the quantity varies depending on weather conditions) or a well with low recharge characteristics, the volume produced may be inadequate, impact livestock health and require the operator to haul water to meet livestock needs. If the volume of water is not adequate, additional water from another source may be supplied. Document the amount of additional water required as a component of the system. To allow the operator time to adjust the operation and set up the water delivery system or move the livestock, it is highly recommended to store 2 or more days of supplemental or additional water on site.

If the source is not adequate and additional water cannot be located, reduce the herd size to meet the water source(s) daily yield in gallons per day (GPD).

Document how the source water is delivered (pumped, gravity or other). If the source water is pumped, refer to Table III for the number of hours that wells, surface systems or solar systems can be pumped. Depending on the source flow (GPM), the maximum allowable number of pumping hours without depleting the source water varies. For example, a well that produces 7 GPM can be pumped 6 hours a day and produces 2,520 GPD. Springs are assumed to produce 24 hours a day, so a spring with an average flow of 0.5 GPM can produce 720 GPD. However, springs may not produce year around depending on their location and weather conditions.

If the water is delivered by gravity, estimate the flow rate at the elevation of the proposed trough. If a non-typical Ram or Nose pump is used, contact the manufacturer for specifications and selection of pump. A Ram pump requires a permanent, clear

stream with a minimum water depth of two feet, a minimum of three feet of fall above the pump, a minimum flow rate of 1 GPM, and an average velocity of 3-5 feet per second. Nose pumps should be designed where they can be mounted 100 feet or less from open water with an elevation lift of 20 feet or less.

Amount

The amount of water livestock drink each day or the Livestock Consumption Volume (LCV) depends on the type of livestock, diet, dry matter intake, travel distance to water, availability, access and water temperature, quality, and quantity. A number of references report the daily Livestock Consumption Volume (LCV) in Gallons per Day (GPD). Table I provides information on daily LCV and additional drinking volumes based on shade, distance to water or type of pasture or paddock. Other factors may also impact livestock water consumption. For example:

- Water intake decreases when livestock are stressed and increases as their activity increases.
- Livestock drink from the closest watering facility to conserve energy.
- Large animals leave the herd and drink independently or in small groups if the travel distance to water is less than 800 feet.
- Small animals stay together and move to water with the herd for protection in both large and small pastures.
- In large pastures where the herd travels more than 800 feet to water, livestock consume less water.
- Livestock crowd each other for water and the stronger animals drink first. When multiple animals drink at a trough, adequate space must be provided around the tank. Table I gives the recommended linear drinking space (Inch/Livestock) required by each livestock type.
- The height of the trough impacts the livestock access. If there are calves or smaller animals, select a trough to meet their drinking height needs.

Once the Livestock Consumption Volume (LCV) is known, the Herd Consumption Volume (HCV) can be calculated. Multiply the number of livestock in the herd times the LCV to determine HCV. If there are herds in multiply fields or pastures supplied by the same source water, sum all of the HCV's and determine if the source water supplies all their needs.

An equally important factor to the volume (GPD) of water consumed each day is the Water Fill Rate (GPM) of the watering facility and the Livestock Drink Rate (LRD). The Water Fill Rate (WFR) may vary for each facility, depending on the elevation, pipeline flow (pressure or gravity) and if there is a float to regulate the water level in the tank. The Livestock Drink Rate (LDR) is the rate at which the animals drink water. References report that large animals can drink 1 to 3 GPM and small animals 0.5 to 2 GPM. When multiple animals simultaneously drink from the tank or trough, the Herd Drink Rate (HDR) must be calculated and considered when selecting the trough volume and the trough linear drinking space available to the livestock. The HDR is calculated by

multiplying the LDR times the number of animals drinking at one time (5% or 10% of the herd).

When selecting a watering facility, document whether the Water Fill Rate (water filling the tank) is equal to or greater than the Herd Drink Rate and the amount of time required for the WFR to supply the daily Herd Consumption Volume. Both of these values influence selection of the minimum size for the watering facility.

Location

Selecting the watering facility location is important for successful management of grazing systems and herd health. Often the water source is not easily accessible or situated in the best location. Delivery of clean and ample water by pipeline (gravity or pressurized) allows selection of the optimum location for the trough.

Questions to consider: Where will the trough(s) be located in the field or pasture? Will they be located adjacent to a fence line, shared between pastures or located in the pasture where the livestock can gather around the trough? The answers to these questions impact the number of livestock that can drink at one time as well as the volume of water available to the herd.

Studies indicate the travel distance to water impacts pasture utilization, distribution of nutrients, livestock consumption rate, and animal stress. If the herd travels more than 800 feet to water, more than one trough should be placed in the pasture. Strategically placed troughs improve pasture grass efficiency and livestock health. Clean, fresh and easily accessible water has been shown to increase livestock weight gain (when all other factors were the same) by 130% and improve livestock health and vigor. Livestock instinctively conserve energy and will drink at the closest available tank, regardless of the health of the pasture. When multiple trough/tanks are provided, livestock energy efficiency improves and the manure-parasite loading is more evenly distributed throughout the pasture. It has been documented that in pastures where troughs are located:

- 200 feet or less from livestock; 60%-70% of the pasture is utilized.
- 200 feet to 800 feet from livestock; 50% of the pasture is utilized.
- greater than 800 feet from livestock; poor grazing distribution, the areas closest to the watering facility become overgrazed
- when water is greater than 1100 feet away, the grazing distribution rapidly declines to less than 10%.

Understand how the livestock will be managed. Are they located in a continuously grazed or an intensely grazed or rotational pasture or paddock? Assuming that adequate water is provided to the watering facility, livestock may be located in different types of pastures or paddocks such as:

- Intensively Grazed, Rotational Managed Pastures or Paddocks

  Planning Assumptions:

- o water volume delivered to the trough is equal or greater than the daily Herd Consumption Volume,
- o livestock have 800 feet or less to travel to water,
- o 5% of herd will drink at the same time,
- o ample space is provided around the trough for livestock to gather and drink at the same time,
- o the minimum trough volume is 25 gallons,
- o the trough may be portable, but secured during use,
- o troughs are monitored daily since they do not provide extra storage volume,
- o The minimum trough volume is
  - 25 gallons when the trough Water Fill Rate (WFR) is greater than the Herd Drink Rate (HDR) measured in GPM or,
  - 50% of the Daily Herd Consumption Volume (HCV) measured in (Gallons per Day) when the WFR is less than the Herd Drink Rate (HDR) and the time to pump the water to replace the HCV is equal or less than 4 hours.
  - 100% of the HCV (gallons) when the WFR is less than the LDR and the fill time is greater than 4 hours.

- Continuous Grazed Pastures

Planning Assumptions:

- o water volume delivered to the trough is equal or greater than the daily Herd Consumption Volume,
- o livestock travel more than 800 feet to water,
- o 10% of Herd will drink at the same time,
- o one or more troughs may be required in the pastures to eliminate excessive walking,
- o ample space is provided around the trough for livestock to gather and drink at the same time,
- o the minimum tank volume is the greater of :
  - 100 % of the Daily Herd Consumption Volume (HCV) or
  - 100 gallons.

<u>Watering Facilities</u>

There are many types of livestock watering facilities (Reference: Table IV). The traditional open top concrete, black polyethylene or rubber tire troughs or tanks are used most often. The water fill rate or flow to these troughs is controlled by a float valve at the level where the water flows to another trough or discharges to a designated location. Concrete or the tire troughs are not portable and polyethylene troughs may or may not be portable.

Watering Facilities can be made from reinforced concrete, 20 gauge galvanized metal (bottom), freeze-proof plastic, fiberglass, heavy equipment tires or other approved materials.

Water facility height varies from 22 inches to 36 inches for horses and cattle. For sheep and goats the height should be no less than 8 inches.

The pump to the watering facility must provide the desired flow rate and pressure to the tank [Reference: CPS Pumping Plant (533)]. Pipe on the inside of the water trough/tank must be installed according to approved WV Engineering Drawings and Construction Specification Watering Facility (614) Trough or Tank. Pipelines inside the tank will be the larger of 1.25 inches (for gravity flow systems), 0.75 inches (pumped pressure systems), or the diameter of the pipeline feeding the trough.

Automatic flow control valves are necessary to prevent water overflow and provide a constant water level. Open flow valves require a minimum of 5-8 pounds per square inch (PSI) of pressure to open and prevent leaking. The valves typically reduce the flow rate to the tank by 20%.

On-demand watering devices require a minimum pressure of 8 PSI and a maximum allowable pressure of 40-60 PSI. Verify the minimum and maximum allowable pressures with the manufacturer of the device. If the pressure is greater than the maximum allowable, install a pressure regulating valve.

Depending on the shape and location of the trough, the amount of available space for livestock around the tank will vary. A round tank in the open provides more linear space than a rectangular tank. Table I provides the recommended livestock space or distance that each type of animal requires when drinking (Inch/Livestock). When information about a particular type animal is unknown, a good rule of thumb is 20” of drinking space per animal for a round tank and 30” of space per animal for a rectangular tank.

Most rectangular or oval tanks are placed along a fence line; therefore, the available tank space is based on the length of the trough. When the tank is shared between pastures, reduce the available space by 50% and subtract 24” to account for the fence line that divides the trough.

Round tanks placed in the open provide 100% of the perimeter to livestock. If a round tank is shared between pastures, reduce the available space by 50% and subtract 24” to account for the fence line that divides the trough. For example: a 60-inch diameter trough (300 gallons) has 188 inches of space available. If one steer requires 16 inches of space, then there is enough room around the tank for 11 steers to drink at one time (188 inches ÷ 16 inches/animal = 11 animals). If the round tank is shared and available to two fields, then the available space per field is [(188” ÷ 2) – 24”]= 70 inches which provides space for four steers (70 inches ÷ 16 inches/animals = 4 animals) to drink at the same time.

Closed top or on-demand frost proof units provide instantaneously water, are permanent, and are typically used in small fields or paddocks where they can be monitored daily. For the systems to work properly, they must have a minimum source

flow (determined by the number of holes or bowls) and pressure based on the manufacturer's specifications. If product selection has not be made during the planning process, then refer to Table II, which provides information on the number of animals a opening or bowl can supply and the minimum flow capacity required for each opening or bowl.

As a minimum, an on-demand system must be:

- designed for freeze protection,
- installed on a concrete base,
- supplied the minimum Water Fill Rate (GPM) according to the Manufacturer's recommendation or Table II, but never less than 2 GPM,
- provided the correct pressure to prevent leakage,
- connected to a pipeline that can withstand the pressure rating,
- equipped with a pressure reducer if the pipeline pressure exceeds 60 PSI,
- designed to meet the manufacturer's required flow rate and pressure rating or else another type watering facility must be used.

<u>Example</u>

Based on the information described above (space, amount, location and type water facility) and Tables I and III, the example below shows how different types of water sources provide water for different size herds and require different trough volumes.

Example							
Water Source	*Source Rate = WFR (GPM)*	*Pump Time (HR) (Table III)*	*Max. Volume (Gallon/ Day)*	*Maximum No. of Cows (HCV = 14 GPD)*	*Needed Storage Volume (Gallons)*	*Intensively Grazed Min. Trough Volume (Gallons)*	*Cont. Grazed Min. Trough Volume (Gallons)*
Water Well	*4*	*4*	*960*	***68***	***0***	***476***	***952***
Spring	*0.2*	*24*	*288*	***20***	***560***	***280***	***280***
Solar Well	*2.0*	*4*	*480*	***34***	***1,428***	***238***	***476***

Summary – Planning and Design Steps

The minimum data required to start the planning process for a watering facility is listed below:

A. Water Source
   a. Type _____
   b. Yield Rate _____ (GPM)
   c. Type of pump or delivery system _____
   d. Maximum pumping hours _____ (HR)
   e. Source water volume _____ (GPD)
   f. Dependable or Non-Dependable Water Source _____
   g. Additional Storage _____ (Days)
   h. Planned Trough Water Fill Rate_____ (GPM)
B. Amount
   a. Type of Livestock _____
   b. Number of Livestock _____ (NO)
   c. LCV (Table I) _____(GPD)
   d. HDV _____ (GPD)
   e. LDR _____ (GPM)
   f. HDR _____ (HDR)
C. Location
   a. Type of Pasture_____
   b. Distance to Water_____
   c. % of Herd drinking at trough(s)_____
   d. Recommend number of troughs_____
D. Type of Trough
   a. Open Top ___
   b. Closed Top ___

Planning Data and Design Calculations

Specific information is required for selecting the type and volume of a watering facility. Reference – Table I, II or III for livestock drinking rates, pumping hours and watering system information or use the Excel™ worksheet *Livestock Watering Facility WV ENG 614A WS*.

1. Basic owner/operator information

2. Water Source and Use Information

   a. Type of water source (well, pumps, spring, etc.).

   b. Estimate average or low flow yield (GPM).

   c. Evaluate water source
      i. Systems considered “Dependable” are continuous such as

a) Water wells
b) Year round water (ponds, streams, rivers or permanent flowing springs).

ii. Systems considered “Not-Dependable” are
a) Solar water systems
b) Intermittent springs

d. Evaluate adequacy of Water Source Volume (GPD)
i. Does it provide the daily Herd(s) Consumption Volume (HCV) or more?

e. Evaluate the need for additional Water Storage Volume
i. If the water source is Dependable and Adequate, no additional storage is needed.
ii. If the water source is Dependable but Not Adequate, supplemental water is required and additional storage is recommended.
iii. If the water source is Non-Dependable but Adequate requires one of the following:
A. Solar Water Pump with 3 Days Battery Backup
a) Requires one (1) day or more of storage [daily Herd(s) Consumption Volume (GAL)].
b) Has a maximum pumping time according to the manufacturer requirements, but does not exceed 8 hours a day.
B. Solar Water Pump without 3 days battery backup
a) Requires three (3) days or more of storage [daily Herd(s) Consumption Volume (GAL)].
b) Maximum pumping time according to the manufacturer requirements, but does not exceed 8 hours a day.
C. Intermittent Spring
a) Requires two (2) days or more of storage [daily Herd(s) Consumption Volume (GAL)] or a documented supplemental water source.
b) Assumes flow delivery of 24 hours a day.
c) Requires a documented Alternative Source of Water, allowing the landowner time to set up another water delivery system or move the livestock to a different location.
iv. If the water source is Not Dependable and Not Adequate, start over by first identifying an adequate water source for the watering facility.

3. Document Field ID, Livestock Information (Table I), Type of Pasture and Travel Distance to Water Information

a. Identify location of field for the watering facility and herd

b. Define the type and number of livestock in the field (Table I)
i. Intensively Grazed or Rotational Managed Pasture(s)
A. Small pastures typically 20 acres (or less) or paddocks

B. Water is within 800 feet of livestock
C. 5% of the Herd will drink at one time
a) Example- 40 steers x 5% = 2 steers drinking at the same time

ii. Continuously Grazed Pasture(s)
A. Large pastures typically 20 acres or greater

c. Calculate the Daily Livestock Consumption Volume (GPD)
i. Use references mentioned in the practice standard or Table I to determine the Livestock Consumption Volume (LCV)
A. Table I, Column A – provides the average livestock consumption volume
B. Table I, Column B – provides extra drinking volume based on whether the livestock are located in a rotational or intensely managed pastures paddock or an area with no shade
ii. Sum column A + B (if needed) to calculate the total LCV (GPD)

d. Calculate the Herd Consumption Volume (HCV)
i. Multiple the number of livestock times the LCV

e. Estimate Tank/Trough Water Fill Rate (WFR) in GPM
i. The rate must be equal to or less than the source flow rate
ii. If there will be a float on the tank, make adjustments to calculations
A. Floats typically deliver 80% of the pipeline flow rate or less, check with the float manufacturer for details
B. Floats require a minimum 5 to 8 psi to operate without leaking.
iii. When an On-Demand facility is selected
A. Verify the number of bowls or holes necessary for the herd, the minimum flow rate to the unit and the minimum and maximum pressure (psi) required to prevent leakage
B. If the pressure to the unit is too great, plan to install a pressure reducer according to manufacturer guidelines

f. Document the livestock travel distance to water.
i. The distance the livestock travel influences the number that will drink at a time.
A. If livestock travel more than 800 feet to water, 10% of the herd will drink at one time
B. If livestock travel less than 800 feet to water, 5% of the herd will drink at one time
C. If the travel distance is greater than 800 feet, consider installing 2 or more troughs to reduce travel distance

g. Determine if the water supply can provide the herd(s) with their daily water needs and how long it will take to supply the daily needs

i. Divide the Herd Consumption Volume by the tank or trough Water Fill Rate (HCV ÷ WFR ÷ 60)
ii. Use this value to calculate the minimum size watering facility

4. Determine if the Water Fill Rate Requirements, Herd Drink Rate, Required Trough Volumes to determine if the Planned Trough(s) is adequate

   a. Herd Drink Rate (HDR)
      i. For design purposes, the livestock drink at a rate of:
         A. 2 GPM per large livestock
         B. 1 GPM per small livestock
      ii. Based on the number of livestock drinking from the tank or trough at one time, multiply the number of livestock drinking at one time (5% or 10% of the herd) times the livestock drink rate

   b. Check Water Fill Rate to ensure that it is greater than or equal to the Herd Drink Rate
      i. Use value to calculate the minimum size watering facility

   c. Calculate the minimum space required around the watering facility, needed by livestock for drinking.
      i. Multiply the number of inches /livestock (Table I) type times the number of livestock drinking at the tank

   d. Select type of trough based on the information calculated, manufacturer's information and/or Table IV
      i. Open-top
         A. Small troughs (25 to 100 gallons)
            a) provide little or no storage
            b) require a higher fill rate than large troughs
            c) use for rotational or intensively grazed pastures
         B. Large troughs (100 Gallons or more)
            a) may provide 50% to 100 % storage volume
            b) more typically have a low fill rate, and are located in continuously grazed pastures
      ii. Closed
         A. Closed Top or On-Demand watering systems provide water as the livestock drink, have no storage, and therefore must provide water at a faster rate than the livestock can drink
         B. Small bowls or open lids provide access for livestock to drink water

Associated Practices

Whenever planning a conservation practice, it is important to evaluate the impact of the new practice on the natural resources. Associated Conservation Practice Standard(s) (CPS) must be planned in conjunction with the watering facility to prevent excessive soil erosion, improve water quality, maintain or improve livestock health and ensure practice implementation success.

When livestock traffic has the potential to cause slippery or muddy conditions by removing vegetation and disturbing the soil around or leading to and from the trough/tank, protect the area according to CPS Heavy Use Protection Area (561) [minimum six (6) feet wide for small animals or ten (10) feet wide for large animals] and CPS Trails and Walkways (575). Other associated standards are Pipeline (516), Pumping Plant (533), Water Well (642), Spring Development (574), Water Harvesting Catchment (636) or Irrigation Reservoir (436), Fence (382), Critical Area Planting (342).

Locate tanks or troughs away from environmentally sensitive areas or open water to reduce potential nutrient loading. Set watering facilities as far from open water, creeks, wells, seeps, sinkholes or springs as possible (recommended minimum distance of 35 feet).

Excel™ Livestock Watering Facility Worksheet (WVENG 614A WS)

The associated Excel™ Livestock Watering Facility Worksheet (WVENG 614A WS) can be used in conjunction with the Watering Facility (614) Engineering Design Guide and the West Virginia Conservation Practice Standard Watering Facility (614) to design a watering facility.

Table I

WV ENG 614 May 2012	**LIVESTOCK DAILY WATER CONSUMPTION VOLUME (LCV) [1] and LIVESTOCK TANK/TROUGH SPACE RECOMMENDATIONS**		
Animal Type	**A MWPS #14, Private Water Systems Handbook Gallons/Day**	**B Additional Water Volume during mid-summer, no shade or small paddock. Gallons/day**	**C Trough Space[2] per Livestock Type Inches**
	LCV (GPD)	LCV (GPD)	Trough Inches
Milking Cow	35-45	8	16
Dry Cow	20-30	5	16
Heifers	10-15	3	16
Calves – nursing	6-10	2	16
Swine – Finishing	3-5	1	12
Swine Nursery (6-10)	1	2	12
Sow & Litter	8	2	12
Gestating Sow	6	2	12
Steer/Cow	8-12	2	16
Cow & Calf or Bull	15	3	24
Llama or Alpaca	3-5	1	12
Sheep or Goat	2	1	12
Horse	12	3	24
100 Broilers	8	2	NA
100 Chicken Layers	9	2	NA
100 Turkey	15	3	NA

Livestock Drinking Rate - Large Animals (2 GPM), Small Animals (1 GPM)

[1]Daily Livestock Consumption Volume (LCV)
[2]Based on MWP-# 14 and # 6 or use 20”/livestock for round, 30”/livestock for rectangular according to NRCS-NJ-LW-V8.06.

Table II		
AUTOMATED OR ON-DEMAND WATERING DEVICES MAXIMUM ANIMALS PER NUMBER OF OPENINGS AND MINIMUM FLOW CAPACITIES		
Type of Animal	Number of Animals Per Watering Facility Opening	Flow Capacity Per Watering Facility Opening (GPM)
Dairy Cattle	8	3/4
Beef Cattle	30	3/4
Swine	25	1/4
Horses	10	3/4
Sheep or Goats	40	1/4
Laying Hens	200	1/8
Broilers	100	1/8
Turkeys	50	3/16

Table III	
MAXIMUM ALLOWABLE PUMP HOURS	
WATER WELL ESTIMATED YIELD (GPM)	MAXIMUM PUMPING HOURS
1 to 4 GPM – with Electric/Solar Pump	4
5 to 7 GPM - with Electric/Solar Pump -	6
8 to 15 GPM - with Electric/Solar Pump	8
16 to 20 GPM - with Electric Pump	10
16 to 20 GPM - with Solar Pump	8
Greater than 20 GPM – with Electric Pump	14
OTHER TYPES OF WATER SYSTEMS	
Spring (Gravity Flow)	24
Pond, Stream, River – with Electric/PTO/Gas Pump	14
Pond, Stream, River – with Solar Pump	8
Municipal Watering System	14

Table IV
Typical Livestock Watering Facilities and Access Space

This section provides examples of typical troughs (concrete, polyethylene, galvanized or equipment tire) used throughout the state. Information is provided about the tank capacity (Gal.), dimensions and estimated linear space available to livestock. Tanks that are rectangular or oval are assumed to be located along a fence line or shared between pastures. Round tanks are either inside the pasture (where 100% is available to the livestock) or shared between pastures. Shared space is calculated by reducing the available length space by 50% and subtracting 12" on each side or 24". Manufacturer's data may also be used in lieu of this table. The estimated number of livestock is based on cows or steers requiring 16" of space and cows with calves or bulls requiring 24" of space.

Concrete

Rectangular

					Along Fence			Shared (1/2 Capacity)		
	Capacity (Gal.)	Length (in.)	Width (in.)	Height (in.)	Tank Space Length (in.)	Cows & Steers (No.)	Cow & Calf, or Bulls (No.)	Tank Space Length (in.)	Cows & Steers (No.)	Cow & Calf, or Bulls (No.)
	100	71	29	24	71	4	2	47	2	1
	323	95	48	30	95	5	3	71	4	2
	550	96	60	32.4	96	6	4	72	4	3
	100 (Freeze Proof)	71	29	24	71	4	2	47	2	1

Round

				100% Access			Shared (1/2 Capacity)		
	Capacity (Gal.)	Diameter (in.)	Height (in.)	Tank Space Length (in.)	Cows & Steers (No.)	Cow & Calf, or Bulls (No.)	Tank Space Length (in.)	Cows & Steers (No.)	Cow & Calf, or Bulls (No.)
	350	76	31	238	14	9	95	5	3
	400	78	30.5	245	15	10	98	6	4
	500	80	36	251	15	10	101	6	4

On-Demand or Automatic Water Facility- Contact Manufacture for Details

	Freeze Proof 2-hole	Freeze Proof 1-hole		Freeze Proof 2-hole	

Black Polyethylene (Oval or Rectangular)

	Capacity (Gal.)	Length (in.)	Width (in.)	Height (in.)	Along Fence			Shared (1/2 Capacity)		
					Trough Space Length (in.)	Cows & Steers (No.)	Cow & Calf, or Bulls (No.)	Trough Space Length (in.)	Cows & Steers (No.)	Cow & Calf, or Bulls (No.)
	27	42	19	12	42	2	1	18	1	0
	60	52	31	14	52	3	2	28	1	1
	100	52	31	25	52	3	2	28	1	1
	300	87	62	20	87	5	3	63	3	2

20 Gauge Galvanized Steel (Oval or Rectangular)

	50	36	18	36	36	2	1	12	0	0
	100	48	24	48	48	3	2	24	1	1
	144	72	24	72	72	4	3	48	3	2
	257	96	30	96	96	6	4	72	4	3
	293	96	36	96	96	6	4	72	4	3

Tractor Tire (Round)

	Capacity (Gal.)	Diameter (in.)	Height (in.)	100% Access			Shared (1/2 Capacity)		
				Trough Space Length (in.)	Cows & Steers (No.)	Cow & Calf, or Bulls (No.)	Trough Space Length (in.)	Cows & Steers (No.)	Cow & Calf, or Bulls (No.)
	173	60	18	188	11	7	70	4	2
D=_____	247	60	24	188	11	7	70	4	2

	270	72	18	226	14	9	89	5	3
	376	72	24	226	14	9	89	5	3
	517	96	18	301	18	12	126	7	5

References

Wildlife Water Catchment Construction in Nevada, Technical Note 397. Brigham, William and Stevenson, Craig, 1997,

Habitat manipulation practices. Ch. 14 in Wildlife Management Techniques, Third Edition. Ed. Robert H. Giles, Jr. Pub. The Wildlife Society. 633 pp. Yoakum, J. and W.P. Dasmann. 1971.

National Engineering Handbook, Part 650 Engineering Field Handbook, Chapters 5, 11 & 12, USDA Natural Resources Conservation Service.

National Range and Pasture Handbook, Chapter 6, Page 6-12, Table 6-7 & 6-8, USDA-Natural Resources Conservation Service.

NRCS National and State Utility Safety Policy (NEM Part 503-Safety, Subpart A-Engineering Activities Affecting Utilities (503.00 through 503.06)

WV FOTG Section IV-Practice Standards and Specifications
http://www.nrcs.usda.gov/technical/efog

Engineering Field Handbook and Part 650, Chapter 5, Preparation of Engineering Plans will guide the development of plans.WV5-Engineering Field Handbook, Appendix A- Quick Reference Design and Construction Support Data for Conservation Practice

Title 210-Engineering; NRCS National Engineering Handbook; Part 650 Engineering Field Handbook http://policy.nrcs.usda.gov/ Handbooks:

Title 190 – Ecological Sciences; Part 601- National Cultural Resources Procedures Handbook

Selection of Alternative Livestock Watering Systems; University of Tennessee Extension PB 1641 https://utextension.tennessee.edu/publications/documents/pb1641.pdf

Solar-Powered Livestock Watering Systems; University of Tennessee Extension PB 1640
http://www.builditsolar.com/Projects/WaterPumping/UTESolarStockWateringpb1640.pdf

Watering Systems for Serious Graziers; U*SDA-NRCS, August 2006*
http://www.mo.nrcs.usda.gov/news/Missouri_Publications.html

The ABC's of Livestock Watering Systems by Ben Bartlett, Michigan State University; LPES Small Farm Fact Sheets; http://www.extension.org/mediawiki/files/d/d2/9_Watering.pdf

Hydraulic Ram Pumps EBAE 161-92-BAE; North Carolina State Cooperative Extension Publication Nohttps://www.bae.ncsu.edu/programs/extension/publicat/wqwm/ebae161_92.html

Water Conservation and Use on Dairy and Livestock Farms; Univ. of New Hampshire Cooperative Extension http://extension.unh.edu/resources/files/Resource000005_Rep4.pdf

NRCS-Tennessee Watering Facility Fact Sheet (March 2003)

Nebraska Stockwater Pipeline Handbook
http://efotg.sc.egov.usda.gov/references/public/NE/NeSPH.pdf

Pumps and Watering Systems for Managed Beef Grazing, Univ. of Missouri Extension
http://extension.missouri.edu/p/EQ380

Miss Utility of West Virginia (MUWV); Call Before you Dig, 1-800-245-4848
http://www.muwv.org/

American Society of Agricultural Engineers; S376.1 Design, Installation and Performance of Underground, Thermoplastic Irrigation Pipelines.

Acronyms

The following acronyms are used in the worksheet/spreadsheet and referenced in the design guide.

WFR – Water Fill Rate (GPM); the pumped or gravity fill rate of the tank or trough

LDR – Livestock Drink Rate (GPM); the assumed rate that livestock drink (GPM)

HDR – Herd Drink Rate (GPM); the rate the herd drinks water from the trough or facility. This is determined by multiplying the number of livestock drinking from the trough times LDR.

LCV – Livestock Consumption Volume (GPD); volume of water a type of livestock drinks in one day (reference Table I).

HCV – Herd Consumption Volume (GPD); volume of water the herd drinks in one day. This is determined by multiplying the number of livestock in the herd times the LCV.

GPD – Gallons per Day

GPM – Gallons per Minute