M I S S O U R I

WATERING SYSTEMS *for* SERIOUS GRAZIERS

UNITED STATES DEPARTMENT OF AGRICULTURE

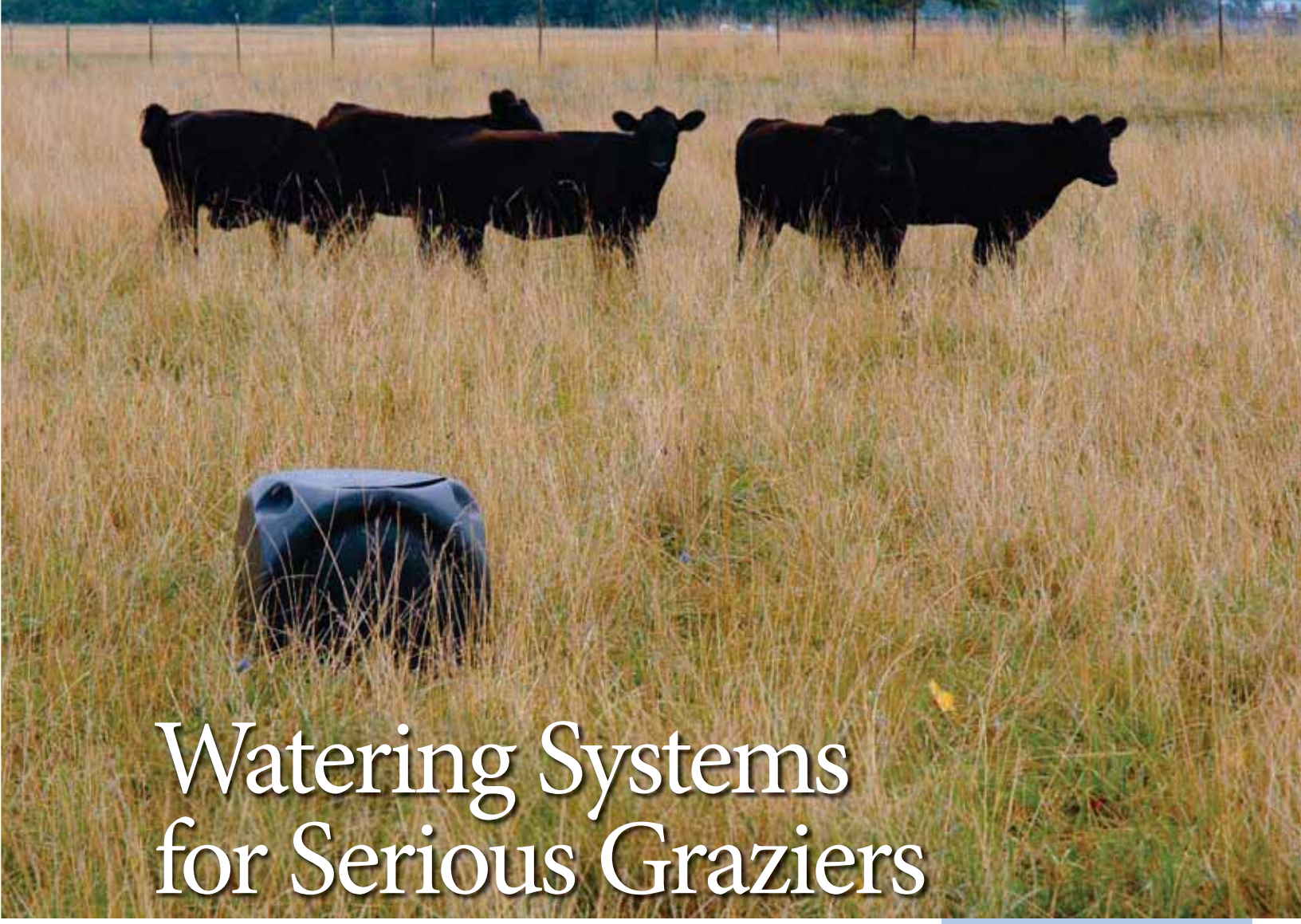
NRCS Natural Resources Conservation Service

WATERING SYSTEMS *for* SERIOUS GRAZIERS

CONTENTS

Livestock Water Needs	6
Water Sources	8
Water Delivery Systems	14
Tanks	18
Protecting Watering Areas	25
Selecting Tank Location	27
Installing Pipelines	29
Collecting Spring Water	34
Maintaining Water Delivery Systems	38
References	39

NRCS
Natural Resources Conservation Service



Watering Systems for Serious Graziers

Water is commonly the weakest link in grazing systems because it is the most overlooked and neglected nutrient on farms. Many people do good jobs ensuring that the pasture, hay and grain they feed to livestock is high quality and of sufficient quantity, but they ignore the quality and quantity of their herds' drinking water. The key to animal health, grazing distribution, and forage management is readily available, adequate supplies of quality water.

The cost of water systems is always a consideration, but cutting too many corners will reduce performance, flexibility, and user satisfaction. Well-designed systems constructed using quality components and good workmanship will provide many years of convenient, low-maintenance, profitable use.

The intent of this publication is to provide livestock producers with the basic information that they need to plan, design and install water systems that will maximize animal performance and minimize the labor necessary to care for their herds' water needs.

tip:

For more information about watering systems or how to improve your existing system, contact the NRCS office serving your county. Look in the telephone directory under "U.S. Government, Department of Agriculture," or access this website: ***http://offices.usda.gov.***

Livestock Water Needs

Failure to get enough water will reduce animal performance more quickly and more severely than any other nutrient deficiency. So producers should provide livestock with plenty of good, clean water to drink. A general rule for water consumption is that livestock need one gallon of water for each pound of dry matter consumed. Access to good, clean water increases the animals' intake of water, which increases their intake of dry matter. More dry matter consumption improves animal performance.

The first step in designing livestock-water systems is to determine the water needs or demand of the animals. Water requirements of grazing animals depends on several factors, including species, age of the animals, air temperature, moisture content of the feed, and the distance animals must travel to water. The chart below provides a general idea of how much water livestock require.

As the air temperature increases from 50 to 90 degrees Fahrenheit, livestock need more than twice as much water (see table).

Livestock	WATER NEEDED PER ANIMAL (50° DAY)	WATER NEEDED PER ANIMAL (90° DAY)
Dry beef cows	8 - 12 gallons	20 - 30 gallons
Lactating beef cows	12 - 20 gallons	25 - 35 gallons
Lactating dairy cows	20 - 30 gallons	30 - 40 gallons
600-pound weaned calves	6 - 9 gallons	10 - 15 gallons
Horses	8 - 12 gallons	20 - 25 gallons
Sheep and goats	2 - 3 gallons	3 - 4 gallons

Moisture in the forage or feed can greatly affect the water intake of livestock. Lush pasture growth in the spring can contain enough moisture to meet part of livestock's daily requirements. For example, if forage contains 80 percent moisture and a cow consumes 150 pounds in a day, she is consuming 30 pounds of dry matter and 120 pounds of water, or 15 gallons. Animals also consume precipitation or dew on forage. That greatly reduces the amount of water that livestock need to drink. On hot, dry days, forage moisture is lower, and animals need to drink more.

Here are some other things that producers should consider:

- Water consumption of Zebu (Bos indicus) breeds such as Brahma is generally lower than that of European (Bos taurus) breeds.
- Dairy breeds usually have a higher daily water need than beef breeds.
- Mature cows need 3 to 5 pounds of water per pound of dry matter intake.
- Calves need 5 to 7 pounds of water per pound of dry matter.
- Lactating females require more water than nonlactating (dry) females.
- Animals will drink more water if it is readily available. Research at the University of Missouri Forage Systems Research Center found that water consumption was 15 percent greater in "water-in-every-paddock" systems, compared to systems where livestock had to travel down lanes to get water.

Water Quality

The temperature of water is not critical. Cattle will readily drink water until its temperature exceeds 105 degrees Fahrenheit. Although cooler water has been shown to improve milk production in dairy cows, an adequate supply of clean water is most important.

It is not ideal for animals to have to drink directly from puddles, ponds, streams and other surface water. Bacteria and other pathogens can contaminate surface runoff, which also can be a source of parasite infestation. It is better for the

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animals if each paddock has an appropriately placed water tank. These can be either permanent tanks or portable tanks.

Some research supports the idea that clean water has a positive effect on animal performance. Researchers in Alberta found that steers provided with fresh water gain 2.6 pounds per day, compared to 2.0 pounds per day when provided with pond water. Texas A&M University and University of Nebraska studies also indicate that water quality has an impact on animal performance.

Surface waters such as ponds and streams can serve as satisfactory sources, but only if the animals' access is limited. The Noble Foundation in Oklahoma found that uncontrolled access to ponds or streams leads to loitering and socializing at the waterhole. This contributes to the transfer of internal parasites. Even controlled-access facilities that are larger than necessary encourage animals to loaf. The result is erosion, water pollution and destruction of cover.

Here are some other things to consider:

- Water contaminated with manure may develop toxic, blue-green algae which can poison livestock and cause muscle tremors, liver damage and death.
- High nitrates interfere with the animal's ability to absorb oxygen.
- High salinity causes a form of dehydration.
- Bacteria cause diseases, such as leptospirosis and brucellosis.
- Sheep and goats tend to be more particular about water quality than cattle. Calves will also avoid fouled water to a greater degree than cows.
- Producer experience has shown significant increases in weaning weights and average daily gain for stockers when provided good, clean water.

Water Sources

The importance of good, reliable water sources to successful livestock operations cannot be overstated. And since sources of livestock water vary greatly in cost, quantity, and quality, they are major considerations for farmers and ranchers.

Wells, ponds, streams, rivers, springs, seeps, and public water systems are all options. The locations of operations, the lay of the land, and the types of soil on farms may limit the number of options.

It's desirable to have a couple of different sources of water for livestock. Drought, freezing weather, power outages, broken pipelines, and other events can render one source useless. Having backup water sources can avoid or reduce problems and expenses, such as moving animals or hauling water from off-site sources.

To be viable options, water sources must meet the needs, goals, and objectives of the operations. Water quantity and quality must be adequate, and the expense of developing the sources must be feasible.

To begin the process of selecting water sources:

- Make a list of available water sources;
- Decide if the quality of water from each source is acceptable;
- Estimate how much usable water each source can dependably supply. Remember to take seasonal fluctuations into account;
- Consider whether the source will be adequate for five-to-10 years.

Wells

Groundwater is high quality in many areas of Missouri, and many wells produce adequate rates of flow to serve livestock operations. For instance, most of southern Missouri has adequate groundwater quality and quantity, and wells should be strongly considered by southern Missouri producers as primary sources of livestock water.

Some parts of the state, however, have limited available groundwater. And a few areas have groundwater with high levels of salt, sulfur or iron that makes the water unsatisfactory. The map on the next page gives a general idea of the prospect for good wells in various parts of the state. The Missouri Department of Natural Resources' Division of Geology and Land Survey can provide valuable information.

Drilling wells can be expensive. Most companies charge for drilling by the foot. Reputable, experienced well drillers should know about how deep wells will need to be in their service areas to provide adequate water.

In addition to drilling costs, start-up costs can include expenses for casings, liners, pumps, pressure tanks, pump houses and electrical hookups. But in considering costs, keep in mind that operation and maintenance costs for good wells are quite low.

Producers should consider using existing wells, such as ones serving their homes, as potential sources of livestock water. They must be careful though, because wells drilled for home use may not be capable of serving both their homes and their livestock. If the yield of a well is not known, it should be tested. Pumps should also be evaluated because they may be incapable of servicing houses and livestock.

Wells that are not in use should be considered, too. They may serve the purpose well, but they need to be carefully evaluated before being counted on to provide water for livestock.

A big advantage of drilling new wells is that they can usually be located where they will best serve the operations. Providing electrical service to new wells may dictate location. Electric cooperatives install power lines to wells, but their costs to

MISSOURI GROUNDWATER

MISSOURI DEPARTMENT OF
NATURAL RESOURCES
GEOLOGICAL SURVEY AND
RESOURCE ASSESSMENT DIVISION
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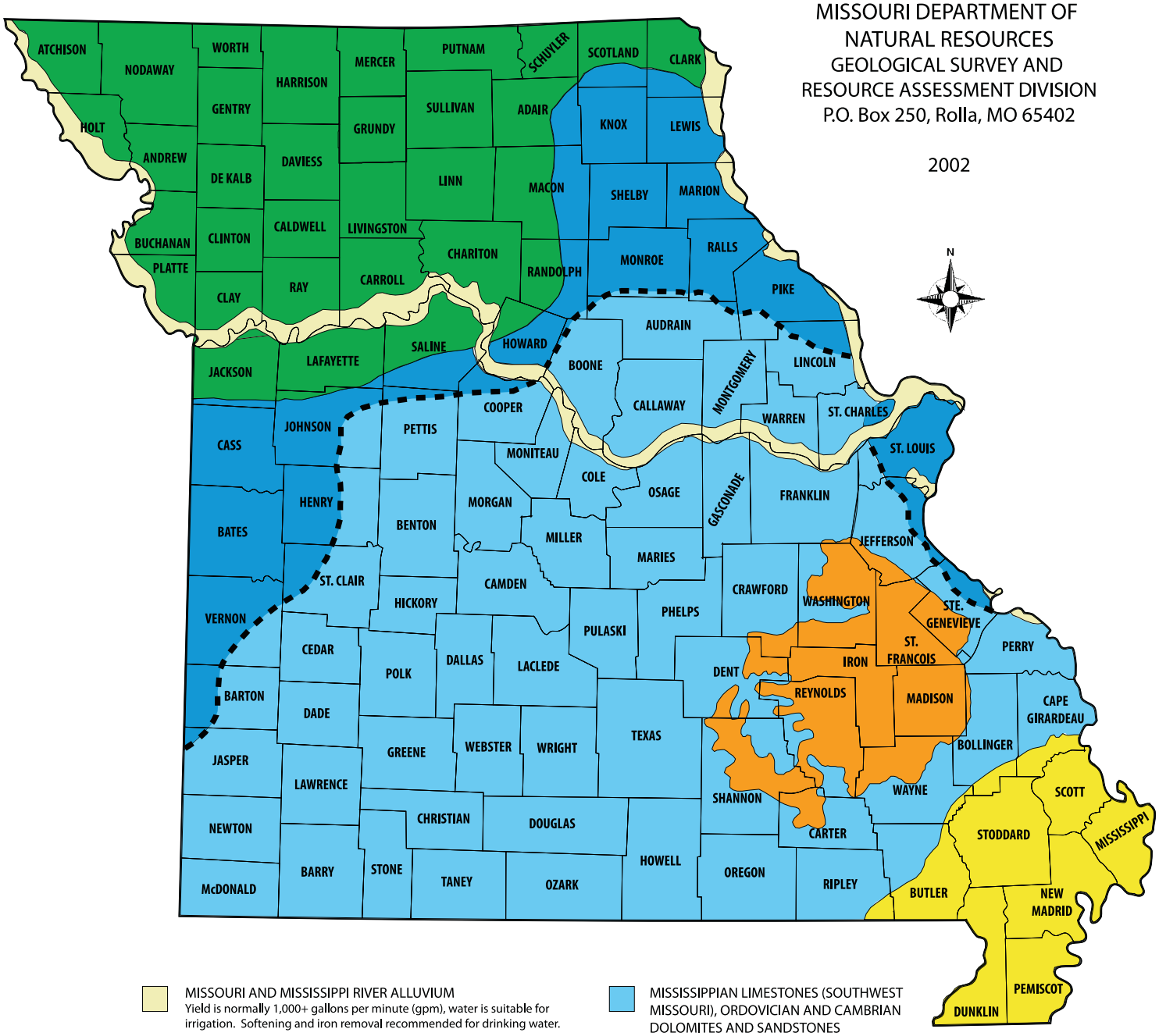


MISSOURI AND MISSISSIPPI RIVER ALLUVIUM
Yield is normally 1,000+ gallons per minute (gpm), water is suitable for irrigation. Softening and iron removal recommended for drinking water.

GLACIAL DRIFT AND ALLUVIUM
Yield is normally 1-15 gpm. Drift-filled preglacial channels locally yield 200 to 500 gpm. Alluvium in lower reaches of major rivers can locally yield 400+ gpm. Iron removal and disinfection is recommended. Bedrock aquifers generally yield mineralized water.

CRETACEOUS AND TERTIARY SANDS, AND ALLUVIUM
Alluvium typically yields 1,000+ gpm; Tertiary sands, 500 to 1,000 gpm. Both contain high iron. Wells in Cretaceous sands typically produce 150 to 1,000 gpm, have lower iron, are softer, have higher temperature waters, and may be artesian.

PENNSYLVANIAN AND MISSISSIPPIAN LIMESTONES AND SANDSTONES
Yield 1 to 15 gpm to depth of about 400 feet. Aquifers below 400 feet yield mineralized water. Wells in shallow Mississippian limestones yield 1 to10 gpm. Deeper high-yield aquifers yield mineralized water.

MISSISSIPPIAN LIMESTONES (SOUTHWEST MISSOURI), ORDOVICIAN AND CAMBRIAN DOLOMITES AND SANDSTONES
Yield 15-500 gpm, depending on depth and producing formations. Yields locally exceed 1,000 gpm in some areas including Springfield, Columbia and Rolla. Yields diminish substantially east of the St. Francois Mt. region. Highly-productive aquifers become mineralized north of freshwater-salinewater transition zone.

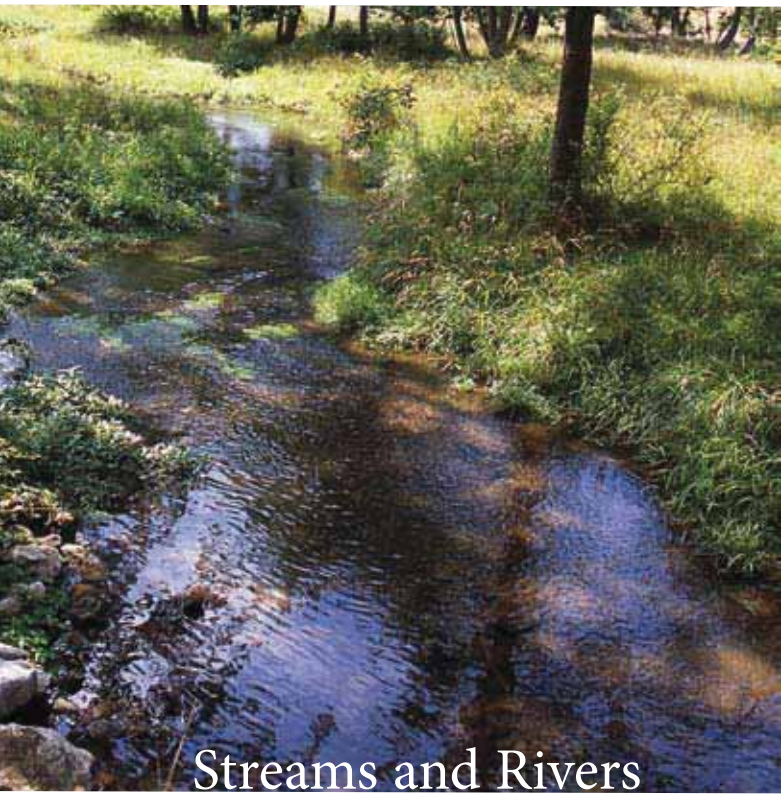
CAMBRIAN AND PRECAMBRIAN ROCKS
Dolomites typically yield 15 to 50 gpm. Lamotte Sandstone locally yields 300+ gpm. Precambrian igneous rocks normally yield 0 to 15 gpm.

FRESHWATER-SALINEWATER TRANSITION ZONE
North and west of this line, high-yielding aquifers contain water too mineralized to be used without extensive treatment.

SCALE
0 20 40 60 80 MILES
0 20 40 60 80 KILOMETERS

DNR/G SRAD Fact Sheet No. 4

do so are related to how far they have to run the power lines. Policies and fees of electric cooperatives vary greatly, so operators should check with local cooperatives about anticipated expenses before making other commitments. It is often cheaper to bury pipelines than to install electric lines, so it could be cheaper to locate wells closer to electric sources and use more pipe to get the water to the supply tanks.



Streams and Rivers

Producers with streams or rivers on their property have probably used them as sources for livestock water. Stream flows vary a lot by season. Unless they are spring-fed, they may go dry at some time. Evaluate the dependability of a stream's flow, and have an emergency plan in mind for times when the stream fails.

The advantages of streams are that the water is free, and that trees bordering streams provide shade in the summer. But there are several disadvantages to using streams as water sources.

Spread of disease is a concern. Leptospirosis, mastitis, coccidiosis, and fusobacterium (foot-rot) is commonly spread from animal to animal through contact with infected mud and water. Livestock can also drown during floods.

Unlimited livestock access causes a great deal of damage to streams as well. Livestock urine and feces, and the animals' excessive trampling, can make water unfit for most aquatic life as well as making the water unfit for livestock to drink.

Traffic up and down streambanks denudes the banks of vegetation, resulting in erosion. Uncontrolled access also encourages livestock to loaf in the shade of the trees along streams. Time spent loafing is a hidden cost, because it uses time that animals should spend grazing. Their loafing also causes excessive grazing and browsing of understory plants, which results in bare ground that is subject to severe scour erosion during floods. Uncontrolled access also causes concentrated nutrients from animal waste deposits in and next to streams.

It is best to provide alternative sources of water so livestock are not forced to use streams. Tanks located away from streams give animals a choice of drinking locations. That could reduce their use of streams by more than half.

If it isn't feasible to provide alternative sources of water, fence livestock out of streams, and install limited-access ramps. Facilities that provide controlled access should limit the accessible water area to 15-20 feet square (225-400 square feet). An access ramp that is 20 feet wide should accommodate herds up to 150 head.

Use smooth wires for stream access fences because they do not collect as much debris as barbed-wire fences. Attach the wires solidly on one side with breakaways on the other. On some streams, depending on the size, electric water-gap fences will work (see drawing on Page 31).

If possible, exclude livestock from larger rivers and streams with very deep channels. Cattle and horses should be excluded from streams with very sandy or gravelly banks because of the damage that these heavy animals cause. Small ruminants (sheep and goats) do less damage to the banks in sandy and gravelly soils.

On smaller streams with channels less than 12-feet deep, manage the fenced areas as grazing paddocks so the forage produced can be utilized. Grazing impact should be carefully managed, however. Grazing periods should be brief, infrequent, and timed to provide a positive effect on the plants and streams.

If expense, flooding, or personal preference makes fencing livestock out of streams impractical, then use controlled grazing systems that minimize damage to streams. Once again, it is better to provide alternative water sources so that livestock are not forced to drink from streams. When streams run through pastures, grazing systems should include at least eight paddocks. That will limit access to any segment of a stream to one-eighth of the time or less.

Streams can be good sources of water. But if creeks or rivers are used for livestock water, take measures to limit the damage that livestock cause.

Ponds

There are thousands of ponds throughout Missouri that are used for livestock water. Ponds can be excellent sources of water. But there are important reasons to keep livestock out of ponds:

- The animals can get stuck in the mud or fall through thin ice;
- Animals standing or loafing in water contaminate ponds, which causes and spreads diseases that are easily passed between animals through water and mud;
- When animals stand in ponds for extended periods, it causes their hooves to soften. The soft hooves can be cut and scraped easily, resulting in infections, foot rot and other foot problems.
- Unlimited livestock access ruins ponds, too. Animals trampling banks and lounging in the water erodes soil and pollutes water. The soil from the eroded banks also fills ponds, which reduces their storage capacity and useful life;

Animals standing or loafing in ponds contaminate water, transmit disease and destroy fish and wildlfe habitat.

- Fish habitat can be destroyed by continuous livestock presence in ponds.

Put fences around ponds to keep livestock from having free access. Water from fenced ponds can be made available to livestock by installing tanks below the ponds. Another option for making pond water available to livestock is installing limited-access ramps that allow the animals' to have access only to small, protected areas of ponds.

Producers may want to consider creating new ponds if additional water sources are needed. The larger the ponds, the more expensive they will be to build. Before building a pond, get technical assistance. Soil scientists and technicians can help determine the suitability of a site. Picking the right contractor is also important. Find one that is experienced in pond building in your area, and talk to several of the contractor's customers to see if they are satisfied with the contractor's work.

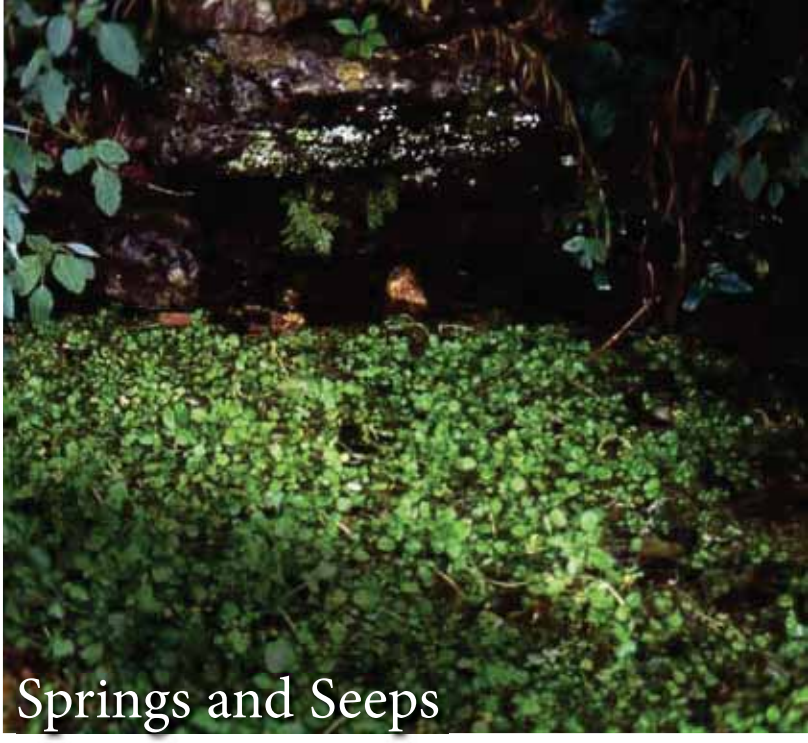
tip:

Before building a pond, get technical assistance. Soil scientists and technicians can help determine the suitability of a site.

In the Ozarks, building ponds can be very risky. High rock content, porous clay, and shallow soils are common. In parts of the Ozarks, ponds are more likely to hold water if they are built near the beginning of the drainage rather than lower in landscapes. These ponds are often small, but relatively small ponds that don't leak will provide water for a lot of livestock.

In other parts of the state, ponds can be built with only small chances that they will leak.

When new ponds are built, install freeze-proof water tanks downstream. If tanks don't fit in the plans, at least install pipes (1¼-inch or larger) under the dams so tanks can be added later. Supply pipes through dams also provide a means of lowering the water level in the ponds when necessary for maintenance or repair. Water supply pipes can be installed in existing ponds, but it is more difficult and expensive after the ponds are built than during initial construction.



Springs and Seeps

Springs or seeps occur where groundwater emerges naturally at the surface. Seeps may have small trickles of water that accumulates. They are usually identified as areas on hillsides or near the bottoms of slopes that are always wet. Plants growing there include those that thrive in wet places, such as willows, cattails and sedges.

It is usually easier to find the spot where springs emerge. Most springs and seeps yield high-quality water, but water yield and dependability varies greatly.

Water flow from springs can vary significantly by season as well as from year to year. Measure or estimate the flow during August or September in a dry year before considering a spring as a source of livestock water. For seeps, the extent of the area occupied by the water-loving plants gives some indication of yield and dependability.

With many springs, livestock can get to the water without development. As with streams and ponds, however, livestock traffic and loafing will make a mess in those areas. Because seeps are often just muddy areas, the damage to them is even worse. It is common for cattle to literally destroy springs and seeps by compacting the soil so tightly that flow is reduced or eliminated. Therefore, development to collect, pipe, and store the water is recommended. Livestock also should be fenced out of the collection areas of seeps and springs.

Springs are frequently located at lower elevations, close to the toes of hills or next to streams where it is difficult or impractical to develop them. Springs that are ideal for using as water sources have good flow year-round, are located higher in landscapes, and make it relatively easy to collect the water and pipe it to tanks at lower elevations.

Springs and seeps are relatively inexpensive to develop, require no energy to operate, and are usually freeze-proof. Producers with the good fortune of having springs or seeps on their property should consider using them as sources of water for their livestock.

Rural Water Supplies

Many areas of Missouri are served by rural water supply districts. Their pipelines are usually located along roads. Intended for human consumption, this source of water is very high quality, and usually chlorinated.

Using water from public supplies is attractive because it is convenient and requires no maintenance. But the expense may be a limiting factor. The costs of getting hooked to the systems can be high, but the bigger expense is buying the water. The cost of water from rural water supply districts varies tremendously from one utility to another. At use rates typical for livestock watering, the cost can vary from $2 to $12 per thousand gallons. Some communities also charge additional wastewater treatment fees.

Where public water is available closer to the $2 level, this is an attractive option, especially for smaller farms. There are many circumstances where using public water makes good sense, especially if it will be used as a temporary or infrequent source. Public water supplies also can be great back-up sources for those times when other sources fail.

If public water supplies are utilized for livestock, water customers are required to prevent backflow in order to protect public health.

Public water supplies can be good back-up sources for other watering systems but can be expensive

Water Delivery Systems

This section includes information about the four water-delivery options that might be useful to producers in deciding which systems are best for providing water to livestock. They are:

- it can be pumped to supply tanks;
- it can flow to tanks by gravity;
- animals can be allowed direct access to ponds and streams;
- producers can haul water to tanks.

Pumps

Many kinds of pumps are used in stock-water pipelines. Pumps move water by positive displacement (piston and diaphragm pumps) or with impellers (centrifugal and turbine pumps). The kind which will work best in a specific system depends on the availability of power, needed flow rate, pressure requirements, how high the water must be lifted, and the water source.

Frequently, the availability of electricity, or the cost to make it available, is a major factor in determining whether electric pumps can be used.

Jet pumps are usually centrifugal pumps with jet or ejector assemblies. A jet assembly constricts the flow of water in a pressure line and forces the water through a small passage. The tube narrows to increase flow velocity. Then the opening widens abruptly, creating a vacuum that draws water from the water source into the output line. Jet pumps have few moving parts, and both shallow-well and deep-well jet pumps can be located some distance from water sources. They provide high volume in installations where pressure and lift requirements are low.

Piston pumps are positive displacement pumps that use a piston and cylinder with valves. Double-action models move water with each stroke (both directions); single-action pumps move water with the up stroke and refill the cylinder with the down stroke. Conventional windmill pumps are piston pumps.

Submersible electric pumps are turbine pumps that operate below water level. They are often used in deep wells, and are typically more expensive than jet pumps.

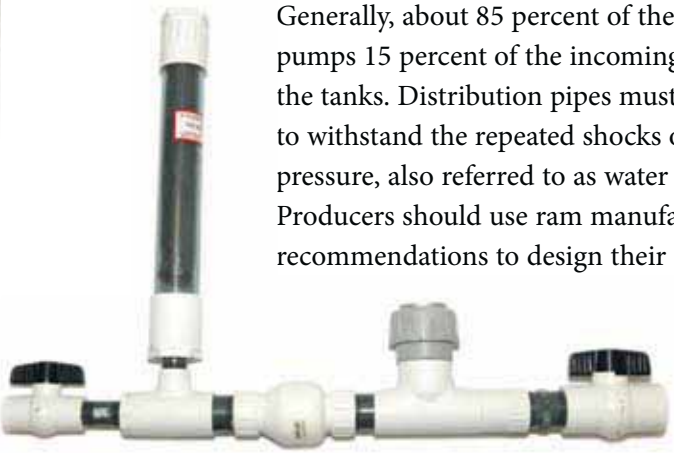
Turbine booster pumps are used to boost pressure from domestic water supplies and storage tanks.

Internal-combustion-engine-powered pumps: Internal combustion engines can be used to operate stockwater pumps. The engines may be started automatically using float-actuated starter and shutoff switches, or the pumps can be operated manually. The engines can be fueled by gasoline, diesel or propane. Engine-operated systems require frequent inspection, service and maintenance. If these engines are used, water systems

should include large water-storage tanks to ensure that there is adequate water for livestock if the systems fail.

Engine-driven systems can be set up in various ways, including: pumps driven directly by the engines; engine-powered pump jacks that drive piston pumps; or engine-powered generators for electric pumps. Engine-powered generators offer the flexibility to power any size pump, depending on the size of the generators.

Hydraulic ram pumps were invented in the late 1700s. They use the energy of falling water to pump a small percentage of that falling water to an elevation higher than the original. At least three feet of fall, and a flow rate of 1 – 3 gallons per minute, is required to drive the systems. Generally, about 85 percent of the flow pumps 15 percent of the incoming water to the tanks. Distribution pipes must be able to withstand the repeated shocks of surge pressure, also referred to as water hammer. Producers should use ram manufacturer recommendations to design their systems.



Windmills once dotted landscapes throughout the Midwest, but they rarely are used now. Windmills are expensive to install but cheap to operate. They can pump from surface water, shallow wells, or deep wells. Windmills are very convenient when electrical power is not available at a site. The most important consideration is providing adequate water storage to cover periods of little or no wind. Windmills also require regular inspection and maintenance.

Wind-powered generators can be used to power low-volume pumps. The generators require less service and maintenance than windmills because there are fewer mechanical parts. They should be more efficient than windmills, and they should be able to pump from greater depths. These systems are expensive, and they have the same disadvantage as windmills in that wind is needed to pump water. Storage tanks that can hold enough water for several days is essential to provide water during calm periods. The large tanks also allow the use of smaller, more economical generators and pumps. Unlike windmills, wind-powered generators can be located quite a distance from the pumps, such as high on hills, for better wind exposure. Wind-powered generators can be used to charge batteries that can be used to power electric-fence energizers and other devices in remote locations.

Solar-powered pumps operate as long as there is adequate sunlight, and many parts of Missouri have a high percentage of cloudless days. A principal disadvantage is that solar pumps are expensive. However, the cost of installing power lines at some sites makes solar power a competitive option. It is important to design the systems to meet water needs during cloudy periods. Producers can utilize batteries to store power or utilize water tanks that will store enough water for several days. Large storage tanks also allow the use of smaller, more economical pumps. Several types of pumps are available, each with particular advantages. Solar-powered systems must be tailored for specific pumps and solar panels, so close coordination with suppliers is essential. Elevating solar panels may reduce theft or vandalism of solar panels in areas where that is a concern. Solar panels can be located some distance from pumps to improve exposure to the sun. Tracking mechanisms that rotate the panels to face the sun also greatly improve efficiency in the summer, when water needs are the highest.

Sling pumps also are powered by moving water. They are open, plastic drums with coiled tubes inside of them. The drums, which float so that they are about halfway submerged, are tethered in flowing streams so that the water flows through them. Each drum has a propeller near the upstream end that rotates the drum, causing

water and air to be alternately taken into the coiled tube. The air pushes the water through pipes to stock tanks. The main drawback of sling pumps is that streams are usually at their lowest flows in mid summer, when the largest volume of water is needed.

Battery-powered pumps are typically 12-volt sump pumps. These pumps can move water a short distance into pastures from streams, ponds, springs, or shallow wells. Battery systems are portable, economical, use locally available parts, and can move a large volume of water quickly at low pumping height. Float switches at the tanks turn the pumps on and off. The disadvantage of battery-powered pumps is the need to frequently recharge batteries. Solar panels may be used to keep batteries charged.

Animal-powered pumps, often called nose pumps, are diaphragm pumps that operate when livestock push paddles out of the way to get to the water in small, sloped troughs. Each time animals raise their noses and release the paddles while getting drinks, about one pint of water is pumped in. Nose pumps are portable, simple, and ruggedly constructed. One nose pump can meet the needs of about 30 cow-calf pairs. Nose pumps can lift water a vertical distance of about 26 feet if they are located immediately adjacent to water sources. However, the amount of lift decreases when water has to travel farther. The paddles also are easier to push when lift and pipe length are shorter. Small calves, sheep, and goats may not be able to operate the pumps. Because water remains in the troughs, animal-powered pumps can't be used in freezing weather. Livestock may need a few days to learn to operate these systems, but most cattle learn to use the pumps rather quickly.

Gravity

When water sources (ponds, springs, or storage tanks) are at higher elevations than tanks, gravity will deliver water to tanks or troughs. Gravity is a free way to move water. It is also quite reliable. Gravity systems are usually low pressure. Therefore, larger pipes are needed to maintain adequate volume. However, low-pressure pipe is usually less expensive than high-pressure pipe. Extra care must be taken to ensure positive grade when installing gravity-flow pipelines because the water velocity is rarely high enough to purge air pockets from minor humps in lines. Those air pockets can reduce or stop water flow. Gravity flow can be used in combination with pumps to reduce the size and cost of the pumps. In this instance water is pumped from the source to reservoirs or tanks at higher elevations, from where it flows by gravity to supply tanks.

Direct Surface Access

Surface access can be simple and inexpensive, but it only provides water at one location, requires investment and maintenance, and provides greater opportunity for water contamination. Producers should include limited access points and ramps with direct-surface-access systems to prevent their livestock from loafing at the water sources, standing in the water, creating mud holes, damaging banks and increasing the transfer of disease.

Limited access points are simply planned locations where livestock can get to water in ponds and streams. Access is limited by some type of barrier, including floating electric fences, permanent electric fences, stock panels, boards or other materials. Access points must be wide enough to serve herds, but not wider than necessary. A rule of thumb is 10 feet wide, plus one foot per 10 head. For example, 100-head herds would require 20-foot-wide access points. Most limited access points need constructed access ramps.

Access ramps are walkways into the water with slopes of about 6:1. They are constructed of concrete or gravel that provides firm, non-slip surfaces. When livestock are given a choice between walking into water with a soft, mud base or a hard base, they will choose the hard base. Installing geotextile fabric under gravel ramps reduces main-

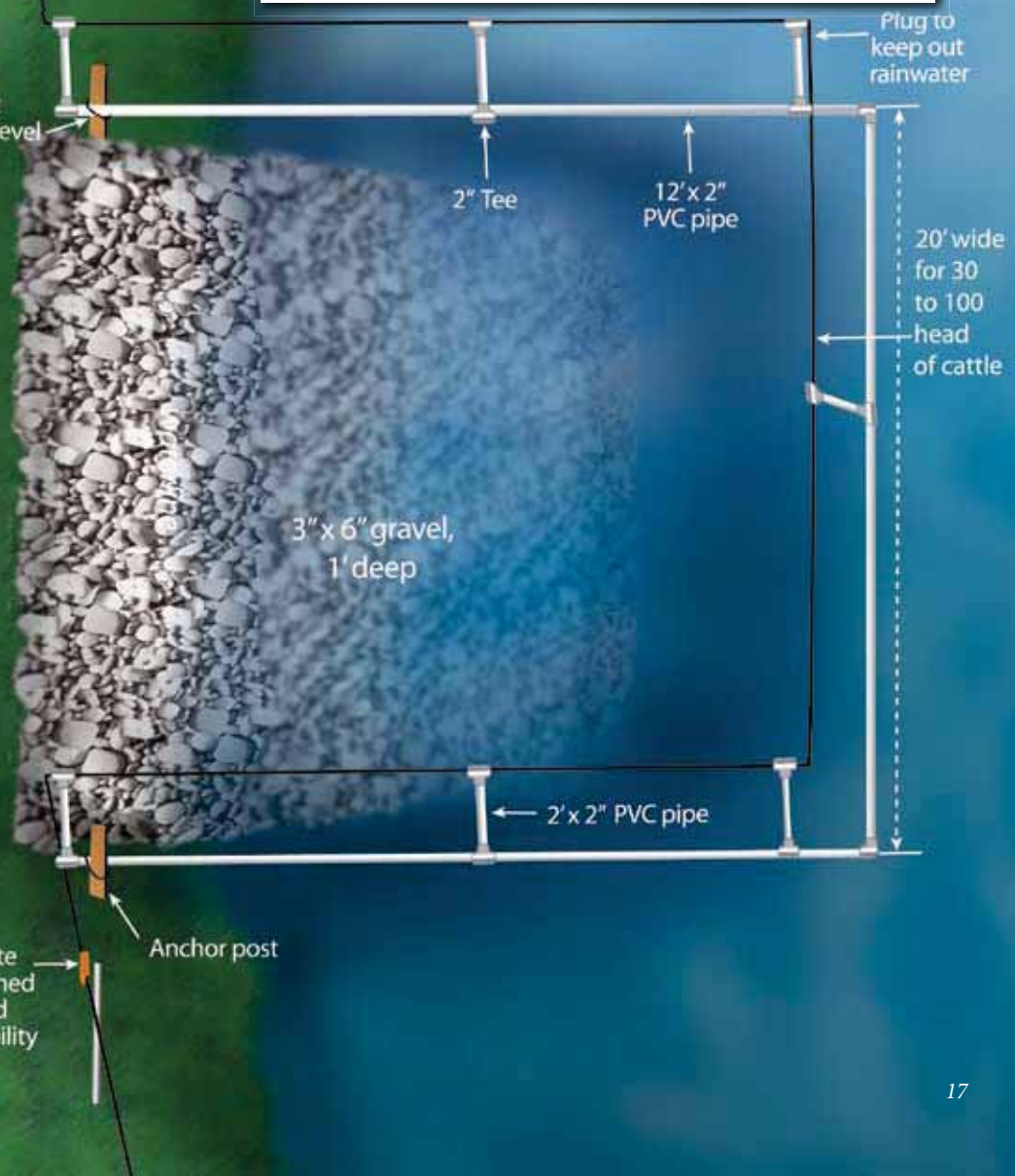
tenance and makes them last longer. Rough walking surfaces are important, especially during icy conditions. Also, ramps need to be rough enough to make them uncomfortable to livestock so the animals won't loaf in the watering points. Using large, coarse rock on the ramps is effective.

Hauling

Hauling water is expensive in the long run. However, there are unique situations where hauling might be the most practical method of delivering water. When it is difficult to pipe water to pastures or paddocks, when the number of animals served at a particular site is small, or when the length of time systems will be used is short, hauling should be considered.

A floating electric fence is a good way to limit livestock access to water in ponds and streams.

Floating Electric Fence



Materials:

- 56' - 2" schedule 40 PVC pipe
- 60' - 12.5 gauge high-tensile wire
- 12 - 2" schedule 40 PVC "T"s
- 2 - Steel "T" posts
- 3 cu. yards - 1" to 1 $^1/_2$" gravel
- 2 - 3' stakes to hold fence in place
- 2 - 2" 90 degree elbows
- 2" PVC caps
- 3"-6" gravel

Notes:

"T"s may be replaced with caps. Drill 3/16" holes below caps to run 12 $^1/_2$ gauge wire through for fence. This will keep water from entering pipe and eliminate the need to plug "T"s.

All connections need to be watertight.

Tanks

A variety of livestock water tanks are available to fit the watering needs and specific site characteristics of farms. The first step producers must take toward selecting tanks that are best for their livestock operations is to determine how large tanks need to be to serve their herds.

About 1.5 inches of trough space per animal in a herd is usually adequate. For example, three-foot diameter round tanks have circumferences of 113 inches. That's enough drinking space for 75 head. But tanks placed in fence lines cut the available drinking space in half, and will only adequately serve half as many animals. Different types of grazing systems also have an effect; less drinking space is required in controlled-grazing systems than in continuous grazing systems because of changes in animal behavior.

With the various types of livestock, herd sizes, water sources and tank locations, one type of tank will not fit all watering needs. Producers need to evaluate all of the sources in order to determine which types of tanks are best for them.

Concrete, Frost-Free Tanks

Concrete, frost-free, livestock water tanks are one way to provide winter water. They were developed to install below pond dams, but have also proven to be excellent alternatives with pressure systems.

Two things keep water in these tanks from freezing: The back halves of the tanks are covered with soil to provide insulation; and the tanks have valves that can be opened during severe cold weather to keep water circulating through the tanks.

Some advantages of concrete tanks include their durability; their ability to hold up to 250 gallons of water; large, open drinking areas which benefit livestock and wildlife; and their ability to provide open water during severe cold weather.

One disadvantage of these tanks is that they are not as easy to split with fences to provide water to two pastures. However, two-sided concrete tanks that are open on both ends and covered in the middle are available. These double-sided tanks can be placed in fence lines to water two areas at a time.

Some producers have found that they do not have to open the valves at all on tanks that are used frequently by livestock. But it might be necessary to run water when the weather is very cold during an extended period to keep the water in the tanks from freezing.

These tanks have a long history of dependable use in Missouri. If installed properly, they last many years.

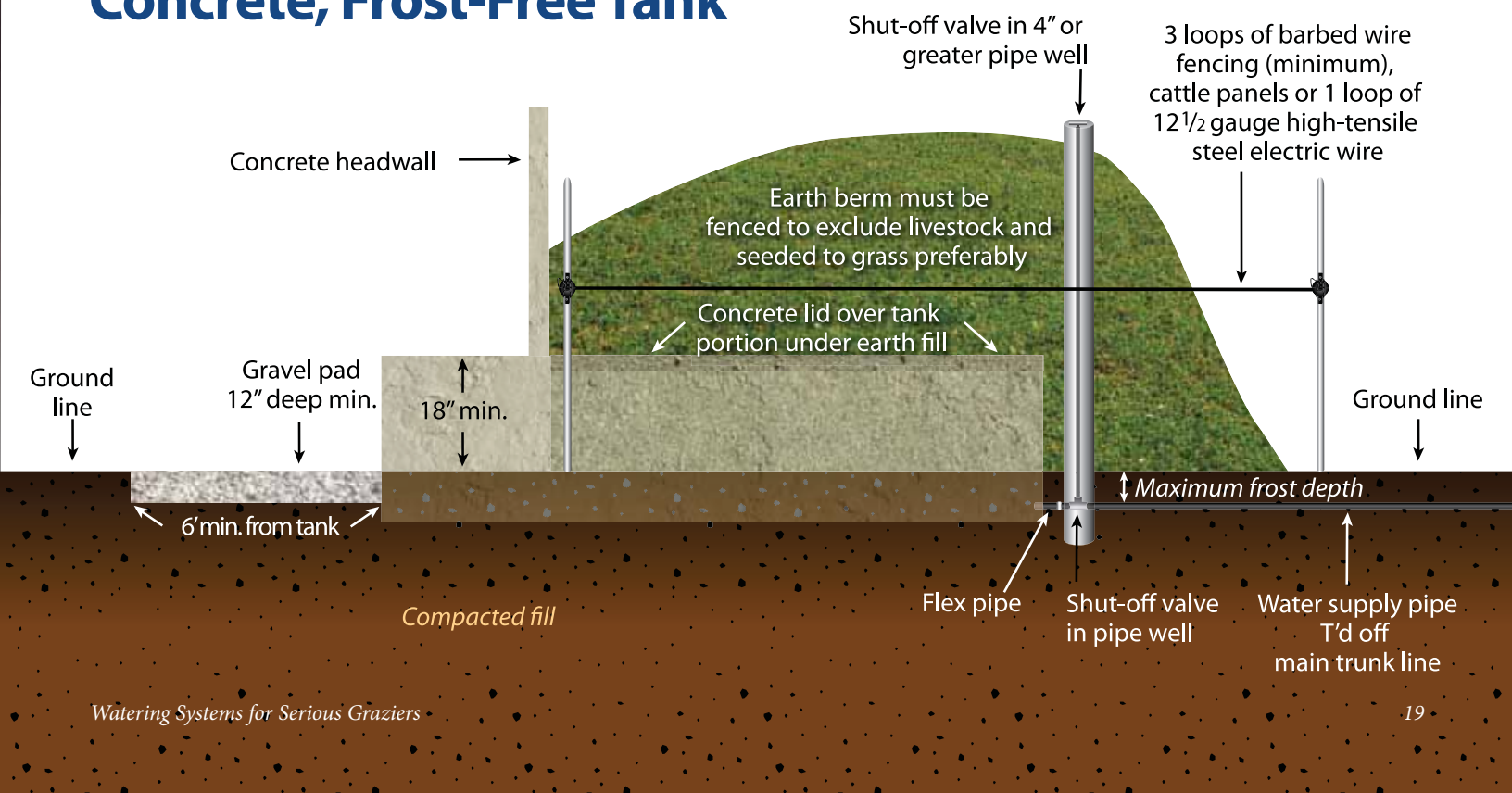
Installation Tips

- Do not bury the drinking portions of tanks. This part of tanks should be at least 12 inches above ground for sheep and goats and 18 inches above ground for cattle and horses. That helps prevent drowning of animals that might otherwise fall or get pushed into the tanks. It also keeps dirt and debris out of the tanks.
- Provide additional insulation by placing one-inch-thick insulation board on the sides and tops of tanks before covering them with soil.
- Install overflow pipes that carry water to open outlets or to pits located 20-40 feet from the tanks. Dig the pits 4-6 feet deep, and place field rock or 2-3 inch gravel in the pits. These overflows prevent muddy areas from developing around tanks when water valves are opened during severely cold weather.
- Cover the backs of the tanks with at least two feet of soil. Backs of tanks must be fenced to keep livestock from removing the soil needed to insulate the tanks.
- Level the tanks before covering them with soil. Tanks that are not level may allow water to run over at corners and cause mud problems at the tanks.
- If possible, face the open ends of tanks to the south to protect them from northerly winter winds and to take advantage of warmer sunlight.

- Install gravel pads around drinking areas (see section about pads).
- Install shutoff valves in pipelines before hooking them to tanks. The valves allow water to be shut off when tank repairs are needed or when tanks need to be drained.

Some versions of concrete, frost-free tanks have easier access to the floats and valves in the backs of the tanks than others. Consider that when purchasing tanks because when tanks need repair, easy access is important.

Concrete, Frost-Free 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 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 when it reaches a preset temperature. Still others are energy free.

Many of these tanks keep water from freezing by incorporating heating elements or immersion heaters. Those tanks are usually located close to electricity.

Other tanks are energy-free. They limit exposure to the cold, have small water-storage areas with frequent replacement of fresh water, are heavily insulated, and are installed over earth tubes (geothermal heat wells) running three to four feet underground.

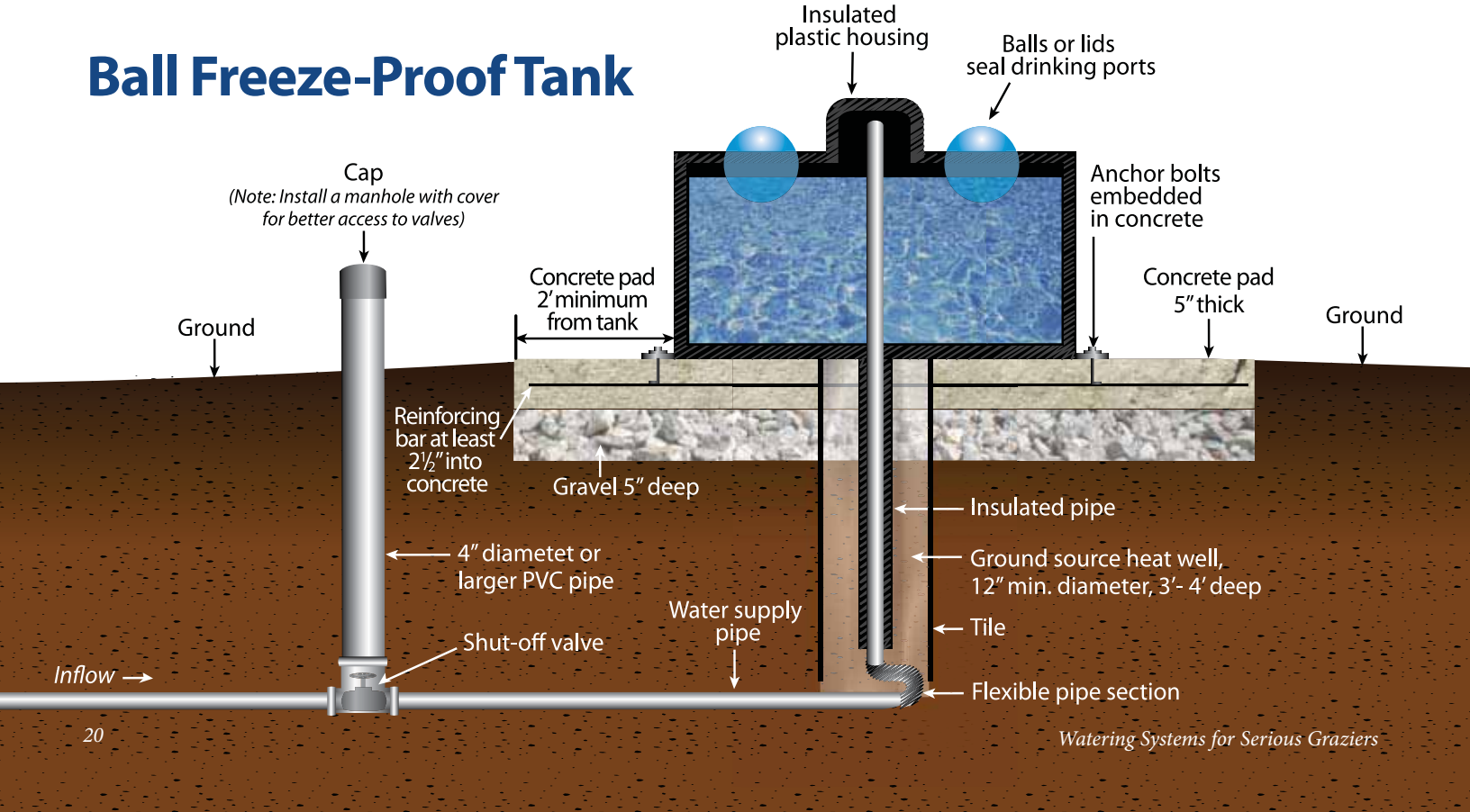
There are many shapes and sizes of tanks designed for various species of livestock. Tanks with lids require animals to lift flaps to gain access to water. Tanks with balls or floats require animals to lightly push the floats down to drink. Livestock need to be trained to drink out of these tanks. Flaps can be tied open or removed, and floats can be removed or adjusted so the balls are not in the water opening. Black balls or floats can get very hot in the summer, so moving them out of the way at those times makes sense.

These tanks come with one to six openings. Manufacturers' recommendations vary somewhat in the number of openings needed. For example, beef cattle recommendations are: one opening serves 25-30 head; two openings serve 75-100 head; four openings serve 200-250 head; and six openings serve 300-350 head.

Water storage in these models ranges from five gallons 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 rates. They allow water to rapidly be replaced as the livestock drink.

Lid and ball freeze-proof tanks must be bolted to level concrete pads. Level pads ensure that the main tank floats can be adjusted properly and that

Ball Freeze-Proof Tank



Livestock learn to push balls and to lift flaps to gain access to water in these freeze-proof tanks.

there will be even water levels under each opening.

Be careful with ball tanks to not set the water levels too high. High water levels cause the floats to press tightly into the tank openings, increasing the pressure required for livestock to push them down and get drinks. It is also important to leave small gaps between balls and tank openings in the winter to prevent the balls from freezing to the cover housings. Install shut-off valves on all tanks, and make sure to protect the shut-off riser pipes from livestock.

The most critical components of energy-free, freeze-proof tanks are ground-source heat wells. A heat well is an open void under a tank that allows the earth's heat to rise through an opening in the concrete pad and warm the underneath side of the tank. The heat that rises from the ground helps keep water and valves from freezing. In southern Missouri, use heat wells that are about 12 inches in diameter and 3-4 feet deep. Larger, deeper wells are recommended for northern Missouri. Shallower or smaller heat wells will not keep tanks and valves from freezing.

Heat wells can be made from various materials. Corrugated plastic pipe is commonly used. Other options include large-diameter schedule 40 PVC pipe, chimney tiles, or even plastic buckets or barrels with the bottoms cut out and placed end-to-end.

Most tank manufacturers specify the types of heat wells to use with their models. Make sure to measure the bottoms of tanks before deciding what size heat wells to install. Heat well openings must be under the tanks, which are sealed to the concrete pads. Wrapping supply lines with insulation adds protection. But do not stuff the tops of heat wells with insulation because the insulation blocks the earth's heat from rising to the tanks.

Cut the side wall from the tires.

Install pipes in the ground before placing tires, leaving an extra length of inlet pipe that can be cut later to the desired height.

Fill the bottom center bead area of tires with concrete, and tamp it to seal tight around the edges.

Tire tanks can also have an entire bead cut out for more drinking area.

Tire Tanks

Livestock water tanks can be made from large machinery tires. Installing tire tanks as permanent water locations has several advantages. For instance, they are very durable and can be made freeze proof. They also put waste products to good use, and save producers the costs of purchasing tanks.

Tire tanks, like all livestock watering tanks, should be located on sites with solid ground, good drainage, and the ability to handle overflow. Large tire tanks are very heavy, so they should be located at sites accessible to heavy equipment.

The size of tires needed depends on the grazing systems and water flow. Large tires can collect enough water from very small spring flows to service many livestock. The top foot of an eight-foot scraper tire holds about 400 gallons of water – or enough to water an 80-head herd of cattle for a day. Tire tanks can also be hooked to pressure systems by installing good float valves on the inlet pipes.

Select solid tires with carcasses that are in good shape. Avoid steel belted tires because they have small cables in the side walls that make it difficult to cut out the sides of the tires. The cables can also injure livestock. Bias ply tires are best.

Outlet pipes should be the same size as inlet pipes, or larger. Four-inch outlet pipes installed with the bell ends flush with the concrete floors make cleaning easy because they allow mud, grass and leaves to pass.

With springs as water sources, tanks may be stair stepped down the pipeline with the outlet of one tank serving as the inlet to the next. When using pressure systems, all tanks need to be hooked to the supply lines and have their own shut-off floats.

One thing to consider with tire tanks is that some horses have been known to chew on the beads of the tires, which could cause health problems for the horses.

tip:

When using tire tanks, avoid steel belted tires. They have small cables in the side walls that are difficult to cut. The cables can also injure livestock.

Installing Tire Tanks

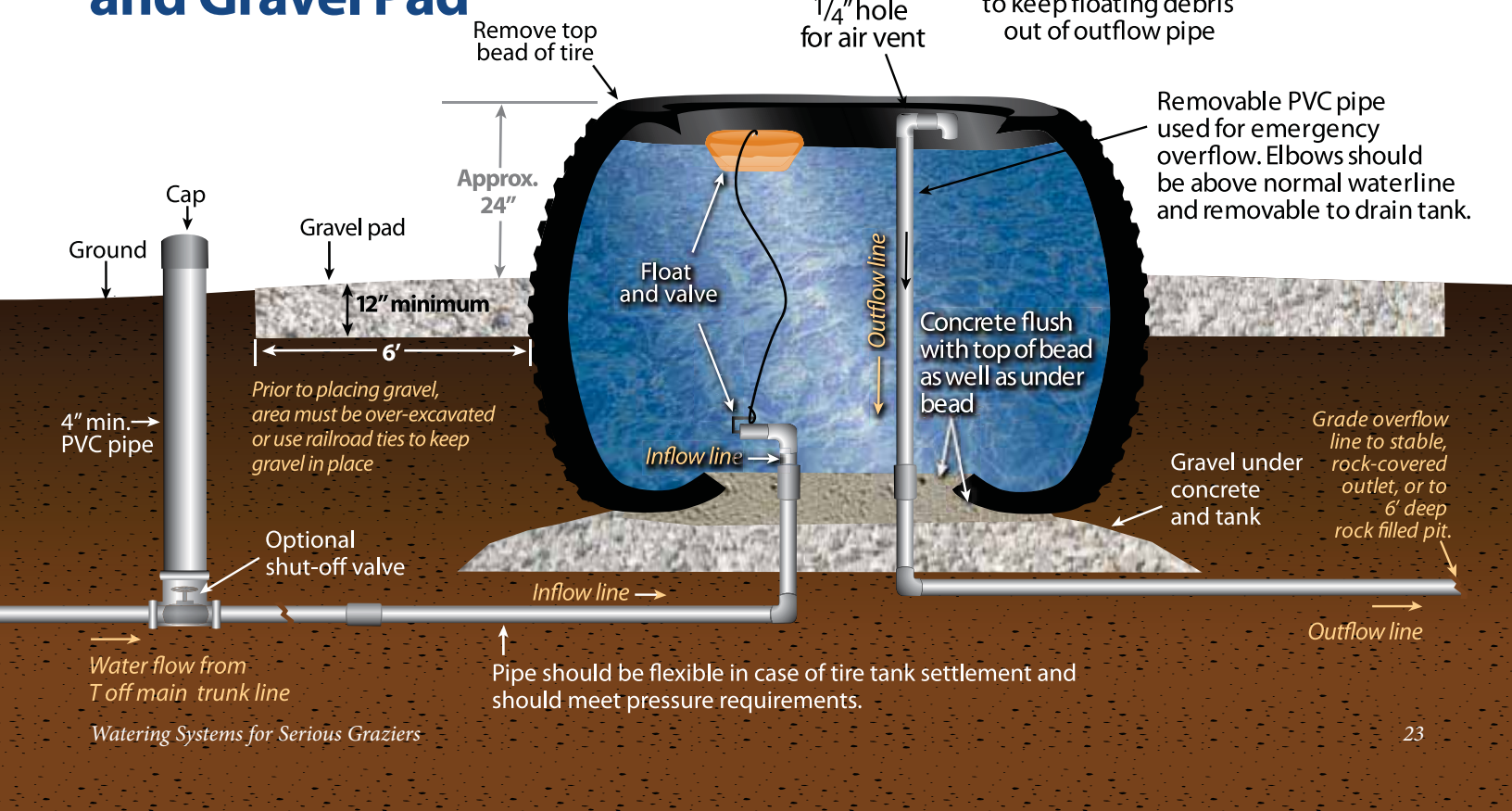
Properly installed tire tanks offer many years of low maintenance performance. Here are some things to consider:

- Tires are very heavy, with many over 1,000 pounds. So never get under tires being installed, and don't stand behind something that could be pushed into you by tires.
- Unless you have purchased pre-cut tires, lay them on their sides, and cut one bead from the tires to allow access to water from the sides. Some people find that removing sections of tire sides is easier than removing whole sidewalls. When cutting with reciprocating saws or chainsaws, angle the blades down and towards the outside of the tires.

The weight of the beads falling inside the tires prevents binding and overheating of saws. Wooden wedges can also open up the splits.

- Fine-toothed blades on reciprocating saws work better than coarse-toothed blades.
- If using chainsaws, grind off the chipper teeth between the cutter teeth of old chains.
- Keep a small, steady flow of water on the saw blades and on the areas being cut. This keeps the reciprocating saw blades cool and helps lubricate the rubber. Dish washing detergent works well in lieu of water. Be sure to keep all electrical cords out of water areas to avoid electrical shocks. Also be careful of the hot, flying, rubber bits.
- Clean tires thoroughly before using them as water tanks for livestock because they may have been filled with chemicals such as ethylene glycol or calcium chloride.
- Install pipes in the ground before placing tires, leaving an extra length of inlet pipe that can be cut later to the desired height. Carefully measure the bell-end of outlet pipes so they will be level with the concrete floors.
- Keep the top edge of tires 12-18 inches out of the ground to keep small livestock from falling in. If mature cows or horses are the only animals watering at the site, a 24-inch height is better.
- Fill the bottom center bead area of tires with concrete, and tamp it to seal tight around the edges. Be sure to get concrete under the bead located between the ground and the tire bead to ensure sealing. Filling the bottom sidewalls is optional; it requires much more concrete, but also makes tanks easier to clean.
- Placing extra ¾-inch pipes through the concrete with sweeps at the elbows allows insulated electric wires to be fed through to the center of the tanks. The insulated wires can feed hot wires across the tops of tanks to keep cattle from crawling into the tanks. Placing tanks in fence lines serves the same purpose.
- Homemade covers can be added to limit drinking areas. They keep cattle out of tanks; protect valves, floats and overflow pipes; insulate; and provide shade to reduce algae growth.

Tire Tank with Concrete Floor and Gravel Pad



Portable, Seasonal Tanks

Using portable watering tanks for seasonal grazing is an excellent way to improve the flexibility of grazing systems. Portable tanks also are an inexpensive way to get water to all of the paddocks during the growing season.

Portable tanks can be made at home from plastic barrels or purchased at local farm supply stores. Plastic and fiberglass tanks are reasonably priced, and come in a variety of sizes. Plastic and fiberglass tanks have several advantages over steel tanks; they last longer, they are less expensive, and they are easier to move around because they are lighter.

Size and quality should be the most important considerations in selecting portable tanks. Tank sizes vary from 55 to 1,000 gallons. However, smaller portable tanks are easier to move. And since portable tanks usually are placed in smaller paddocks where the entire herd won't be watering at the same time, large tanks usually are not necessary.

Portable tanks can greatly improve the flexibility of grazing systems. They can be placed under fences to supply two to four separate paddocks with water. Tanks also can be located close to areas being grazed to create shorter distances for livestock to travel to water.

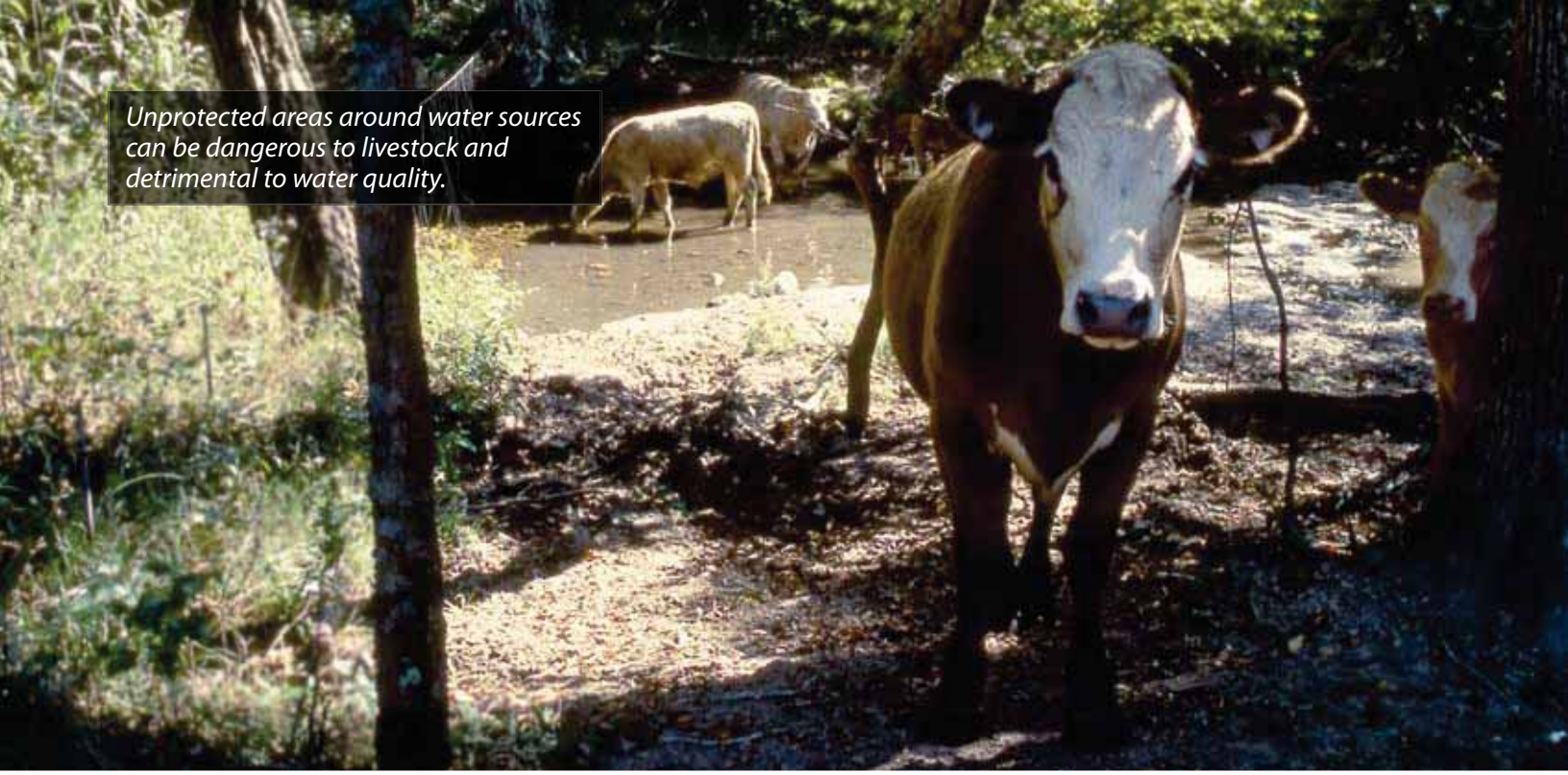
Livestock quickly learn that the old herd mentality is not necessary with these tanks; one or two head at a time will go to water, making it possible for smaller tanks with full-flow water valves to remain nearly full at all times. Also, if smaller tanks are used, one tank can be moved easily to other paddocks. That reduces costs because one tank can supply water to several paddocks.

Water valves are available in a variety of sizes and with a variety of flow rates. The flow rates of valves needed with portable tanks will, in large part, depend upon tank sizes and herd numbers. Use "full flow" float valves with smaller, portable tanks to allow rapid refill of the tanks. Avoid the smaller float valves that clamp on the sides of tanks because they do not refill tanks rapidly enough, often resulting in livestock damaging empty tanks. Protect valves from cattle by placing the valves beneath fences.

Examples of full flow float valves

Portable, seasonal tanks can be hooked to plastic pipe rolled hundreds of feet above ground or hooked to hydrants with short feeder hoses. Having those watering points in all paddocks improves grazing efficiency in the systems.

Portable tanks can greatly improve the flexibility of grazing systems. Size and quality should be the most important considerations in selecting portable tanks.



Unprotected areas around water sources can be dangerous to livestock and detrimental to water quality.

Protecting Watering Areas

Areas around tanks, ponds and streams need to be protected by gravel or concrete pads. Areas that become muddy are dangerous to livestock, and erosion caused by animal traffic damages water quality. Pads provide firm footing for animals, and they reduce erosion around tanks. Tank type determines what kind of pads to use and where to locate them.

Concrete and Gravel Pads

Recommended pad size depends upon individual needs and preferences, animal size, and tank size. Some producers prefer that animals have all four of their feet on the pads while they drink. For cattle, that may require 20-foot-by-20-foot pads. Smaller livestock may only need pads that are 10 feet by 10 feet. Other producers prefer that their animals' have only their two front feet on the pads while drinking. For them, pads that extend about two feet from the tanks are adequate.

Pads that are large enough to allow animals to place all four feet on them can reduce erosion. However, the animals may get too comfortable, linger on the pads, and deposit manure in the tanks. Smaller pads encourage animals to drink and leave.

Plastic ball or flap tanks must be bolted to level, concrete pads. When forming pads, know where the shut-off valves in the supply lines will be placed. Shut-off valves must be protected from animal traffic and freezing. They can be placed close to tanks, but off the pads. Another option is to form access wells in pads, and locate the shut-off valves in the access wells. Access wells require heavy duty lids to support the weight of the animals.

Concrete pads should be at least five-inches thick, and the pads should extend at least two feet from tanks on all sides that provide access to the water. Add steel reinforcement to the concrete – either No. 4 steel rebar 18 inches apart; a single layer of six-inch-

Gravel pads should be at least 12" thick and extend at least six feet from all drinking areas of tanks.

by-six-inch, 6-gauge welded wire; or two layers of six-inch-by-six-inch, 10 gauge welded wire fabric. Concrete and gravel pads should be slightly above ground level. If pads are high above ground level, livestock will create holes as they step on and off the pads. Put five inches of gravel under concrete pads for drainage. Concrete surfaces should have rough textures to keep animals from slipping. When placing tanks in fence lines, add posts on both sides of the tanks before the concrete pads are poured. The posts can be metal, hedge or fiberglass.

Geoweb on top of geotextile reinforces gravel pads.

Freeze-proof concrete tanks, open-top concrete tanks and tire tanks are typically installed with gravel pads placed around them, but concrete pads can be used. Tank style determines the size and placement of pads. Freeze-proof tanks that have one side open for drinking are usually set on compacted soil, with gravel pads placed along the three sides of the tank's drinking area. The rest of the tank is covered with soil for insulation, and fenced from livestock.

Freeze-proof tanks with two open sides, concrete open-top tanks or tire tanks need pads on all sides of the tanks. Gravel pads should be at least 12-inches thick, and they should extend at least six feet from all drinking areas of the tanks.

Excavate 12 inches below ground level or use a curb made of railroad ties to help retain gravel around tanks. Installing geotextile fabric under gravel pads will keep the gravel from sinking into the soil.

Approach Ramps

Stabilize the banks at limited-access points at ponds and streams to prevent erosion. The approach ramps should be as wide as the access points and at least eight feet long and 12 inches thick. Ramps should extend into the water. Use two-inch to four-inch rock on these ramps. The rock should be small enough to allow the animals to walk on it without getting injured but large enough to make it uncomfortable for them to loaf in the watering areas. Geotextile fabric placed under the rock will help stabilize these areas. Less rock is needed and the areas require less maintenance when fabric is used.

Selecting Tank Location

Watering tank location is important to successful management of grazing systems. Consider whether the locations will be flexible enough to accommodate future changes. Also consider whether the locations will allow easy pasture subdivisions during peak growth seasons or for strip grazing of stockpiled forage during the winter.

Soils

Producers need to think about the soils where their tanks, or other watering points, will be located. If the soils are gravelly, wetness and mud probably will not be problems. If the soils are free of gravel, or moist, it may be necessary to install geotextile fabric to keep the gravel from being pushed down into the soil. If possible, place tanks on well-drained soils.

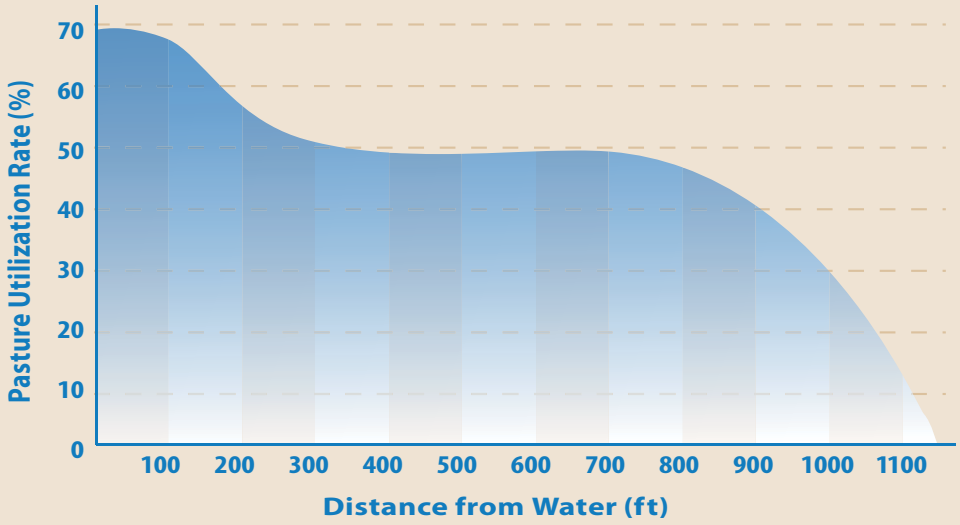
Animal Travel

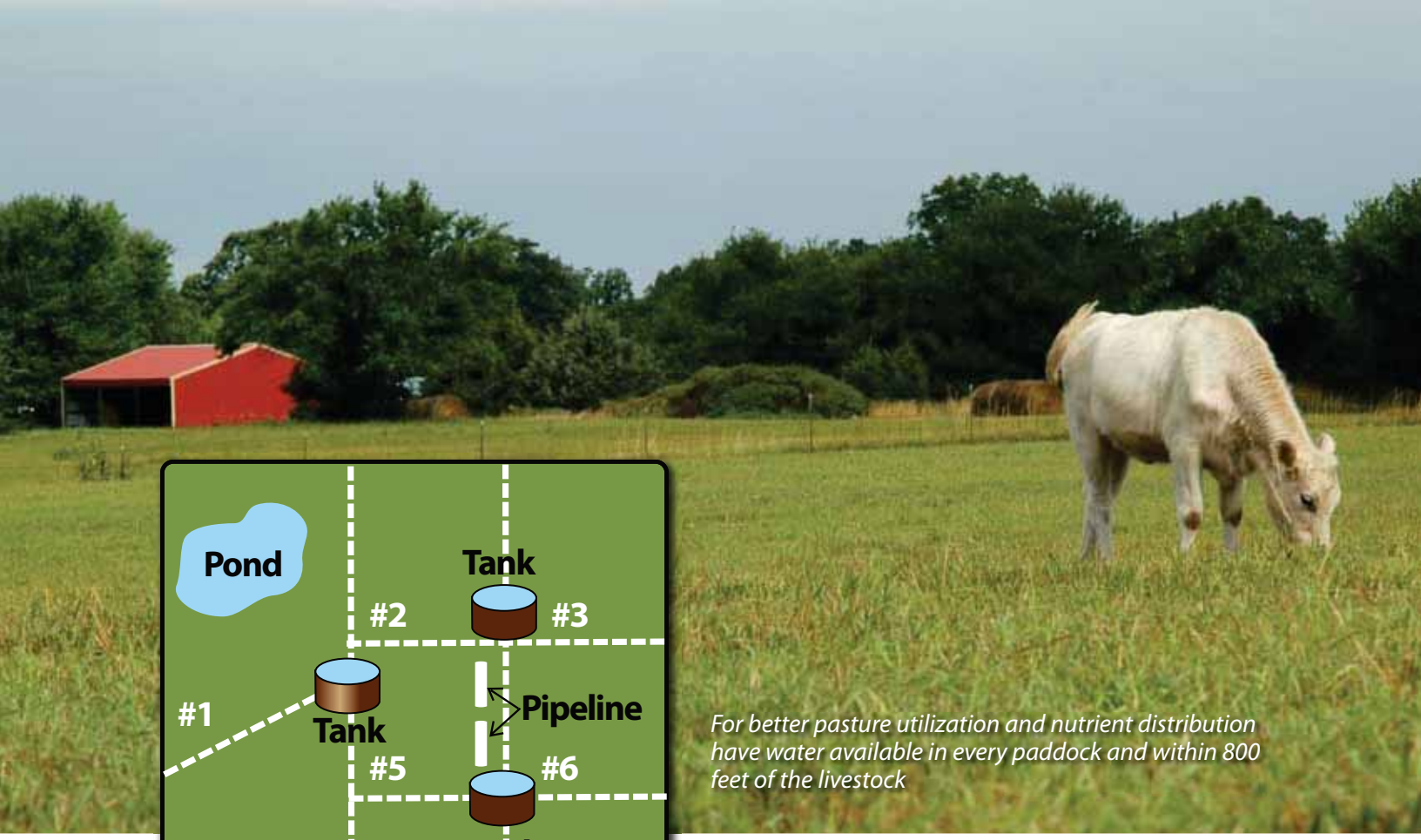
Livestock should never have to travel more than 800 feet to get a drink. When the distance from the far end of the pasture to water is greater than 800 feet, getting a drink becomes a social event; the entire herd goes together. This is especially true when animals have to go through gates and down lanes to get water. When water is located in each pasture, and the animals can stay within sight of the herd, they are more likely to drink as individuals. That reduces the strain on water supply systems and reduces the need for large tanks, which are more costly to install.

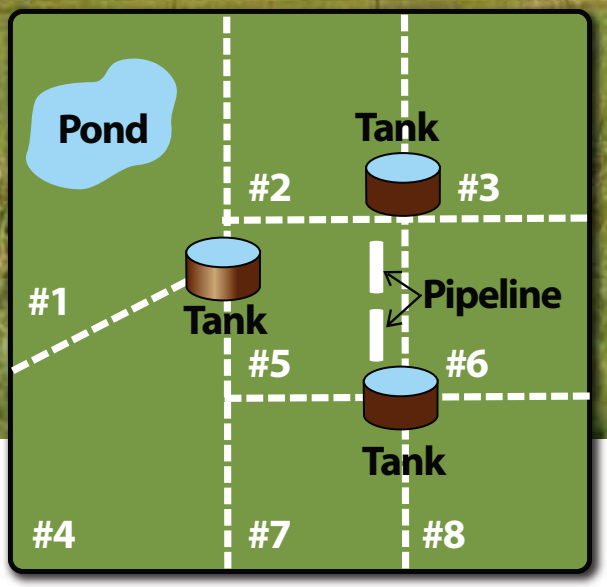
Excessive distance from the pasture to water also causes a decline in pasture utilization. A lower percentage of available forage will be eaten because areas close to the water will be overgrazed while forage in the far ends of pastures is undergrazed. Excessive distance also causes manure and urine to be concentrated close to water sources. And, when animals have to go down lanes to get drinks, about 15 percent of the manure is deposited in the lanes. Nutrients provide little or no benefit there.

When planning water facilities for grazing systems, every effort should be made to put water in each paddock. The Oklahoma-based Noble Foundation

Impact of distance from water on pasture utilization rate in rectangular 10-acre paddocks







For better pasture utilization and nutrient distribution have water available in every paddock and within 800 feet of the livestock

reported that grazing systems with one watering point per 10 paddocks had 10-20 percent bare ground in the paddocks. When each paddock had water, only 1 percent of the ground was bare. In the latter situation, the watering points could be moved to allow water tank areas to be rested.

The best situation is a combination of permanent and portable watering points. The permanent watering points should be freeze-proof tanks that can be used year around in conjunction with hydrants to provide water to the remaining paddocks. Many times it is possible to water two, three or more paddocks or grazing strips from the same tank when it is located in a fence line.

Winter Water

When locating winter watering points, consider placing freeze-proof tanks facing south to protect them from cold, north winds. Livestock can travel farther to water in cooler weather, so permanent winter watering points could be located in lanes.

Slope

Establishing watering points on steep slopes can be challenging. Steep slopes make it difficult to level tanks, and make it difficult for livestock to drink. If watering points cannot be moved to level areas, it might be necessary to use heavy equipment to create level pads on slopes.

Cost

Costs should not dictate every aspect of how systems are set up, but rather how they will perform in the future, how flexible they will be and how they meet the needs of livestock and resources. Invest the minimum amount necessary to meet the needs of the forage and the livestock.

Installing Pipelines

Decisions regarding installing pipelines may be the most important decisions ranchers make in designing their water-delivery systems. Well-designed pipelines take dependable water to the livestock on pasture, making them the key point in future operation and flexibility of grazing management.

Design Considerations

There are many things to consider in selecting routes for livestock-water pipelines. Here are some of the most important considerations:

- Locate water tanks on solid ground with good drainage. Some styles of tanks need to be located where it will be easy to manage tank overflow.
- Select pipeline routes that minimize the number of high and low spots in the lines. High spots may require air valves, and low spots in shallow lines may require drains.
- One pound of pressure equals 2.31 feet of elevation change in water. Water pressure will decrease when tanks are uphill from the sources, and booster pumps may be needed to access high hills. Getting water to tanks that are downhill from the sources may require pressure reducers or valve limiters to keep from damaging tanks, floats, pipes, etc.
- Avoid landslide areas, and avoid crossing watercourses that are eroding. Route pipelines to avoid shallow and very rocky soils if possible.
- Consider future expansion to systems. If pipeline extensions are anticipated, then pipe sizes and ratings should be appropriate for the ultimate extensions.
- Make sure that pump installers know where water needs to go so they recommend the right size pumps, pressure tanks and pressure switches.
- Locate large stock tanks or storage tanks where heavy equipment can be used to install them.

Route Surveys

The type of survey information required for pipelines depends on the characteristics of the routes. For example, a spring development with a 300-foot pipeline and a total fall of only four feet between the spring and the tanks may require a very detailed survey to ensure that the pipe grade and tank elevation will allow the system to operate properly.

On the other hand, a mile-long pipeline that drops 100 feet from the source may only need a careful study of contours on a U.S. Geological Survey (USGS) quadrangle map to get enough information for an adequate design.

Determine the freeze depth for your area and dig pipe trenches at least that deep to protect pipelines from freezing

And in a third example, a mile-long pipeline traveling over gently undulating topography with total elevation differences not exceeding 25 feet may need a detailed profile run with an engineer's level.

The difference in these installations is that installers must predict where air can collect in the pipe systems, and provide ways to release it. Defining where these problem locations are dictates the types of surveys necessary.

Use onsite, detailed surveys when water pressure is low and where many small undulations in the terrain make it difficult to locate all of the high and low spots. A good set of survey notes also is a valuable reference for future expansions of the systems.

Using Geological Survey Quad Maps

For long pipelines with major elevation changes, it is usually adequate to use contour elevation data from 7-1/2 minute series USGS quadrangle maps. The contour interval on most quad sheets of interest in Missouri is either 10 or 20 feet. Fairly accurate interpolations can be made to elevations of five to 10 feet, which is usually adequate for high pressure pipelines. It is extremely important to accurately locate ground locations on the maps. If there is any question as to location, other methods of determining elevations should be used.

Horizontal distances can be estimated from the maps to the nearest 100 feet. Because of elevation changes, the actual pipeline length will be longer than horizontal distances measured from the maps. Corrections must be made for the additional distances.

Reduce guesswork by physically measuring the route distance. Depending on the accuracy needed, pipeline length can be measured by pacing, using tape measures, string measures, measuring wheels or GPS units.

Installation Considerations

Buried pipelines provide water during all types of weather, and they are located out of harm's way. Surface pipelines offer more location flexibility and the ability to be moved. Systems that combine buried lines and surface lines provide optimum flexibility.

Buried Lines

- Identify possible buried utilities, and contact utility companies for technical guidance if routes must be located where they will intersect the utility routes. Missouri One Call System, Inc. (1-800-344-7483; **http://www.mo1call.com/**) can aid in locating buried utilities.
- Routing pipelines over moderately sloped terrain makes it easier to trench.
- Determine the freeze depth for your area, and dig trenches at least that deep. Soils need to be deep enough for trenching to the design and freeze depths.
- In rocky or gravelly areas of trenches, bed the pipes in dirt, sand, lime or pea gravel to protect the pipes from sharp projections.
- Offset all attachments (tanks, hydrants, etc.) from main lines with 'T' connectors. This prevents having to break into main lines to gain access.
- Install 'T' connectors with short lengths of pipes and caps glued on anywhere there is a possibility of tapping into lines in the future. It is much easier to dig down, saw the caps off and take off in another direction than to try to tap into main lines. In addition, the short pipes absorb the shock of water hammer when valves and floats are shut off.
- Install blind stubs at the ends of lines to make future extensions easier.
- Install manifold systems with shutoffs on each branch line at wells or other water sources. This prevents having to shut down whole systems to repair one item.
- Install shutoffs so whole lines do not have to be shut off for tank repairs. Use full-flow shut off valves, like ball valves, to avoid flow restrictions. Valves may be buried with faucets, drains, etc., in separate manholes, access wells, or inside tanks where they can be easily reached.
- Under roads and heavy-use areas where ruts may form, place pipes inside larger pipes or bury them much deeper to avoid wear to pressure pipes.

- Be certain to install pressure fittings instead of lighter-weight drain fittings. Bell-end pipes speed the gluing process and reduce the number of joints and fittings.
- Pressure test systems for leaks before covering pipes.
- To avoid cracking pipes, always cover pipes by hand with at least six inches of soil before mechanically backfilling with rocky or chunky soil.
- Seed disturbed areas after grading the pipelines. The trenches will settle for a couple of years, and may need additional grading or fill. However, established grass will usually withstand moderate grading.
- Pipelines shouldn't freeze under good stands of grass, but they might freeze under lanes or gates. Consider putting foot-wide pieces of ground-contact foam over pipes in those areas before filling the trenches. The foam traps heat coming from underneath, and helps keep pipes from freezing.

Stream Crossings

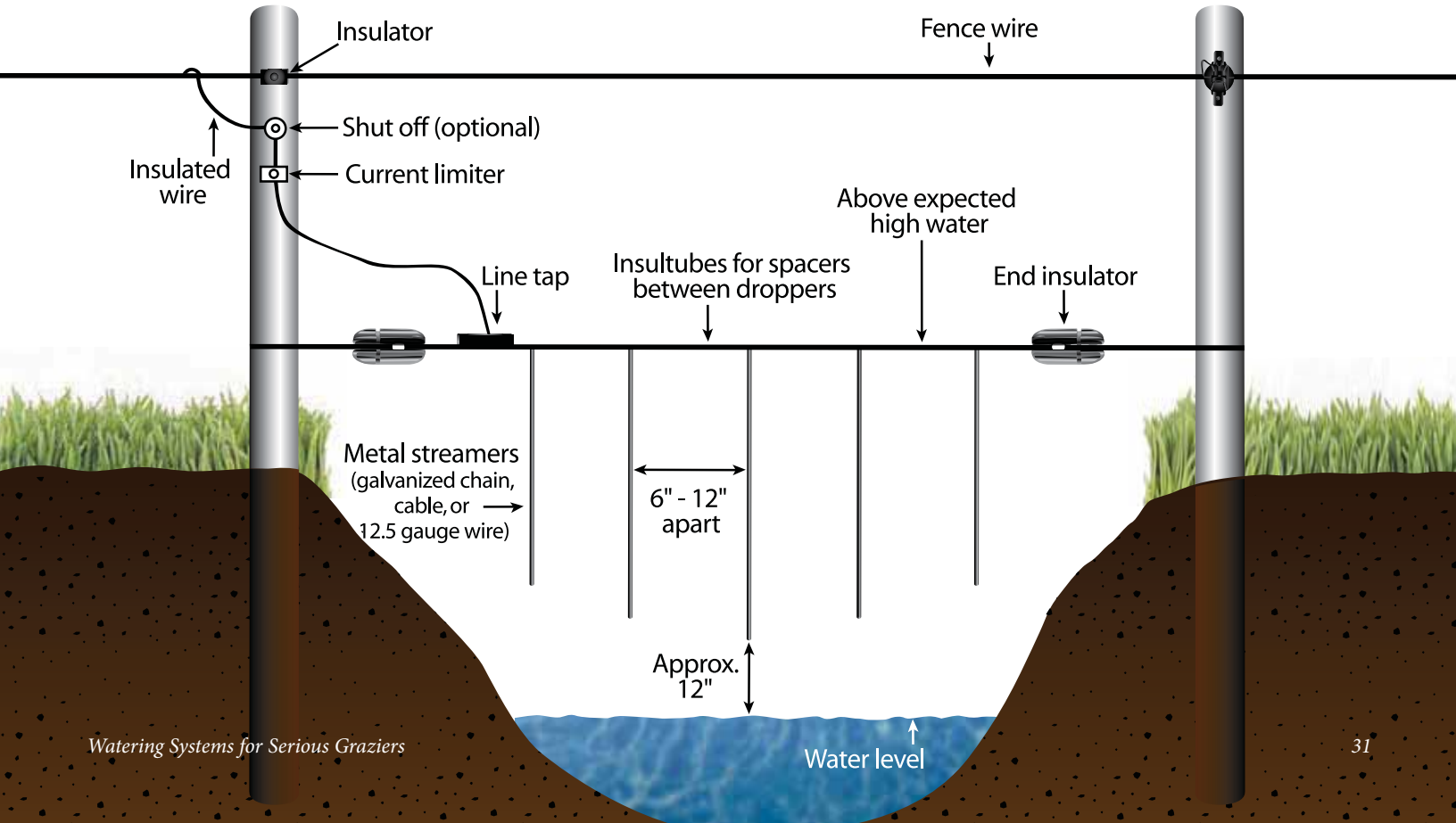
Crossing streams with pipelines may be relatively simple, depending on width, depth, drainage area and, especially, composition of the streambeds.

Selecting stable portions of streams is important, and pipeline alignment might need to be changed from a preferred location in order to accommodate this. Construct stream crossings first, then bring the rest of the pipelines to the crossings.

Cross gravel or earth bottom streams at right angles, and dig to the maximum depth possible. Freezing probably won't be a problem, but use burst-proof pipe if the possibility of freezing exists.

Crossing solid-rock-bottom streams is another proposition. Think carefully about site selection and installation methods. One method which has worked is to jack hammer trenches across the streams' rock bottoms. Trenches one-foot deep and as wide as a backhoe bucket have been suc-

Water Gaps (Flood Gates)



cessful. Place the water pipes in larger sections of heavy, thick-walled, steel pipes, and backfill with a mix of fine and larger materials. Consider pouring some concrete over the larger pipes.

Another method which has worked on rock-bottom streams is to place the water pipes in larger sections of thick-walled pipes, lay the pipes on top of the streams' rock bottoms, and cover them with stiff concrete mixes. The concrete will set up in the flowing water. The water flowing over the tops of the pipes protects them from freezing.

In either case, consider using burst-proof pipes and installing shut off valves in case there are problems.

Another thing to consider is to run the sections of pipes above streams at heights that are well above expected high-water marks. These pipelines would need to be shut down and drained during freezing weather.

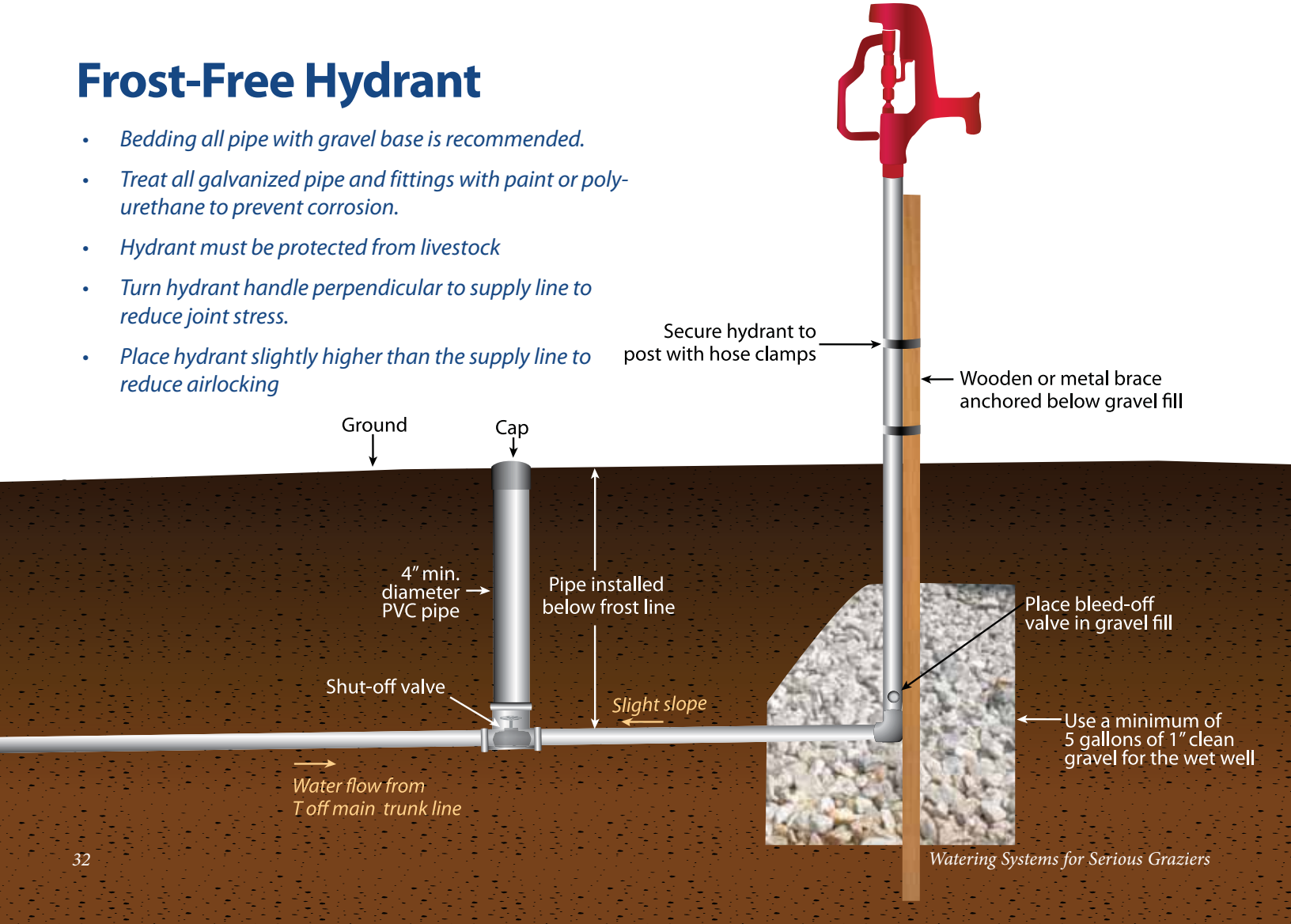
Keep in mind that some larger streams will require permits. Check with the U.S. Army Corps of Engineers to see if permits are required.

Hydrants

Install freeze-proof hydrants when crossing fences, near tanks and at other points along pipelines. Hydrants located at high points in lines can be used to bleed air pockets that restrict water flow. They also double as water-delivery points. The hydrants can be very handy for accessing water for many purposes, including surface pipes and tanks, for better grazing distribution. If possible, place hydrants close to hot wires so livestock won't crowd them. But keep the hydrants far enough away from the wires to prevent grounding the fencing systems.

Frost-Free Hydrant

- *Bedding all pipe with gravel base is recommended.*
- *Treat all galvanized pipe and fittings with paint or polyurethane to prevent corrosion.*
- *Hydrant must be protected from livestock*
- *Turn hydrant handle perpendicular to supply line to reduce joint stress.*
- *Place hydrant slightly higher than the supply line to reduce airlocking*



Lay above-ground pipe directly beneath fences to protect the pipe from livestock and vehicle traffic.

Use flexible hose to attach above-ground pipe to hydrants. Automotive heater hose has proven to work well.

Brace hydrant supply pipes and stand pipes. Hedge posts (or other long-lasting posts) put in the trenches as they are backfilled give good support and bracing.

Using Above-Ground Pipe

Thanks to advancements in technology, above-ground high density polyethylene (HDEP) rolled pipe is a viable option for seasonal livestock watering. This pipe is available in diameters of ¾-inch to two inches. Depending on the thickness of the pipe, it is available in rolls containing 100 to 400 feet, and it can withstand water pressures ranging from 100 to 160 pounds per square inch.

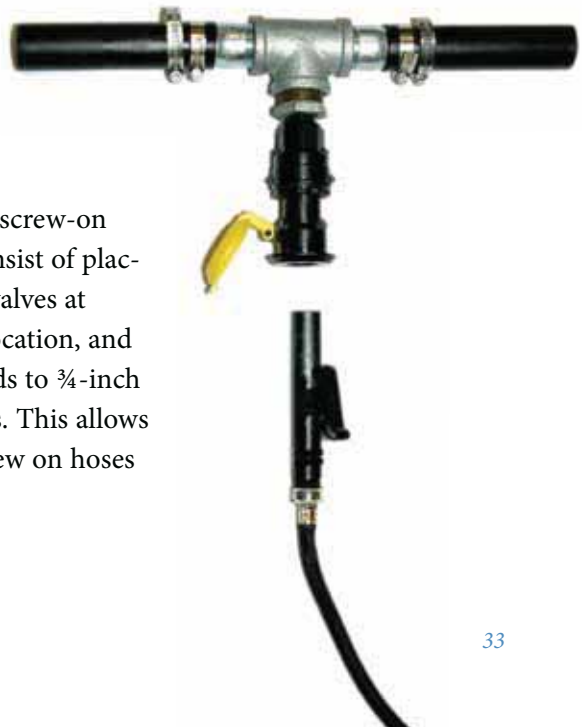
Lay above-ground pipe directly beneath existing fences to make it easier to locate the pipe. Lay the pipe in a snakelike fashion that allows it to expand and contract, which reduces the stress on joints and fittings. Grass growing over the pipe shades it from the heat and helps protect it. Where animal or vehicular traffic could damage pipe, slip it through larger pipes.

Place hydrants in all low spots so they can be drained in the winter. Also avoid extremely long runs of surface pipe. Longer runs require larger pipe. Smaller pipe is preferable because water is stored longer in larger pipe, causing the water to heat up in the summer. Larger pipe also stores more pressure, which can cause joints to separate.

It is imperative to unroll this type of pipe by simply rolling it across the top of the ground. That decreases the likelihood of kinks in the pipe. It also helps to use zip ties to secure the pipe to T posts. This helps keep the pipe in place and makes it easier to unroll and straighten the pipe.

There are many types of fittings available for use with polyethylene pipe. However, galvanized steel connectors are better than the plastic-barbed connectors sold at many stores. It is a good idea, especially with larger pipe, to heat the ends with small propane torches before inserting the connectors. Use two stainless-steel hose clamps on each side of connectors – with tightening screws on opposite sides of the pipe – to ensure leak-free connections.

Many types of tank connectors are available. Although quick-coupler connectors are convenient, they may not be cost effective unless the outlet will be used many times during the season. The screw-on types simply consist of placing plastic ball valves at each watering location, and adapting the ends to ¾-inch hose bib threads. This allows operators to screw on hoses to fill tanks.



Collecting Spring Water

There are many different ways to collect spring water. Several types of systems can be developed depending upon the type of spring, location, landscape, soils and other conditions.

The first step is to decide if a spring is worth developing. That process may take up to a year, especially if the history of the spring is not known. If the history is not known, it is important to record spring flow. Record the flow monthly – but not right after a heavy rain – by channeling the flow so that it can be captured in a bucket. Measuring the number of gallons that flow per minute into the five-gallon bucket will provide a good estimate of spring flow.

It is most important to know the flow during and immediately after the typically dry months of July and August, plus January and February when freezing may slow output. The months following a dry spell, such as September and October, also should be watched carefully because spring flows may be affected by dry spells months after the dry spells.

One gallon of flow per minute output equals 1,440 gallons per day. That's enough water for 50 cow-calf pairs. A larger tank will be needed for smaller spring flows.

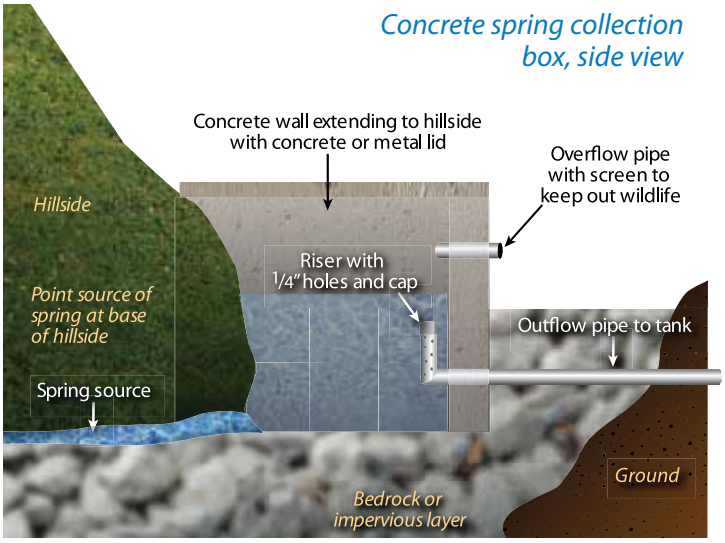
Another consideration is that there should be at least a four-foot drop in elevation to the place where tanks will be placed.

Install the water tanks and pipelines first to allow tank installation without dealing with the water flow from the spring. Since spring flow is continuous, install overflow pipes to carry excess water to natural ditches or to other tanks. Overflow pipes should be threaded at the floor of the tanks so they can be removed to drain the tanks when needed. Always put fences around springs and collection areas to exclude livestock and to protect the water sources.

Concrete Collection Boxes

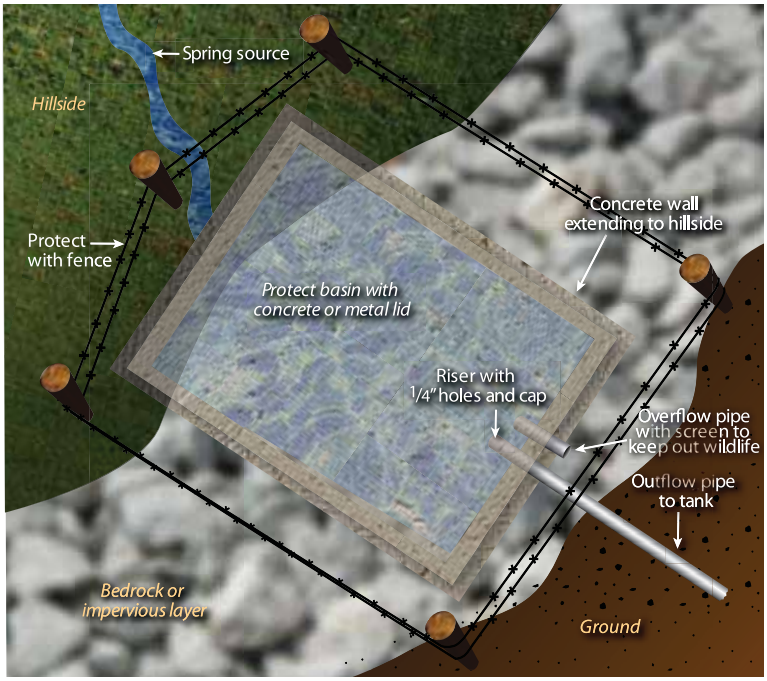
Collect spring water surfacing out of cracks in bedrock by forming and pouring concrete boxes around the spring heads, then piping the water to watering tanks. Follow these steps in constructing concrete collection boxes:

Concrete spring collection box, side view



- Clean the bedrock around the spring flow to provide a clean floor to the spring.
- Place a temporary stub pipe into the spring, and pack clay around it to divert the water through the pipe while forming and pouring the concrete box. This pipe will later serve as the supply pipe to the tank; it will go through the forms, and should rest at the bottom of the box.
- Form a three-sided box around the spring. The back side of the box will be the bedrock at the spring.
- Place a 4-inch-diameter plastic pipe in the form at the very top to provide an overflow pipe for the box. Pour concrete around this pipe so it becomes part of the wall.
- Pour all walls of the box.

- Separately form and pour a concrete lid. Place rebar handles in the forms before pouring.
- Place rebar or wire mesh in the walls and lid.
- When the concrete has set, remove the forms.
- Remove the clay dam formed earlier around the supply (diverting) pipe. Place a 90-degree elbow onto the end of the supply pipe; into the elbow, place a capped riser pipe with several holes drilled in it.
- Dig a trench to the watering tank and install the supply pipe.
- Place the concrete lid, constructed earlier, onto the spring box to keep dirt and leaves out, and to protect the spring from livestock and surface water flow.



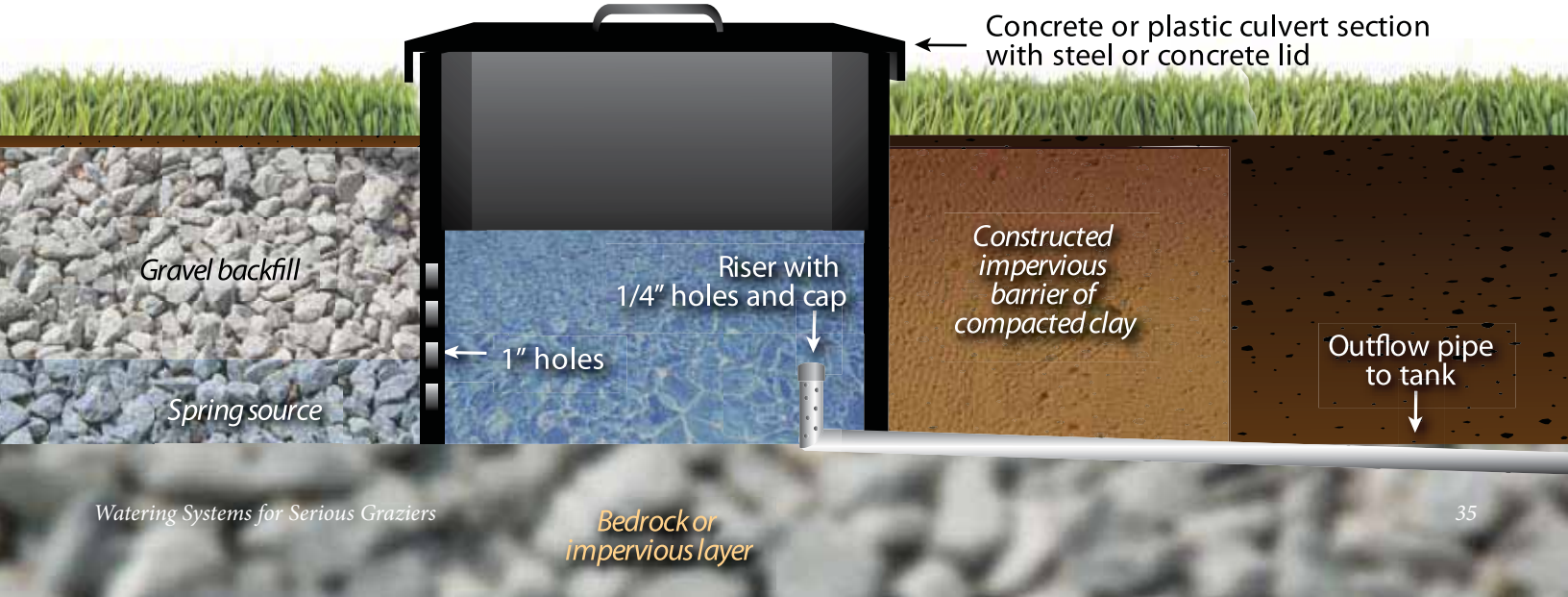
Culvert Collector Boxes

A concrete or plastic culvert can also be used to capture spring water. Use this method if the water flow is 5 to 15 feet wide.

Select a concrete or plastic culvert with a diameter of 2-6 feet and few perforations. The necessary culvert size depends on spring flow and planned usage. Concrete culverts not suitable for their originally intended use because of fabrication flaws often can be purchased at a discount from pre-cast concrete companies.

Here's how to install culvert collector boxes:

- Dig out the spring area to create a pool; dig down to gray clay or bedrock, if possible. This will be the collection pit for the system.
- Extend the supply pipeline into the center of the pool. This pipe will run from the collection culvert to the watering tank.
- The supply pipe should be at least 1¼-inch diameter. It will be installed below the bottom edge of the culvert. Glue a 90-degree elbow to the end of this pipeline where it will be inside the culvert.
- Build a standpipe by capping one end, and drilling a series of holes up and down the



sides to allow water to flow into the perforated standpipe. Insert this perforated standpipe vertically into the elbow installed on the end of the supply pipe. This standpipe should be 12-24 inches long, and it should not be glued. That way, the standpipe can be removed to drain the storage culvert quickly if repairs are needed.

- Prepare the culvert by drilling holes on one side of the culvert up to about 18 inches from the end, depending on the depth of the pool. The culvert should only be perforated for 2-3 feet at the bottom to allow spring water flow into the culvert collection box. If more than one section of culvert is needed, due to depth, use non-perforated culvert sections above the spring flow elevation.
- Notch the lip of the culvert on the end that is placed into the pool.
- Place the collection culvert over the standpipe, lining up the notch in the lip over the supply line to keep the culvert from crushing the pipe.
- Place a gravel jacket 1.5 to 2 feet thick on the water-source side of the culvert. Tamp the downstream side of the culvert with good clay or a combination of clay soil and bentonite. Place clay on top of the gravel jacket, 1.5 to 2.5 feet thick.
- Backfill all open trenches with excavated material.
- Backfill soil around the collection pit area; allow for settling of the soil.
- Install a fence around the spring and collection area to exclude livestock and protect the water source.
- For a pumping system, submersible pumps work very well. Install a supply line above the stored water level and below the frost line. Platforms to hold pressure tanks and fittings can easily be constructed inside the upper part of the larger diameter storage culvert.
- A good steel or concrete lid is essential to keep children and livestock out of the culvert.

Corrugated Perforated Pipe System

If spring water flows are 30-100 feet wide and perpendicular to the normal surface runoff flow direction, use corrugated perforated pipes that are 4-8 inches in diameter.

Dig a short test trench parallel to the water flow area that is about 2-3 feet above the wetland plant edge. The trench should be 3-4 feet wide and 4-5 feet deep. The soil type and texture is the key indicator of the proper depth. Digging to bedrock or into gray clay is essential. The grade of the trench should be surveyed so that humps and dips will not cause flow problems. Grade for the tile should be four inches of drop per 100 feet.

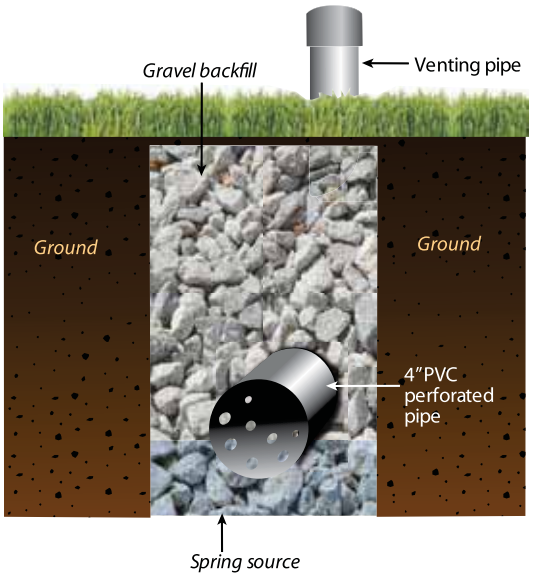
Once the depth is determined, the exact elevation of the gravity fed tank can be determined. This elevation can be predetermined if there is a large elevation change from the spring to the tank. However, if available space is limited, definite elevation plans must be made after the spring is exposed. In those situations, dig a trench towards the tank area, but divert it away from the tank installation area to keep the area dry. This trench often can be used with the final overflow pipe from the tank.

Install collection pipe as the trench is dug, placing gravel at the same time as the pipe. Continue placing segments of the collection tile and gravel until the entire seep area has been cut off. Then attach a cap with a one-foot long stub of PVC pipe to the end of the collection tile.

Dig a trench for the supply pipe and attaché pipe to the stub. Tamp a barrier of good clay to form a seal at the end of the seep area. Use bentonite if good clay soil is not available. This seal should be 4-6 feet horizontally and as deep as the trench. The supply pipe leading to the watering tank should be at least 1¼ -inch in diameter.

Rigid Perforated Pipe (French Drain)

A French drain is simply a cross trench with perforated pipe and clean rock that intercepts spring water and sends it into a supply line.



- To install a French drain, dig as close as possible to the spring without getting into the spring or in the outflow area. The collection trench should go from dry ground on one side, across the spring flow, to dry ground on the other side. Dig to solid rock or clay material to ensure as much water as possible without it going under the collection pipe.
- Surveying is essential to ensure positive grade in the collection pipe and the distribution line to the tank. The depth of the collection pipe may affect tank location. As a general rule, there should be at least a one-foot drop in elevation between the collection pipe and the water level in the tank. Do not allow water to stand in the collection pipe or to backup into it.
- Collection and distribution pipe should be 4-inch PVC (schedule 40 or 35) with bell ends. The bell ends should be placed upstream. Glue an end cap onto the perforated pipe or attach a vented stand pipe to keep air from being trapped in the system. Be sure to place the pipe so that the holes are facing to the sides of the trench.
- A straight line collection or a "T" collection can be used. Drill a single row of 3/8-inch holes through the pipe to collect water. Place the holes on the side to allow for settlement of fine sands and dirt in the bottom of the collection pit. A filter sock can be placed over the pipe if the spring is yielding sand.
- An upright pipe placed at the end of the perforated collection pipe allows for venting of the pipeline, inspection of spring flow or for cleaning and flushing the system.
- Attach the solid pipe at the end of the collection area, and continue laying the pipe to the watering tank site.
- Spread bentonite in the bottom of the collection pit along the back part of the trench away from the spring area. This will help force the water into the pipe.
- Backfill the collection pit with 1-inch, clean rock up past the collection pipe. Cover the gravel with a geotextile fabric, then place soil on top of the fabric. This will keep soil from seeping into the system.
- Backfill the rest of the trench with excavated material.
- Fence the collection area to keep livestock from damaging the system and to guarantee improved water quality.

Spring Tanks

A watering tank for springs is installed with inlet and outlet pipes to allow the continuous flow of the spring to fill the tank and flow out to a protected area away from the tank. Some producers plumb the outlet pipe into secondary tanks downhill, allowing for multiple watering tanks from the same spring.

Maintaining Water Delivery Systems

It is important to plan and schedule routine maintenance of water systems to avoid costly repairs and to ensure longer service lives of the systems. Here are a few things to do periodically to keep water delivery systems as trouble free as possible.

Wells

- Check that pressure tanks and piping, electrical switches and valves are all connected and working properly. This is especially important if wells are not used during the winter.
- Make sure that insulation remains installed, and replace worn door gaskets in the well house.
- Always keep extra sets of pump switches and pump fuses on hand.

Pipelines

- When systems are installed, create maps containing reference measurements from permanent structures. The maps help to easily locate buried lines if they develop leaks or to locate pipelines before drilling or excavating in the area.
- Check pipeline routes for leaks, especially in rocky areas that become wet.
- Check pipeline routes for adequate coverage of dirt for insulation. Soil coverage will settle 10 percent or more over time.
- Check shut-off valves to make sure they function properly.

Above Ground Pipe

- At the beginning of every grazing year, turn the water on and let the lines flush to remove water scale, debris and gravel before installing valves.
- Check all fittings used to connect pipelines to make sure that they have not broken during the winter.
- Keep hose bibs open during the flush sequence, then close them to see if they shut off properly.

Tanks

- Drain plastic or concrete tanks monthly
- Replace worn or broken balls, floats, and valves as needed.
- Check the flexible lines in plastic water tanks for wear or breaks, and replace worn seals.
- Check insulation around pipes and in insulated tanks, and replace it as needed.
- Make sure the bottoms of plastic tanks are caulked or sealed.
- When they are not in use, store portable tanks where livestock will not damage them.

Winter Care

- Install thermostatically controlled heat in well houses.
- Drain wells, tanks and pipelines when the tanks and pipelines are not being used.

Pads

- Rough up surfaces of concrete pads that have become smooth after years of use.
- Patch or replace broken pads.
- Add more gravel to gravel pads as needed. Geotextile fabric and geo-webbing will extend the life of gravel pads and reduce maintenance costs.

Algae Control

- Control algae growth in tanks by placing a few goldfish in them. The fish keep the tanks clean by eating algae. Goldfish seem to survive winters with no problems; some tanks have had the same goldfish for eight years.

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