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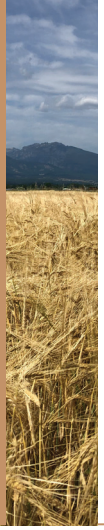


Patrick Mangan

AGRICULTURE AND NATURAL RESOURCES

MT202209AG, NEW 5/22

Water Quality for Livestock

By Adam Sigler, Extension Water Quality Specialist; Marley Manoukian, MSU Extension Agent In Richland County; Megan Van Emon, Extension Beef Cattle Specialist

Fresh, clean water is a daily requirement of all classes of livestock. Water requirements vary greatly depending on several factors including temperature, animal size, production stage, and moisture content of the diet. The following is an overview of common livestock water quality issues in Montana, water testing guidance, and a synopsis of options when water quality is very poor.

Livestock water needs

Fresh, clean water is a daily requirement of all classes of livestock. Water requirements vary greatly depending on several factors including temperature, animal size, production stage, and moisture content of the diet. Water requirements for a 1,300 pound mature beef cow are estimated at 9.2 gallons per day at 40° F, increasing to 14.3 gallons per day for the same animal at 90° F. When that cow is lactating and producing 15 pounds of milk per day, estimates of water requirements increase to 12.2 gallons per day at 40° F, and 17.4 gallons per day at 90° F. In fact, water is the most essential nutrient for livestock health and production. Animals need water to help them regulate body temperature, digest feed, lubricate joints, grow muscle, lactate, and carry out other biological processes. Additionally, water intake drives feed intake; if water intake decreases, feed intake will follow suit.

Water quality can be impacted by many factors, including but not limited to location, year, precipitation, soil composition, and season. Water quality may be impaired by contaminants such as salts, excessive nutrients, or bacteria, which can become more concentrated during drought as water sources dry up. Many contaminants will cause animals to drink less water, which causes them to eat less, resulting in a negative impact on health and production. However, if livestock water (or feed) contains a high amount of salt, animals may drink more water because salty water doesn't fully quench thirst. This is why testing to know what is in animals' drinking water is extremely important for livestock production.

Cattle drinking from a stock pond in Eastern Montana. Photo by Marley Manoukian.

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) is the sum of all the dissolved minerals, metals, and nutrients in water and is sometimes simply referred to as salinity. TDS is a nonspecific indicator of water quality. Highly saline water sources with TDS values over 10,000 mg/L (1 mg/L = 1 ppm) are not suitable for livestock for the same reason that a person cannot survive by drinking ocean water, the water will actually dehydrate the animal. Suitability of water for livestock use based on TDS level is summarized in Table 1. The table also includes specific conductance values that can be used to estimate the TDS with a handheld meter. More detail on handheld specific conductance meters is included in the testing section.

Units of Concentration: mg/L = ppm

Concentration units of mg/L (milligrams per liter) can be considered equivalent to ppm (parts per million).

Converting Specific Conductance (SC) to Total Dissolved Solids (TDS)

- To estimate TDS from SC, multiply the SC (in units of mS/cm) value by 650.
- mS/cm (milli-siemens per cm) x 1000 = µS/cm (micro-siemens per centimeter)
- 1 mS/cm = 1,000 µS/cm ≈ 650 mg/L TDS

Concentration of TDS may change throughout the year in one water source and be relatively stable in other sources. TDS tends to be more variable in surface water and shallow groundwater, and less variable in deeper groundwater. Figure 1 shows TDS fluctuations in three water sources tested in southeastern Montana over a season. Based on these results, water Source 1 would not provide suitable livestock drinking water during most of the summer and fall. Variability in results illustrates the importance of testing water sources immediately before and during livestock use. Water with high TDS may also have high concentrations of sulfate or nitrate.

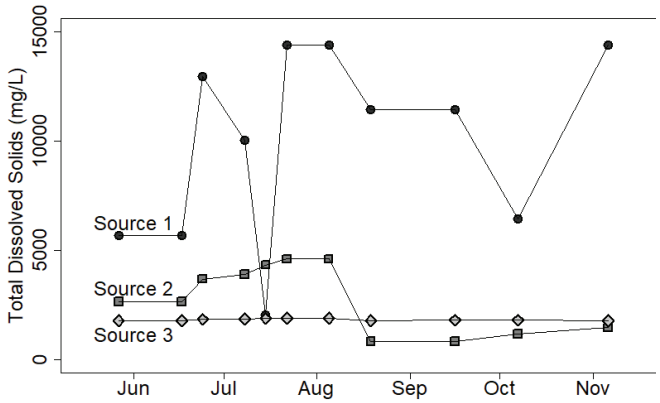


Figure 1. *Total Dissolved Solids for three water sources in Southeast Montana in 2014.*

Table 1. Total dissolved solids, approximate specific conductance, and suitability for livestock use.

Total Dissolved Solids *(≈ Specific Conductance)*	**Suitability for Livestock**
Less than 1,000 mg/L *(≈ SC < 1.5 mS/cm)*	Relatively low in salinity. Excellent for all classes of livestock and poultry.
1,000 – 2,999 mg/L *(≈ SC 1.5 to 5 mS/cm)*	Very satisfactory for all classes of livestock and poultry. May cause temporary and mild diarrhea in livestock not accustomed to the water.
3,000 – 4,999 mg/L *(≈ SC 5 to 8 mS/cm)*	Satisfactory for livestock but may cause temporary diarrhea or be refused at first by animals not accustomed to the water. Poor water for poultry.
5,000 – 6,999 mg/L *(≈ SC 8 to 11 mS/cm)*	Can be used with reasonable safety for cattle, sheep, swine, and horses. Avoid use for pregnant or lactating animals. Not acceptable for poultry.
7,000 – 10,000 mg/L *(≈ SC 11 to 16 mS/cm)*	Considerable risk for pregnant or lactating cows, cattle in confinement, horses, sheep, or young animals. In general, should avoid use. Unfit for poultry and swine.
More than 10,000 mg/L *(≈ SC > 16 mS/cm)*	Extremely high risk. Not recommended for use under any conditions.

Note: *If an SC reading is greater than 5 mS/cm (or 3,000 mg/L as TDS), consider testing for sulfate.*

Sulfate

High sulfate concentrations cause issues with livestock water in much of central and eastern Montana. High sulfate water tastes bitter and livestock may drink less water than they need to remain healthy. High sulfate concentrations in water can also lead to polioencephalomalacia (PEM or polio), a neurological disorder that is commonly fatal. Symptoms of PEM include seizures, blindness, ataxia (loss of coordination), and recumbency (leaning, resting, reclining). Livestock owners should be especially aware of water sulfate concentrations when feeding high-sulfur feedstuffs, such as distillers grains, corn gluten feed, and brassica crops including radishes and turnips, because the combination of sulfates in the water and sulfur in the feed can be toxic to livestock. It is recommended to calculate total sulfur intake in these situations. See the Additional Resources section for detailed guidance on calculating sulfur intake.

High-sulfate water is also a concern when livestock are consuming feeds high in molybdenum. Molybdenum concentration is highly variable in forages, tending to be higher where soils have high pH or high organic matter. Molybdenum concentrations in supplements may be available from the supplier. Sulfur and molybdenum form chemical compounds in the rumen (thiomolybdates), which can negatively affect the metabolism of copper. Stock water high in sulfate exacerbates this issue, so it may be necessary to supplement cattle with copper when they are consuming feed high in sulfur and molybdenum. Suitability of water for livestock based on sulfate concentration is summarized in Table 2.

Table 2. Sulfate concentrations in water and suitability for livestock use.

Sulfate Concentration (mg/L)	Suitability for Livestock
< 500	Safe for use.
500 – 1000	No harmful effects. May have temporary refusal of water close to 1000 mg/L. For maximum performance, calculate total sulfur intake.
1000 – 1800	May be consumed for short periods, but long-term use may result in reduced performance. Calculation of total sulfur intake is recommended.
1800 – 2500	May have temporary diarrhea. May contribute significantly to total sulfur intake and cause a reduction in copper availability. Calculation of total sulfur intake is recommended.
2500 – 3500	Laxative effects. Diarrhea will usually disappear after a few weeks. May have sporadic cases of sulfur-associated polio. Can cause a significant reduction in copper availability. May reduce daily gain. Calculation of total sulfur intake is recommended.
3500 – 4000	Laxative effects. Do not use for pregnant or lactating ruminants or horses, or ruminants fed in confinement. Cases of sulfur-associated polio and death are likely. Significant reduction in copper availability.
> 4000	High mortality rates. NOT recommended for livestock use under any conditions.

Note: *See the Additional Resources section for guidance on calculating sulfur intake.*

Nitrate

Nitrate may leach from soil into groundwater or may run-off into surface water. Water from shallow wells typically contains more nitrate than deep wells. High levels of nitrate in water can be toxic and should be considered in combination with the nitrate level in feeds. Forage nitrate toxicity information may be found in the *Nitrate Toxicity of Montana Forages* MontGuide (MT200205AG). Suitability of water for livestock based on nitrate concentration is summarized in Table 3.

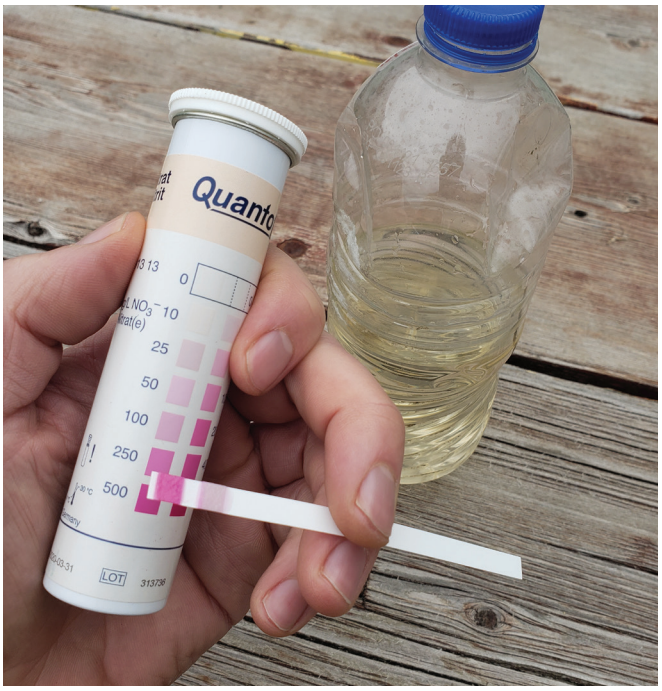
Reporting Nitrate Concentrations

- Nitrate concentrations can be reported as NO_3 (nitrate) or NO_3-N (nitrate as nitrogen), which are different by a factor of 4.4.
- Divide a NO_3 concentration by 4.4 to convert to NO_3-N
- Multiply a NO_3-N concentration by 4.4 to convert to NO_3

Examples:

100 mg/L NO_3 = 22.7 mg/L NO_3-N

100 mg/L NO_3-N = 440 mg/L NO_3



Testing a water sample with a nitrate test strip to get a rough estimate of nitrate concentration. Image by Adam Sigler.

Table 3. Nitrate concentrations in water and suitability for livestock use.

Nitrate-N Concentration (mg/L)	Suitability for Livestock
< 40	Safe for livestock; but values near the top of this range can become important in total nitrate intake if feed is high in nitrate.
40 – 100	Water alone should be safe for livestock. However, if hay, forage, or silage has high nitrate concentrations, water may contribute significantly to nitrate toxicity.
100 – 200	Dangerous and should not be used. General symptoms such as poor appetite are likely to develop. Water may also be contaminated with other foreign substances.
> 200	DO NOT USE. Acute toxicity and some mortality could occur in swine. Probably too much total nitrate intake for ruminants on usual feeds.

Cyanobacteria and Algae

Light and temperature are primary controls of algae and aquatic plant growth, which is why these issues typically occur during the summer. Algae growth rates increase with temperature and maximum growth occurs when water is between 80° and 100° F.

Algae is a general term for a broad group of photosynthetic organisms, and is commonly used to describe anything green growing in water. However, important distinctions must be made between groups of algae to understand the risks to livestock. Cyanobacteria, also known as blue-green algae, are a specific type of algae that can release toxins, causing Harmful Algal Blooms (HABs) in stagnant water. Green algae does not release toxins and does not cause HABs. Cyanobacteria often looks like green pea soup or paint scum floating on the water surface that may turn blue. If a stick is dipped into a cyanobacteria bloom, it commonly comes out looking like it is coated in paint. This is in contrast to algae dangling off the stick, which indicates filamentous green algae or submerged plants (macrophytes), which do not release toxins. If a cyanobacteria bloom is identified, the only way to protect livestock from risk of toxins is to remove them from the water source since it is not possible to predict toxin release when cyanobacteria are present. Dead animals found near a water source (mice, birds, etc.) are an indicator that toxins may be present.

If a producer has a bloom they think may be cyanobacteria, they can submit a picture of the bloom to the Montana HABs website (http://hab.mt.gov) for a professional to assess whether the algae is cyanobacteria. If the bloom is identified as cyanobacteria, assistance is available through the website to test for presence of toxins. The only option to definitively identify cyanobacteria in a water source is to submit a sample to a laboratory for evaluation under a microscope (see Water Testing and Sampling below). Care should be taken when collecting the sample due to its toxic effects. See the Additional Resources section for guidance on identifying cyanobacteria blooms.

Cyanobacteria bloom in Holter Lake during summer 2021. Photo credit: Montana HAB Program.

Green algae growth in stock ponds or tanks can be a nuisance and clog infrastructure, but green algae does not pose a direct health risk to livestock. The best option for reducing algae growth is by reducing nitrogen and phosphorus input to the water through nutrient management strategies. In addition to managing nutrients, adding a structure to shade a stock tank can reduce algae growth in the tank because algae thrive with direct sunlight.

Bacteria

Bacteria are another common water contaminant that can depress livestock health. High bacteria concentrations in livestock drinking water can cause infertility, foot rot, and low milk production. Manure contamination of stagnant water sources is a common source of bacteria and can also contribute to blue-green algae problems, which can be toxic to livestock.

Additionally, leptospirosis and fusobacterium can contaminate water and mud. Leptospirosis is shed through urine and can rapidly spread through the herd from contaminated water and mud. Fusobacterium causes foot rot and is spread on hooves, which can lead to contamination of other water sources and the mud around water sources. For these reasons, minimizing waste reaching water sources will improve livestock health.

Water Testing and Sampling

Simple handheld meters can estimate TDS using specific conductance. Many local MSU Extension offices have meters available to test water samples. These meters work because deionized water does not conduct electricity, but the more dissolved salt in water, the more electricity it conducts. A cost of $50 to $100 can purchase a handheld meter that will fit in a pocket and is accurate enough to be useful for assessing water livestock suitability. When using a meter, it is important to check its accuracy at least once a month with a calibration solution. Purchased calibration packets with a concentration of 12,880 µS/cm work well.

Test strips are available commercially to roughly estimate sulfate and nitrate concentrations quickly in the field. Many local MSU Extension offices have test strips on hand. Sulfate test strips can typically only estimate concentrations up to 1,200 mg/L. Test strips will not provide information about sulfate concentrations above their range, and in this case submitting a sample to a lab for analysis is recommended. Nitrate test strips are available with different concentration testing ranges. Nitrate strips with 100 mg/L near the middle of their testing range are best suited for livestock water testing. If a test strip indicates a nitrate concentration near or over 100 mg/L, submitting a sample to a lab is recommended.

Using a specific conductance meter to estimate salt concentration in a stock pond. Photo by Adam Sigler.

Laboratory testing is necessary to provide accurate water quality information. Lab testing involves contacting a lab for price and sample handling information, collecting a water sample, and mailing the sample to the lab with payment. See the Additional Information section for information on a list of certified water testing labs in Montana. TDS is the most common test, followed by sulfate for most locations in Montana east of the continental divide. Additional parameters might include nitrate, molybdenum, sodium, and selenium. A more comprehensive test might also include calcium, copper, chloride, iron, pH, and magnesium.

Recommended testing frequency is different by region and type of water source. Producers west of the continental divide in Montana or in more mountainous regions with generally low salinity may never test water quality and not see negative effects. In much of eastern Montana however, especially with surface water or shallow groundwater sources, water quality can change from acceptable to lethal over the course of a season. In regions prone to poor water quality, an efficient approach is to rely on testing with a specific conductance meter (to estimate TDS) as a general quality indicator, then submit samples to a testing lab when the meter indicates the quality is approaching unsuitable limits.

Presence of cyanobacteria (blue-green algae) can be evaluated visually by submitting a picture to the Montana HABs website (http://hab.mt.gov). Information on labs that can identify cyanobacteria in water samples using microscopes is included in the Additional Resources section.

Drought/Weather Impacts on Water Quality

Periods of limited precipitation and drought conditions are common in Montana. Lack of precipitation and runoff can reduce recharge to water sources that typically dilutes salt concentrations. High temperatures associated with drought will increase evaporation and further concentrate salts in stock ponds and reservoirs. During drought, more regular water testing for quality is important to ensure salt concentrations are not exceeding acceptable limits.

Very Poor Water Quality – A Few Options

Hauling water is the most common response when water quality decreases. If there is an opportunity to store hauled water in a tank at the location of use, it may be possible to mix the poor-quality water with the hauled water to reduce the amount of hauling required. Mixing requires testing both sources and/or the mixed water to determine how much clean water is necessary to dilute the poor-quality water to acceptable levels. A handheld specific conductance meter (to estimate TDS) is a useful tool for this.

It is possible to treat water high in TDS, nitrate, or sulfate with reverse osmosis (RO), but the cost of installation and maintenance results in few producers pursuing this option. Some of the considerations for feasibility include: TDS of water to be treated; acceptable TDS level in treated water; calcium concentration that will cause membrane fouling (coating/clogging); how much particulate is in the water; what pre-treatment is necessary; whether power is available at the site; how much water flow is available relative to how much is needed; is there a place to discharge the wastewater with concentrated TDS? With the answers to these questions and a water lab analysis, a treatment system contractor can design a system for an application, including the up-front cost and estimates of the cost to maintain the system. While some relatively low-cost systems are available, they may have short longevity and/or have high maintenance costs and require regular attention.

Stock tank in central Montana. Photo by Adam Sigler.

Engineered rainwater catchment systems have been used in some locations in Montana. These systems may use a polypropylene liner covering a catchment area that routes water into storage that is sealed against evaporation. Some storage designs use a polypropylene liner to create a bag, but these systems require careful protection and maintenance to avoid leaks. Other systems store water in tanks. For these systems to function properly over time (especially those using polypropylene liners), they should be designed by an engineer, should use high quality materials, and should be constructed by an experienced installer.

Additional Resources

- Sulfur Intake Calculation Guidance (CSU) http://csu-cvmbs.colostate.edu/vth/livestock/integrated-livestock-management/Pages/sulfur-intake-in-cattle.aspx
- Sulfur Water and Feed Intake Calculator (CSU) https://dlab3.cvmbs.colostate.edu/sulfurcalc/sulfur.html
- Harmful Algal Blooms (Montana Information and Reporting Website) https://dphhs.mt.gov/publichealth/Epidemiology/hab/
- Water Sample Analysis for Cyanobacteria (blue-green algae) by Microscope (NDSU Lab) https://www.vdl.ndsu.edu/tests/water-blue-green-algae-cyanobacteria-id/
- Interpretation Tool for Water Quality by Use, Enter Results for Feedback (CSU and Partners) https://erams.com/wqtool/
- Livestock Water Requirements (NDSU) https://www.ag.ndsu.edu/publications/livestock/livestock-water-requirements
- Livestock Water Quality (NDSU) https://www.ag.ndsu.edu/publications/livestock/livestock-water-quality
- Water Quality Impacts on Livestock (Agriculture Canada) https://agriculture.canada.ca/en/agriculture-and-environment/agriculture-and-water/livestock-watering/water-quality-impacts-livestock
- List of certified water testing laboratories in Montana https://waterquality.montana.edu/well-ed/testing/certifiedlabs.html

References

Subcommittee Of Beef Cattle Nutrition, C.O.A.N., Agriculture, B.O., Council, N.R., 1996. *Nutrient Requirements of Beef Cattle*, Seventh edition. National Academy Press.

Lopez, A., Arroquy, J., Hernandez, O., Nasca, J.A., Juarez Sequeira, A., DiLorenzo, N., Distel, R.A., 2021. *A Meta-analytical Evaluation of the Effects of High-salt Water Intake on Beef Cattle*. J. Anim. Sci. 99, skab215. https://doi.org/10.1093/jas/skab215

Water Quality for Wyoming Livestock and Wildlife (Raiseback et al. 2008, University of Wyoming) https://www.wyoextension.org/publications/Search_Details.php?pubid=822

Livestock Water Quality (Olkowski, 2009, University of Saskatchewan) https://www.ag.ndsu.edu/waterquality/livestock/Livestock_Water_QualityFINALweb.pdf

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