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Agdex 400/716-2

Water Analysis Interpretation for Livestock

Water consists of two simple compounds: two hydrogen atoms and one oxygen atom bonded together (H_2O). It is the most essential nutrient needed to sustain life. In most animals, water accounts for 50 to 70 per cent of body weight.

Water contains many different elements and compounds besides hydrogen and oxygen. These elements exist in water in a variety of forms, entering and leaving the water depending on the surrounding environment.

For example, the mineral composition of ground water is affected by the rock or soil type the water passes through or the amount of time it spends in an aquifer. Surface water can be affected by many of the same factors as ground water. In addition, surface water is influenced by airborne and soil pollutants, decaying organic matter and the removal of minerals by vegetative growth.

Watering livestock

When assessing the suitability of a water supply for any class of livestock, consider each case individually. Give attention to the following factors:

- species
- class of animal
- physical condition of the animals
- environment
- feed and the water

Compounds and elements in water may work together to create an effect greater than the sum of the separate components, or they may act against each other, interfering with the physiological action of each or against another element. Levels of compounds and elements in the feed should also be taken into account when evaluating the suitability of a water supply.

If applying reported information to practical situations, use good judgment. Many conditions are involved in determining whether or not certain levels of a toxicant will cause harm. So no

single concentration can be accepted as dangerous in all situations.

Toxic substances may be in water in two phases: either in solution or as suspended solids. The nutritional availability of toxic elements or substances in these phases may differ considerably among animals. For the animals consuming them, different chemical forms of the elements frequently result in different toxicities.

The short-term intake of a toxic substance may have no observable effects while long-term consumption may result in serious harm. Different species of animals may react differently to a toxic element. Young healthy animals or unhealthy mature ones may not respond in the same way as mature healthy animals. The rate of consumption may also be a factor in the animals' reactions.

Finally, the intake of toxic substances may not cause any measurable effect on growth, production or reproduction yet may cause sub-cellular damage. This damage can be expressed as increased susceptibility to disease or to parasitic invasion.

It should be pointed out that water sources, especially those from surface or shallow wells, can be subject to sudden or seasonal changes in composition from natural or human causes.

Water quality interpretation chart for livestock

For Table 1 to give meaningful results, users must also consider the salt and mineral content of the feed used along with the water.

Most of the figures in this chart are from studies where the feed contained levels of salt and minerals that met and did not exceed the requirements of the livestock species.

Add the water mineral content to the feed mineral content to determine the total mineral intake for an animal.

Table 1. Water quality interpretation chart for livestock use (page 1 of 7 chart pages)

Item analysed	Water content (mg/L or ppm)	Usefulness for poultry	Usefulness for pigs	Usefulness for cattle, sheep and horses
Alkalinity (as CaCO₃) - measured as mg/l as CaCO₃ - alkalinity measures water's ability to neutralize acid - lower levels of CaCO₃ can increase the laxative effects caused by high sulphate levels in young poultry or young animals	<500	Acceptable	Acceptable	Acceptable
	501 - 1,000*	Acceptable	Acceptable	Acceptable
	1,001 - 2,500	Poor - acceptable for mature birds - unsuitable for young poultry at higher levels	Poor - acceptable for mature animals - unsuitable for young pigs at higher level	Poor - acceptable for mature dry cows - unsuitable for young calves or lactating cows at higher levels
Conductivity related to total dissolved solids	All levels	Acceptable	Acceptable	Acceptable
Hardness (as CaCO₃) - measured as CaCO₃ - as hardness level increases, scaling on distribution pipes, water heaters and fixtures may occur	<100 (soft)	Acceptable	Acceptable	Acceptable
	101 - 2,000 (hard)	Acceptable	Acceptable	Acceptable
Ignition loss* measures organic matter, temporary hardness and some carbonates	All levels*	Acceptable	Acceptable	Acceptable
* If water is discolored with a rotten or brackish taste, check for bacterial contamination that may be a health hazard.				
pH	<5.5	Acceptable	Acceptable	Unsuitable - reduced feed intake in cattle - acidosis may occur in feedlot or dairy cattle
	6.5 - 8.0	Acceptable	Acceptable	Acceptable
	8.0 - 10	Poor	Poor	Poor
	>10	Unsuitable	Unsuitable	Unsuitable

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Item analysed	Water content (mg/L or ppm)	Usefulness for poultry	Usefulness for pigs	Usefulness for cattle, sheep and horses
Total dissolved solids (TDS)	<1,000	Acceptable	Acceptable	Acceptable
	1,001 - 3,000	Acceptable - except for poult under three weeks old - may cause watery droppings (at higher levels) but should not affect health or performance	Acceptable	Acceptable
	3,001 - 5,000*	Poor - watery droppings - increased mortality, decreased growth (especially turkeys)	Acceptable but may cause diarrhea or refusal of water by animals not accustomed to it	Acceptable - but may cause diarrhea - may reduce performance and affect health of calves at higher levels
	5,001 - 7,000	Unsuitable - erratic water intake - reduced productivity - health hazard may result in death	Poor - causes diarrhea - reduced water intake - health hazard	Poor - higher levels cause diarrhea, especially in lactating cows - avoid use for pregnant and/or lactating cows - test for sulfates
	7,001 - 10,000	Unsuitable	Unsuitable	Poor - older animals may subsist on it for longer periods - do not use for pregnant or lactating cattle or young animals. - sulfates likely to be high
	>10,000	Unsuitable	Unsuitable	Unsuitable

* Under experimental conditions, animals have produced satisfactorily at this and higher levels of TDS. However, production and health problems have been noted in the field even at levels of TDS below 4,000 ppm such as during hot, dry weather when polioencephalomalacia has been diagnosed in range cattle drinking from dugouts and ponds in Southern Alberta

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Item analysed	Water content (mg/L or ppm)	Usefulness for poultry	Usefulness for pigs	Usefulness for cattle, sheep and horses
Major ions				
Calcium (Ca)				
calcium ions*	<1,000	Acceptable	Acceptable	Acceptable
Nitrate (NO₃⁻) (alone) or Nitrate Nitrogen (NO₃-N) (alone)		adapted from Watkins 2004**		
100 mg NO₃⁻ alone or 23 NO₃-N alone recommended upper limit for livestock and poultry	0 - 11 NO₃⁻ or 0 - 2 NO₃-N	Acceptable**	Acceptable	Acceptable
- Nitrate (NO₃⁻) plus nitrite (NO₂⁻) should also not exceed 100 mg/L - The values in this table only apply when water is the sole source of nitrate (NO₃⁻) - When nitrates (NO₃⁻) are present from multiple sources (e.g., feed and water) consult your nutritionist and/or veterinarian	12 - 44 NO₃⁻ or 3 - 10 NO₃-N	Poor** - nitrate levels greater than 10 may impact broiler performance as seen by poor weight gains, health problems or poor flock performance - nitrate levels above 20 may be detrimental to mature poultry performance	Acceptable	Acceptable
- Animals adapted to nitrate (NO₃⁻) may tolerate higher NO₃⁻ levels - Animals that are stressed or unhealthy may show symptoms of NO₃⁻ toxicity with NO₃⁻ levels below the guidelines	45 - 132 NO₃⁻ or 10 - 30 NO₃-N	Poor** may decrease body weight, health problems or poor flock performance	Acceptable	Acceptable generally safe in balanced diets with low nitrate feeds
	133 - 220 NO₃⁻ or 30 - 49 NO₃-N	Unsuitable - chickens – may decrease body weight after 30 days of exposure - may result in death	Acceptable	Poor could be harmful if consumed over long periods with feeds containing nitrate
Conversions				
when measured as NO₃⁻ divide by 4.43 to obtain ppm nitrate nitrogen (NO₃-N)	221 - 443 NO₃⁻ or 50 - 100 NO₃-N	Unsuitable	Acceptable	Unsuitable - cattle at risk especially if feeds also high in nitrates - abortions and/or death
- when measured as NO₃-N multiply by 4.43 to obtain ppm nitrate (NO₃⁻) - when measured as NaNO₃ multiply by 0.729 to obtain ppm NO₃⁻ - when measured as KNO₃ multiply by 0.613 to obtain ppm nitrate (NO₃⁻)	>443 NO₃⁻ or >100 NO₃-N	Unsuitable toxic resulting in death	Poor levels up to 750 mg/L can be tolerated by pigs before daily gain decreases	Unsuitable - toxic - high risk of abortions and death - should not be used as a source of water

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Item analysed	Water content (mg/L or ppm)	Usefulness for poultry	Usefulness for pigs	Usefulness for cattle, sheep and horses
Nitrite (NO₂⁻) 10 mg/L nitrites recommended upper limit for livestock and poultry - Nitrate (NO₃⁻) plus nitrite (NO₂⁻) should also not exceed 100 mg/L	<10	Acceptable	Acceptable	Acceptable
may indicate fecal contamination*	11 - 23*	Poor	Poor	Poor
Conversion Nitrite nitrogen (NO ₂ -N) multiply by 3.29 to obtain nitrite (NO ₂ ⁻)	>23	Unsuitable may decrease body weight	Poor	Unsuitable potentially dangerous if nitrates high in water or feed
Potassium (K) both sodium and potassium contribute to alkalinity	<20	Acceptable	Acceptable	Acceptable
additive with sodium; therefore, they should be added together when water quality is being evaluated	21 to 300	Acceptable but may be unsuitable depending on alkalinity and pH	Acceptable but may be unsuitable depending on alkalinity and pH	Acceptable but may be depending on alkalinity and pH
Sodium (Na) by itself, sodium poses little risk to livestock, but its association with sulphate is a major concern	<400 mg/L	Acceptable	Acceptable	Acceptable
- sodium chloride (salt) has additive effects with sulphates; therefore, these two should be added together when water quality is evaluated - both sodium and potassium contribute to alkalinity and therefore should be added together when water quality is being evaluated	>400	Acceptable but may be unsuitable depending on alkalinity and pH	Acceptable - but may be unsuitable depending on alkalinity and pH - salt may be reduced in swine diets if the sodium in the water exceeds 400 mg/L	Acceptable - but may be unsuitable depending on alkalinity and pH - over 800 mg/L Na can cause diarrhea and a drop in milk production in dairy cows. - high sodium levels in water may require adjustments to the amount of salt (NaCl) added to beef and dairy ration

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Item analysed	Water content (mg/L or ppm)	Usefulness for poultry	Usefulness for pigs	Usefulness for cattle, sheep and horses
Sulphate (SO₄⁻)				
measured as SO₄⁻	<125	Acceptable desirable sulphate level in drinking water	Acceptable	Acceptable
part of Epsom salt (MgSO₄)	<500	Acceptable maximum acceptable level of sulphate in drinking water	Acceptable	Acceptable tolerance of cattle to sulphur in water depends on the level in feed
- additive effect with sodium chloride - they should be added together when water quality is evaluated	501 - 1000	Unsuitable - wet droppings - the smaller the animal, the greater the effect	Acceptable - diarrhea in animals not accustomed to it - effect of sulphates depends on body mass of an animal - the smaller the animal, the greater the effect - weanling pigs can be affected by relatively low levels of sulphates	Acceptable - diarrhea or refusal of water by animals not accustomed to it 500 to 800 mg/L may affect calves inducing a trace mineral deficiency - trace mineral deficiencies can cause depressed growth rate, fertility and depressed immune response - decreased performance in feedlot cattle 1,000 mg/L recommended maximum if feed level is high or temperature is high
	1,001 - 2,500	Unsuitable - increased water intake - increased wet droppings	Poor - no effect on growth performance - feces not as firm, mild diarrhea in older animals - weanling pigs can have chronic diarrhea	Poor - laxative - sporadic cases of polio seen in feedlot cattle - performance reduced 2,000 mg/L > can cause diarrhea and reduced milk production in dairy cows - high levels of sulphates can also contribute to copper deficiencies in beef and dairy cattle
	>2,500	Unsuitable - over 3,000 mg/L, health hazard to young birds 4,400 mg/L depresses feed intake and egg production and resulted in 15% mortality over a 3-to-4 week period 7,000 mg/L sodium sulphate for 15 days resulted in 33% mortality 15,000 mg/L reduced growth rate in immature chicks	Unsuitable - increases diarrhea - no effect on growth performance 3,320 mg/L sodium sulphate in water may increase water consumption	Unsuitable - sporadic cases of polio are highly probable in feedlot cattle - performance of feedlot cattle reduced - performance of grazing cattle may be affected - scours - unsuitable for lactating dairy cows - greater than 4,000 mg/L dangerous health problems expected

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Item analysed	Water content (mg/L or ppm)	Usefulness for poultry	Usefulness for pigs	Usefulness for cattle, sheep and horses
Heavy metals and trace ions				
Aluminum (Al) - recommended maximum concentration in water - not essential to animals	5.0	Acceptable	Acceptable	Acceptable
Arsenic (As) maximum concentration in water if arsenic added to feed to enhance growth	<0.5	Acceptable	Acceptable	Acceptable
maximum concentration if arsenic not added to feed	5.0	Acceptable	Acceptable	Acceptable
Boron (B) - maximum concentration in water - safe concentrations may be as high as 40 mg/L	5	Acceptable	Acceptable	Acceptable
Cadmium (Cd) recommended maximum concentration in water	0.02	Acceptable	Acceptable	Acceptable
Chloride (Cl) sodium chloride (salt) has additive effects with sulphates. Therefore, these two should be added together when water quality is evaluated	<15,000	Acceptable	Acceptable	Acceptable
	>15,000	Acceptable - reduced growth of immature chickens - effect largely overcome by adding Na and K	Acceptable	Acceptable
Cobalt (Co) - recommended maximum concentration in water - toxicity symptoms not likely as cobalt is an essential trace element	1.0	Acceptable	Acceptable	Acceptable

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Item analysed	Water content (mg/L or ppm)	Usefulness for poultry	Usefulness for pigs	Usefulness for cattle, sheep and horses
Copper (Cu) copper is essential to animal health	< 0.5	Acceptable	Acceptable	Acceptable - maximum for sheep - greater than 0.5 fatal for sheep 0.1 mg/L of copper can oxidize flavour in cows milk
	1.0	Acceptable	Acceptable	Acceptable - maximum for cattle - levels above 0.6 mg/L can result in liver damage in dairy cows, even though this is below the level considered toxic
	5.0	Acceptable maximum for poultry	Acceptable maximum for swine	Unsuitable
Fluoride (F)	<2.0	Acceptable	Acceptable	Acceptable
	>2.0	Acceptable - browning and mottling of teeth may occur - if fluoride is included in feed, concentration should not exceed 1 mg/L	Acceptable - browning and mottling of teeth may occur - if fluoride is included in feed, concentration should not exceed 1 mg/	Acceptable - browning and mottling of teeth may occur - if fluoride is included in feed, concentration should not exceed 1 mg/
Iron (Fe)	<0.3	Acceptable	Acceptable	Acceptable 0.1 mg/L can cause coloration of meat in veal calves. 0.1 mg/l can also give milk an oxidized flavour
	>0.3	Acceptable tastes bad, minimal effect on water intake or productivity	Acceptable tastes bad, minimal effect on water intake or productivity	Acceptable tastes bad, minimal effect on water intake or productivity
Lead (Pb) - recommended maximum concentration in water - young animals tend to be more susceptible to lead poisoning than adults	0.1	Acceptable	Acceptable	Acceptable
Mercury (Hg) - recommended maximum concentration in water - health hazard to animals and to human consumers	0.003	Acceptable	Acceptable	Acceptable

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Item analysed	Water content (mg/L or ppm)	Usefulness for poultry	Usefulness for pigs	Usefulness for cattle, sheep and horses
Molybdenum (Mo) - recommended maximum concentration in water - an essential element, but it is toxic - linked to intake of copper and sulphate - copper: Mo ration of 2:1 will prevent poisoning	0.5	Acceptable poultry more tolerant than cattle to poisoning	Acceptable swine more tolerant than cattle to poisoning	Acceptable molybdenum can reduce absorption of copper causing a copper deficiency
Selenium (Se) - recommended maximum concentration in water - an essential element, but at high levels can be toxic - total diet intake of selenium (feed plus water levels) should be monitored if toxicity suspected	0.05	Acceptable	Acceptable	Acceptable
Vanadium (V) recommended maximum concentration in water	0.01	Acceptable	Acceptable	Acceptable

An on-line tool is available to assess the suitability of water quality for privately owned and operated rural water supplies for a variety of uses including livestock watering. The Rural Water Quality Information Tool or RWQIT resides on the Alberta Agriculture and Food website and can be accessed at <http://www.agric.gov.ab.ca/app84/rwqit>

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