4.3 Livestock drinking water quality

Good water quality is essential for successful livestock production. Poor quality water may reduce animal production and impair fertility. In extreme cases, stock may die. Contaminants in drinking water can produce residues in animal products (e.g. meat, milk and eggs), adversely affecting their saleability and/or creating human health risks. Animal industries themselves may impair water quality downstream (e.g. through faecal contamination), highlighting the need for an integrated approach to land and water management in rural catchments.

Daily water intake varies widely among different forms of livestock and is also influenced by factors such as climate and the type of feed being consumed. Average and peak daily water requirements for a range of livestock are given in Volume 3, Section 9.3.1.

4.3.1 Derivation and use of guidelines

Many factors influence the suitability of waters for livestock watering. Requirements may differ between animal species (generally tolerances decrease in the order sheep, cattle, horses, pigs, poultry), and between different stages of growth and animal condition, and between monogastric and ruminant animals. Moreover, stock accustomed to good quality water can initially suffer ill effects or refuse to drink water of poorer quality, but may adjust if introduced gradually.

A review of the scientific literature reveals that most trigger values tend to be based on field observations rather than rigorous experimentation, although there are notable exceptions. In the present guidelines, several new trigger values have been calculated using data on chronic and toxic effect levels on animals. Since derivation of most trigger values for livestock drinking water needs further validation, they should be considered interim guidelines at this stage. Further details on the derivation of each trigger value and a more detailed discussion of all water quality parameters included in the guidelines are given in Volume 3, Section 9.3.

The scope of the guidelines for livestock drinking water includes biological, chemical and radiological characteristics that may affect animal health. The guidelines are trigger values below which there should be minimal risk to animal health. If the water quality exceeds a trigger value, it is advisable to investigate further to determine the level of risk.

4.3.2 Biological parameters

4.3.2.1 Cyanobacteria (blue-green algae)

An increasing risk to livestock health is likely when cell counts of Microcystis exceed 11 500 cells/mL and/or concentrations of microcystins exceed 2.3 µg/L expressed as microcystin-LR toxicity equivalents. There are insufficient data available to derive trigger values for other species of cyanobacteria.

Diagnostic procedure

The presence of an algal bloom does not necessarily mean that animals will be poisoned, so the following steps should be taken to assess the risk from such a bloom (after Carmichael & Falconer 1993).

1. Establish that animals are drinking the water or eating algal mats from the area where there is a substantial bloom.
2. Indentify the algae associated with the bloom to determine whether cyanobacteria are present in numbers large enough to constitute a risk.
3. If necessary, chemically analyse a sample of the bloom to identify and quantify toxins present.

Since all blooms of cyanobacteria have the potential to be toxic and all livestock are susceptible, it is prudent to consider all scums toxic until proven safe, as described above. In the interim, stock should be withdrawn from the water supply and an alternative source used. Where an alternative source is not available and the bloom is localised, it may be possible to allow stock to drink from an area on the upwind side of the bloom. In the long term, prevention of blooms is by far the best strategy, and water supplies should be managed so that nutrient inputs are minimal.[a]

a See also Section 9.3.3.1

4.3.2.2 Pathogens and parasites

Drinking water for livestock should contain less than 100 thermotolerant coliforms per 100 mL (median value).

It is generally not feasible nor warranted to test livestock drinking water for the presence of the wide range of water-borne microbial pathogens (bacteria, viruses and protozoa) and parasites that may affect stock health. In practice, water supplies are more commonly tested for the presence of thermotolerant coliforms (also known as faecal coliforms), to give an indication of faecal contamination and thus the possible presence of microbial pathogens (NHMRC & ARMCANZ 1996). However, the test does not specifically indicate whether pathogenic organisms are present or not. Testing for specific organisms may be necessary in these situations if animal health is affected.

It is recommended that a median value of thermotolerant coliforms is used, based on a number of readings generated over time from a regular monitoring program. Investigations of likely causes are warranted when 20% of results exceed four times the median trigger value (ARMCANZ, ANZECC & NHMRC 1999).[b]

b Section 9.3.3.2

4.3.3 Major ions of concern for livestock drinking water quality

Many inorganic salts are essential nutrients for animal health, but elevated concentrations of certain compounds may cause chronic or toxic effects in livestock. Unless otherwise stated, the trigger values relate to the total concentration of the constituent, irrespective of whether it is dissolved, complexed with an organic compound, or bound to suspended solids.[c]

c Section 9.3.4

4.3.3.1 Calcium

Stock should tolerate concentrations of calcium in water up to 1000 mg/L, if calcium is the dominant cation and dietary phosphorus levels are adequate. In the presence of high concentrations of magnesium and sodium, or if calcium is added to feed as a dietary supplement, the level of calcium tolerable in drinking water may be less.

Calcium is an essential element in the animal diet. However, high calcium concentrations may cause phosphorus deficiency by interfering with phosphorus absorption in the gastrointestinal tract.

4.3.3.2 Magnesium

Insufficient information is available to set trigger values for magnesium in livestock drinking water.

Magnesium is an essential element for animal nutrition. In high doses magnesium can cause scouring and diarrhoea, lethargy, lameness, decreased feed intake and decreased performance. Drinking water containing magnesium at concentrations up to 2000 mg/L has been found to have no adverse effects on cattle.[a]

a See Section 9.3.4.2

4.3.3.3 Nitrate and nitrite

Nitrate concentrations less than 400 mg/L in livestock drinking water should not be harmful to animal health. Stock may tolerate higher nitrate concentrations in drinking water, provided nitrate concentrations in feed are not high. Water containing more than 1500 mg/L nitrate is likely to be toxic to animals and should be avoided.

Concentrations of nitrite exceeding 30 mg/L may be hazardous to animal health.

Both nitrate and nitrite can cause toxicity to animals, with nitrite being far more toxic than nitrate. Symptoms of acute poisoning include increased urination, restlessness and cyanosis, leading to vomiting, convulsions and death.

Confusion can arise concerning trigger values for nitrate and nitrite because concentrations are sometimes reported on the basis of their respective nitrogen (N) contents, i.e. as nitrate-N and nitrite-N. Note that trigger values in the present guidelines are expressed as nitrate and nitrite. The conversions are as follows:

$$1 \text{ mg/L nitrate-N} = 4.43 \text{ mg/L nitrate}, \tag{4.3}$$

$$1 \text{ mg/L nitrite-N} = 3.29 \text{ mg/L nitrite}. \tag{4.4}$$

4.3.3.4 Sulfate

No adverse effects to stock are expected if the concentration of sulfate in drinking water does not exceed 1000 mg/L. Adverse effects may occur at sulfate concentrations between 1000 and 2000 mg/L, especially in young or lactating animals or in dry, hot weather when water intake is high. These effects may be temporary and may cease once stock become accustomed to the water. Levels of sulfate greater than 2000 mg/L may cause chronic or acute health problems in stock.

Sulfur is essential for animal nutrition. Excessive concentrations of sulfate in water typically cause diarrhoea in stock, but animals generally avoid water containing high sulfate concentrations.

4.3.3.5 Total dissolved solids (salinity)

Recommended concentrations of total dissolved solids in drinking water for livestock are given in table 4.3.1.

Table 4.3.1 Tolerances of livestock to total dissolved solids (salinity) in drinking water[a]

Livestock	Total dissolved solids (mg/L)		
	No adverse effects on animals expected	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef cattle	0–4000	4000–5000	5000–10 000
Dairy cattle	0–2500	2500–4000	4000–7000
Sheep	0–5000	5000–10 000	10 000–13 000[b]
Horses	0–4000	4000–6000	6000–7000
Pigs	0–4000	4000–6000	6000–8000
Poultry	0–2000	2000–3000	3000–4000

a From ANZECC (1992), adapted to incorporate more recent information

b Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production

Total dissolved solids (TDS) is a measure of all inorganic salts dissolved in water and is a guide to water quality. For convenience, TDS is often estimated from electrical conductivity (EC). An approximate conversion of EC to TDS is:

$$\text{EC (dS/m)} \times 670 = \text{TDS (mg/L)} \text{ or,} \quad (4.5)$$

$$\text{EC } (\mu\text{S/cm}) \times 0.67 = \text{TDS (mg/L)} \quad (4.6)$$

Salinity is used as a convenient guide to the suitability of water for livestock watering. If a water has purgative or toxic effects, especially if the TDS concentration is above 2400 mg/L, the water should be analysed to determine the concentrations of specific ions.

4.3.4 Heavy metals and metalloids

Many metal elements are essential nutrients for animal health, but elevated concentrations of certain compounds may cause chronic or toxic effects in livestock. Stock can tolerate many metal elements in drinking water if they are not ingesting them in quantity in the diet, because accumulation in the body depends on the amount ingested from both food and water sources. The trigger values in table 4.3.2 are the metal concentrations below which there is a minimal risk of toxic effects. If these values are exceeded the situation should be investigated further. In some cases higher concentrations may be tolerated, depending on factors such as total dietary exposure to the metal or levels of other compensating elements.[a] Unless otherwise stated, the trigger values relate to the total concentration of the constituent, irrespective of whether it is dissolved, complexed with an organic compound, or bound to suspended solids.

a See also Section 9.3.5

Table 4.3.2 Recommended water quality trigger values (low risk) for heavy metals and metalloids in livestock drinking water [a]

Metal or metalloid	Trigger value (low risk)[a,b] (mg/L)
Aluminium	5
Arsenic	0.5 up to 5[c]
Beryllium	ND
Boron	5
Cadmium	0.01
Chromium	1
Cobalt	1
Copper	0.4 (sheep) 1 (cattle) 5 (pigs) 5 (poultry)
Fluoride	2
Iron	not sufficiently toxic
Lead	0.1
Manganese	not sufficiently toxic
Mercury	0.002
Molybdenum	0.15
Nickel	1
Selenium	0.02
Uranium	0.2
Vanadium	ND
Zinc	20

a Higher concentrations may be tolerated in some situations (details provided in Volume 3, Section 9.3.5)

b ND = not determined, insufficient background data to calculate

c May be tolerated if not provided as a food additive and natural levels in the diet are low

4.3.5 Pesticides and other organic contaminants

In the absence of adequate information derived specifically for livestock under Australian and New Zealand conditions, it is recommended that the drinking water guidelines for human health be adopted.

A major concern in rural environments is the potential for pesticide residues to contaminate water supplies by spray drift, deep percolation, surface runoff, accidental spillage, or by direct application to water supplies for controlling aquatic weeds. In the absence of guidelines derived specifically for livestock, the reader is referred to the *Australian Drinking Water Guidelines* (NHMRC & ARMCANZ 1996). Readers in New Zealand are referred to the *Drinking-water Standards for New Zealand* (New Zealand Ministry of Health 1995a) and the *Guidelines for Drinking-water Quality Management for New Zealand* (New Zealand Ministry of Health 1995b).

4.3.6 Radiological quality of livestock drinking water

Trigger values for the radiological quality of livestock drinking water are given in table 4.3.3.

Table 4.3.3 Trigger values for radioactive contaminants in livestock drinking water

Radionuclide	Trigger value
Radium 226	5 Bq/L
Radium 228	2 Bq/L
Uranium 238	0.2 Bq/L
Gross alpha	0.5 Bq/L
Gross beta (excluding K-40)	0.5 Bq/L

Radioactive contaminants can originate from both natural and artificial sources and can potentially be found in surface waters and groundwaters. For livestock, the main water-related risks due to radioactivity arise from the transfer of radionuclides from irrigation or stock drinking water to animals and animal products for human consumption. Cancer is a potential health hazard for humans associated with exposure to radionuclides.