Domestic

26,100 million gallons per day

Domestic water use during 1995 was an estimated 26,100 Mgal/d, or 3 percent more than during 1990. Domestic use represents about 8 percent of freshwater use for all offstream categories. Self-supplied domestic withdrawals were an estimated 3,390 Mgal/d (tables 11, 12). Ground water was the source for about 99 percent of self-supplied domestic withdrawals. Public suppliers delivered about 22,700 Mgal/d of water to domestic users; this accounted for 56 percent of total public-supply withdrawals.

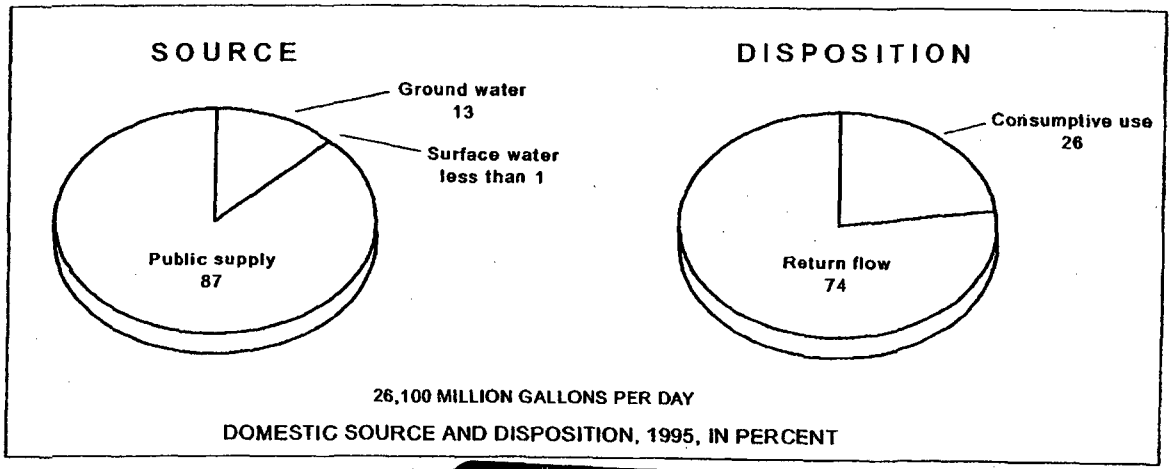
The source and disposition of water for domestic purposes for 1995 are shown in the chart below. Public supply is the dominant source of water (87 percent) for domestic use. The consumptive use of water for domestic purposes in 1995 was estimated at about 6,680 Mgal/d, or about 26 percent of withdrawals and deliveries.

Domestic water use includes water for normal household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Information from public suppliers about withdrawals and population served generally is reliable. Information on deliveries to various users is more difficult to obtain and generally is estimated from the population served.

The number of people served by their own water systems (self supplied) is determined by subtracting the number of people served by public suppliers from the total population as reported by the U.S. Bureau of the Census (1996). The difference between these totals indicates that 42.4 million people, or 16 percent of the Nation's total population, were served by their own water-supply systems in 1995, compared with 42.8 million people in 1990. Self-supplied domestic systems rarely are metered and few data exist. Self-supplied domestic withdrawals are estimated using per-capita use coefficients generally ranging from 60 to 120 gallons per person per day. Consumptive-use estimates are based on coefficients generally ranging from 10 to 50 percent of withdrawals and deliveries.

Withdrawals for the population served by their own water systems averaged about 80 gal/d for each person in 1995, about the same as 1990. Public-supply domestic deliveries averaged 101 gal/d for each person served in 1995, compared to 105 gal/d during 1990 and 1985. Per-capita use has remained about the same or declined in some areas for the last decade as the result of active conservation programs in many states that include the installation of additional meters and water-conserving plumbing fixtures.

In 1995, the South Atlantic-Gulf and Mid-Atlantic water-resources region had the largest self-supplied withdrawals for domestic purposes (figure 10), whereas the Mid-Atlantic, California, and South Atlantic-Gulf regions had a large total of domestic withdrawals and deliveries (table 11). Self-supplied withdrawals for domestic purposes are fairly evenly distributed among the States, led by Florida, Michigan, Pennsylvania, and North Carolina. (See figure 11; table 12.) California and Texas, along with New York, Florida, and Illinois, lead the Nation in total domestic use (withdrawals, deliveries) as shown in figure 12.



DOMESTIC SOURCE AND DISPOSITION, 1995, IN PERCENT

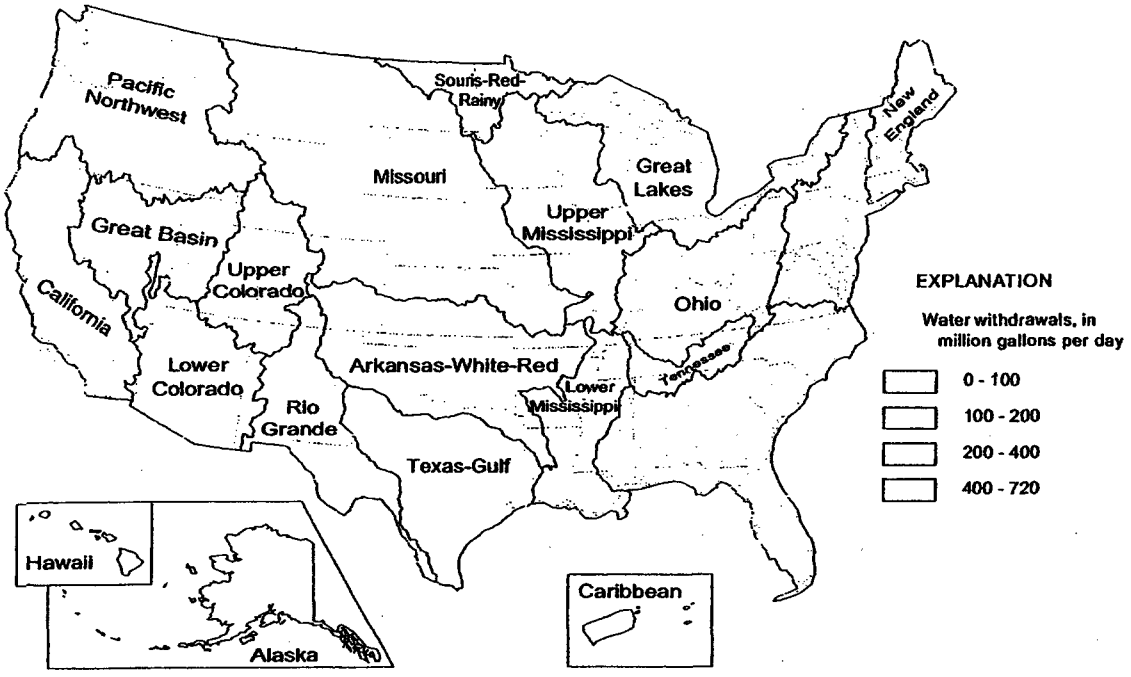


Figure 10. Domestic self-supplied withdrawals by water-resources region, 1995.

Table 11. Domestic freshwater use by water-resources region, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; gal/d = gallons per day]

REGION	SELF SUPPLIED					PUBLIC SUPPLY			TOTAL USE	
	Population, in thousands	Water withdrawals, in Mgal/d			Per capita use, in gal/d	Population served, in thousands	Water deliveries, in Mgal/d	Per capita use, in gal/d	Withdrawals and deliveries, in Mgal/d	Consumptive use, in Mgal/d
		Source		Total						
		Ground water	Surface water							
New England	2,420	168	0.5	169	70	10,400	717	69	886	139
Mid-Atlantic	6,730	485	.6	486	72	35,700	3,340	94	3,830	355
South Atlantic-Gulf	7,700	719	0	719	93	30,100	3,080	102	3,800	888
Great Lakes	4,870	354	1.0	355	73	17,000	1,400	83	1,760	248
Ohio	4,640	323	5.0	328	71	18,000	1,140	63	1,470	189
Tennessee	953	64	0	64	67	3,250	274	85	338	51
Upper Mississippi	4,290	311	0	311	72	18,000	1,450	81	1,760	329
Lower Mississippi	996	73	.1	73	74	6,330	703	111	776	529
Souris-Red-Rainy	248	17	0	17	67	446	26	59	43	17
Missouri Basin	1,690	137	1.2	138	82	8,980	966	108	1,100	423
Arkansas-White-Red	1,250	105	0	105	84	7,680	767	100	872	374
Texas-Gulf	1,070	115	0	115	108	15,700	2,160	138	2,270	958
Rio Grande	269	25	0	25	94	2,300	340	148	365	173
Upper Colorado	153	11	.4	12	76	561	86	154	98	36
Lower Colorado	367	44	.2	45	121	4,950	757	153	802	397
Great Basin	126	13	1.6	14	114	2,280	417	183	431	160
Pacific Northwest	2,470	253	7.3	260	105	7,480	1,020	136	1,280	190
California	1,620	112	12	124	76	30,400	3,700	122	3,830	1,060
Alaska	223	8.3	.4	8.7	39	381	38	99	46	4.5
Hawaii	65	2.4	1.3	3.7	57	1,120	131	117	134	76
Caribbean	274	6.4	6.9	13	49	3,580	173	48	186	83
Total	42,400	3,350	38	3,390	80	225,000	22,700	101	26,100	6,680

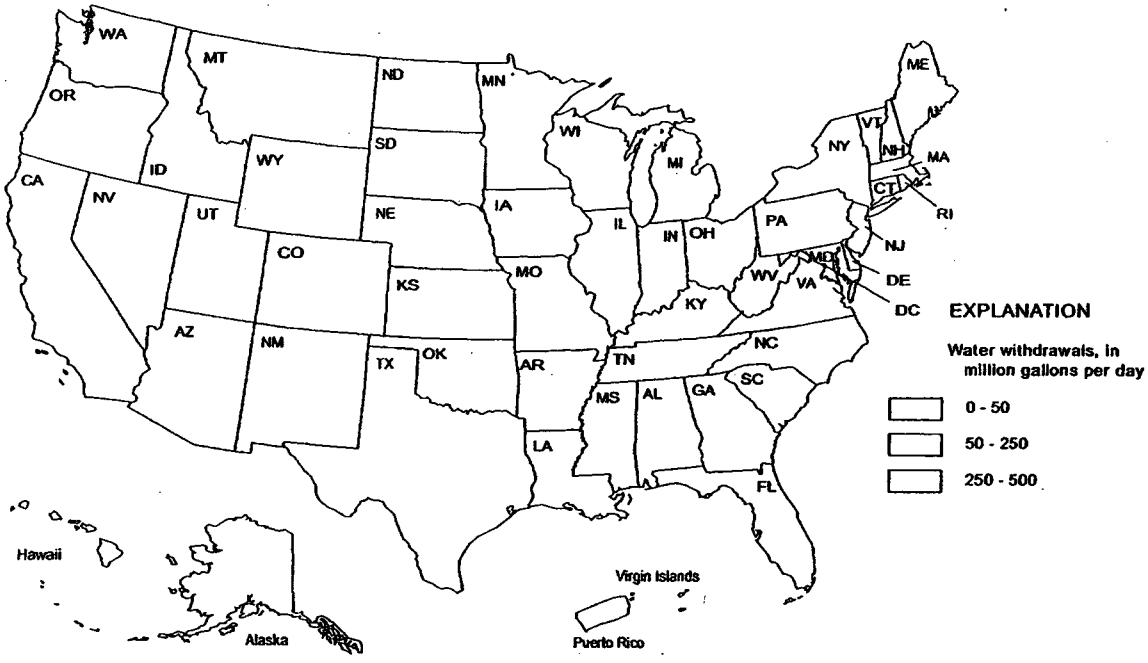


Figure 11. Domestic self-supplied withdrawals by State, 1995.

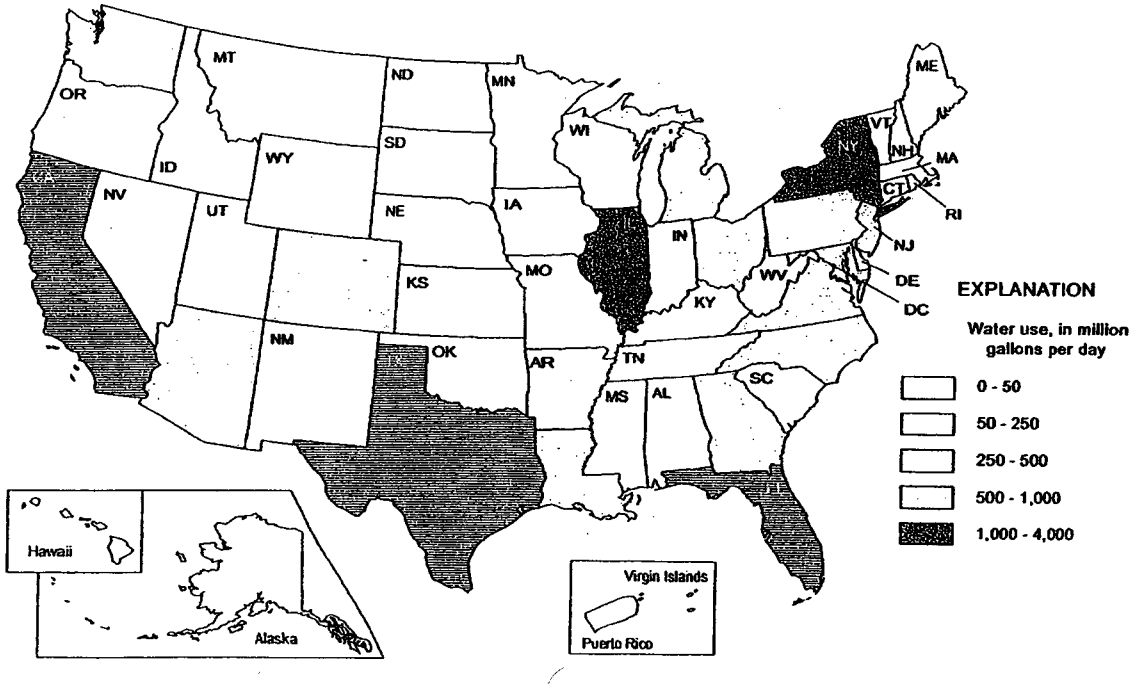


Figure 12. Domestic freshwater use (withdrawals, deliveries) by State, 1995.

Table 12. Domestic freshwater use by State, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; gal/d = gallons per day]

STATE	SELF SUPPLIED					PUBLIC SUPPLY			TOTAL USE	
	Population, in thousands	Water withdrawals, in Mgal/d			Per capita use, in gal/d	Population served, in thousands	Water deliveries, in Mgal/d	Per capita use, in gal/d	Withdrawals and deliveries, in Mgal/d	Consumptive use, in Mgal/d
		Source		Total						
		Ground water	Surface water							
Alabama	826	62	0	62	75	3,430	383	112	445	89
Alaska	223	8.3	.3	8.6	39	381	38	99	46	4.5
Arizona	301	39	0	39	131	3,920	526	134	565	283
Arkansas	488	38	0	38	78	2,000	193	97	231	100
California	1,600	108	12	120	75	30,500	3,710	122	3,830	1,060
Colorado	353	27	0	27	76	3,390	481	142	508	154
Connecticut	742	55	0	55	74	2,530	191	75	246	49
Delaware	153	12	0	12	80	564	43	76	55	5.5
D.C.	0	0	0	0	0	554	95	171	95	9.5
Florida	1,950	297	0	297	152	12,200	1,260	103	1,560	389
Georgia	1,300	99	0	99	76	5,900	629	107	728	131
Hawaii	65	2.4	1.3	3.7	57	1,120	131	117	134	76
Idaho	383	65	0	65	168	780	141	181	206	9.8
Illinois	1,430	129	0	129	90	10,400	936	90	1,060	107
Indiana	1,520	115	0	115	76	4,280	326	76	441	66
Iowa	689	45	0	45	65	2,150	139	65	184	73
Kansas	242	24	0	24	100	2,320	191	82	215	140
Kentucky	505	23	2.5	25	50	3,360	235	70	260	34
Louisiana	496	39	0	39	79	3,850	468	122	508	508
Maine	533	35	0	35	65	708	46	65	81	12
Maryland	875	73	0	73	83	4,170	433	104	506	51
Massachusetts	497	34	0	34	68	5,580	362	65	396	54
Michigan	2,650	194	.1	194	73	6,900	623	90	817	119
Minnesota	1,270	88	0	88	69	3,340	239	71	326	110
Mississippi	434	33	0	33	75	2,260	248	110	281	75
Missouri	995	58	0	58	59	4,330	374	86	433	108
Montana	225	17	1.0	18	78	645	77	119	94	46
Nebraska	346	42	0	42	121	1,290	155	120	197	100
Nevada	91	11	.2	11	120	1,440	306	213	317	158
New Hampshire	451	31	.5	32	70	697	57	82	89	13
New Jersey	1,010	86	0	86	85	6,930	538	78	624	122
New Mexico	306	26	0	26	86	1,380	188	136	215	118
New York	1,930	144	0	144	75	16,200	1,810	112	1,960	107
North Carolina	2,450	172	0	172	70	4,750	332	70	504	163
North Dakota	152	12	0	12	79	489	40	82	52	16
Ohio	1,870	138	2.8	140	75	9,280	497	54	637	96
Oklahoma	351	30	0	30	85	2,930	241	82	270	81
Oregon	995	61	7.2	68	68	2,150	292	136	360	83
Pennsylvania	3,020	181	0	181	60	9,050	559	62	740	74
Rhode Island	112	7.3	0	7.3	65	878	57	65	64	9.6
South Carolina	951	71	0	71	75	2,720	368	135	439	88
South Dakota	127	9.3	0	9.4	74	602	52	87	62	15
Tennessee	838	54	0	54	65	4,420	355	80	409	41
Texas	1,170	130	0	130	110	17,600	2,450	140	2,580	1,080
Utah	103	7.7	1.7	9.4	91	1,850	340	184	349	118
Vermont	270	18	.4	19	70	315	26	82	45	6.7
Virginia	1,660	125	0	125	75	4,960	424	86	548	55
Washington	1,000	125	0	125	125	4,430	565	128	691	83
West Virginia	509	40	.8	41	80	1,320	96	72	136	14
Wisconsin	1,540	92	0	92	60	3,560	189	53	281	56
Wyoming	136	9.7	.5	10	75	344	54	157	64	33
Puerto Rico	217	6.4	5.5	12	55	3,540	171	48	183	83
Virgin Islands	57	0	1.4	1.4	24	47	1.6	35	3.0	.7
Total	42,400	3,350	38	3,390	80	225,000	22,700	101	26,100	6,680

New Mexico QuickFacts

Chaves County, New Mexico

People QuickFacts	Chaves County	New Mexico
Population, 2003 estimate	60,591	1,874,614
Population, percent change, April 1, 2000 to July 1, 2003	-1.3%	3.1%
Population, 2000	61,382	1,819,046
Population, percent change, 1990 to 2000	6.1%	20.1%
Persons under 5 years old, percent, 2000	7.2%	7.2%
Persons under 18 years old, percent, 2000	29.1%	28.0%
Persons 65 years old and over, percent, 2000	14.7%	11.7%
Female persons, percent, 2000	51.0%	50.8%
White persons, percent, 2000 (a)	72.0%	66.8%
Black or African American persons, percent, 2000 (a)	2.0%	1.9%
American Indian and Alaska Native persons, percent, 2000 (a)	1.1%	9.5%
Asian persons, percent, 2000 (a)	0.5%	1.1%
Native Hawaiian and Other Pacific Islander, percent, 2000 (a)	0.1%	0.1%
Persons reporting some other race, percent, 2000 (a)	21.2%	17.0%
Persons reporting two or more races, percent, 2000	3.1%	3.6%
White persons, not of Hispanic/Latino origin, percent, 2000	52.1%	44.7%
Persons of Hispanic or Latino origin, percent, 2000 (b)	43.8%	42.1%
Living in same house in 1995 and 2000', pct age 5+, 2000	55.6%	54.4%
Foreign born persons, percent, 2000	11.2%	8.2%
Language other than English spoken at home, pct age 5+, 2000	33.4%	36.5%
High school graduates, percent of persons age 25+, 2000	72.6%	78.9%
Bachelor's degree or higher, pct of persons age 25+, 2000	16.2%	23.5%
Persons with a disability, age 5+, 2000	12,614	338,430
Mean travel time to work (minutes), workers age 16+, 2000	17.1	21.9
Housing units, 2002	25,948	805,293
Homeownership rate, 2000	70.9%	70.0%
Housing units in multi-unit structures, percent, 2000	10.6%	15.3%
Median value of owner-occupied housing units, 2000	$61,000	$108,100
Households, 2000	22,561	677,971
Persons per household, 2000	2.66	2.63
Median household income, 1999	$28,513	$34,133
Per capita money income, 1999	$14,990	$17,261

Persons below poverty, percent, 1999	21.3%	18.4%

Business QuickFacts	Chaves County	New Mexico
Private nonfarm establishments with paid employees, 2001	1,479	42,686
Private nonfarm employment, 2001	14,837	553,357
Private nonfarm employment, percent change 2000-2001	-2.2%	0.7%
Nonemployer establishments, 2000	2,381	81,398
Manufacturers shipments, 1997 ($1000)	D	17,906,091
Retail sales, 1997 ($1000)	411,020	14,984,454
Retail sales per capita, 1997	$6,569	$8,697
Minority-owned firms, percent of total, 1997	13.8%	28.5%
Women-owned firms, percent of total, 1997	23.0%	29.4%
Housing units authorized by building permits, 2002	29	12,066[1]
Federal funds and grants, 2002 ($1000)	336,561	17,477,521

Geography QuickFacts	Chaves County	New Mexico
Land area, 2000 (square miles)	6,071	121,356
Persons per square mile, 2000	10.1	15.0
Metropolitan Area	None	
FIPS Code	005	35

1: Includes data not distributed by county.

(a) Includes persons reporting only one race.
(b) Hispanics may be of any race, so also are included in applicable race categories.

FN: Footnote on this item for this area in place of data
NA: Not available
D: Suppressed to avoid disclosure of confidential information
X: Not applicable
S: Suppressed; does not meet publication standards
Z: Value greater than zero but less than half unit of measure shown
F: Fewer than 100 firms

Source U.S. Census Bureau: State and County QuickFacts. Data derived from Population Estimates, 2000 Census of Population and Housing, 1990 Census of Population and Housing, Small Area Income and Poverty Estimates, County Business Patterns, 1997 Economic Census, Minority- and Women-Owned Business, Building Permits, Consolidated Federal Funds Report, 1997 Census of Governments

Last Revised: Tuesday, 01-Feb-2005 15:49:28 EST

Census Bureau Links: . . . . . .

EPA WASTE CLASSIFICATION
O & G EXPLORATION AND PRODUCTION WASTES

WHAT IS EXEMPT

(Oil and natural gas exploration and production materials and wastes exempted by EPA from consideration as "Hazardous Wastes")

. Produced water;
. Drilling fluids & cuttings;
. Rigwash;
. Geothermal production fluids;
. Hydrogen sulfide abatement wastes;
. Well completion and workover wastes;
. BS&W and other tank bottoms facilities that hold exempt waste;
. Accumulated materials from production impoundments;
. Pit sludges and contaminated bottoms from treatment, storage or disposal of exempt wastes;
. Gas plant dehydration wastes;
. Gas plant sweetening wastes;
. Cooling tower blowdown;
. Spent filters, filter media, and backwash (assuming the filter itself is not hazardous and the residue in it is from an exempt waste steam);
. Packing fluids;
. Produced sand;
. Deposits removed from piping and equipment prior to transportation;
. Hydrocarbon-bearing soil contaminated from exempt streams;
. Pigging wastes from gathering lines;
. Wastes from subsurface gas storage and retrieval;
. Constituents removed from produced water;
. Liquid hydrocarbons & gases removed from the production stream but not from oil refining;
. Waste crude oil from primary field operations;
. Light organics volatilized from exempt wastes;
. Liquid and solid wastes generated by crude oil and crude tank bottom reclaimers,
. Stormwater runoff contaminated by exempt materials,
. Mixtures of exempt and non exempt wastes pursuant to OCD mixture policy (see reverse)

WHAT IS NOT EXEMPT

(Materials and wastes not exempted and may be a "hazardous waste" if tests or EPA listing define as "hazardous")

. Unused fracturing fluids or acids;
. Cooling tower cleaning wastes;
. Painting wastes;
. Oil and gas service company wastes;
. Vacuum truck and drum rinsate from trucks and drums transporting or containing non-exempt waste;
. Refinery wastes;
. Used lubrication oils;
. Waste compressor oil and filters;
. Used hydraulic fluids;
. Waste solvents;
. Transportation Waste;
. Caustic or acid cleaners;
. Boiler cleaning wastes;
. Incinerator ash;
. Laboratory wastes;
. Pesticide wastes;
. Radioactive tracer wastes;
. Drums, insulation, and miscellaneous solids;
. Industrial wastes from activities other than oil & gas exploration & production;
. Manufacturing wastes;
. Contamination from refined products.

NEW MEXICO OIL CONSERVATION DIVISION
1220 S. St. Francis Dr.
Santa Fe New Mexico 87505
(505) 476-3440
www.emnrd.state.nm.us/ocd/

(rev. 9/97)

NOTES:

1. As of September 1997 The OCD has adopted the following mixture policy:

   A mixtures of exempt and nonexempt waste will be considered exempt **ONLY** if it meets all of the following conditions:

   A. The nonexempt portion of the waste is nonhazardous through testing,
   2. The total nonexempt portion of the waste constitutes no more than five (5) percent by volume of the final mixture unless an exception is granted by the director,
   3. The mixture is the result of an incidental and unavoidable part of an OCD approved process ,
   4. Both the exempt and nonexempt portion of the waste are generated as a result of exploration and production of oil and gas, processing of gas or the transportation of natural gas prior to processing.

   If a waste which is classified as hazardous by testing or listing is mixed with any other waste, the entire resultant volume will be considered hazardous.

2. The following OCD regulated facilities may be subject to hazardous waste rules for disposal of wastes and contaminated soils containing benzene:

   -- Oil and gas service companies having wastes such as vacuum truck, tank, and drum rinsate from trucks, tanks and drums transporting or containing non-exempt waste.
   -- Transportation pipelines and mainline compressor stations generating waste, including waste deposited in transportation pipeline-related pits.

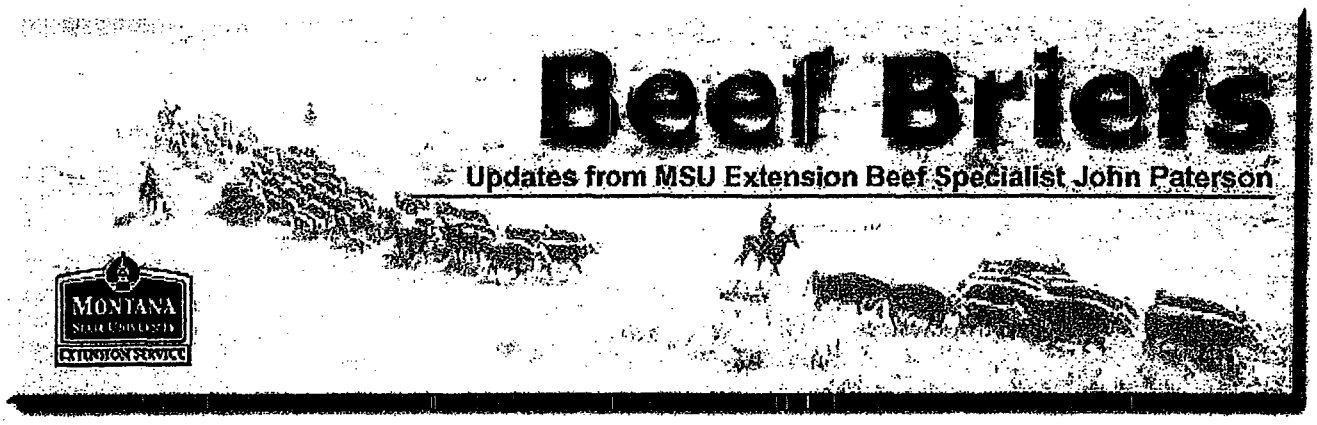
   Source: Federal Register, Thursday, March 29, 1990, p.11,798 - 11,877.

3. In April, 1991, EPA clarified the status of oil and tank bottom reclamation facilities:

   A Those wastes that are derived from the processing by reclaimers of only exempt wastes from primary oil and gas field operations are also exempt from the hazardous waste requirements. For example, wastes generated from the process of recovering crude oil from tank bottoms are exempt because the crude storage tanks are exempt.

   B. Those reclaimer wastes derived from non-exempt wastes (e.g. reclamation of used motor oil, refined product tank bottoms), or that otherwise contain material which are not uniquely associated with or intrinsic to primary exploration and production field operations would not be exempt. An example of such non-exempt wastes would be waste solvent generated from the solvent cleaning of tank trucks that are used to transport oil field tank bottoms. The use of solvent is neither unique nor intrinsic to the production of crude oil.

   Source: EPA Office of Solid Waste and Emergency Response letter opinion dated April 2, 1991, signed by Don R. Clay, Assistant Administrator.



Question of the Week: What are some guidelines that I can use to evaluate livestock water quality?

(This question comes from a Veterinarian in Central Iowa)

WATER QUALITY AND GUIDELINES

by Dr. Dave Hutcheson, PhD

Water is the most common molecule in the body, and makes up about 98 percent of all molecules in the body. Loss of 20 percent of body water is fatal. Water has the highest heat of vaporization, heat of fusion, heat capacity, dielectric constant, electrical conductivity and surface tension (Quinton, 1979). Water is needed for regulation of the body temperature, digestion, metabolism, excretion, hydrolysis of protein, fat, and carbohydrates, lubrication of joints, nervous system cushion, transporting sound and eye sight. Water distribution in the body is divided into two major compartments, extracellular (33 percent) and intracellular (67 percent). Most of the water is in the intracellular pool and the proportions vary with feeding practices and environmental conditions. The intracellular pool is made up of interstitial water, plasma and transcellular water. The interstitial water is the spaces surrounding cells in the body. The transcellular water is gastrointestinal water that can range from 15 percent of the body to 35 percent of the body. (Guyton, 1971).

The minimum requirement of cattle for water is a reflection of that needed for body growth; for fetal growth or lactation; and of that lost by excretion in the urine, feces, or sweat or by evaporation from the lungs or skin. Water requirements are affected by many factors, and it is impossible to list specific requirements with accuracy. Water intake equation for feedlot steers has been developed by (Hicks et al. 1988):

Water intake(gallons/day) = - 4.939 + (.1040xMT) + (.2923xDMI) - (2.5971xPP) - (1.1739xDS).

- MT is the weekly maximum temperature in degrees Fahrenheit
- DMI is dry matter intake in lbs fed daily

> It is possible to program intake of corn based diets to meet requirements for gestation, lactation, or a level of growth desired for replacement heifers.

RELATED STORIES

Water Quality and Your Livestock Facilities

Drinking Water Quality for Beef Cattle

Can I Make My Cows More Efficient Through Modified Water Sources?

- PP is weekly mean precipitation inches
- DS is the percent of dietary salt in %.

The major influences on water intake in beef cattle fed typical rations are dry matter intake, environmental temperature, and stage and type of production. Water quality is important in maintaining water consumption of cattle. Physio-chemical (pH, total dissolved solids, hardness, and total dissolved oxygen), organoleptic (odor and taste), compounds present in excess (nitrates, iron, sodium, sulfates, and fluorine), toxic compounds (arsenic, cyanide, lead, mercury, hydrocarbons, organochlorides and organophosphates) and bacteria are criteria for evaluating drink water for humans and livestock.

Salinity
Salinity refers to the amount of dissolved salts in water and is measured by total dissolved solids. These dissolved salts are primarily sodium chloride but may include carbonates, nitrates, sulfates, calcium, magnesium and potassium Table 1 was adapted from Nutrients and toxic substances in water for livestock and poultry, NAS, 1974.

Table 1 - Guide to the Use of Saline Water

Total Dissolved Solids (TDS) mg/l or ppm	
Less than 1,000 ppm fresh water	Presents no serious burden to livestock
1,000 – 2,999 ppm slightly saline	Should not affect health or performance but may cause temporary mild diarrhea
3,000 – 4,999 ppm moderately saline	Generally satisfactory, but may cause diarrhea, especially on initial consumption
5,000 - 6,999 ppm saline	Can be used for reasonable safety for adult ruminants but should be avoided for pregnant cattle and baby calves.
7,000 - 10,000 ppm very saline	Should be avoided if possible. Pregnant, lactating, stressed or young animals can be affected.
Greater than 10,000 ppm brine	Unsafe, should not be used under any conditions

Salinity is part of the total dissolved solids but is not hardness. For and example high saline waters may contain high degree of salt and yet not be hard due to the lack of magnesium and calcium. Concentration of calcium and magnesium contributes to hardness. Hardness, calcium plus magnesium classification is defined in table 2 (Nutrients and toxic substances in water for livestock and poultry, NAS, 1974).

Table 2 - Calcium and Magnesium Concentrations and Hardness

Hardness	**Calcium plus Magnesium ppm**
Soft	0 - 60 ppm

Moderate	61 - 120 ppm
Hard	121 - 180 ppm
Very Hard	181 ppm and greater

Apparently, degree of hardness does not effect livestock production (Blosser and Soni, 1957). Laboratory analysis sometimes reports hardness as grains of hardness. One grain per gallon is equal to .0058 ppm.

Nitrates
Cattle performance and reproduction is effected by nitrates in the water.. Nitrate (NO_3) is reduced to nitrite (NO_2) which creates the toxicity. Nitrate levels in water in excess of .3 mg of nitrate nitrogen per liter contributes to excessive algae growth. Table 3 is a guide to levels of nitrate and nitrate nitrogen and precautions (Nutrients and toxic substances in water for livestock and poultry, NAS, 1974).

Table 3 - Nitrates in Water.

Nitrate (NO_3) ppm	Nitrate Nitrogen (NO_3 - N) ppm	Comments
0 - 44 ppm	0 - 10 ppm	No harmful effects
45 - 132 ppm	10 - 20 ppm	Safe if diet is low in nitrates and nutritionally balanced
133 - 220 ppm	20 - 40 ppm	Could be harmful if consumed over long periods of time
221 - 660 ppm	40 - 100 ppm	Cattle at risk; possible death losses
661 - 800 ppm	100 - 200 ppm	Unsafe; high probability of death losses
Over 800 ppm	Over 200 ppm	Unsafe; do not use

Water Quality Guidelines
Table 4 has been adapted from Mineral Tolerance Domestic Animals, NAS, 1980 and Nutrients and toxic substances in water for livestock and poultry, NAS, 1974 as a guide line for water quality for cattle.

Table 4 - Water Quality Guidelines

Substance	Desired Upper Limits ppm	Maximum Upper Limits ppm
Aluminum	5	10
Arsenic	0.2	0.2
Bicarbonate	Unknown	<1000

Boron	5	30
Cadmium	0.01	0.05
Calcium	100	150
Chloride	100	300
Chromium	1	1
Cobalt	1	1
Copper	0.2	0.5
Fluoride	2	2
Lead	0.05	0.1
Magnesium	50	100
Manganese	0.05	0.5
Mercury	0.01	0.01
Nickel	0.25	1
Selenium	0.05	0.10
Sodium	50	300
Sulfate (S from SO4)	20	100
Sulfate (SO4)	50	300
Vanadium	0	0.1
Zinc	25	50
Nitrate (NO3-N)N from NO3	10	20
Total Dissolved Solids (TDS)	960	5000

References

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Livestock and Water

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Greg Lardy, Beef Cattle Specialist
Charles Stoltenow, Extension Veterinarian

Water is an important but often overlooked nutrient for livestock.

Water makes up over 98 percent of all molecules in the body and is necessary for regulation of body temperature, growth, reproduction, lactation, digestion, lubrication of joints, eyesight, and as a cleansing agent.

Water Intake

Before discussing water quality, it is important to know how much water animals require. Water requirements are influenced by several factors, including rate of gain, pregnancy, lactation, activity, type of diet, feed intake, and environmental temperature. These requirements are met by water consumed from wells, ponds, fountains, etc., as well as moisture found in feedstuffs.

Table 1 lists estimated water intakes for lactating beef cows, dry beef cows, and bulls. Table 2 lists estimated water intakes for growing and finishing beef cattle. Water requirements of cattle can also be estimated based on ambient temperatures and feed intake (Table 3). Table 4 lists the water requirements for sheep. Table 5 lists recommended water intakes for dairy cattle. Table 6 lists the water requirements for swine. Table 7 lists the water requirements for horses.

Table 1. Estimated daily water intakes (gallons per head per day) for lactating beef cows, bred cows, dry cows, and bulls.

Month	Monthly Average Temp	Lactating Cows	Dry Cows, Bred Cows, and Heifers	Bulls
	(°F)	- - gallons per head per day - -		
January	36	11.0	6.0	7.0
February	40	11.5	6.0	8.0
March	50	12.5	6.5	8.6
April	64	15.5	8.0	10.5
May	73	17.0	9.0	12.0

June	78	17.5	10.0	13.0
July	90	16.5	14.5	19.0
August	88	16.5	14.0	18.0
September	78	17.5	10.0	13.0
October	68	16.5	8.5	11.5
November	52	13.0	6.5	9.0
December	38	11.0	6.0	7.5

Adapted from GPE-1400, Water Requirements for Beef Cattle.

Table 2. Water requirements of growing and finishing beef cattle (gallons per head per day).

		Growing Cattle			Finishing Cattle			
Month	Avg. Temp.	400 lb	600 lb	800 lb	600 lb	800 lb	1000 lb	1200 lb
	(°F)	gallons per head per day						
January	36	3.5	5.0	6.0	5.5	7.0	8.5	9.5
February	40	4.0	5.5	6.5	6.0	7.5	9.0	10.0
March	50	4.5	6.0	7.0	6.5	8.0	9.5	10.5
April	64	5.5	7.0	8.5	8.0	9.5	11.0	12.5
May	73	6.0	8.0	9.5	9.0	11.0	13.0	14.5
June	78	6.5	8.5	10.0	9.5	12.0	14.0	16.0
July	90	9.5	13.0	15.0	14.5	17.5	20.5	23.0
August	88	9.0	12.0	14.0	14.0	17.0	20.0	22.5
September	78	6.5	8.5	10.0	9.5	12.0	14.0	16.0
October	68	5.5	7.5	9.0	8.5	10.0	12.0	14.0
November	52	4.5	6.0	7.0	6.5	8.0	10.0	10.5
December	38	4.0	5.0	6.0	6.0	7.0	8.5	9.5

Adapted from GPE-1400, Water Requirements for Beef Cattle.

Table 3. Water consumption estimates for beef cattle based on thermal environment and dry matter intake.

Thermal Environment	Water Requirements
>95°F	8 to 15 pounds of water per pound of DM intake
77 to 95°F	4 to 10 pounds of water per pound of DM intake
59 to 77°F	3 to 5 pounds of water per pound of DM intake (young and lactating animals require 10 to 50% more water.)
29 to 59°F	2 to 4 pounds of water per pound of DM intake

Less than 29°F	2 to 3 pounds water per pound of DM intake (increases of 50 to 100% occur with a rise in ambient temperature following a period of very cold temperatures, e.g. a rise from -5° to 30°F.)

Adapted from Effect of Environment on Nutrient Requirements of Domestic Animals, 1981, NRC.

Table 4. Daily water requirements of sheep.

Class of Animal	Gallons/Day
Rams	2
Dry Ewes	2
Ewes with Lambs	3
5-20 pound Lambs	0.1 to 0.3
Feeder Lambs	1.5

Adapted from MWPS-3, Sheep Housing and Equipment Handbook.

Table 5. Water consumption of dairy cattle.[a]

Class of Cattle	Age or Condition	Gallons Per Day[b]
	Drinking Water Only	
Holstein Calves	1 month	1.3 to 2.0
Holstein Calves	2 months	1.5 to 2.4
Holstein Calves	3 months	2.1 to 2.8
Holstein Calves	4 months	3.0 to 3.5
Holstein Heifers	5 months	3.8 to 4.6
Holstein Heifers	15 to 18 months	5.9 to 7.1
Holstein Heifers	18 to 24 months	7.3 to 9.6
Jersey Cows	30 lbs milk/day	13.0 to 15.5
Guernsey Cows	30 lbs milk/day	13.8 to 16.0
Ayrshire, Brown Swiss, and Holstein Cows	30 lbs milk/day	14.5 to 17.0
Ayrshire, Brown Swiss, and Holstein Cows	50 lbs milk/day	24.0 to 27.0
Dry Cows	Pregnant, 6 to 9 months	9.0 to 13.0
	Water Intake From Feed and Drinking Water	
Milk Cows	4.5 to 5.0 lbs/lb milk produced daily	

[a] Adapted from Dairy Reference Manual, Pennsylvania State University.

[b] Consumption at air temperatures of 50 to 80°F, intake depends upon water content of the forage ration. Higher levels apply

to an all hay ration. One gallon of water weighs 8.34 pounds. A cubic foot of water weighs 62.4 pounds.

Table 6. Water intake for various classes of swine.

Class	Gallons/Day
25 lb Pig	0.5
60 lb Pig	1.5
100 lb Pig	1.75
200 lb Pig	2.5
Gestating Sows	4.5
Sow Plus Litter	6.0
Nonpregnant Gilts	3.2
Pregnant Gilts	5.5

Table 7. Water requirements of various classes of horses.

Class	Estimated Water Consumption (gal/day)
Maintenance, 1100 lbs, thermoneutral environment	6-8 gallons
Maintenance, 1100 lbs, warm environment	8-15 gallons
Lactating Mare, 1100 lbs	10-15 gallons
Working Horse, 1100 lbs, moderate work	10-12 gallons
Working Horse, 1100 lbs, moderate work, warm environment	12-18 gallons
Weanling, 650 lbs, thermoneutral environment	6-8 gallons

Adapted from Lawrence (1998).

Limiting water intake can depress animal performance more quickly and drastically than any other nutrient deficiency. Domesticated animals can live about 60 days without food, but only seven days without water. Hearing and sight are impaired without water.

Signs of dehydration

Signs of dehydration or lack of water are tightening of the skin, loss of weight, and drying of mucous membranes and eyes. In cattle, the eyes will appear sunken and dull. Dehydration in lactating dairy animals results in near cessation of milk production.

One way to check for dehydration in the horse is by skin folds. Pull the skin and hold a moment. Release and count the seconds until the fold disappears. On a dehydrated horse, the skin will stand for several seconds.

Weather conditions may affect water intake and lead to problems such as urinary calculi (waterbelly). Cold weather may reduce water intake, which reduces water flow through the bladder and kidneys. This reduced water flow allows kidney stones to form. When desirable weather returns, water intake increases and urinary calculi problems are seen, because the stones have become too big to pass through the urethra, primarily in males. Any factor that reduces water intake can be a contributing factor to urinary calculi. Hard water does not cause urinary calculi problems but may be a factor if the hardness effects water palatability.

Temperature

Avoid watering systems which allow the water to get too hot or to freeze. Drinkable water is usually between 40° and 65° F. Steers that have access to cool drinking water will gain .3 to .4 pounds more per day than those drinking warm water. Occasionally check waterers with heaters to detect a "runaway" (a heating element which is not working properly). Dip a thermometer into the water, but do not allow it to rest on the bottom. Touching the heated bottom of the pan can result in recording a higher temperature than the actual water temperature. Check the temperature over several cold days. Water temperatures of at least 40° F should minimize mechanical problems and maintain animal performance.

Insulate waterers to reduce problems with water freezing and keep electric costs down in North Dakota winters. Make sure the insulation inside the waterer is still in good condition. Conserve heat by caulking the base of the automatic waterer and seal the access door with weather proof tape. Reducing wind exposure on the waterer with a windbreak can also reduce electrical costs.

Extra external insulation may be added to some automatic waterers. Surround the external surface with 2 inches or more of Styrofoam. Place ½ -inch plywood over the Styrofoam. Put galvanized steel on the top part of the Styrofoam-plywood pieces and angle iron on the vertical edges. Wrap this external insulation with some -inch steel cable to keep it in place.

Stray voltage in a self-heating trough can reduce water consumption and thus reduce feed intake. Shut off the electricity to automatic waterers and check the inside for rodent nests or other malfunctions which may be causing the stray current. Make sure the connections are dry and there is a clean, tight ground. Remember to use caution when working with electrical connections.

Access

Cows given free access to water will produce more milk and more butterfat than cows allowed to drink only twice a day. The same animal will consume different levels of water at different physiological states. For example, a pregnant or lactating animal will consume more than an non-pregnant, non-lactating animal.

In some cases, it may be necessary to regulate access to water. Horses that are hot from strenuous exercise should not have free access to water. Unlimited access to water by hot horses can lead to colic,

laminitis, and/or exertional rhabdomyolysis (tying up). They should be allowed only a few sips every three to five minutes until they cool down.

If swine on a high energy diet are deprived of water (such as can occur during power outages), and then allowed free access to water (power is restored), they may die from salt poisoning. Salt poisoning is also known as cerebral edema. Swine should be given access to water sparingly until fully rehydrated. Prognosis for swine making a full recovery from salt poisoning is very guarded.

Nutrients in Diet

Increasing the salt concentration or the protein level of the diet stimulates increased water intake in all species because of the increase in urine volume necessary for excretion of salt and urea. Studies with poultry have shown an increase in water consumption due to increases in fat, protein, salt, or potassium in the diet. Feeds high in crude fiber, such as roughages, will require more water for ingestion than feeds low in crude fiber, like barley and corn.

Stress

Reduced water consumption can be a sign of sickness or other stressors. Special considerations may be needed for valuable animals. Newly arrived animals may refuse water at first due to differences in palatability, so water intake in newly received cattle should be carefully monitored to make sure there are no signs of dehydration. Allowing animals to become accustomed to the new water supply gradually by mixing water from old and new sources is often not practical or even possible. Mixing small amounts of molasses with water sources can hide differences in taste.

Have water available during low activity times during the day. Consumption of water and feed can be reduced when there is a lot of activity which diverts the animals' attention. Allowing waterers to run over for the first few days may help cattle acclimate to drinking from fountains or new water sources, since the sound of running water will draw animals to the waterer. In addition, waterers should be placed in the fence line, since newly received cattle tend to pace back and forth along the fence.

Composition of Water

Water quality and quantity may affect feed consumption and animal health. Low quality water will normally result in reduced water and feed consumption. Absolutely pure water is not found in nature. Actually, deionized-distilled (pure) water is undesirable for livestock. Certain salts and gases in solution make water more palatable if not present in excess.

Substances which may reduce palatability of water include various salts. Salts may be toxic at high levels. Substances which are toxic without much effect on palatability include nitrates and fluorine, as well as salts of various heavy metals. Other materials which may effect palatability or toxicity include pathogenic microorganisms, hydrocarbons, oily substances, pesticides, and many industrial chemicals which sometimes pollute water supplies.

Contamination of water sources can occur when a hose is placed where it can become submerged when filling an animal watering tank. If the tank fills over the outlet of the hose, and the hose or faucet has automatic back siphoning, the entire water system may then become contaminated by impurities or poisonous solutions with the loss of water pressure.

Cleanliness

All water troughs should be cleaned frequently. Livestock should never be forced to drink dirty or contaminated water. Stale water can cause reduced water consumption. Even when clean water is available, animals may continue to consume dirty water if it is available.

Dirty water is a host for disease organisms. Disease can spread rapidly if animals drink from the same trough, so sick animals should be isolated from the trough and the trough cleaned and disinfected. A good disinfectant is dilute bleach solution after the trough has been thoroughly cleaned. Sprinkling baking soda into the fountain periodically may reduce algae growth. Tip tanks are sometimes installed in larger dairy freestall barns to simplify cleaning.

Have an elevated base around automatic waterers. Make the base wide enough so animals can easily put their front legs on it when they are drinking, but not their hind legs. Animals will not normally place only their hind legs on this base and therefore will not defecate in the water. Placement and height of the base are the key to avoiding fecal contamination. Make the surface rough so animals will not slip.

Water Quality

If there is a question of water quality, it should be tested. The following chemical properties should be considered when evaluating the quality of water for livestock.

Salinity

Salinity refers to salt dissolved in water and is expressed as parts per million (ppm) or as milligrams per liter (mg/L). The State Health Laboratory (Bismarck) and the NDSU Veterinary Diagnostic Laboratory (Fargo) conduct salinity tests. The expression "total dissolved solids" (TDS) is often used to denote the level of water salinity.

Salts commonly present include carbonate, bicarbonates, sulfates, nitrates, chlorides, phosphates, and fluorides. Highly mineralized waters (high solids) do not have much effect on health as long as there are no objectionable effects from specific ions, such as sulfate, and as long as normal amounts of water are consumed. One gram of sulfate per liter (1000 ppm) may result in scours. High levels of sulfate in the water may also reduce copper availability in the diet. In North Dakota, well water high in TDS is often high in sulfates. The limiting health concern is often sulfate, because the acceptable sulfate level will be exceeded before TDS levels are high enough to be a concern.

Salts, such as sodium chloride, change the electrolyte balance and intracellular pressure in the body, producing a form of dehydration. Salts also place a strain on the kidneys. Excess fluoride causes degeneration of the teeth.

High salt concentrations that are less than toxic may actually cause an increase in water consumption. Animals may refuse to drink high saline water for many days, followed by a period when they drink a large amount. They may then become sick or die. The tolerance of animals to salts in water depends on factors such as water requirements, species, age, physiological condition, season of the year, and salt content of the total diet, as well as the water. Animals have the ability to adapt to saline water. However, abrupt changes from water with low salt to water with high salt concentrations may cause harm while gradual changes do not.

Table 8 gives the level of mineral content that either makes the water taste too bad to drink or causes a detrimental effect on health. It ap-pears to make little difference wheth-er the total quantity of dissolved salts or dissolved solids is made up of a single salt or a number of different salts. Table 9 shows recommendations for various animal species in relation to dissolved solids content.

Table 8. Recommendations for livestock water use based on Total Dissolved Solids (TDS).

TDS	Comments
(ppm or mg/L)	
Less than 3,000	Usually satisfactory for most livestock.
3,000-5,000	May not cause adverse effects to adult livestock. Growing/young livestock could be effected by looseness or poor feed conversion. At levels near 5,000 ppm the water is unacceptable for poultry.
5,000-7,000	Should not be used for pregnant or lactating females. Usually laxative and may result in reduced water intake.
7,000-10,000	Do not use for swine. Do not use for pregnant or lactating ruminants or horses.
10,000 or more	May cause brain damage or death.

Table 9. Recommended levels of Dissolved Solids for various animal species.

	Dissolved Solids (ppm)				
Species	Excellent	Good	Fair	Poor	Limit
Humans	0-800	800-1,600	1,600-2,500	2,500-4,000	5,000
Horses:					
- Working	0-1,000	1,000-2,000	2,000-3,000	3,000-5,000	6,000
- Others	0-1,000	1,000-2,000	2,000-4,000	4,000-6,000	10,000
Cattle	0-1,000	1,000-2,000	2,000-4,000	4,000-6,000	10,000
Sheep and	0-1,000	1,000-3,000	3,000-6,000	6,000-10,000	15,000
Poultry					
Chickens	0-1,000	1,000-2,000	2,000-3,000	3,000-5,000	6,000

Swine (young pigs and market pigs appear to tolerate less than cattle)

Sulfates

Animals can become acclimated to the sulfates in water. Consider diluting high sulfate water with low sulfate water for newly arrived animals. Use the same procedure for pigs at weaning time. The sulfate recommendation for calves is for less than 500 ppm (167 ppm sulfur as sulfate). For adult cattle the recommendation is less than 1,000 ppm (333 ppm sulfur as sulfate). Caution is required in evaluating sulfate levels in water because of interactions with copper and molybdenum and the inhibiting effect compounds such as sodium fluoride have on sulfate absorption for the digestive tract. In addition, high levels of sulfates may also contribute to an increased incidence of polioencephelomalacia (PEM), a brain disorder found in cattle. If copper deficiency problems are suspected, water sources should be analyzed for sulfates to determine if high sulfate levels are contributing to the problem.

Other minerals

Water hardness is actually caused by calcium and magnesium. Softening the water through exchange of calcium and magnesium with sodium may cause problems if water is already high in salinity.

When there is a significant amount of calcium in water, it should be considered as a part of the total mineral intake. However, many mineral salts are relatively insoluble and pass through the body without being absorbed. Even in hard water, the amount of mineral ingested from the water is not likely to be substantial.

Nitrates

Water can also be contaminated with nitrates. For more information regarding nitrates and nitrate poisoning, please refer to Nitrate Poisoning of Livestock (V-839 Revised).

pH

Water pH denotes either alkalinity or acidity. High saline water is not the same as alkaline water. A pH of 7 would be neutral; over 7 indicates alkalinity; below 7 designates acidity. Most North Dakota waters are mildly alkaline with a pH value between 7 and 8. Acidic water (pH below 7) has not been found to occur in most of North Dakota; however, there are some reports of acidic water in the western part of the state in proximity to lignite veins. Various degrees of alkalinity have been reported in the state. High alkalinity may cause digestive upsets, laxative action, poor feed conversion, and reduced water and/or feed intake.

Microbiological properties

There are many microorganisms in our water supply. Most are quite harmless but some do cause animal health problems.

Coliform counts below 50 per milliliter of water are safe for all cattle. Other possible contaminants include coccidia, staph, strep, virus, lepto, etc.

Green scum that builds up in livestock drinking troughs and tanks is algae. It cannot grow without sunlight. Some blue-green algae are toxic. No good method exists to predict whether toxins will be produced. Livestock behavior should be monitored closely during periods of heavy algal blooms. Copper sulfate ($CuSO_4$) or other commercial copper-containing products, often called bluestone, will kill the algae for a period of several months. In troughs or small tanks, a safe dosage is one level teaspoon of copper sulfate per 1,500 gallons of water. One ounce will treat 8,000 gallons of water. One pound per acre-foot is a good estimate for larger bodies of water. Generally, treatment is done only when algae growth is heavy or if a toxicity prob-lem occurs. Hold livestock off the treated water source for at least 24 hours.

In treating large stock tanks or ponds, drag a sack containing the correct amount of copper sulfate behind a boat, pacing yourself to cover the heavily infested areas first. If the tank contains catfish (not scaled fish), treat half of the pond at a time and allow the fish to move to untreated water. Occasionally putting baking soda in water troughs will help prevent algae growth. Proper cleaning of automatic waterers can be quite effective in preventing algae growth. Consider the use of a disinfectant with poultry waterers. Table 10 lists the recommended treatment levels for adding copper sulfate to water to reduce algae growth. Management in the watersheds above stock ponds that reduces runoff and erosion will help reduce nutrient impacts needed for algal growth.

Table 10. Recommended levels of copper sulfate needed to treat water for algae.

Amount of CuSO4 Used	Water Volume for 1 ppm	Water Volume for ½ ppm
	- - - - gallons - - - -	
1 oz	7,800	15,000
8 oz	62,500	125,000
1 lb	125,000	250,000
8 lb	1,000,000	2,000,000

The desired level of CuSO4 is 0.2 to 0.4 ppm, which is equivalent to 0.65 to 1.3 oz per 10,000 gallons of water or 1.4 to 2.8 pounds per acre foot of water.

Signs of blue green algae poisoning are diarrhea, lack of coordination, labored breathing, and death.

During recovery, unpigmented skin may slough off. A suggested treatment for algae afflicted animals is large quantities of medical-grade charcoal and mineral oil, given orally. These are given to try to prevent any further absorption of the toxins by the affected animals. Contact your veterinarian for more information and assistance.

For additional information on algae poisoning please refer to NDSU Extension Service publication V-1136, Cyanobacteria (Blue-Green Algae) Poisoning.

Microorganisms can enter a well which has improper surface protection. A well is situated improperly if it receives drainage from livestock pens or a manure storage structure. Cracked well casings may also allow bacteria to enter the water supply. Cracks in cisterns can also allow access to microorganisms. Contamination might occur from a heavy spring rainfall. Protect the surface of wells from contamination by rodents.

Other chemicals

Many other chemicals may be found in water, some of which could be detrimental to livestock production. Safe levels of herbicides and pesticides in water for animals have not been determined. Table 11 gives guidelines for humans. These appear to be reasonable for livestock.

Table 11. Maximum tolerable levels of various pesticides in water for humans.

Pesticide	Maximum Concentration
	mg/L
Chlordane	0.002
Endrin	0.002
Hephtachlor epoxide	0.0002
Hephtachlor	0.0004
Lindane	0.0002
Methoxychlor	0.04
Toxaphene	0.003
2,4-D	0.07
2,4,5-T	0.07

Pesticides can enter a ground water or surface water supply from run-off, drift, and accidental spills. Provide adequate drainage around the water supply. Wells should be located on elevated ground to prevent surface run-off in to the well. Fish are much more sensitive to pesticides than other livestock.

Table 12 lists the safe levels of potentially toxic nutrients and contaminants in water for cattle. These should be analyzed only when there is good reason to suspect their presence at excessive levels.

Table 12. Safe levels of potentially toxic nutrients and contaminants in water for livestock.

Element	ppm
Aluminum	5.0
Arsenic	0.2
Boron	5.0
Cadmium	0.05
Chromium	1.0
Cobalt	1.0
Copper	0.5
Fluorine	2.0
Lead	0.05
Mercury	0.01
Nickel	1.0
Nitrate-Nitrogen	100.0
Nitrite-Nitrogen	10.0
Selenium	0.05
Sulfate	1,000.0
Vanadium	0.1
Zinc	25.0

Adapted from Shirley et al. (1974).

Water testing requirements for dairies

Water used for cleaning equipment in the milking barn and parlor must be tested annually. Contact the North Dakota Department of Agriculture-Dairy Division, regarding referrals on water quality and inspection requirements.

Water requirements are influenced by several factors, including
rate of gain
pregnancy
lactation
activity
type of diet
feed intake
environmental temperature

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