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Conversion Factors and Constants used in Forestry, With Emphasis on Water and Soil Resources

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Abstract

Conversion factors and constants used in forestry are listed. Values applicable to forest hydrology, watershed management, and soils are emphasized. Brief explanations and derivations of some chemical parameters are given.

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Introduction

This report is a compilation of many of the most common constants and conversion factors used in forestry. Values applicable to forest hydrology, watershed management, and soils are emphasized. This compilation contains both basic and more advanced concepts to maximize its applicability. English, metric, and Systeme International d'Unites (SI) units are given. The following is a list of abbreviations used in this report. The abbreviations are those approved by the "Government Printing Office Style Manual" (March 1984), and may not be accepted universally as standard abbreviations.

at = atmosphere
fbm = board foot
Btu = British thermal unit
°C = degree Celsius
ft^3/s = cubic foot per second
cal = calorie
cm = centimeter
°F = degree Fahrenheit
ft = foot
gal = gallon
g = gram
ha = hectare
hp = horsepower
h = hour
I = solar constant
in = inch
K = degree Kelvin
kcal = kilocalorie
kg = kilogram
km = kilometer
kn = knot
kW = kilowatt
L = liter
lb = pound
ly = langley
m = meter
mbar = millibar
mg = milligram
Mgal/d = million gallons per day
mi = mile
min = minute
mL = milliliter
mm = millimeter
mol = mole
mo = month
oz = ounce
p/m = part per million
lb/in^2 = pounds per square inch
pt = pint
qt = quart
s = second
yd = yard
yr = year

The SI recommends that large numbers be written using a blank space rather than punctuation to identify each thousand. For example, one hundred thousand should be written as 100 000 rather than 100,000. This practice is becoming more prevalent in scientific writing and is employed herein.

Conversions

Metric System

Magnitudes of basic metric units are defined by the assignment of the appropriate prefix to the basic unit (Table 1). For example, 1 millimeter is 1/1 000 of a meter; conversely, 1 meter has 1 000 millimeters. The prefix is the same for measurements of length, area, volume, and mass.

Weight and Mass

Frequently used conversion factors for weight and mass are given in Table 2. To convert a value of a given unit to another unit, locate the known unit on the left side of the table. Then locate the desired unit at the top of the table. The value at the intersection of the known row and desired column is the correct conversion factor. Multiply the known value by this conversion factor to obtain the desired value. For example, to calculate the number of grams in 5 milligrams, multiply 5 by 0.001. Thus, 5 mg are equivalent to 0.005 g.

Length and Area

Length conversions are given in Table 3. Table 4 lists conversions for area.

Volume

Geometric volume conversions are given in Table 5. These are used in forestry and water resources to express volumes of both solids and fluids. By contrast, the volumes and capacities listed in Table 6 are used primarily for liquid measurements.

Hydrologic Parameters

Table 7 includes conversion factors for water supply volumes and flow rates used in hydrologic studies.

Loadings

Sediment and chemical measurements are used in forestry studies. These values often are expressed initially as concentrations and later converted to weight per unit area (or volume) or mass per unit area (or volume). These values, called loadings, indicate how much sediment or chemical constituents have been lost from, added to, or passed through a site. Commonly used loading values and appropriate conversions are given in Table 8. To convert a known value of a unit listed in column 1 to a unit listed in column 2, multiply the known value by the appropriate conversion factor in column 3. To convert a known value of a unit in column 2 to a unit in column 1, divide the known value by the appropriate conversion factor in column 3.

Chemistry

Chemical analyses are performed routinely in many watershed studies. Laboratory analyses often record results on a weight-per-weight basis, such as parts per million. One part per million is defined as 1 milligram of solute per kilogram of solution (Hem 1978). Other weight-per-weight units are similarly defined. These concentrations are called weight per weight even though they are defined in terms of mass rather than true weight. They are dimensionless.

The magnitude in which a concentration is expressed depends on the abundance of the particular constituent of interest. Generally, concentrations of the most common ionic species in fresh water are stated in parts per million, while trace constituent concentrations are given in parts per billion or parts per trillion. High concentrations, such as oceanic salt concentrations, are expressed in parts per thousand.

Parts per million is a convenient way to express concentrations for most chemical analyses because 1 p/m is essentially equal to 1 mg/L. This approximation holds true for waters with total ionic concentrations less than 7 000 mg/L. Density differences must be accounted for when p/m are converted to mg/L in waters with concentrations above 7 000 mg/L (Hem 1978). Weight-per-weight measurements can be converted easily from one magnitude to another using Table 9.

Laboratory equipment and chemical standards dictate which chemical analyses can be determined and the chemical form in which the results are reported. Occasionally, results may need to be expressed in terms of ions other than those reported from the laboratory. Common elements and compounds and alternative expressions for each are given in Table 10.

The conversion factors in Table 10 are unit-independent; they can be used so long as the units of both columns 1 and 2 are the same. For example, the factor 2.497 can be used to convert mg/L of Ca^{2+} to mg/L of $CaCO_3$, or to convert tons per acre of Ca^{2+} to tons per acre of $CaCO_3$. Also, if the concentrations of several different species are converted to a single species, the results can be summed to determine the contribution of that individual species.

Some species, such as NO_3-N, are hyphenated (Table 10). The hyphen means "as"; so in this case, the ion is read nitrate as nitrogen (or simply, nitrate nitrogen). This expression means that the ionic concentration is given in terms of the element (here, nitrogen). In other words, the concentration being reported is the concentration of the nitrogen in the nitrate ion rather than the nitrate concentration itself.

For the hyphenated expressions and salts listed in Table 10, derivation of the conversion factors is relatively easy. Approaching the problem using dimensional analysis (i.e., getting the correct units to "cancel out") (Brown and LeMay 1977) assures that the calculation is performed correctly. However, instead of treating the units as algebraic quantities, as is normally done in dimensional analysis, the chemical constituents are treated as the algebraic quantities. For example, to convert a known concentration of NO_3-N to NO_3^-, the following procedure is used:

$$\text{mg/L } NO_3^- = \text{mg/L } NO_3\text{-N} \times \frac{\text{molecular weight } NO_3^-}{\text{atomic weight N}} \qquad (1)$$

Since NO_3-N is really elemental nitrogen, both it and the elemental nitrogen in the denominator cancel out, leaving only the desired nitrate term.

Similarly, given the concentration of a salt (e.g., NaCl), the concentration attributable to one of its elements can be determined by:

$$\text{mg/L Na}^+ = \text{mg/L NaCl} \times \frac{\text{atomic weight of Na}^+}{\text{molecular weight of NaCl}} \quad (2)$$

Analogous conversions can be used to isolate the desired term of salts and hyphenated species not given in Table 10.

Unfortunately, conversion factors for all alternate species expressions cannot be derived so simply. Equivalent weights often must be figured into the calculation. The previous two examples have implicitly accounted for equivalent weights because of the 1:1 relationship between reactants and products. Where a 1:1 relationship does not hold, equivalent weights must be used explicitly in the calculation.

An equivalent weight is different from but dependent on atomic or molecular weight. The specific definition of an equivalent weight varies with the type of chemical reaction involved (Brown and LeMay 1977). The equivalent weight of an element is its atomic weight divided by the absolute value of its charge. In acid–base reactions, the equivalent weight of a base is the weight of the base needed to neutralize 1 mole of hydrogen ions (H^+), and the equivalent weight of an acid is the weight of an acid needed to neutralize 1 mole of hydroxide (OH^-) (Strauss 1976). To illustrate:

$$H_2SO_4 + 2NaOH \rightarrow 2H_2O + Na_2SO_4 \quad (3)$$

where the molecular weight of H_2SO_4 is 98 g.

However, equation 3 shows that 2 moles of NaOH are required to neutralize 1 mole of H_2SO_4. Thus, the equivalent weight of H_2SO_4 is 98/2, or 49 g. In an oxidation-reduction reaction, an equivalent weight is the weight of a substance that loses or gains 1 mole of electrons. For example, in the case where the reactant (oxidant) is $KMnO_4$ (Mn^{7+}) and the product is Mn^{2+}, a reduction occurs in which Mn gains 5 electrons. The molecular weight of $KMnO_4$ is 158 g; thus, the equivalent weight of $KMnO_4$ is 158/5, or 31.6 g. Similarly, in the oxidation reaction with reactant and product $Na_2C_2O_4$ and CO_2, respectively, the reactant (reductant) loses 2 electrons. Since the molecular weight of $Na_2C_2O_4$ is 134 g, 1 equivalent weight of $Na_2C_2O_4$ is 134/2, or 67 g. In general, an equivalent weight is the weight of 1 reagent required to react with 1 mole of another reagent (Brown and LeMay 1977).

Since an equivalent weight is the amount of a reagent required to react with another reagent, equivalents are either the number of moles required for a reaction or the charge of a monoatomic particle. Thus, the equivalent weight of Ca^{2+}, for example, is 20.04 g (atomic weight 40.08/2); likewise, Ca^{2+} can be said to have 2 equivalents per mole.

The use of equivalents and equivalent weights in the determination of the Table 10 conversion factors can be demonstrated with the reaction:

$$2HCO_3^- \rightarrow CO_3^{2-} + H_2O + CO_2 \quad (4)$$

To calculate the concentration of the product CO_3^{2-} from a given concentration of the known reactant HCO_3^-, an equation is formulated so that all of the chemical constituents except CO_3^{2-} will cancel out:

$$CO_3^{2-}\ \text{mg/L} = HCO_3^-\ \text{mg/L} \times \frac{\text{molecular weight } CO_3^{2-}}{\text{molecular weight } HCO_3^-} \quad (5)$$

However, review of equation 4 and the definition of an equivalent show that 2 moles of HCO_3^- are required to form 1 mole of CO_3^{2-} (this is not a 1:1 reactant to product reaction as was discussed earlier). Therefore, equation 5 must be further modified using equivalent weights:

$$CO_3^{2-}\ \text{mg/L} = HCO_3^-\ \text{mg/L} \times \frac{1 \times \text{molecular weight } CO_3^{2-}}{2 \times \text{molecular weight } HCO_3^-} \quad (6)$$

So when the appropriate molecular weights are substituted into this equation, the conversion factor is 0.4917, as given in Table 10.

Equivalent measures also can be used for purposes other than converting from one form of a constituent to another. Many times, equivalent values or magnitudes of equivalent values are used in studies to evaluate the amounts of nutrients entering and leaving an ecosystem, or to compare cation and anion inputs. Since equivalent weights account for the differences in formula weights and valences (charges) among different ions, the concentrations or loadings can be converted to an "equal" basis using equivalent weights for subsequent comparison or evaluation.

Conversion factors required for the transformation of concentrations to equivalents are given for common water quality parameters in Table 11. This table can be used for several equivalent conversions. For each of the ions, the factors can be used to convert mg to µeq (1 eq has 10^6 µeq), mg/L to µeq/L, or any other mg to µeq expression with like denominators. Similarly, the same factors can be used to convert kg to eq, kg/ha to eq/ha, or any other kg to eq expression with like denominators.

The particular form of the species for which the conversion factors hold true is given in parentheses in the left column of Table 11. These conversion factors hold only for those forms of the ion; therefore, a knowledge about the nature of the dissolved species within the sample is necessary (Hem 1978).

The conversion factors in Table 11 can be determined easily because the species are not being transformed to other species. The number of equivalents per mole of material is equal to the absolute value of the ionic charge (or valence). Therefore, the calculation from mg/L to eq/L is:

$$\text{eq/L} = \frac{\text{mg}}{\text{L}} \times \frac{1\text{ g}}{1\ 000\text{ mg}} \times \frac{1\text{ mol}}{\text{formula weight (g)}} \times \frac{\#\text{ eq}}{1\text{ mol}} \qquad (7)$$

Note that all of the units other than equivalents and liters cancel out. Different magnitudes of equivalents are determined this same way. For example, µeq/L can be subsequently calculated by multiplying the eq/L value obtained in equation 7 by 10^6, the number of microequivalents in 1 equivalent.

For species with no electrical charge, equivalents cannot be calculated (Hem 1978) since no valence is available to substitute into equation 7. Where this situation occurs, several options for expressing concentrations exist; mg/L, p/m, or other quantifications of laboratory results can be used for reporting scientific results. However, concentrations may be more useful if converted to a molar basis, such as mol/L. In the latter method the formula weight is accounted for even though a charge is not present.

Current practice in some disciplines, particularly soil science, is replacing equivalent units with the corresponding SI units, moles of ion charge. Moles of ion charge are defined as "the number of moles multiplied by (1) the number of moles of H^+ or OH^- that react with 1 mole of the substance, or (2) the number of 'moles' or Faradays of electrons that 1 mole of the substance accepts or donates" (Bohn et al. 1985). Notation for this unit is $\text{mol}^{(+)}$ or $\text{mol}^{(-)}$, which is read as moles of positive or negative charge, respectively.

Arithmetically, moles of ion charge are equal to equivalents, as might be anticipated when the definitions of both are compared. Therefore, in general:

$$\text{mol}^{(+)} \text{ or } \text{mol}^{(-)} = \text{mol} \times \text{ion charge} = \text{equivalent} \qquad (8)$$

Moles of ion charge frequently are expressed per volume of solution or per weight of soil. Note that if expressed on a per-liter basis, equation 8 is conceptually identical to equation 7. Thus, the approach shown for calculating equivalents per liter also can be used for calculating moles of ion charge per liter. Again, this approach can be used regardless of what unit is in the denominator.

The purpose of this paper is not to isolate and discuss specific chemical constituents; however, a brief summary of pH is merited. By definition,

$$\text{pH} = -\log[H^+] \qquad (9)$$

Since pH is a logarithmic function, many calculations and mathematical manipulations involving pH must be done using hydrogen ion concentrations. Consequently, equation 9 can be rearranged to solve for the hydrogen ion concentration $[H^+]$:

$$10^{-\text{pH}} = [H^+] \qquad (10)$$

The units of $[H^+]$ are mol/L. Since mol/L is not a common unit reported from laboratory analyses, mol/L can be transformed to other desired units in subsequent calculations. In addition, pH cannot be averaged directly because it is logarithmic. Average pH values can be determined only by converting all pH values to hydrogen ion concentrations, summing those values and finding their average, and then converting the average hydrogen ion concentration back to pH using equation 9. For example, the average pH of pH 4.00 and pH 8.00 is calculated by converting both pH values to $[H^+]$ concentrations using equation 10. Thus, the respective hydrogen ion concentrations are 1×10^{-4} and 1×10^{-8}. Their sum is 1.0001×10^{-4}, and their average is 5.0005×10^{-5}.

Substituting this latter [H⁺] average into equation 9 gives an average pH value of 4.30. Note that this average differs from pH 6, which would be the result of averaging the two pH values directly.

Climatology and Physics

Climatological and physical parameters are increasingly important as more intensive studies are being performed in forestry, soil, and water resources. The list of physical and climatological factors in Table 12 is limited. Because of the complexity of physical and climatological principles, the values given represent only several of those used most frequently. Other sources provide more complete lists of climatological and physical constants (Brooks 1960; CRC Press 1984; Rosenberg 1974).

Miscellaneous

Values for commonly used constants that do not fit conveniently into Tables 2-12 are given in Table 13.

Appendix

Table 1.—Metric prefixes and corresponding mathematical factor

Prefix	Abbreviation	Factor
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deka	da	10^{1}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	µ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

Table 2.—Conversion factors for mass and weight

	mg	g	kg	oz (fluid)	lb	ton (short)
mg	1	0.001	1×10^{-6}	3.527×10^{-5}	2.205×10^{-6}	1.103×10^{-9}
g	1 000	1	0.001	0.03527	0.002205	1.103×10^{-6}
kg	1×10^{6}	1 000	1	35.27	2.205	1.103×10^{-3}
oz (fluid)	2.835×10^{4}	28.35	0.02835	1	0.06250	3.125×10^{-5}
lb	4.536×10^{5}	453.5	0.4535	16	1	0.0005
ton (short)	9.072×10^{8}	9.072×10^{5}	907.2	3.2×10^{4}	2 000	1

Table 3.—Conversion factors for length

	mm	cm	m	km	in	ft	yd	mi
mm	1	0.10	0.001	1×10^{-6}	0.03937	0.003281	0.001094	6.214×10^{-7}
cm	10	1	0.01	1×10^{-5}	0.3937	0.03281	0.01094	6.214×10^{-6}
m	1 000	100	1	0.001	39.37	3.281	1.094	6.214×10^{-4}
km	1×10^{6}	1×10^{5}	1 000	1	39 370	3 281	1 094	0.6214
in	25.40	2.540	0.02540	2.540×10^{-5}	1	0.08333	0.02778	1.578×10^{-5}
ft	304.8	30.48	0.3048	3.048×10^{-4}	12	1	0.333	1.894×10^{-4}
yd	914.4	91.44	0.9144	9.144×10^{-4}	36	3	1	5.682×10^{-4}
mi	1.609×10^{6}	1.609×10^{5}	1 609	1.609	63 360	5 280	1 760	1

Table 4.—Conversion factors for area

	cm^2	m^2	km^2	ha	in^2	ft^2	yd^2	mi^2	acre
cm^2	1	0.0001	1×10^{-10}	1×10^{-8}	0.1550	0.001076	0.0001196	3.861×10^{-11}	2.471×10^{-8}
m^2	10 000	1	1×10^{-6}	0.0001	1 550	10.76	1.196	3.861×10^{-7}	2.471×10^{-4}
km^2	1×10^{10}	1×10^{6}	1	100	1.550×10^{9}	1.076×10^{7}	1.196×10^{6}	0.3861	247.1
ha	1×10^{8}	10 000	0.01	1	1.550×10^{7}	1.076×10^{5}	1.196×10^{4}	3.861×10^{-3}	2.471
in^2	6.452	0.0006452	6.452×10^{-10}	6.452×10^{-8}	1	0.006944	0.0007716	2.491×10^{-10}	1.594×10^{-7}
ft^2	929.0	0.09290	9.290×10^{-8}	9.290×10^{-6}	144	1	0.1111	3.587×10^{-8}	2.296×10^{-5}
yd^2	8 361.3	0.8361	8.361×10^{-7}	8.361×10^{-5}	1 296	9	1	3.228×10^{-7}	2.066×10^{-4}
mi^2	2.590×10^{10}	2.590×10^{6}	2.590	259.0	4.014×10^{9}	2.788×10^{7}	3.098×10^{6}	1	640
acre	4.047×10^{7}	4.047×10^{3}	0.004047	0.4047	6.273×10^{6}	43 560	4.840×10^{3}	0.001563	1

Table 5.—Conversion factors for geometric volume

	mm^3	cm^3	m^3	in^3	ft^3	yd^3
mm^3	1	0.001	1×10^{-9}	6.102×10^{-5}	3.531×10^{-8}	1.308×10^{-9}
cm^3	1 000	1	1×10^{-6}	0.06102	3.531×10^{-5}	1.308×10^{-6}
m^3	1×10^{9}	1×10^{6}	1	6.102×10^{4}	35.31	1.308
in^3	1.639×10^{4}	16.39	1.639×10^{-5}	1	5.787×10^{-4}	2.143×10^{-5}
ft^3	2.832×10^{7}	2.832×10^{4}	0.02832	1 728	1	0.03704
yd^3	7.645×10^{8}	7.645×10^{5}	0.7645	46 656	27	1

Table 6.—Conversion factors for volume and capacity

	cm^3	L	in^3	ft^3	oz (fluid)	pt	qt	gal
cm^3	1	0.001	0.06102	3.531×10^{-5}	0.03381	0.002113	0.001057	0.0002642
L	1 000	1	61.02	0.03531	33.81	2.113	1.057	0.2642
in^3	16.39	0.01639	1	5.787×10^{-4}	0.5540	0.03463	0.01732	0.004329
ft^3	28 320	28.32	1 728	1	957.5	59.85	29.92	7.481
oz (fluid)	29.57	0.02957	1.805	0.001044	1	0.06250	0.03125	0.007812
pt	473.2	0.4732	28.88	0.01671	16	1	0.5	0.1250
qt	946.4	0.9464	57.75	0.03342	32	2	1	0.25
gal	3 785	3.785	231.0	0.1337	128	8	4	1

Table 7.—Conversion factors for water supply volumes and flow rates

To convert	To	Multiply by	To convert	To	Multiply by
ft^3	gal	7.481	L/s	ft^3/s	0.03532
ft^3/s	m^3/s	0.02831		gal/min	15.85
	m^3/d	2 447		Mgal/d	0.02282
	gal/min	448.8		acre ft/d	0.0707
	Mgal/d	0.6463	ft^3/s mi^2	in/mo (28-day month)	1.041
	L/s	28.32		in/mo (29-day month)	1.078
	in/h	0.9917		in/mo (30-day month)	1.116
	acre in/h	0.9917		in/mo (31-day month)	1.153
	acre ft/d	1.984		in/yr (365-day year)	13.57
	acre ft/yr (365-day year)	724.2		in/yr (366-day year)	13.61
	acre ft/yr (366-day year)	726.1		in/h	0.001550
m^3/s	ft^3/s	35.31		in/d	0.03719
	m^3/d	8.640×10^4	ft^3/s d	acre ft	1.984
	gal/min	1.585×10^4	ft^3/s h	acre in	0.9917
	Mgal/d	22.82		ft^3	3 600
	L/s	1 000	s ft	ft^3/s	1.0
	acre ft/d	70.04		gal/min	448.8
U.S. gal	Imperial gal (40 U.K. fl oz)	0.8327	s ft/d	gal/d	646 317
				acre ft	1.984
gal/min	Mgal/d	1.440×10^{-3}	acre ft	gal	325 851
	L/s	0.06308		ft^3	43 560
	m^3/s	6.308×10^{-5}		m^3	1 234
	m^3/min	0.003785		acre in	12
	m^3/d	5.450	acre ft/d	gal/min	226.3
	ft^3/s	2.228×10^{-3}		Mgal/d	0.3259
	acre ft/d	4.421×10^{-3}		ft^3/s	0.5042
	L/min	3.785		m^3/s	0.01428
Mgal/d	gal/min	694.4		m^3/d	1 234
	ft^3/s	1.547		L/s	14.28
	m^3/s	0.04381	mi/h	ft/s	1.467
	m^3/d	3 785		m/s	0.4470
	L/s	43.81		km/h	1.609
	acre ft/d	3.069		kn	0.8688
L/s	m^3/s	0.0010	ft/s	m/s	0.3048
	m^3/d	86.40		mi/h	0.6818

Table 8.—Conversion factors for loadings

To convert	To	Multiply by
mg/m^2	kg/ha	0.0100
mg/L	ton/acre ft	0.001360
	ton/d	s ft × 0.00297
kg/ha	lb/acre	0.8923
	lb/mi^2	571.1
	ton/acre	0.00045
	ton/mi^2	0.2855
lb/acre	lb/mi^2	640.0
	ton/acre	0.0005
	ton/mi^2	0.3200
lb/mi^2	ton/acre	7.813×10^{-7}
lb/ft^2	g/cm^2	0.4881
lb/ft^3	kg/m^3	16.02
ton/acre	metric ton/ha	2.242
	g/m^2	224.2
ton/ft^2	kg/cm^2	0.9765
	kg/m^2	9 765
ton/mi^2	kg/km^2	350.3

Table 9.—Conversion factors for weight-per-weight chemical expressions

Parts per:	Parts per:				
	Thousand	Ten thousand	Million	Billion	Trillion
Thousand	1	10	1 000	1×10^6	1×10^9
Ten thousand	0.1	1	100	1×10^5	1×10^8
Million	0.001	0.01	1	1 000	1×10^6
Billion	1×10^{-6}	1×10^{-5}	0.001	1	1 000
Trillion	1×10^{-9}	1×10^{-8}	1×10^{-6}	0.001	1

Table 10.—Conversion factors for alternative expressions for common elements and compounds

To express	As	Multiply by
Ca^{2+}	$CaCO_3$	2.497
$CaCl_2$	$CaCO_3$	0.9018
Fe^{3+}	H_2SO_4	2.634
HCO_3^-	$CaCO_3$	0.8202
$^*HCO_3^-$	CO_3^{2-}	0.4917
K_2O	K^+	0.8302
Mg^{2+}	$CaCO_3$	4.116
$MgCl_2$	$CaCO_3$	1.051
Na_2CO_3	$CaCO_3$	0.9442
NH_3-N	NH_4^+	1.288
NH_3	NH_4^+	1.059
NO_3-N	NO_3^-	4.427
NH_3-N	NH_3	1.216
P_2O_5	P^{3-}	0.4364
SO_4-S	SO_4^{2-}	2.996

*In reaction: $2HCO_3^- = CO_3^{2-} + H_2O + CO_{2(g)}$

Table 11.—Conversion factors for transforming mg to μeq, mg/L to μeq/L, or any other mg to μeq expression with like denominators; these factors can be used to convert kg to eq, kg/ha to eq/ha, or any other kg to eq expression with like denominators

Species	Conversion factor
Aluminum (Al^{3+})	111.19
Ammonium (NH_4^+)	55.44
Barium (Ba^{2+})	14.56
Bicarbonate (HCO_3^-)	16.39
Bromide (Br^-)	12.51
Cadmium (Cd^{2+})	17.79
Calcium (Ca^{2+})	49.90
Carbonate (CO_3^{2-})	33.33
Chloride (Cl^-)	28.21
Chromium (Cr^{6+})	115.36
Copper (Cu^{2+})	31.48
Fluoride (F^-)	52.64
Hydrogen (H^+)	992.09
Hydroxide (OH^-)	58.80
Iodide (I^-)	7.88
Iron (Fe^{2+})	35.81
Iron (Fe^{3+})	53.72
Lead (Pb^{2+})	9.65
Lithium (Li^+)	144.09
Magnesium (Mg^{2+})	82.26
Manganese (Mn^{2+})	36.40
Manganese (Mn^{4+})	72.81
Nitrate (NO_3^-)	16.13
Nitrite (NO_2^-)	21.74
Phosphate (PO_4^{3-})	31.59
Phosphate (HPO_4^{2-})	20.84
Phosphate ($H_2PO_4^-$)	10.31
Potassium (K^+)	25.57
Sodium (Na^+)	43.50
Strontium (Sr^{2+})	22.82
Sulfate (SO_4^{2-})	20.82
Sulfide (S^{2-})	62.38
Zinc (Zn^{2+})	30.60

Table 12.—Common conversion factors used in climatology and physics

To convert	To	Multiply by
lb/in^2	ft water	2.307
mbar	cm water	1.0
	in mercury	0.02953
	lb/in^2	0.01450
at	in mercury (at 0°C)	29.92
ly	cal/cm^2	1.0
Btu	g cal	252.0
kW	Btu/h	3 415
	hp	1.360
kW h	Btu	3 415
	kcal	859.2

Temperature Conversions:
°C = 5/9 (°F − 32)
°F = 9/5 (°C) + 32
K = (°C) + 273.15
°C = (K) − 273.15
°F = 9/5 (K) − 459.69

Table 13.—Conversion factors for miscellaneous constants

Length	1 chain (Gunter's) = 66 ft = 100 links 1 link = 0.66 ft 1 rod = 16.50 ft
Geometric volume	1 fbm = 2 360 cm^3 = 0.8333 ft^3 = 144 in^3
Volume and capacity	1 ft^3 water at 60°F = 62.37 lb 1 gal water at 62°F = 8.337 lb 1 g/cm^3 water = 62.37 lb/ft^3 1 lb/ft^3 water = 0.1337 lb/gal 1 ml water = 1 g 1 cm^3 water = 1 g 1 ml = 1 cm^3
Flow rates	1 miners inch = 0.025 ft^3/s (in Arizona, California, Montana, and Oregon) = 0.02 ft^3/s (in Idaho, Kansas, Nebraska, New Mexico, North Dakota, South Dakota, and Utah) = 0.026 ft^3/s (in Colorado) = 0.028 ft^3/s (in British Columbia)
Chemistry	1 p/m = 1 mg/L (for waters with concentrations less than 7 000 p/m)
Climatology	Solar constant (I) = 1.98 ly/min

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Conversion factors and constants used in forestry are listed. Quantitative and qualitative water and soil resources values are emphasized. Brief explanations and derivations of some chemical parameters are given.

ODC 116.9x4.5

Keywords: Length; area; volume; chemical conversions