

Water Chemistry Field Measurements

Field equipment is available to make measurements of several of the parameters that can be used to characterize water quality. You should make these measurements *in situ* to record the conditions at the time of sample collection. These are standard field measurements.

Specific Conductance:

Specific conductance, also referred to as *conductivity*, *electrical conductivity* or *specific electrical conductance*, is a measure of the ability of a water to conduct electricity. In general, the higher the concentration of dissolved salts in the water, the easier it is for electricity to pass through water. Conductivity is reported in *micromhos* (μmhos) or *microSiemens* (μS) per centimeter (cm). Conductivity measurements can be converted to *total dissolved solids* measurements which are reported in parts per thousands (ppt), parts per million (ppm), or parts per billion (ppb). A rough approximation of the concentration of dissolved solids in a freshwater source in ppm (milligrams/liter) can be obtained by multiplying your $\mu\text{mhos/cm}$, or $\mu\text{S/cm}$, value by 0.66 (the actual conversion factor may range from 0.55 to 0.80 for water of different sources). Because they are temperature dependant, measurements are usually corrected and reported as if they were made at 25°C. Most conductivity meters have the ability to correct the readings (ATC – automatic temperature compensation) to 25°C before presenting the reading on the display. When using a meter for the first time, always check to see if the correction is automatically made, or needs to be corrected, and note this in your field notebook. Specific conductance is temperature dependant and measurements should be taken in place.

Conductivity meters should be periodically calibrated. The calibrating fluid is typically a solution of potassium chloride (KCl) in de-ionized water. The concentration of KCl is variable, and is chosen based on the expected range of sample values and the range of the conductivity meter. Ranges of expected specific conductance (SpC), Eh, and pH values for various types of natural waters are given in Table 1.

TABLE 1
Typical ranges of values for some water field measurements.

Type of waters:	Specific Conductance ($\mu\text{S/cm}$)	Eh (millivolts)	pH (pH units)
rain water	2 to 100	+400 to +600	4 - 7
freshwater lakes/streams	2 to 100	+300 to +500	6.5 - 8.5
ground water	50 to 50,000	-200 to +100	6 - 8.5
brines	up to 500,000	-300 to -600	near neutral
ocean water	~ 50,000	+300 to +500	7.8 - 8.4
landfill leachate	10,000	variable	near neutral
acid mine drainage	up to 500,000	+600 to +800	below 5
wetlands / bogs	50 to 50,000	+100 to -100	variable

From: Sanders, L.L., 1998, A Manual of Field Hydrogeology: Prentice-Hall, NJ, 381p.

pH:

The negative logarithm of the hydrogen ion concentration in an aqueous solution is the pH of the solution. In other words, pH is the ability of a water to supply protons (hydrogen ions) to a base, or to take up protons from an acid. The pH of a water sample is reported in pH units on a scale that is generally taken to range from 0 to 14. Most natural waters typically range from 5 to 9. Extreme readings are rarely encountered in the field. Like specific conductance, pH is temperature dependent and measurements should be taken in place, and the actual temperature of the water should be reported for the sample along with the pH measurement. Figure 1 illustrates the range of values along the x-axis for typical types of natural waters.

Eh (redox potential):

Eh is a measure of the reduction-oxidation (redox) potential (pe) of a water sample, or stated another way, the ability of an environment to supply electrons to an oxidizing agent, or to take up electrons from a reducing agent. Eh measurements are semi-quantitative measurements and assume that equilibrium in the system has been achieved. Eh is measured in millivolts (mV, or milliV), or volts (V) and like specific conductance is reported as a corrected value at 25°C. Figure 1 illustrates the range of Eh values typically encountered in natural waters along the y-axis. Temperature of the water, amount of dissolved gases, and amount of oxygen present have a strong affect on Eh measurements. So, like specific

conductance and pH, Eh is temperature dependent and measurements should be taken *in situ*, or immediately after a water sample is taken. Ranges of expected specific conductance, Eh, and pH values for various types of natural waters are given in Table 1.

Eh meters are calibrated to one of two solutions: Zobell's Solution or Light's Solution. Both are potentially hazardous and should be handled with care. Used calibration solutions should be saved in sturdy waste containers, and disposed of in a laboratory setting. Never dump used calibration solutions into the environment.

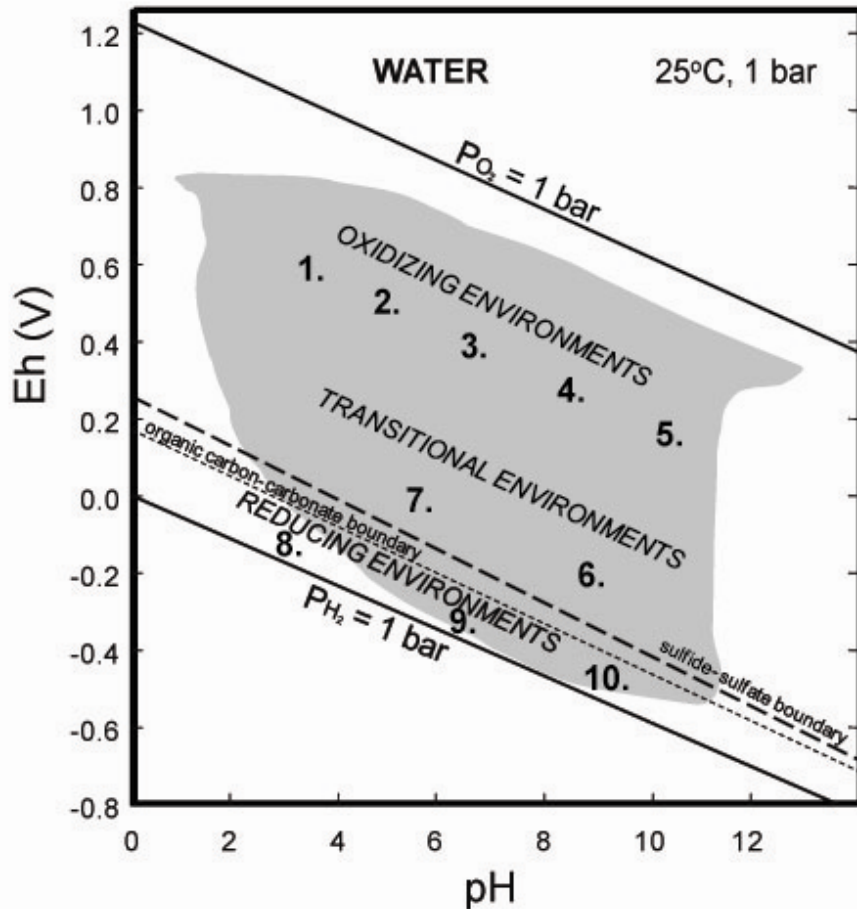


Figure 1: The framework of Eh-pH diagrams are illustrated above. Diagonal lines define the upper and lower stability limits for water at 25°C and 1 bar of pressure. The shaded area shows the generalized measured limits of Eh and pH in natural environments. (1) mine waters, (2) meteoric water, (3) streams, (4) normal marine water, (5) saline water, (6) groundwater, (7) bog water, (8) water-logged soils, (9) euxinic marine waters, (10) organic-rich, saline waters. From: Krauskopf, K.B., and Bird, D.K., 1995, *Introduction to Geochemistry*, 3rd edition, McGraw Hill, p.227.

Temperature:

Once temperature changes, it can control other parameters including Eh, pH, SpC, and concentrations of dissolved oxygen and other dissolved gases like CO₂, and H₂S. Temperature also controls rates of reactions. Temperature should always be recorded in conjunction with other measurements, and noted in degrees Celsius (°C) along with the ambient air temperature at the time of sample collection.

Alkalinity

Alkalinity (A_T) is the measure of the buffering capacity of an aqueous solution, or the ability of a solution to neutralize acids to the equivalence point of carbonate or bicarbonate. The alkalinity is equal to the stoichiometric sum of the bases in solution. In the natural environment carbonate alkalinity tends to make up most of the total alkalinity owing to its common occurrence from dissolution of carbonate rocks and the presence of CO₂ in the atmosphere. Other natural components that can contribute to alkalinity include borate, hydroxide, phosphate, silicate, nitrate, ammonia (aq), the conjugate bases of some organic acids and sulfide. Alkalinity is usually given in the unit meq/L (milliequivalent per liter). Alkalinity may also be reported in the unit ppm (parts per million) or mg/L of the constituent phase (e.g. "as HCO₃⁻").