WATER

Dictionary.com defines water as:

> A clear, colorless, odorless, and tasteless liquid, H_2O, essential for most plant and animal life and the most widely used of all solvents. Freezing point 0°C (32°F); boiling point 100°C (212°F); specific gravity (4°C) 1.0000; weight per gallon (15°C) 8.338 pounds (3.782 kilograms).

A solvent is defined as:

a. A substance in which another substance is dissolved, forming a solution.
b. A substance, usually a liquid, capable of dissolving another substance.

Our natural water supplies are derived chiefly from the oceans. Clouds are formed by solar evaporation and are driven by winds overland, to condense and precipitate as rain, snow, or hail. After these fall to the earth, they either flow over the surface or percolate into the ground. Excess water then returns to the primary source by way of the rivers that flow back to the oceans. This is known as the hydrological cycle.

Our water supplies are therefore classified into two main groups, surface water and underground waters. The surface supplies are rivers, streams, brooks, creeks, lakes, ponds and reservoirs; the underground waters are wells and springs.

The water vapor in the clouds is quite pure, but as the rain falls through the atmosphere, it gathers dust and gases. Then when it reaches the earth, it picks up impurities from the ground. The surface supplies contain suspended matter eroded from river banks, such as mud, dirt, and turbidity. In addition they contain dissolved mineral matter, leached from the earth and rocks, and organic matter and color from sewage, industrial wastes, and decaying vegetation.

The underground supplies, by virtue of the filtering effect during percolation through the earth, are usually free from suspended matter and low in organic content, but, owing to the presence of gases and longer contact with the soil and rocks, most of them contain more dissolved mater than do the surface supplies. The nature of the dissolved substances is determined by the composition of the rocks encountered. For example, hardness (calcium and magnesium) is derived from limestone and gypsum, silica from quartz, and iron and manganese from metallic constituents of the soil. The deeper wells are usually more highly mineralized than the shallow wells.

Despite their greater dissolved content, well waters have the advantage of clarity and greater freedom from bacterial contamination, making them more suitable as drinking water. They also are more constant in temperature, making them preferable for cooling purposes. Moreover, their chemical composition is more constant than that of the surface supplies, which varies with the rainfall, and this facilitates the control of their treatment.

The major impurities of our natural waters can be classed in three main groups: first, ionic and dissolved; second, nonionic and undissolved; and third, gaseous. The ionic impurities in the first group are subdivided into positively charged cations and negatively charged anions. Organic mater and color appear in both the first two groups, because there are many types. Table 1 lists these major impurities.

Table 1
Major Impurities of Water

Ionic and dissolved		Nonionic and undissolved	Gaseous
Cationic	Anionic		
Calcium	Bicarbonate	Turbidity, silt, mud, dirt and other suspended matter	Carbon dioxide
Magnesium	Carbonate	Color	Hydrogen sulfide
Sodium	Hydroxide	Organic Mater	Ammonia
Potassium	Sulfate	Colloidal Silica	Methane
Ammonium	Chloride	Microorganisms, Plankton	Oxygen
Iron	Nitrate	Bacteria	Chlorine
Manganese	Phosphate	Oil	
	Silica	Corrosion Products	
	Organic Matter		
	Color		

In general, the harmful effects of water impurities may be classified as:

a) Deposits or scales, formed in hot water heaters, boilers and other heat-exchange equipment, which act as insulation, preventing efficient heat transfer and causing equipment failures through overheating of the metal
b) Poor-quality boiler steam, which contains impurities that foul steam-using equipment such as turbines and decrease their efficiency rapidly
c) Stains, discoloration, spots, and other surface defects on dishwashers, sinks, toilets, laundry equipment, many industrial products and off-flavors and poor tastes in food and drinks
d) Corrosion of boilers, heaters, and other metal containers and piping
e) Destruction and waste of various chemicals, such as soap and alkalis used in washing, dyeing, and similar operations, resulting in undesirable precipitates on textiles being produced or laundered
f) Water unsuitable for drinking and other purposes because of objectionable tastes and odors or bacterial contamination

Hardness, one of the most common impurities in water, is defined as anything that will react with soap to form a scum or curd. Calcium, magnesium, iron, acid, and others not commonly encountered, will form a soap curd and therefore, are defined as hardness. Water containing these minerals is said to be hard water. Conversely, water devoid of

these minerals is called soft water. Salts of calcium and magnesium are the primary constituents that makeup hard water.

The amount of hardness in water supplies varies over a wide range. Table 2 gives the U.S. Department of the Interior and Water Quality Association hardness classification. In this table ppm is parts per million or milligrams per liter and gpg is grains per gallon.

Table 2
Hardness Classification

Total Hardness Range		Hardness Classification
Less than 17.1 ppm	Less than 1 gpg	Soft
17 – 60 ppm	1 – 3.5 gpg	Slightly Hard
61 – 120 ppm	3.6 – 7.0 gpg	Moderately Hard
121 – 120 ppm	7.1 – 10.5 gpg	Hard
Over 180 ppm	Over 10.5 gpg	Very Hard

Hardness can be easily removed from water by the process of ion exchange in a water softener.