Factors Affecting Groundwater Quality

An understanding of the factors that affect groundwater quality can help you make decisions on well depth and the best water quality for a particular application. There are several factors that affect groundwater quality:

- Depth from surface
- Permeability and chemical makeup of the sediments through which groundwater moves
- Climatic variations.

Depth from surface
Water is the world's greatest and most abundant solvent. It attempts to dissolve everything it comes in contact with. As a result, the longer groundwater takes to move through the sediments, the more mineralized it becomes. Thus, shallow groundwater aquifers have a lower level of mineralization, or total dissolved solids (TDS), than deeper aquifers. Water from deeper groundwater aquifers typically has a much longer trip to its destination and thus it is usually more mineralized.

While shallow wells have lower levels of TDS, they do have higher levels of calcium, magnesium and iron than deeper wells. High levels of these minerals make the water "hard." Deeper wells have higher levels of sodium and lower levels of hardness, making the water "soft." The reason is that deeper sediments and rock formations contain higher levels of sodium and as water moves downward through the sediment and rock formation, a natural ion exchange process occurs. Calcium, magnesium and iron in the groundwater are exchanged for sodium in the sediment and rock formations. The result is groundwater with higher levels of sodium and little or no hardness. The process is identical to what occurs in an automatic water softener, except in this case, it is a natural phenomenon.

Permeability of sediments
Groundwater moves very slowly through sediments with low permeability, such as clay. This allows more time for minerals to dissolve. In contrast, sediments with high permeability, such as sand, allow groundwater to move more quickly. There is less time for minerals to dissolve and thus the groundwater usually contains lower levels of dissolved minerals.

There is also a difference in dissolved solids between groundwater in recharge zones and water in discharge zones. Recharge zones are uplands areas where precipitation readily enters the ground through permeable, sandier sediments. Generally, water in recharge zones has a low level of mineralization. Discharge areas are low areas where groundwater flow eventually makes its way back to (or near) the ground surface. Groundwater found in such areas can be extremely high in minerals such as sodium, sulfates and chlorides. Examples are saline seeps, sloughs and lakes.

Chemical makeup of sediments
Another factor affecting groundwater quality is the chemical makeup of minerals. Some chemicals are more soluble than others, making them more likely to become dissolved in the water. For example, groundwater in contact with sediments containing large concentrations of sodium, sulfate and chloride will become mineralized at a faster rate than if other chemicals were present.

Climatic variations
Climatic variations such as annual rainfall and evaporation rates also play an important role in groundwater quality. In semi-arid regions, discharging groundwater often evaporates as it approaches the surface. The minerals from the water are deposited in the soil, creating a salt buildup. Precipitation infiltrating through the soil can redissolve the salts, carrying them back into the groundwater. For example, in east central and southern Alberta where annual precipitation is from 25-40 cm (10-16 in.) and the evaporation rate is high, TDS are about 2500 parts per million (ppm). In areas with higher precipitation and lower evaporation rates, precipitation that reaches groundwater is less mineralized. For example, in western Alberta where annual precipitation is more than 45 cm (18 in.) groundwater in surficial deposits contains less than 800 ppm of TDS.