DRAGUN CORPORATION'S
ENVIRONMENTAL MINUTE

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Conceptual Site Models (Part 5 of 8)

Introducing Groundwater

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Mike is a hydrogeologist with a passion for getting things right the first time. He also isn't afraid to buck conventional thought, when necessary. Mike brings these two characteristics to every environmental project he touches. Mike has a deep and broad background in hydrogeology, formed from a demanding geological engineering undergraduate degree, followed by a Ph.D. from the world-class hydrogeology program at the University of Waterloo. Mike's 15-year academic career prior to consulting served to further broaden his knowledge and hone his communication skills.

In our Environmental Minute #4, we discussed the importance of understanding the geology at a site as building a basis, the building blocks if you will, for a robust, conceptual site model (CSM). Soil and bedrock geology have significant influence on how groundwater (and contamination) will move through a site. Understanding the interaction of the geology and groundwater, "the hydrogeology" of the site, is critical to evaluating contaminant movement and, ultimately, designing a remediation or mitigation that will be successful.

Being a city kid, my first "official sighting" of groundwater came during the winter of 1974/75 when my thesis supervisor, Bob Farvolden, and I went poking around along a stream on the coldest day possible.

I thought, "But, how does a stream flow when everything around it is frozen?"
Because it is Groundwater!

"What is Groundwater?"

Technically, groundwater is any water below the ground surface. We find groundwater by digging or drilling a hole … *anywhere*. How deep we need to drill or dig to encounter free-flowing groundwater depends on several factors, including topography, precipitation, season, and soil type. If you followed the steps we discussed in our previous Environmental Minutes, you will have a fairly good idea as to how deep the water table will be at the site.

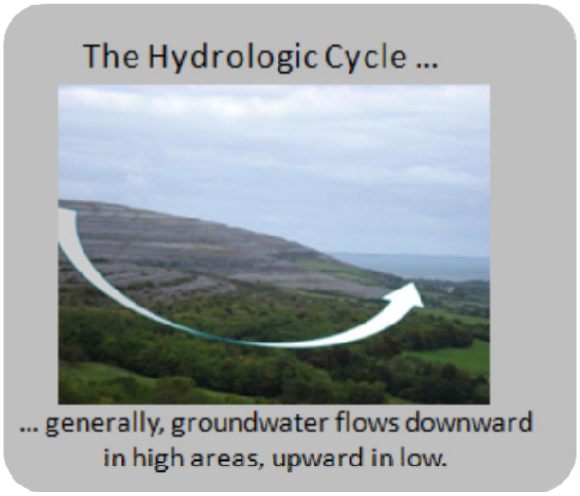
In the example above, the "surface" water in the stream is a manifestation of the shallow "groundwater." At other locations, the groundwater may be significantly deeper.

As we dig deeper, we first encounter soil or rock where the pore (open) space is not full of water. This is the "unsaturated" or "vadose zone." As we continue to dig deeper, we encounter soil or rock where the pore space is filled with water. This is the "saturated zone," the top of which is called the "water table."

Sounds simple, but it is interesting how often people get the water table wrong and the significance that can play when developing the CSM and designing a successful remediation.

So, if we have to "dig" to find groundwater, **where does groundwater originate?**

You might remember the "hydrologic cycle" from elementary school. The hydrologic cycle describes how water circulates in the biosphere.

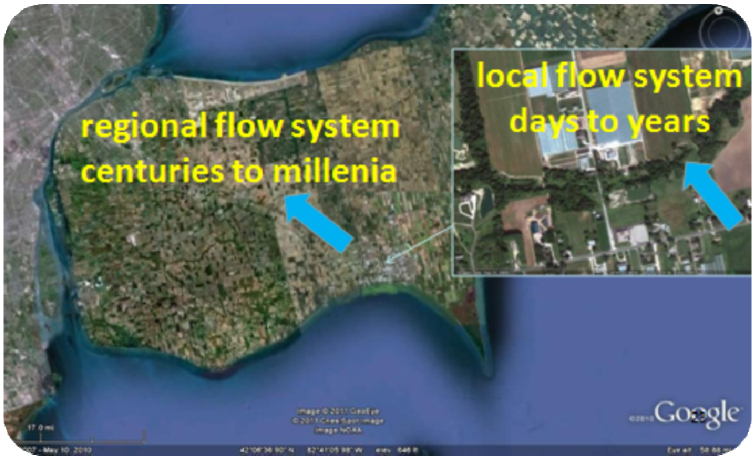


Evaporation from oceans and lakes leads to clouds and precipitation (rain, snow, etc.) that falls on the Earth. Part of the precipitation runs over the ground (i.e. rain or snowmelt runoff), part evaporates or is used by plants (evapotranspiration), and part goes into the ground.

In humid temperate areas, about 1/3 of the precipitation will make it to the water table. That groundwater eventually discharges to streams, lakes, or oceans to continue the hydrologic cycle cycling. ***These connections, and where your site is located relative to the hydrologic cycle, are significant factors*** in understanding the CSM and selecting optimal remedial options.

Timing is everything, and, in the case of contaminant transport, **the time it takes for groundwater to travel is everything** and is a significant component of developing your CSM**.**

In general, groundwater moves very, very, *very*, ***s l o w l y***. Although shallow groundwater may only take days to flow from the recharge area to discharge into a local stream, deeper groundwater may not discharge for years, centuries, or millennia. For example, groundwater below Windsor, Ontario (just south of Detroit), is more than 10,000 years old.



Understanding the rate of groundwater movement is a key to protecting groundwater supplies, selecting remedial options, and allocating responsibility for impacted groundwater.

In previous Environmental Minutes and up to this point, we have discussed the need to do your homework and to under-stand the soil, geology, and hydrogeology of the site to develop a CSM and a remedial action that has a high probability for success. We will build on this general idea in the remaining environmental minutes.

In our next Environmental Minute, we will discuss how to collect data that are reliable, useful, and representative of the site conditions; because improperly collected data will result in a faulty CSM! If you have questions about this series of Environmental Minutes, or if you have an immediate question or concern, please contact Dr. Michael Sklash (msklash@dragun.com) at 248-932-0228, ext 120.

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