

# Monitoring to Determine Effectiveness of Mitigation and Aquifer Storage/Recovery (ASR) Plans

Fate and Transport of Bacterial, Viral and Protozoan Pathogens,  
Kate Miller, DEQ

Deteriorating ground-water quality has stimulated new research initiatives that focus on subsurface fate and transport behavior of pathogens.

'Little regulatory guidance and limited understanding of how pathogens within the subsurface are affected by this type of water handling.

Factors that influence survival of enteric microorganisms within ground water matrices:

- Temperature
- Salinity
- Dissolved oxygen
- pH
- Microbial size
- Predation
- Metal/nutrient availability
- Microbial growth

Dissolved oxygen and temperature most significant factors in loss of enteric virus infectivity and bacterial activity.

Below 10C many viruses can survive for months or even years. Montana ground-water temperatures are typically below 10C

In contrast, at higher temperatures greater than 20C, inactivation of most viruses occurs rapidly.

In Florida, ASR temperatures range from 22-28 C; these conditions promote both enteric bacteria and viral die off.

Currently, there is little data on enteric protozoa (e.g. Cryptosporidium and Giardia lamblia) survival in ground water.

Thus, different conditions may promote or inhibit microbial survival and may be site-specific. Nevertheless, regular screening for coliform bacteria, indicator virus and *Cryptosporidium* should be undertaken.

- \* Surrogates (non-pathogenic bacteria) can be used in lieu of pathogens in experiments (column and field).
- \* Slight differences in aquifer properties affect the degree of subsurface microbial transport.
- \* Surface waters injected underground during ASR operation can have difference physicochemical characteristics than the groundwater they displace. However, it is unknown if introduction of water with different geochemical characteristics accelerate, inhibit or modify naturally occurring rock-water interaction and microbial-sediment interaction. These modifications may be operational on regional scales. In other words, "Can we permanently change the porosity or other physical characteristics of an aquifer by injecting water with a foreign water quality signature?" and, if so, "Does it matter?"
- \* Emphasize need to treat surface water to drinking water standards.
  - Florida experience

**From, Metge, D., 2002, Workshop Proceedings, USGS OFR 02-89: Fate and Transport of Bacterial, Viral, and Protozoan Pathogens During ASR Operations - What Microorganisms Do We Need To Worry About and Why?**