

Utilities that employ deep well injection in South Florida must maintain disinfection capability, but many do not disinfect treated effluent prior to injection. For example, treatment of wastewater that is injected by Class I municipal wells in Dade and Brevard Counties consists of secondary treatment with no disinfection, although backup disinfection capability is required. In contrast, in Pinellas County, wastewater is treated to reclaimed water standards before being discharged into Class I municipal wells, because the Class I wells are used to dispose of reclaimed water during periods of wet weather. Reclaimed water standards, as specified by the State of Florida, include secondary treatment and a variety of techniques to address pathogenic microorganisms, including filtration and high-level disinfection.

#### *B. What Stressors Remain (After Treatment) That May Be a Concern for Deep Well Injection?*

"Stressors" include chemical or biological agents that may cause adverse effects if exposure levels are high enough. They may pose a risk to human health and/or ecological health if they reach receptors (USDWs, drinking water supply wells, surface waters) at sufficiently high concentration levels. EPA has included USDW's as a receptor because of the Agency's responsibility under the Safe Drinking Water Act to prescribe regulations for State underground injection programs, like Florida's, that contain minimum requirements to prevent underground injection from endangering USDW's.

In cases where injectate has received secondary treatment only, bacteria, viruses, and protozoa (e.g., *Cryptosporidium* and *Giardia*) are generally not inactivated prior to deep well injection in South Florida. In cases, such as Pinellas County, where injectate has been treated to reclaimed water standards, viruses and bacteria have likely been largely inactivated through disinfection and protozoa have been largely removed through filtration.

Disinfection (or chlorination) by-products such as trihalomethanes may also be present in some wastewater, although no data are available to suggest that such by-products are a serious concern for deep well injection or any of the other wastewater management options studied in South Florida. EPA would not expect such by-products to be present in wastewaters that have not undergone basic disinfection, as is often the case for Class I injectate.

Nutrients are potential ecological stressors for deep well injection, assuming the injected wastewater

contains significant quantities of nutrients and assuming the injected wastewater is able to migrate underground and discharge into the ocean or into other surface water bodies. Nutrients can potentially stimulate production of algae, which can lead to adverse side effects such as eutrophication. Nitrogen is the primary nutrient concern for Class I injection, because of its mobility in ground water. Nitrogen is also the primary nutrient of concern if it migrates to the ocean, because it is generally the limiting nutrient for algae production in the ocean. Phosphorus is of less concern for underground injection because it tends to adsorb quickly to sediment or soil.

#### *C. What Exposure Pathways Are (or May Be) of Significance for Deep Well Injection?*

An "exposure pathway" is the course a stressor takes from a source of release to an exposed organism. It is defined by the different environmental media through which a stressor migrates (e.g., air, surface water, ground water) as well as the mechanism by which an organism is actually exposed (e.g., inhalation, drinking).

There are documented impacts to USDWs resulting from deep well injection in South Florida, which raise concerns about potential human exposures via the drinking water pathway. Beginning in the late 1980s, ground water monitoring wells at 18 of the 45 municipal facilities that utilize Class I deep well injection in South Florida began to detect the movement of fluid outside of the permitted injection zones. Movement of effluent into USDWs either has been confirmed or is suspected at nine facilities, as evidenced by levels of nitrates and ammonia, as well as significant changes in dissolved solids concentrations.

Contaminants released by deep well injection can migrate through the subsurface and discharge into marine and/or surface waters, where they could pose risk via other pathways if loadings were sufficiently large. Such subsurface transport is especially a concern where contaminants can migrate relatively rapidly and with relatively little attenuation through preferential flow paths (fractures, faults, and solution cavities) common in the carbonate rocks in South Florida. Potential concerns associated with injectate migrating into the ocean or other surface water bodies could include the risk of ecological damage as well as the risk of human exposure to contaminants through such recreational activities as fishing, swimming, and boating.

#### *D. What Is the Overall Estimate of Risk for Deep Well Injection?*

The human health risks associated with deep well injection of treated municipal wastewater in South Florida are generally low. Several factors affect risk levels at particular sites.

The degree of wastewater treatment, and in particular the level of disinfection and filtration of pathogenic microorganisms (e.g., *Cryptosporidium*, *Giardia*), is one such factor. Risks are lower when wastewater has been treated to remove microorganisms. For wastewater that has received only secondary treatment, risk would be high in situations where the injectate migrates through fractures, faults, and solution cavities and lower in situations where the injection is dominated by porous media flow, characterized by long travel times to current or potential drinking water sources, and flows through fine pore spaces capable of retaining microorganisms.

Once *Cryptosporidium*, *Giardia*, and other stressors are released to the environment, the level of risk they pose to human health depends largely on how likely they are to enter drinking water supplies and over what time horizon. The record shows that such contamination of drinking water supplies or USDWs is a possibility as a result of the movement of fluid found at some injection facilities. In some cases, the time frames for fluid to potentially reach USDWs are short enough that treatment of injectate (i.e., inactivation, filtration) may be warranted.

Overall, the risk to surface water ecosystems is low when treated wastewater is managed by deep well injection in South Florida. The potential for damage may be higher where treated wastewater is released in proximity to surface water that already has impaired water quality, which is the case for many surface water bodies in South Florida. In these cases, the nutrients that might enter impaired waters could exacerbate existing water quality and ecological problems. The dynamics of potential fluid movement from UIC wells to surface waters is still not well understood, however, at present there is no evidence of contamination of surface water by Class I injectate.

Deep well injection could also pose a risk to marine ecology if contaminants readily migrate and discharge to offshore waters. However, whether this actually happens in South Florida, and whether it poses a real threat in the ocean, is unknown. Given, however, that direct discharge of effluent which has received only secondary treatment and basic disinfection to the ocean