

of magnitude shorter than the porous media flow model. EPA believes, and the reviewers agreed, that this second model largely addresses the concerns raised, but recognizes that significant uncertainty regarding the dynamics of underground fluid movement remain.

4. The location and connectivity of natural conduits for flow (*i.e.*, fractures, faults, and solution cavities) are unknown, although their existence is well known by the type of rock present (*e.g.*, limestone) and confirmed by logs during deep well construction. Where such conduits are present, they may contribute to rapid migration of injected fluids or displaced formation water, with little attenuation of contaminant concentrations. Furthermore, such conduits may result in unpredictable patterns of movement in the subsurface. The relative risk assessment attempts to simulate such flows on a regional (not site-specific) basis using a first order analytical model with conservative parameter assumptions. However, there is significant uncertainty in these results.

B. Feasibility of a Hydrogeologic Demonstration

Option 2 proposed on July 7, 2000, (as described above) would allow facilities operating Class I municipal wells that have caused or may cause fluid movement in South Florida to continue injection if they perform a detailed hydrogeologic demonstration showing that injection will not cause fluids to migrate and cause USDWs to exceed any national primary drinking water regulations in 40 CFR part 141, and other health-based standards. Where this demonstration cannot be made, Option 2 would require facilities to provide additional treatment as necessary to address contaminants of concern and ensure that the continued injection does not endanger USDWs. All facilities qualifying for authorization to inject in accordance with Option 2 would be required to have advanced wastewater treatment and high-level disinfection in place by the year 2015. This requirement to phase in additional treatment by 2015 was intended to provide municipalities with more time to provide additional treatment if the municipality could conduct a successful hydrogeologic demonstration.

EPA believes the following relative risk assessment findings are relevant for assessing the feasibility of conducting a credible detailed hydrogeologic demonstration, as proposed under Option 2.

1. As noted in the preceding section, the specific location, extent, and connectivity of natural conduits for flow

are unknown and unpredictable in the South Florida areas targeted by the proposal. Therefore, some of the key parameter values that would be used in ground water modeling may be highly uncertain, and this may lead to a broad range of predicted results for the location and movement of the injected fluid. The relative risk assessment attempted to address this issue on a regional (not site specific) basis by using first order analytical methods to modeling bulk/preferential flow. This may or may not be practicable for site-specific numerical modeling.

2. The ground water monitoring wells (or networks of monitoring wells) at most deep well facilities in South Florida are sufficient only for the purpose of providing an early warning of fluid movement. Typically, ground water monitoring networks are used at waste management facilities (*e.g.*, hazardous waste landfills) to detect and characterize the movement of relatively small volumes of contaminants in shallow ground water. No deep well municipal waste disposal facilities in South Florida have designed, constructed, and implemented ground water monitoring programs capable of describing the full areal extent of fluid movement, especially where natural conduits for flow are present. In addition, few facilities perform extensive monitoring between the base of the lowermost USDWs and the shallower surficial aquifers. As noted above, however, modeling results suggest that the areal extent of contamination that reaches the surface rapidly through preferential flow may be limited (up to a few miles), although there is significant uncertainty in these results due to the volumes of fluid being injected and the possibility of fairly rapid horizontal movement in the Boulder zone below the USDW, which was not explicitly modeled.

3. It is unclear whether it would be practicable to provide enough additional ground water monitoring wells to provide the information needed to demonstrate that fluid movement is not occurring and USDWs are not being contaminated at sites where natural conduits for flow exist. Because flow could well progress at different rates in different directions, monitoring results for well locations at such sites would not necessarily be representative of conditions at unmonitored locations. Furthermore, there could be concern about the installation of many monitoring wells to examine a particular site, because they may penetrate rock and other materials that are otherwise barriers to fluid movement. If such monitoring wells are

constructed or managed improperly, they could present man-made conduits for fluid movement.

C. Some Deep Wells May Have Been Misclassified as Class I, When They Are Actually Class V

Given the extent of fluid movement documented at some sites, as well as information concerning the geology and the construction of some municipal wells in South Florida, it is possible that some wells may have been misclassified as Class I when they are actually Class V. According to the Federal UIC regulations, Class I wells "inject fluids beneath the lowermost formation containing, within one quarter mile of the well bore, an underground source of drinking water" (40 CFR 144.6(a)(2)). Class V wells are defined as wells that are not included in Class I, II, III, or IV. Typically, Class V wells release non-hazardous fluids into or above formations containing USDWs.

Separate from the issue of how Class I and Class V wells are defined, the Federal Class I and Class V UIC programs differ in their basic approach to protecting USDWs. The basic standard of protection in the Class I program is to ensure that there is no movement of any contaminant into USDWs. This standard is achieved through a Class I regulatory program that focuses on the development and enforcement of stringent permit requirements, including, but not limited to, criteria for well siting, construction, and operation and maintenance. A key component of the Class I program is ensuring that adequate confinement exists between the permitted injection zone and USDWs at a given site.

Since most Class V wells release fluids either directly into or above USDWs, they by definition cause the movement of fluid, which may contain contaminants, into or above USDWs. Therefore, the basic standard of protection in the Class V program is to prevent any contaminants in the fluid from endangering USDWs. Protection efforts in the Class V program mainly focus on regulating and monitoring injectate quality to ensure that the movement of injected fluid will not contain any contaminants that may endanger USDWs. This standard is achieved through inventory and assessment requirements, additional reporting requirements, closure requirements, and other requirements (possibly including permitting requirements) believed by UIC program staff to be necessary to protect drinking water supplies.

The failures of confinement that have been documented at some municipal