

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 more stringent 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 plus a variety of techniques to remove microorganisms, including basic disinfection, filtration, and high-level disinfection.

## 2. Ocean Disposal

Utilities in South Florida that employ ocean disposal provide basic disinfection in addition to secondary treatment prior to discharge. Basic disinfection removes fecal coliform bacteria by treating the wastewater with chlorine. However, wastewater that is discharged into the ocean does not undergo filtration. This means that pathogenic protozoans, such as *Cryptosporidium*, *Giardia*, and other chlorine-resistant microorganisms, may remain in the treated wastewater.

## 3. Aquifer Recharge

Utilities that employ aquifer recharge (which includes but is not limited to replenishment of surficial aquifers through irrigation, wetlands discharge, or discharge to percolation ponds) treat to reclaimed water standards prior to discharge. Small amounts of nitrogen and phosphorus and trace amounts of other inorganic and organic constituents remain. However, viruses and bacteria are inactivated and *Cryptosporidium* and *Giardia* are largely removed through filtration.

## 4. Surface Discharge

Utilities in South Florida that employ surface water discharges provide advanced treatment as required to meet State water quality-based effluent limits. Advanced wastewater treatment includes secondary treatment, basic disinfection, filtration, high-level disinfection, removal of chlorine following disinfection (*i.e.*, dechlorination), and further removal of nitrogen and phosphorus. It represents the highest level of treatment conducted in South Florida.

### B. What Stressors Remain (After Treatment) That May Be a Concern?

“Stressors” include chemical or biological agents that may cause adverse effects if exposure levels are high

enough. The relative risk assessment report describes the human health and ecological health stressors that may be found in wastewater effluent after it has been treated and that may pose a risk.

### C. What Exposure Pathways Are (or May Be) of Significance?

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, topical contact). The relative risk assessment report discusses a variety of exposure pathways by which humans, plants, and animals may be exposed to municipal wastewater contaminants under each of the management options.

### D. What Is the Overall Estimate of Risk?

Although the report does not quantify risks, it offers conclusions about the relative risks of the four wastewater management options and about the various factors that influence risks to human and ecological health.

#### 1. Human Health

The human health risks associated with all four management options in South Florida are generally low. While it is difficult to compare the overall risks of the options directly, a relative comparison can be made on the basis of certain factors that tend to increase or decrease the risks of one or more options relative to the others. In particular, as discussed in turn in the following paragraphs, relative human health risks are higher when: (1) An option provides less wastewater treatment; (2) is more likely to contaminate current or potential drinking supplies; and (3) is more likely to result in people being exposed to discharged contaminants in other ways besides drinking.

The degree of wastewater treatment, and in particular the level of disinfection and filtration of pathogenic microorganisms (*Cryptosporidium*, *Giardia*), is a major risk driver. Clearly, there is greater potential risks associated with wastewater that is not treated to remove microorganisms. This would suggest higher relative risks for the deep well injection and ocean disposal options, which generally do not filter wastewater to remove *Cryptosporidium* and *Giardia* prior to disposal. Looking just at deep well injection, the risk would be highest in situations where the injectate migrates through fractures, faults, and solution cavities. The risk

associated with *Cryptosporidium* and *Giardia* being released by deep well injection would be mitigated somewhat in situations where the injection is dominated by porous media flow, characterized by long travel times to current or potential drinking water sources and 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. The relative risk assessment again suggests that deep well injection has a higher risk than the other options based on this factor. Movement of contamination into USDWs has been confirmed or is suspected at 9 of the 45 municipal facilities that utilize Class I deep injection in South Florida, as evidenced by levels of nitrates and ammonia, as well as significant changes in dissolved solids concentrations. The other option with a relatively high risk of contaminating drinking water supplies is aquifer recharge. Ocean outfalls and surface water discharges pose a lower risk of contaminating drinking water supplies, for reasons given previously.

Relative to the other options, however, ocean outfalls and surface water discharges pose a higher risk of people coming into direct contact with the released contaminants in other ways, such as by eating contaminated fish, by swimming in contaminated waters, and by participating in other recreational activities. These same two options also pose a risk of stimulating algal blooms that could be harmful, although this risk associated with surface water discharges is mitigated substantially by the removal of wastewater nutrients prior to release to surface waters in South Florida.

#### 2. Ecological Health

Overall, the risk to surface water ecosystems is low when treated wastewater is managed by deep well injection and aquifer recharge in South Florida. The risk to surface water ecosystems is also generally low when treated wastewater is discharged directly to surface waters. For all three of these management options, however, 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.