Reducing health risks of treated wastewater

BY KATHLEEN KEARNS

The 16,000 municipal wastewater treatment plants in the United States produce about 6 million tons of biosolids every year, and all those solids have to go somewhere.

More than half of the biosolids are applied to agricultural land, according to estimates. The rest are incinerated or spread on forest land or in landfills. Depending on how source sludge has been treated, biosolids may be pathogen-free (Class A), but most are currently treated by Class B processes, which do not destroy all pathogens.

Both classes are allowed to be spread on agricultural land—biosolids, in fact, are considered a useful amendment in the soil. But the practice is not without controversy, and there are many restrictions on where and when Class B biosolids can be applied because of concerns about exposing humans to serious health risks.

"We know bad things can happen when fecal matter with undesirable levels of pathogens is applied to agricultural land," says Dr. Mark Sobsey, UNC Kenan Distinguished Professor of environmental sciences and engineering in the UNC School of Public Health. "Think of recent outbreaks of *E. coli* from contamination of spinach or lettuce because fecal matter from people or animals got on food which we eat raw. Pathogens can also migrate into groundwater."

UNC School of Public Health researchers have investigated innovative treatment methods that result in safer Class A biosolids and are developing a protocol to investigate health concerns that might be related to the application of biosolids on agricultural fields.

Sobsey and Dr. Michael Aitken, chair of the School's Department of Environmental Sciences and Engineering, recently completed a project for the city of Columbus, Ga., to investigate whether a conventional sludge treatment process could be adapted to produce Class A biosolids. In most sewage treatment plants today, wastewater goes through a multi-step process that aerates it and allows impurities to settle in a series of basins. What settles out contains biodegradable solid material that can attract vectors of disease (such as insects or rodents) and so must be treated before being released into the environment.

Dr. Michael Aitken

"Usually, the treatment is another biological process, referred to as the digestion process," Sobsey explains. "In many places, that process is done without oxygen at moderate temperatures — either ambient outdoor temperatures or a little higher. While that process is reasonably effective at degrading some of the organic matter in sludge and making it more stable, it doesn't do much to kill off pathogens."

Billy Turner, president of Columbus Water Works in Georgia, earned a master's degree in environmental sciences and engineering from Carolina and was well acquainted with the expertise on tap here. With funding from the Environmental Protection Agency (EPA), Columbus Water Works invited Aitken and Sobsey to investigate whether using higher temperatures — a process called thermophilic anaerobic digestion — would meet the EPA's standards for producing Class A biosolids.

Approximately 3 million tons of biosolids (treated sludge) produced by U.S. wastewater treatment plants are applied to agricultural land each year. UNC researchers are investigating innovative treatment methods that result in safer Class A biosolids and are developing a protocol to investigate health concerns that might be related to the application of biosolids on agricultural fields.

Thermophilic anaerobic digestion degrades organic matter and reduces pathogens through the combined effects of biological activity and exposure to temperatures in the mid-50s Celsius. The process has been well known for several decades, and laboratory and field studies have documented that it reduces disease-causing microorganisms to very low levels.

UNC School of Public Health researchers have found that treating sludge with a process called thermophilic anaerobic digestion removed all viruses, bacteria and parasites.

The problem, Sobsey says, was that "the way it's typically carried out does not allow for all the sludge to be exposed to the higher-temperature digestion process long enough to have its load of pathogens sufficiently reduced. The project in Columbus intended to document that if the process was applied in such a way that all of the sludge could get exposed to the digestion process at thermophilic temperatures for a sufficient period of time, then indeed it would have its pathogen content dramatically reduced to the low levels EPA requires to be considered a Class A process."

Aitken and Sobsey first ran experiments in the laboratory to document performance of the process. A national environmental engineering firm, Brown and Caldwell, took time and temperature conditions Aitken and Sobsey determined to be adequate and designed a prototype system at the Columbus plant to meet them. Modifications ensured that all the sludge would be treated at known temperatures for a known period of time, long enough to get rid of the pathogens.

Aitken and Sobsey documented that at the end of the modified process, the biosolids were free of viruses, bacteria and parasites. The EPA approved Columbus Water Works' method as a Class A procedure. The prototype system received an award for excellence in environmental engineering from the American Academy of Environmental Engineers.

"We suspect the process will become more widespread, and of course, that was the goal," Sobsey says. "A lot more utilities will be able to make only minor modifications to their processes and have the benefits of being able to get Class A sludge."

Developing protocols

Aitken also has been working with Dr. Steven Wing, UNC School of Public Health associate professor of epidemiology, to develop protocols for investigating reports of health concerns that may be related to the application of biosolids on agricultural fields. "What's driven both projects is the underlying concern that potential human-health impacts of land application of biosolids have really not been well established," Aitken says. "Municipalities like Columbus are much more interested in producing Class A biosolids because, by destroying the pathogens, they have removed a significant health concern." Complaints about land application of Class B biosolids have been so vociferous in some areas that some communities have prohibited the practice, Aitken notes.

Wing, the principal investigator for the project, says that some people who live near sites where biosolids have been applied report respiratory, gastrointestinal and dermatologic problems that they attribute to exposure to pollutants that migrate off-site. Biosolids contain nutrients and have value for the soil for agriculture, he notes, but they also can contain endotoxins, live pathogens, metals and chemicals that run off from streets or are flushed down the drain by industry. "When the material is applied to land, it can in some situations move off-site in the air. It's also possible that when it rains, the material could migrate down into groundwater or run off into local surface water."

The protocol on which the team is working includes a health questionnaire that could be administered by a responding agency, such as a health department. It also includes various means to acquire information about sources of sludge; how sludge was treated, stored and applied; and its potential to migrate off-site. "We're also including guidelines that could be used by an agency if they felt they needed to go on-site and investigate through inspection and other measures," Wing says. The information that's gathered also could be entered into a large database, which would facilitate an epidemiological study of links between biosolids and health. The project is funded by the Water Environment Research Foundation, a research agency supported by various wastewater utilities, state agencies, industries and consulting firms, as well as by the EPA. ■

TIP: Keep your septic system in good working order. Mow the septic field often, inspect your tank annually and pump it out at least every three to five years. Failing septic systems leach organic wastes that can cause excessive algae growth and disease-producing pathogens in water sources.

UNC faculty train North Carolina wastewater treatment plant operators

Dr. Donald Francisco

More than 7,200 North Carolina wastewater treatment plant operators owe their training to Dr. Donald Francisco, clinical professor emeritus of environmental sciences and engineering at the UNC School of Public Health. Francisco coordinated the North Carolina Annual School for Wastewater Treatment Plant Operators for 32 years (1971 to 2003). The curriculum and instructors are approved and selected by a committee of the N.C. Water Environment Association. Francisco chaired that committee for 33 years. In 2003, in recognition of his service, the N.C. chapter of the American Water Works Association and Water Environment Association, named Francisco the first recipient of a new award named in his honor—the "Donald E. Francisco Educator of the Year Award." ■

UNC researchers recently completed a project for the city of Columbus, Ga., exploring whether a process called thermophilic anaerobic digestion could reduce the number of disease-causing microorganisms in sludge treated by this process. They found that the process removed all viruses, bacteria and parasites from the sludge. The thermophilic anaerobic digester prototype in Columbus (right) was constructed by modifying a conventional sludge treatment processing system.