Site Specific Risk Assessment Tools for Land-Applied Biosolids

Current biosolids regulations use treatment requirements and site restrictions for pathogens because reliable microbial risk assessment methods were not available when the regulations were developed. While land application has proven to be a safe and desirable way to manage biosolids within these regulations, practitioners constantly strive to improve the efficacy of the practice. The WERF Research Challenge, *Applying Advances in Pathogen Risk Assessment and Communicating the Results*, took advantage of advancements in pathogen risk assessment to provide new tools for wastewater utilities, land appliers, and regulators to further ensure the safety of land application practices.

The SMART Biosolids Tool provides estimates of human illness as a result of exposure to biosolids from five pathways.

From 2009 until 2011, WERF supported researchers at five universities (Drexel, Carnegie Mellon, Michigan State, Utah State, and University of Arizona) who worked collaboratively to investigate the microbial risks associated with the land application of biosolids. The research developed a range of products to inform biosolids management, including: 1) a site specific microbial risk assessment tool, 2) results of a field monitoring study that addressed the impact of wet weather on the mobility of pathogens in biosolids, and 3) results of surveys and workshops on appropriate stakeholder engagement processes for land application programs. Each product brings a different but important source of information to aid in the development of effective land application programs. The risk assessment tool brings technical modeling and risk assessment knowledge to program management, the field monitoring serves to inform and validate the modeling tool, and the surveys and workshops help to collect and report practical knowledge from dozens of land application program managers.

Innovative Approaches Will Enable Many Practitioners to Assess Their Own Sites

The research team developed a microbial risk assessment model for land application, called the Spreadsheet Microbial Assessment of Risk: Tool for Biosolids (SMART Biosolids). This model provides estimates of human illness as a result of exposure to biosolids from five pathways: 1) inhalation, 2) ingestion of groundwater, 3) ingestion of surface water, 4) incidental ingestion of soil-amended with biosolids, and 5) ingestion of produce impacted by runoff from a biosolids amended field. A spreadsheet environment is used for the model because many biosolids professionals are already familiar with spreadsheets, making this a user-friendly format for the model. In addition, spreadsheets are easily modifiable and adaptable to different uses. This enables users to draw on a library of microbial occurrence data, dose-response models, and dispersion and attenuation models to custom build risk assessments for different scenarios, beyond those already built into the model. This model will assist engineers and managers in assessing the appropriateness of different sites for land application, and the risk reduction achieved by various potential setback distances.

BENEFITS

- Provides a tool for regulators and land applicators to perform site-specific assessments of microbial risk.
- Provides insight into the relative risks associated with 24 associated pathogens and five exposure pathways.
- Helps estimate the effect of different setback requirements on microbial risk.
- Provides estimates of the correspondence between indicator organisms and pathogens.
- Provides a compilation of a wide variety of information used in quantitative microbial risk assessments with the sources of all parameter values identified.

RELATED PRODUCTS

A Dynamic Model to Assess Microbial Health Risks Associated with Beneficial Uses of Biosolids (98REM1)

Application of a Dynamic Model to Assess Microbial Health Risks Associated with Beneficial Uses of Biosolids (98REM1a)

Assessing the Fate of Emerging Pathogens in Biosolids (01HHE3)

Quantification of Airborne Biological Contaminants Associated with Land Applied Biosolids (02PUM1)

A Strategic Risk Communications Process for Outreach and Dialogue on Biosolids Land Application (SRSK2R08)

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Field Monitoring Validated Models

The mathematical model drew on a wide variety of information in the technical literature on how pathogens move in the environment. Much of this previous research had been conducted in arid climates. Additional field monitoring was therefore focused on how wet weather influences the fate of biosolids-associated contaminants (BACs). Three media (soil, surface water, and tile-drain effluent samples) were sampled and analyzed after biosolids application events on a field site equipped with tile-drains. Tile-drains are networks of perforated pipes that are placed below agricultural fields to intercept and collect irrigation water before it reaches the groundwater table beneath the field. All samples were analyzed for 11 BACs: fecal coliforms, *E. coli*, enterococci, somatic coliphage; Salmonella; adenovirus 40/41, total adenovirus, enterovirus, hepatitis A virus; tetracycline-resistance bacteria, and tetracycline-resistance genes. After the biosolids application, no significant differences in microbial quality of soil and tile-drain effluent samples were observed. No pathogens were observed in environmental media after the application. Findings of this study indicated that the biosolids did not appear to contribute additional contamination to environment.

At the second site, the monitoring focused on the evaluation of leaching and ponding of viral contaminants following land application of biosolids on sandy-loam soil. Portable rainfall simulators were used to evaluate the transport of viral contaminants under nearly saturated conditions. Samples were collected and analyzed for somatic phage, adenoviruses, anionic, and microbial tracers.

Neither study was able to measure detectable quantities of pathogens after transport through several feet of soil in the field. However, the second study did quantify some desorption of pathogens and indicators into ponded surface water, suggesting that runoff from biosolids amended fields may have trace amounts of pathogens. The risk assessment model can be used to quantify the risks this runoff might pose to surface waterbodies on a site-specific basis, but example scenarios suggest that microbial risk due to contamination of surface waters from land application runoff would be more than a factor of 10 below existing risk standards for recreation surface waters.

Program Management Guidance

While results of field studies and mathematical modeling give insight into risk associated with land application, the actual experiences of biosolids professionals constitute a third major source of information that had not been gathered systematically. The research team sought to indentify both concerns and promising program strategies by drawing on the knowledge of biosolids professionals. The team conducted numerous phone interviews, administered two surveys, and convened two workshops on program management issues. Program managers shared strategies, such as notifying neighbors before applying, providing farmers with educational materials to distribute to their neighbors, maintaining a large bank of available land application sites that enable them to accommodate request by neighbors to reschedule land application, and developing enforceable standards for odor. These results have also informed an assessment of where process or program failures might lead to inappropriate exposure to biosolids and have also identified promising strategies of engaging the public and managing a land application program. The knowledge captured by these efforts can provide guidance to land application program managers seeking to both substantively improve risk management and to productively engage the public to ensure the success of land application programs.

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The research on which this report is based was funded in part by the U.S. Environmental Protection Agency (U.S. EPA) through Cooperative Agreement No. CR-831559-01 with the Water Environment Research Foundation (WERF). Unless an U.S. EPA logo appears on the cover, this report is a publication of WERF, not U.S. EPA. Funds awarded under the agreement cited above were not used for editorial services, reproduction, printing, or distribution.

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