Microbial Risk Assessment Interface Tool: User Documentation

Assessing the public health risk from exposure to microorganisms has become more important as sampling and analytical techniques have improved. Microbial risk assessment (MRA) is an iterative process that evaluates the likelihood that adverse health effects will occur following exposure to a pathogenic microorganism. MRA investigations have not been widely conducted as routine components of reclaimed water investigations. To facilitate microbial risk assessments, researchersdeveloped a software package for water and wastewater utility engineers and managers who have a basic understanding of quantitative MRA. The MRA Interface Tool facilitates the evaluation of the potential public health risk associated with the ingestion of a range of pathogens from exposure associated with reclaimed water uses.

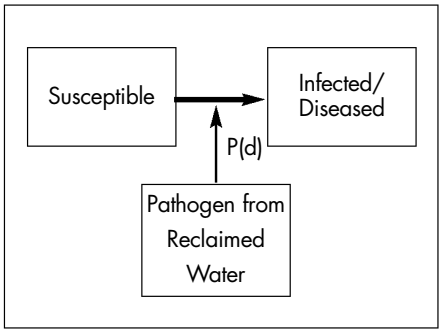

Figure 1. Static risk assessment conceptual model

In 2004, WERF issued *Evaluation of Microbial Risk Assessment Techniques and Applications* (stock no. 00PUM3). The research evaluated different methodologies used for microbial risk assessment, and demonstrated—through case study examples—the most applicable microbial risk assessment methodologies for reclaimed water applications within the context of existing reuse regulations. This project builds on those results, producing an electronic version of the MRA Interface Tool (a Mathcad worksheet) and a user's documentation report, with extended appendices in the basic report.

The software provides the ability to use both static (individual-based, as presented in Figure 1) and dynamic (population-based, presented in Figure 2) models.

For both static and dynamic models, parametric variability and uncertainty are addressed via Monte Carlo simulations. Multiple simulations generate a distribution of the resulting risk that represents both the uncertainty and variability in the input parameters .

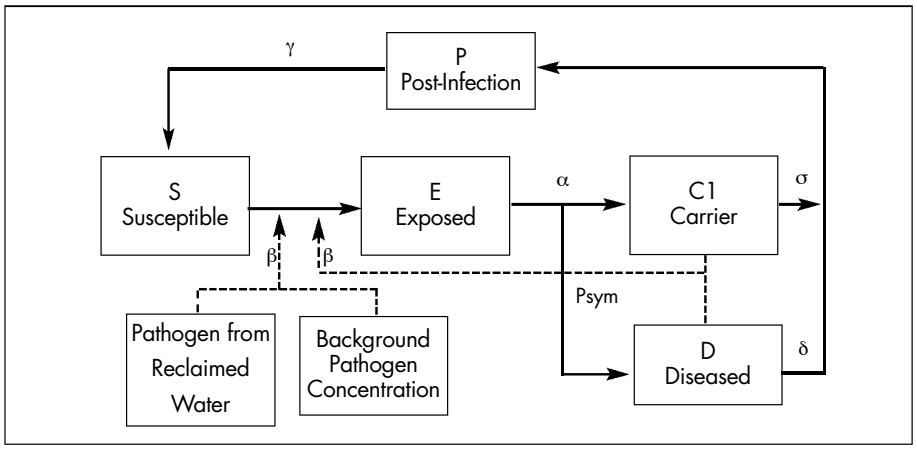

Figure 2. Dynamic risk assessment conceptual model

BENEFITS

- Simplifies microbial risk assessments for human exposure to pathogens in reclaimed water.
- Provides water and wastewater utility managerswith a streamlined ability to make informed risk-based management decisions about reclaimed water treatment, end uses, and management options.
- Enhances the transparency of the microbial risk assessment process.
- Provides a straightforward means of evaluating the potential public health risks associated with existing or proposed water reclamation regulations.

RELATED PRODUCTS

Evaluation of Microbial Risk Assessment Techniques and Applications (00PUM3)

Pathogen Removal and Inactivation in Water Reclamation for Nonpotable Uses (00PUM2T)

Online Toxicologic Methods for Ensuring Safety of Reclaimed Water (01HHE4A)

Removal of Endocrine Disrupting Compounds in Water Reclamation Systems (01HHE20T)

RELATED ONGOING RESEARCH

Pathogen Risk Indicators for Wastewater and Biosolids (03-HHE-2)

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EXECUTIVE SUMMARY

A New Interface

The MRA Interface Tool is implemented as an open source Mathcad worksheet. Mathcad is a software program developed by Parametric Technology Corporation (formerly Mathsoft, Inc.). The MRA Interface Tool requires the user to have Mathcad running on their computer. The tool takes pathogen concentration data as input. The user specifies the pathogen that the input data correspond to, additional or incremental wastewater treatment that occurs prior to human exposure, and the route of human exposure to the pathogen of interest. The interface tool contains default values based on published literature for all model parameters including dose-response relationships for a variety of pathogens and the ingestion rates associated with different exposure pathways. The tool allows the user to accept or override any of the default parameter values. It recommends a static or dynamic risk characterization methodology based on the input data and the user's model parameter selections. An estimate of the potential public health risk associated with the specific pathogen and exposure scenario is made via numerical simulation. The results are presented graphically.

User Documentation

Hardware and software requirements Mathcad version 13 or higher is required to open and run the MRA Interface Tool worksheet. The worksheet runs numerical simulations, and these simulations can be computationally intensive. It is recommended that Mathcad be installed and the worksheet be run on a computer with a fast processor and a minimum of 512 MB of RAM. It is also recommended that the worksheet be run on a computer with an up-to-date operating system (the worksheet was developed using Windows XP).

The amount of time required to run the numerical simulations varies from computer to computer. Static simulations are usually completed in less than one minute for any number of simulations (up to the maximum of 5,000). A typical run of 100 dynamic simulations on a notebook computer with a 1.5 GHz Pentium-M processor and 512 MB of RAM are completed in approximately one minute. One thousand simulations on the same computer are completed in less than 15 minutes and 5,000 simulations may take over an hour.

User Mathcad knowledge requirements The user needs to have a basic knowledge of Mathcad, including: opening files in Mathcad; entering data into a textbox; maneuvering through the worksheet; making changes to the layout and programming codes; and saving the worksheets. It is recommended that users complete the Mathcad tutorial in the help menu before using the MRA Interface Tool. A more extensive knowledge of Mathcad is required for advanced users who intend to modify the worksheet or review equations used to implement simulations.

Putting the Interface Tool to Use

The usefulness of the MRA tool, highlighting the type of output that can be expected, is presented in Appendix B of the report. In the case study using *Cryptosporidium*, a microbial risk assessment was desired to estimate the risks to an individual for a single exposure event. The MRA tool was able to output a median risk of infection of approximately $1x10^{-4}$ per recreation event with lower and upper 90% confidence bounds of $4x10^{-6}$ and $5x10^{-3}$, respectively. It was assumed that *Cryptosporidium* data are available for raw wastewater which will be treated by a conventional tertiary wastewater treatment plant employing primary treatment, activated sludge secondary treatment, clarification, coagulation, and chlorine disinfection.

Results should be interpreted with extreme caution. There are numerous factors that could cause estimated risk to be higher or lower than reported. Treatment efficiencies of various wastewater treatment facilities are known to vary substantially from facility to facility and over time. It should be clear that accurate site specific information should always be used whenever possible.

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To purchase Mathcad, please contact Mr. Gordie Clarke, Account Manager, at gclarke@ptc.com or call 781-370-6704.

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