Abstract: Historically the design of water treatment systems (including potable reuse systems) with respect to pathogen removal has been based on the concept of multiple barriers. Although leading to important improvements in human health, this approach has not well considered variability and uncertainty of performance. In addition, common failure modes have not been addressed. The tools of risk analysis and probabilistic modeling are useful in advancing the state of understanding and design, and perhaps reducing over-design of systems. Particularly with the increasing tractability of physics-based (e.g., computational fluid dynamic) models, it is becoming more feasible to use these approaches. However there are a number of basic limitations in our knowledge of process dynamics that limit full use of these approaches for dynamic systems.

In this talk, I will review the history and current applications of multiple barrier design, present a conceptual framework for more advanced consideration, and highlight research needs that would facilitate application of these approaches.