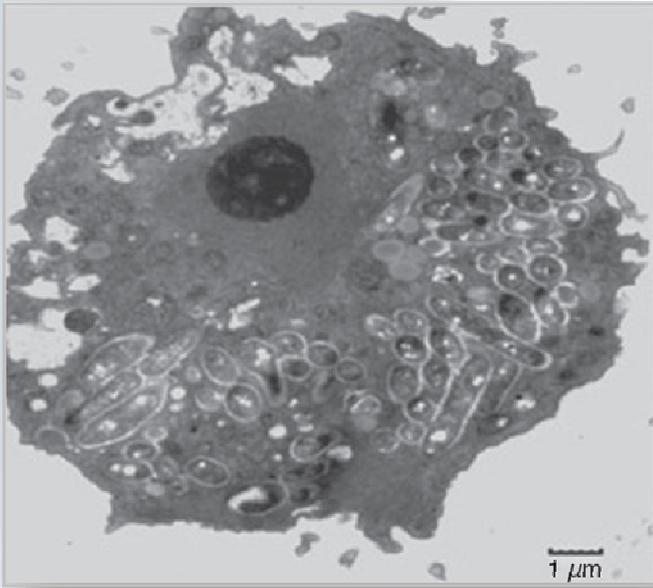


### **INFLUENCE OF DISINFECTANT RESIDUAL ON BIOFILM DEVELOPMENT, MICROBIAL ECOLOGY, AND PATHOGEN FATE AND TRANSPORT IN DRINKING WATER INFRASTRUCTURE**

#### **IMPACT STATEMENT**

One of the U.S. Environmental Protection Agency's (EPA) primary roles is that of an advocate for sustainable water infrastructure. Biofilms, which form on interior surfaces of the drinking water infrastructure, can sequester, accumulate and protect viruses, bacteria, fungi, and parasitic protozoa. Release of biofilms may therefore release a more infectious dose back into drinking water. The experimental studies performed through this project are designed to evaluate risks to human health posed by pathogens associated with these biofilms, initially focusing on bacterial pathogens that may grow in association with amoebae in biofilms. By providing the science and engineering information that we and our partners need, EPA research contributes measurable results that advance our efforts to ensure safe drinking water.



*Legionella* cells growing within an amoeba that may colonize piped water biofilms

#### **BACKGROUND:**

Biofilms form on interior surfaces of the drinking water infrastructure, including storage facilities and distribution systems. Pathogens may enter drinking water systems in the bulk water or through intrusions or physical breaches. Biofilms can sorb pathogens (viruses, bacteria and parasitic protozoa) and serve as a protective niche for their survival. In addition, opportunistic pathogens, principally respiratory pathogens such as nontuberculous mycobacteria [NTM] and *Legionella*-like bacterial pathogens, may grow within biofilms in storage facilities and distribution systems, including premise plumbing. Recent data suggests that disinfection practices may selectively control opportunistic pathogens. For example, chloramination is reputed to control *Legionella*, but may be less effective for NTM bacteria. However, there are limited data on how disinfection strategies impact the biofilm community structure that may support opportunistic pathogens and that may also provide a niche for sequestering fecal pathogens. Current models assessing risks from drinking water are limited by not accounting for pathogen biofilm effects.

#### **DESCRIPTION:**

This project focuses on providing basic data to bound risk estimates resulting from pathogens associated with pipe biofilms. Researchers will compare biofilm pathogen effects under two different disinfection scenarios (free chlorine or chloramines) for a conventionally treated source water (Potomac River). Samples will be collected from storage facilities, dedicated sampling taps used for TCR compliance monitoring, and biofilm swabs from household cold water taps and shower heads (premise plumbing). Microbial community structures, NTM, and *Legionella*-like bacteria and their amoebae hosts will be characterized. Potential novel biomarkers of exposure will be collected and used to explore the

potential for salivary and urine antibody tests. Water quality data, operations information, and system condition information will also be collected to aid in interpretation of microbial data. In addition to disinfectant residual, key water quality variables including nitrogen species (ammonia, nitrite, nitrate, and organic-nitrogen), phosphorus, metals (lead, copper, arsenic), fluoride, organic carbon, pH, alkalinity, temperature, sulfate, chloride, and other inorganics will be assessed. All potential pathogens will be genotyped and stored for future reference. In addition, if a water main break or other ingress event occurs during the project-sampling phase, material will also be stored for molecular identification of fecal pathogens and indicators.

EPA's Office of Research and Development has funded this research project in support of its Aging Water Infrastructure Research Program. Phase I of this project will run from March 2010 through March 2011, and dependent on project success, Phase II will run for a second year.

**EPA GOAL:** Goal #2 - *Clean & Safe Water*; Objective 2.1.1- *Water Safe to Drink*

**ORD MULTI YEAR PLAN:** Drinking Water (DW), Long Term Goal (LTG) - DW-1 *Characterize risks associated with DW sources, distribution, treatment, and use*

#### **RESEARCH PARTNERS:**

- EPA's National Exposure Research Laboratory: Stacy Pfaller (NTM); Shay Fout (salivary antibodies)
- EPA's National Risk Management Research Laboratory: Laura Boczek (biofilm disinfection); Randy Revetta (biofilm community structure)
- EPA's National Health and Environmental Effects Research Laboratory: Elizabeth Hilborn & Andrey Egorov (human health effects)
- EPA's Office of Water: Susan Shaw (coordination of EPA staff/home access)
- Washington Aqueduct & WSSC contacts

#### **EXPECTED OUTCOMES AND IMPACTS:**

It is expected that this study will have a direct impact on public health by providing utilities information on pathogen risks associated with biofilm growth in storage facilities and water distribution systems. This information will facilitate better management decisions, which will result in a decrease in the risk of waterborne illness.

#### **OUTPUTS:**

Primary outputs from this project will be journal and technical papers describing key parameters that will enable quantitative microbial risk assessments of opportunistic and fecal pathogens associated with biofilms in drinking water systems. This information will enable updates to EPA's hydraulic models for drinking water distribution systems, so that the role of pathogen-biofilm interactions can be included.

#### **RESOURCES:**

Aging Water Infrastructure Research Program: <http://www.epa.gov/awi/>

National Exposure Research Laboratory: <http://www.epa.gov/nerl/>

National Risk Management Research Laboratory: <http://www.epa.gov/nrmrl/>

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Drinking Water



Aging Water Infrastructure