Status of Bacterial Monitoring

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ASU REGIONAL WATER QUALITY WORKSHOP
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Project Objective

Provide timely input on water quality issues such as:

• Taste and odors for process control and canal-management decisions
• To build a database of microbial quality in the source waters
• Critical information on other water quality parameters in the water supply system
• Conduct applied research
• Education/Communication
Microbial Contaminants

- Coliforms – *E. coli*
  - Standard for microbial quality of water
- Emerging Contaminants
  - Contaminant Candidate List 4
    - *Campylobacter*
    - *Helicobacter*
    - *Legionella*
    - *Mycobacterium*
    - *Salmonella*
    - *Shigella*
    - *E. coli O157*
Mycobacterium Associated Common Clinical Syndromes

- Pulmonary infection
- Lymphadenitis
- Otologic infection
- Skin and soft tissue infection,
- Catheter-associated infection
- Disseminated infection
- 25% to 50% of individuals with AIDS will get Mycobacterium infection
**Mycobacterium**

- Relatively resistant to disinfection including chlorine
- Multiply in water that is essentially devoid of nutrients
- Recovered from surface, ground & waste waters
- Recovered from aerosols associated with water sources.
- Incidence increasing
  - 1983–1996: 1.8 to 7.7 per 100,000 (CDC 1999)
  - 1997–2003: 1.9 to 9.0 per 100,000 (Marras 2007)
- <20 to 10,400 CFU per day can be ingested
  - If water has mycobacteria concentration ranging from 0.01 to 5.2 CFU/mL
Nontuberculous Mycobacteria in Tap Water

• A Study conducted in the U.S.
  • No of distribution system: 8
  • Water treatment: 2 to 4 log reduction in mycobacteria in raw waters
  • No of sample collected: 583 (528 water; 55 biofilm)
  • Positive for NTM: 15 %
  • Concentration of NTM: 10 to 700,000 CFU/L
  • *Mycobacterium intracellulare* more prevalent in biofilms

• A study conducted in Australia
  • No of sites: 384 (189 summer & 195 winter)
  • Positive: Summer 40.21% (76/189); Winter 82.05%(160/195).
    (BMC Microbiology.2013. 13:89)

• A Study conducted in the U.S. in 2011
  • Public/private system: 19/27 positive
  • Well: 5/12 positive
Legionella – An Emerging Threat

- More outbreaks than any other microorganisms
- EPA Candidate Contaminant List 3 & 4
- Human – Lung infection –pneumonia outbreaks
  - 8,000 to 100,000 cases annually
  - Fatality rates 5% to 30%
- Also know to infect and proliferate in
  - 13 species of amoeba
  - 2 species of ciliated protozoa
- Prevalent in environmental water
  - How does it transport in subsurface environment?
Legionella Physiology

• Single genus family containing over 50 species

• Heterotrophic, gram-negative, non-encapsulated, aerobic, differentially motile

• Highly pleiomorphic forming cocci, baccili, and filaments
Legionella

- Relatively resistant to disinfection including chlorine
- Survive and multiply in water that lacks nutrients
- Recovered from surface, ground & waste waters
- Recovered from aerosols associated with water sources
- Incidence increasing
Legionella in the US Waters

- CDC MMWR Report 2009-2010
- 19/33 drinking water
- 7/12 non-recreational water

2000–2014: 286% increase in reported cases of Legionella per 100,000 population in the U.S.
Legionella in Arizona Waters

**Tap Water**

- Central AZ water meter biofilms
  - 72 meters sampled from two municipalities
  - 0% and 26% PCR positive for *Legionella*, 16% for Lp

- Two large buildings periodically sampled
  - Common contamination up to 100 CFU/mL *Legionella*

- Apartment Water heater
  - 42 °C, Extremely high microbial load
  - 3x10⁴ CFU/mL, present after flushing and superheating

**Recycled Water**

- West Valley water reclamation facility pond culture positive for *Legionella*

- East valley reclaimed ground water recharge basin
  - TP secondary and tertiary effluent
  - Both culture negative and PCR positive
  - PCR signal substantially stronger for secondary

- *Legionella* detected by PCR in 3/3 plants
Total coliforms in Central Arizona source waters - 2014 -2015
Total coliforms in Central Arizona source waters - 2016
E. coli in Central Arizona source waters- 2014-2015

Monthly E. coli Data

**# of colonies per 100 mL**

- **Jun-14**
- **Jul-14**
- **Aug-14**
- **Sep-14**
- **Oct-14**
- **Nov-14**
- **Dec-14**
- **Jan-15**
- **Feb-15**
- **Mar-15**
- **Apr-15**
- **May-15**
- **Jun-15**
- **Jul-15**
- **Aug-15**
- **Sep-15**

**Cap Canal Average**
**Verde River Average**
**Arizona Canal Average**
**Tempe Canal Average**
**South Canal Average**
**Consolidated Canal Average**
E. coli in Central Arizona source waters-2016
Mycobacterium in central Arizona source waters 2014-2015
Mycobacterium in central Arizona source waters – 2016
Comparison of coliforms, *E. coli* *Mycobacterium* & *Legionella* in central Arizona source waters – 2016
Summary

• A 3-year database of microbial occurrence in the source waters developed. Some key finding are:
  • Total coliforms occurrence in 2016 has followed trend observed in 2014-2015
    • Higher concentration during summer months
    • 100% samples/sampling sites tested positive
  • The concentration of *E. coli* and coliforms has fluctuated from month to month; however, for each month all sampling sites showed similar trend in the occurrence of indicators
  • Although a crude similarity in occurrence can be noted; however, *E. coli* or coliform concentrations are not good predictor of *Mycobacterium* and *Legionella* in surface water
  • Water treatment process can remove 2 to 4 log of Mycobacteria
  • Mycobacteria concentration in surface water is generally between 1 to 2log with few incidents of higher than 3log
  • Monitoring of *Mycobacteria* and *Legionella* in source water provides valuable information to water utilities